

EXAMINING THE RELATIONSHIP  
BETWEEN MANAGERS' COMMITMENT TO  
SAFETY, LEADERSHIP STYLE, AND THEIR  
ROLE IN SAFETY IMPORTANT ACTIONS IN  
SAFETY CRITICAL ORGANISATIONS

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ORGANISATIONS  
**Doctoral Dissertation**

PROUČEVANJE RAZMERIJ MED PREDANOSTJO  
MANAGERJEV VARNOSTI, SLOGOM VODENJA IN  
NJIHOVO VLOGO PRI VARNOSTNIH UKREPIH V  
VARNOSTNO POMEMBNIH ORGANIZACIJAH  
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# Abstract

Managers' commitment to safety has been recognised as a focal concept that can play an important role as organisations strive to improve safety performance and prevent major accidents (Flin, 2003; Flin & Yule, 2004). When management is committed to safety, this shows employees that safety is an important value to the organisation (Laurent et al., 2018; Ye et al., 2020). Flin (2003) suggests that in addition to managers' behaviours that demonstrate their commitment to safety, managers' leadership styles should also be considered. However, the main question that remains to be researched is how managers can most effectively convey their commitment to safety to employees and through what mechanisms.

In the first part of the dissertation, we conducted a bibliometric analysis to better understand the research on safety commitment and leadership. The analysis revealed that the majority of publications were published after 2010, drawing a clear distinction between the two periods. The results showed that safety culture and climate, and leadership behaviours represented the main topics in both periods. We identified the main influx of knowledge from three major disciplines (i.e., safety science, management and organisation, and psychology), indicating the interdisciplinary nature of this topic. Based on the analysis, we were also able to discuss the direction in which research on this topic might develop.

To gain a deeper understanding of safety commitment and leadership, we conducted a systematic review, presented in the second part. The study enabled us to identify the theoretical foundations on which research on safety commitment and leadership is based and how the aforementioned concepts have been addressed in the literature. Moreover, we identified the main characteristic of the concept of safety commitment, the most frequently addressed antecedents (e.g., leadership), consequences (e.g., safety behaviour), and main issues and challenges that should be addressed in the future (e.g., levels of analysis).

In the third part, we conducted an exploratory qualitative study to examine how COVID-19 and its associated mitigation measures affected the process safety management in safety-critical organisations. The results of the study provided in-depth insight into how organisations adapted to the changed circumstances and what measures they implemented to maintain their operational activities. Further, we identified the main challenges organisations faced during the COVID-19 pandemic and the most important factors that enabled them to endure during these times of crisis. The study also revealed that managers played an important role during the COVID-19 pandemic.

To examine the relationship between managers' commitment to safety and employees' perceptions of managers' commitment to safety and the potential mediating effect of leadership style, we also conducted an explanatory quantitative study described in the fourth part of the dissertation. The study confirmed a positive and significant relationship between managers' commitment to safety and employees' perceptions of managers' commitment to safety. Furthermore, we found a statistically significant difference between managers' and employees' perceptions. The results of the mediation analysis also confirmed that leadership style mediates the relationship between managers' commitment to safety and employees' perceptions of managers' commitment.



# Povzetek

Predanost managerjev varnosti je bila prepoznana kot osrednji koncept, ki igra pomembno vlogo, ko si organizacije prizadevajo izboljšati varnost in preprečiti večje nesreče (Flin, 2003; Flin & Yule, 2004). Če je management predan varnosti, s tem zaposlenim sporoča, da je varnost pomembna vrednota za organizacijo (Laurent et al., 2018; Ye et al., 2020). Flin (2003) ugotavlja, da je treba poleg vedenja, ki odraža predanost managerjev, upoštevati tudi njihov slog vodenja. Vendar pa so empirične raziskave o tem, kako in prek katerih mehanizmov managerji najučinkoviteje prenesejo svojo predanost varnosti na zaposlene, še vedno zelo omejene.

Da bi bolje razumeli raziskave, ki obravnavajo predanost varnosti in vodenje, smo izvedli bibliometrično analizo, ki jo predstavimo v prvem delu doktorske naloge. Z analizo smo ugotovili, da je bila večina publikacij objavljena po letu 2010, kar jasno nakazuje razliko med dvema obdobjema. Rezultati so pokazali, da so varnostna kultura in klima ter vodstveno vedenje predstavljali glavne tematike v obeh časovnih obdobjih. Prepoznali smo tri discipline (tj. znanost o varnosti, management in organizacijo ter psihologijo), ki predstavljajo ključni pritok znanja, kar nakazuje na interdisciplinarnost tematike.

Da bi pridobili poglobljeno razumevanje tematike predanosti varnosti in vodenja, smo naredili tudi sistematični pregled literature, ki je predstavljen v drugem delu. S pomočjo sistematičnega pregleda literature smo identificirali različne teoretične podlage, na katerih temeljijo raziskave s področja predanosti varnosti in vodenja, ter pridobili vpogled v to, kako sta bila omenjena koncepta obravnavana v literaturi. Ob tem smo identificirali tudi glavne značilnosti koncepta predanosti varnosti, najpogosteje obravnavane predhodnike (npr. vodenje), posledice (npr. varnostno vedenje), glavna vprašanja in izzive, ki bi jih bilo treba nasloviti v prihodnje (npr. nivo analize).

V tretjem delu je predstavljena eksplorativna kvalitativna študija, s pomočjo katere smo želeli proučiti, kako so pandemija COVID-19 in z njo povezani ukrepi vplivali na management procesne varnosti v varnostno pomembnih organizacijah. Omenjena študija nam je omogočila poglobljen vpogled v to, kako so se organizacije prilagodile na spremenjene okoliščine in katere ukrepe so implementirale za ohranitev operativnih aktivnosti. S pomočjo kvalitativne študije smo identificirali tudi glavne izzive, s katerimi so se organizacije soočale med pandemijo COVID-19, in najpomembnejše dejavnike, ki so organizacijam omogočili, da so ohranjale poslovanje v teh kriznih časih. Študija je hkrati razkrila, da so imeli managerji pomembno vlogo pri soočanju s pandemijo COVID-19.

Da bi raziskali povezavo med predanostjo managerjev varnosti in percepcijo zaposlenih o predanosti managerjev varnosti ter morebitni mediacijski učinek sloga vodenja, smo izvedli tudi eksplikativno kvantitativno študijo, ki je predstavljena v četrtem delu doktorske naloge. Študija je potrdila pozitivno, statistično značilno povezavo med predanostjo managerjev varnosti in percepcijo zaposlenih o predanosti managerjev varnosti. Hkrati smo na podlagi rezultatov študije ugotovili, da obstaja statistično značilna razlika med percepcijo managerjev in zaposlenih glede predanosti managerjev varnosti. Rezultati mediacijske analize so pokazali, da slog vodenja mediira odnos med predanostjo managerjev varnosti in percepcijo zaposlenih o predanosti managerjev varnosti.



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# Abbreviations

COVID-19 . . . Corona Virus Disease 2019 caused by SARS-CoV-2  
SARS-CoV-2 . . . Severe Acute Respiratory Syndrome Coronavirus-2



# Chapter 1

## Introduction

### 1.1 Description of the Dissertation Topic and the Issues It Addresses

Major industrial accidents that took place in the '70s and '80s in Flixborough (Venart, 2007), Seveso (Fabiano et al., 2017), and Bhopal (Bowonder & Miyake, 1988) have highlighted the importance of process safety management. These accidents had serious consequences that were not limited to the organisation where they occurred but also had significant impacts on other stakeholders and the environment. Severe health consequences for the surrounding population, adverse effects on the environment and damage to other organisations in the vicinity of the accident site are just some of the most obvious examples. These accidents raise the question of how process safety can be improved to prevent such events in the future. In the centre of the process safety is the goal to prevent unwanted release of dangerous substances, fire, explosion or structural damage (Nwankwo et al., 2020). To prevent major accidents, management adopts safety policies, implements a safety management system, establishes important safety rules, and formulates safe work procedures in relation to relevant laws and industrial guidelines (Center for Chemical Process Safety, 2007; The Control of Major-Accident Hazards Involving Dangerous Substances, Directive 2012/18). However, Broadribb (2018) noted that despite considerable efforts, organisations sometimes fail to achieve the required process safety performance. The recent accidents that occurred in Visakhapatnam (Gill, 2020) and Beirut (Abouzeid et al., 2020) clearly demonstrate that major accidents are still a serious threat in safety-critical organisations. In addition, two other accidents in Leverkusen (Reuters, 2021) and Northern Illinois (Li, 2021) have shown that major accidents cannot occur only in developing countries, as we may mistakenly assume. The notion that major accidents still pose a threat is further supported by the Major Accident Reporting System (European Commission, 2021). The database collects reports on near misses, major accidents, and other safety-related events that have occurred in the Member States of the European Union or other associated countries. The data show that around 30 to 35 major accidents still occur each year. These events highlight not only the importance of understanding why, how, and under what circumstances such major accidents occur but also how such major accidents can be prevented in the future.

Several researchers indicate that the number of major accidents is plateauing. This stagnant trend suggests that existing process safety practices should be improved to further reduce the number of adverse events (Behie et al., 2020; Maniar et al., 2020; Nwankwo et al., 2020). Knegtering and Pasman (2009) point out that there is a need for a different approach to process safety since much has changed in this field over the last three decades. Whereas in the early days of process safety, major accidents were usually due to an

unexpected risk, today, the cause of accidents is more likely related to management and various organisational and human factors (Knegtering & Pasma, 2009). To achieve the desired effect, the safety policies, systems, rules, and procedures adopted to ensure process safety must be properly integrated into the existing organisational structure and incorporated into the daily work tasks of employees. At the same time, they must be endorsed by all employees and then followed consistently. Employee compliance with standards, practices, and procedures can be facilitated by management that enforces and monitors their implementation; however, this requires that continuous monitoring is possible and that the use of monitoring is appropriate in all situations (Bieder & Bourrier, 2013). Moreover, mere compliance with safety standards is not always sufficient, as safety standards cannot cover all potential situations that may arise in different organisations. Therefore, there is a need to examine the mechanism that can help to improve process safety beyond safety compliance. Barling and Hutchinson (2000) argue that in order to enhance safety performance, organisations should focus on developing a concept of safety commitment rather than just focusing on compliance. Compliance with safety standards provides only a basic level of safety and can therefore be seen as necessary, albeit insufficient, to achieve a high level of safety performance. Focusing on safety commitment could give the organisation a much-needed edge and push employees to go even beyond basic safety standards. This can help organisations achieve better safety performance and lead to desired safety outcomes that could shift down a stagnant trend of major accidents. As Halim and Mannan (2018) point out, the path to process safety excellence starts with the safety commitment.

Preventing major accidents requires the commitment of all employees, as safety can only be achieved through a collective effort by the entire organisation (Gerde, 2015). However, some researchers suggest that the commitment of high-level managers might be particularly important, as they can play a decisive role in achieving higher process safety performance (Roger et al., 2009). Because of their position in the organisation, high-level managers can make various decisions and take various actions that can have an important impact on safety (Fruhen et al., 2019). High-level managers can influence numerous aspects of work or working environment that cannot be influenced by managers at other organisational levels or other employees. Without the committed support of high-level managers, all endeavours of employees will not yield the desired process safety results (Gravina et al., 2017). Through their behaviour, managers also show employees what kind of safety behaviours are acceptable and promoted in the organisation (Laurent et al., 2018; Ye et al., 2020). By promoting employee commitment, managers can influence their attitudes and behaviours related to process safety (Bieder & Bourrier, 2013). However, Taylor and Snyder (2017) emphasise that further research is needed to deepen our understanding of the mechanisms through which managers actually influence employee safety behaviours.

In the safety climate and culture literature, management commitment to safety has been recognised as a focal concept that can play an important and multifaceted role when organisations strive to improve safety performance (Flin, 2003; Flin & Yule, 2004). For example, various recent studies show that the safety commitment of managers can have a positive influence on employees' safety behaviours as it can influence both safety compliance and safety participation (Lim et al., 2018; Schwatka & Rosecrance, 2016). Among other things, managers' safety commitment can also influence the unsafe behaviours of employees, such as different types of rule violations (Liang & Zhang, 2019) or risk-taking behaviours (Bosak et al., 2013), and even positively affect employees' non-safety behaviours (Clark et al., 2014). The important role of managers' commitment to safety has also been recognised when it comes to safety management systems (Levovnik et al., 2019b; Nwankwo et al., 2020; Stackhouse & Turner, 2019) and various safety programmes and initiatives

(Igić et al., 2020). Gao et al. (2019) showed that managers' commitment to safety could significantly influence various safety practices that are essential for ensuring process safety in the organisation.

## 1.2 Research Questions

The aforementioned studies show that safety commitment is an important concept in the field of safety science. This is also reflected in the increased number of publications. Based on the data from the Web of Science database (Clarivate, 2021b), 46 % of all papers that address the concept of safety commitment have been published in the last 5 years. However, most studies address commitment to safety from the employee's perspective and focus on how employees perceive managers' commitment to safety (e.g., Beus et al., 2019; Bosak et al., 2013; Clark et al., 2014; Pronovost et al., 2003; Schwatka & Rosecrance, 2016; Taylor & Snyder, 2017; Wu et al., 2008), leaving the managerial side of this relationship under-researched (Fruhen et al., 2014; Fruhen & Flin, 2016). This can be attributed to the theoretical foundation of most studies, which build on the safety climate and culture literature, in which employees' "shared perceptions" are central to the safety climate (Griffin & Curcuruto, 2016). Although some recent studies have begun to focus directly on managers' commitment to safety and their perceptions (Fruhen et al., 2019; Tappura, Nenonen, et al., 2017; Tong et al., 2015), such studies are still scarce. Addressing managers' commitment to safety from their perspective can add new insights to the existing body of knowledge on safety commitment. However, studies that would examine both sides of the relationship between managers' safety commitment and employees' perceptions of managers' safety commitment would extend the current understanding of this topic even further. Such a holistic approach would add new insights to the existing body of knowledge on managers' safety commitment and shed light on managers as key protagonists that were otherwise usually overlooked. It would also deepen the knowledge of how managers experience safety commitment, which later reflects in their safety-related decisions and behaviours (Fruhen et al., 2019). Scholars would benefit from a better understanding of the aforementioned relationship and how managers convey their safety commitment to employees. This can have an important role in shaping employees' perceptions of managers' safety commitment that is known to be an essential factor in the prevention of major industrial accidents (Cui et al., 2013; Taylor & Snyder, 2017). Gaining a better understanding of this can also enable more efficient development and promotion of safety commitment among employees in safety-critical organisations. Therefore, we aim to contribute to the literature by theoretically and empirically exploring both sides of the relationship between managers' safety commitment and employees' perceptions of managers' safety commitment and by examining the mechanism by which managers can convey their commitment to employees.

## 1.3 Managing Process Safety During the COVID-19 Pandemic

A global Corona Virus Disease 2019 (hereafter COVID-19) pandemic caused by Severe Acute Respiratory Syndrome Coronavirus-2 (hereafter SARS-CoV-2) was not a completely unforeseeable event. Researchers warned of society's inadequate preparation and vulnerability to the next pandemic, arguing that the consequences of such an event could be global (Fauci, 2006; Morse et al., 2012). Every pandemic is both a scientific and a political challenge that requires well-coordinated actions between various institutions

across different countries (McCloskey et al., 2014). Pike et al. (2014) argue for global prevention policies and mitigation strategies that would be more cost-effective than the potential financial consequences of maintaining business as usual. Nonetheless, SARS-CoV-2 spread rapidly. The COVID-19 outbreak, which resulted in a crisis that caught everyone relatively unprepared (Bryce et al., 2020), posed several challenges to process safety management.

Starting as a public health issue, COVID-19 severely affected the global economy and may even lead to long-term shifts in existing paradigms (Howe et al., 2020). COVID-19 pandemic has changed established business practices and affected all organisations to some extent, regardless of the organisation's business activities or the economic sector to which the particular organisation belongs (Nicola et al., 2020; Seetharaman, 2020). Therefore, safety-critical organisations were also affected by the COVID-19 pandemic. These organisations have to manage various hazards that, if not handled appropriately, could lead to a major accident that would negatively affect the employees, the public, or the environment. One of the most important characteristics is that safety-critical organisations are expected to maintain their operational functions despite various risks that could manifest (Reiman & Oedewald, 2009). Safety-critical organisations (e.g., gas and oil industry, chemical industry, maritime industry, railways, aviation, and other high-risk industries) have a high potential for a major accident (Hystad et al., 2014). Therefore, it is critical that safety-critical organisations, described in more detail in Chapter 4.2.2, can withstand the added stress of such circumstances.

The global COVID-19 pandemic either directly or indirectly affected various business functions in organisations, as it challenged the established ways in which organisations manage their activities (Alam, 2020). The pandemic and the associated health risks pose an additional challenge to the process safety management, as this health crisis has increased the pressure on the organisation and its management. COVID-19 may hinder the organisations' ability to maintain control over their hazardous operations and lead to a series of events that could result in a major accident. In addition, the preventive measures taken to contain the spread of the COVID-19 pandemic also influenced the management of process safety. During the health crisis, governments and organisations around the world employed various restrictions and measures to contain the spread of COVID-19 (Anderson et al., 2020; Bruinen de Bruin et al., 2020; Haigh & Gandhi, 2021). These restrictions and measures affected various day-to-day business functions of the organisations and placed an additional strain on the organisations. Based on the arguments presented, we propose the following exploratory research question – *RQ1: “How did COVID-19 and the related mitigation measures affect the process safety management in safety-critical organisations?”* Therefore, the important contribution of this dissertation is the investigation of the consequences that COVID-19 and associated mitigation measures may have on process safety management.

## **1.4 The Relationship Between Managers' Safety Commitment, Leadership Style, and Employees' Perceptions of Safety Commitment**

The way employees perceive their managers' safety commitment plays an important role. If management is committed to safety, this shows employees that safety is important for the organisation. By observing managers' safety commitment, employees develop a clearer understanding of what activities and responsibilities are expected of them. In addition, managers who are committed to safety may also set a safety example for employees

(Laurent et al., 2018; Ye et al., 2020). This is especially important in a time of crisis, as COVID-19 certainly is. When employees perceive that safety takes precedence over other goals (e.g., productivity), they are more likely to follow safety procedures and even actively participate in safety programmes (Bowers & Fleming, 2018). However, the main question that has yet to be adequately researched is how managers can most effectively convey their commitment to safety to employees and through what mechanisms.

Existing studies show that managers can send safety signals through their behaviour and decisions, which in turn can influence employees' perceptions of managers' safety commitment. Demonstrating safety commitment is clearly important as it signals to employees that managers place a high priority on safety (Bowers & Fleming, 2018; Fruhen et al., 2019). Flin (2003) suggests that in addition to managers' behaviours that demonstrate their commitment to safety, managers' leadership styles should also be considered. The specific role of managers and their leadership has been highlighted as particularly important by a number of researchers (e.g., Biggs et al., 2013; Flin & Yule, 2004).

Therefore, we propose that managers can convey their commitment to safety to employees through their leadership. Flin and Yule (2004) relate transformational, transactional, and laissez-faire leadership to the various safety roles that managers can have at different organisational levels. The important role of different leadership styles has also been recognised by other researchers (e.g., Du & Sun, 2012; Ye et al., 2020). Delegach et al. (2017), for example, suggested that different leadership styles can further promote the development of safety commitment in employees. Recently, researchers presented a conceptual model proposing that leadership styles play an important role in helping managers convey their safety commitment to employees through various safety-related decisions and actions (Levovnik & Gerbec, 2020). Demonstration of managers' commitment shape employees' perceptions of managers' commitment to safety and consequently influence employees' commitment to safety. Thus, the first part of our second research question reads – *RQ2a: “What is the relationship between managers’ safety commitment, leadership style, and employees’ perceived safety commitment?”* The main thesis of this dissertation is that managers can demonstrate their commitment to safety to employees through their leadership, which, in turn, influences employees' perceptions of managers' safety commitment. By empirically examining the proposed relationship, we contribute to the literature on safety commitment and leadership.

Further, we propose that there may be a difference between managers' perceptions of their safety commitment and employees' perception of managers' safety commitment. Namely, existing research suggests that the perceptions of high-level managers' commitment to safety may vary by the unit of observation (Biggs et al., 2013; Bowers & Fleming, 2018; Fruhen et al., 2019). Determining the degree of alignment between employees' and managers' perceptions may contribute to further understanding of this topic. Hence, the second part of our second research question reads – *RQ2b: “Is there a difference between managers’ safety commitment and perceived safety commitment of managers among employees?”* By examining the difference between managers' perceptions of safety commitment and employees' perceptions of managers' safety commitment, we further contribute to the safety commitment literature.

## 1.5 Structure of the Dissertation

The dissertation consists of five chapters following the initial, introductory chapter. The second chapter includes the bibliometric analysis conducted to position the research on safety commitment and leadership within the broader research area. The next chapter

presents the systematic review of the literature. We employ a systematic approach to provide an unbiased and comprehensive synthesis of the literature on safety commitment and leadership. The results of the bibliometric analysis and systematic review of the literature form the foundation for our further chapters. In the fourth chapter, we conduct a qualitative study to explore how safety-critical organisations were dealing with the COVID-19 pandemic and to gain insight into how the measures taken to contain the spread of COVID-19 influence the process safety management in the organisation (RQ1). The results of the qualitative study were used in chapter five to position our quantitative study in the context of COVID-19. In this chapter, we address the relationship between managers' safety commitment, their leadership style, and the perceived safety commitment of managers among employees (RQ2a and RQ2b). In the final sixth chapter of the dissertation, we discuss the main findings of the dissertation, its contribution, limitations, and potential avenues for future research on this topic.

## Chapter 2

# Bibliometric Analysis of Safety Commitment and Leadership

### 2.1 Introduction

The importance of management commitment to safety in relation to safety culture or safety climate is well established in the safety literature (Flin, 2003; O’Dea & Flin, 2001). However, while a large part of the safety commitment studies focus on how employees perceive managers’ commitment to safety, fewer studies focus on the managerial side of this relationship. In recent years, some studies have emerged that directly address managers’ tasks that support a manifestation of commitment (Tappura, Teperi, et al., 2017), how managers’ commitment to safety manifests (Fruhen et al., 2014), how managers experience their commitment to safety (Fruhen et al., 2019), or what factors may influence managers’ commitment to safety (Tappura, Nenonen, et al., 2017).

Although this clearly indicates a positive trend, managers’ safety commitment and leadership remain under-researched and fragmented. In order to provide an objective overview of the state of research on this topic, we decided to employ a bibliometric approach.

The bibliometric analysis represents a **rigorous approach to data analysis** that facilitates the analysis of an extensive amount of literature in various scientific fields (Donthu et al., 2021; Haddow, 2018). As Donthu et al. (2021) point out, bibliometric analysis allows researchers to explore the evolution of a specific research field and identify emerging research topics in that field. It enables researchers to identify the emerging trend in a particular scientific field, uncover the collaborative networks, and capture the intellectual structure of the particular research topic in the literature. If performed properly, bibliometric analysis can provide the basis for further development of the research area as it (Donthu et al., 2021):

- provides a better overview of the research;
- recognises possible gaps in knowledge;
- generates new ideas for future research;
- enables the positioning of research contributions in the scientific field.

Therefore, such a research approach is also suitable for researching the interdisciplinary topic of safety commitment and leadership.

Bibliometric research uses a **quantitative research approach** to examine the trends, patterns, and networks emerging from the analysed literature. According to Haddow (2018), conducting bibliometric research requires a specific blend of skills and knowledge from the researchers that are undertaking this type of study. There are various types of bibliometric methods that focus on different indicators such as citations, authorship, publication, or content of the analysed literature (Haddow, 2018). Donthu et al. (2021) argue that bibliometric analysis can be conducted instead of or in addition to other types of reviews such as systematic reviews and meta-analyses, depending on how researchers use these analyses.

Although the results of bibliometric research provide a more robust and objective measure of the particular research field, Haddow (2018) points out that all **bibliometric studies** are based on certain **assumptions**. For example, it is assumed that there is a relationship between citing and cited units, that publications are cited based on their relevance, or that all citations are “created equally”. Wallin (2005) points out that the assumed relationship between the number of citations and the quality of publications, for example, is the basis for citation analysis as it provides a brief assessment of research quality. In reality, however, different citation patterns can be observed, varying according to the type of research, publications or research disciplines (Wallin, 2005).

Notwithstanding some potential limitations of bibliometric analysis, the advantages of this research approach have been recognised in various scientific fields. For example, bibliometric analysis has been recognised as an important type of research in the field of management and organisation, where it has been used by various researchers to address different research topics such as individual creativity (Bogilović & Černe, 2018), business models (Budler et al., 2021), or leadership (Vogel et al., 2020).

In recent years, bibliometric methods have also become increasingly popular among scholars in safety science (Li et al., 2021). In their work, the authors outline research that has been conducted on safety leadership (Tao et al., 2020), safety culture (van Nunen et al., 2018), safety climate (Bamel et al., 2020), and process safety and risk (Amin et al., 2019). However, to the best of our knowledge, no study has been published on managers’ safety commitment and leadership.

Through the bibliometric analysis, **we aim to establish:**

- the knowledge structure of managers’ commitment to safety and leadership, and to position the research within broader research area;
- to identify how this research topic has evolved over time;
- to identify possible directions in which this research field might develop in the future.

## 2.2 Process of the Bibliometric Analysis

Donthu et al. (2021) **distinguish between two basic steps** in bibliometric analysis: **performance analysis** and **science mapping**. Performance analysis is the central feature of any bibliometric research. It is used to examine the performance of authors, countries, institutions, or journals in the research field of interest. The most commonly used measure of performance is the number of publications (productivity) and citations (impact). Science mapping, on the other hand, explores the relationships between authors, countries, institutions, or journals. Science mapping refers to the interactions and connections between the aforementioned units and forms the basis for the bibliometric and intellectual structure of the particular topic or research field (Donthu et al., 2021).

To gain a better understanding of this niche research field, we conducted a bibliometric study combining several types of bibliometric analysis. In conducting the bibliometric analysis, we followed the five-step science mapping process recommended by Zupić and Čater (2015). The first step involves determining the research question that the researchers aim to answer. It is also important to select the right bibliographic methods that correspond to the proposed research question. Different methods are appropriate for different questions. The next step is to select the appropriate data source from which the bibliographic information will be obtained. In this stage, the bibliographic data of the selected core literature is filtered, exported from the data source and cleaned. In the third step, the bibliometric data are analysed using bibliometric software. In the fourth step, the results are visualised using the appropriate visualisation method. The fifth step is perhaps the most subjective part of bibliometric analysis. It requires the researcher to describe and interpret the results obtained during the analysis (Zupić & Čater, 2015). The main steps of the research process are summarised in Figure 1. The aforementioned steps are presented in more detail in the next chapters.

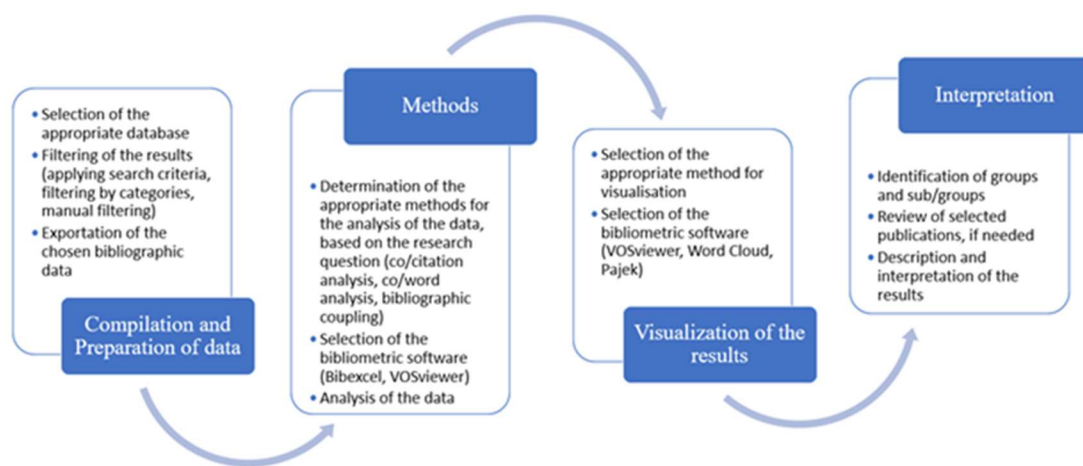


Figure 1: Steps in the research process. Adapted from “Bibliometric Methods in Management and Organization,” by I. Zupić and T. Čater, 2015, *Organizational Research Methods*, 18(3), p. 429–472.

## 2.3 Data and Methods

### 2.3.1 Data collection and refinement

The data for our research was collected from the Web of Science database (Clarivate, 2021b). This particular data source was used as it is the **most recognised** and **widely used database** for bibliometric research among scholars (Mongeon & Paul-Hus, 2016; van Nunen et al., 2018; Zupić & Čater, 2015). It contains a variety of bibliographic information about the relevant articles, including information about the title, authors, type, authors’ affiliations, number of citations, keywords, abstract, or references used. It also includes information about the journal in which the article was published, such as journal name, publisher, year, issue number, volume. Researchers can also use various search criteria to refine the results, including an option to search within results, publication year, Web of Science Categories, research areas, document type, type of access, or refine based on Web of Science Index criteria. In addition, the Web of Science database offers the possibility to

quickly analyse the results obtained, visualise them (bar chart, tree-map) and also generate citation reports.

Data were retrieved from the Web of Science Core Collection database on 2 February 2021 (the database was last updated on 1 February 2021). All publications from 1970 to 2020 were included in the data collection. We performed an advance search using field tag Topic; Boolean operators AND, OR; and truncation (\*). We used multiple search strings to determine the sample that would represent our core literature on the research topic of safety commitment and leadership. By introducing new keywords, modifying Boolean operators, creating nested sets, and using truncation, we broadened and narrowed our scope to obtain the most relevant results. About 20 different search strings were used, for example TS = (“safety” AND “commitment” AND “leade\*”), TS = ((“safety commitment” OR “commitment to safety”) AND (“leade\*” OR “manage\*")), and TS = (“safety” AND “commitment” AND (“leade\*” OR “manage\*")). Obtained results were analysed based on articles titles and used keywords to determine the appropriateness of the search string. Final search string that was used contained: “TS = ((“safety commitment” OR “commitment to safety”) AND “leade\*”)”. We would like to point out that our goal was to explore the development of a niche topic; therefore, a specific search string was used. The search **yielded 58 publications** dealing with the topic of safety commitment and leadership. The full record and cited references of the 58 documents were exported in both plain text and Excel format. All documents (full text) were also downloaded for further analysis.

All publications were manually reviewed based on the title, keywords, and abstract. To be included in the study, publications had to contain both the construct of commitment and the construct of leadership and address the research subject that falls within the domain of safety science. We followed the approach used by Reniers and Anthone (2012) for ranking journals in the field of safety science. Therefore, we also limit our focus only to the publications that explore safety in the sense of general and process safety, as these terms most accurately describe the research field of safety science and leave out topics such as food safety or financial security. Publications that addressed topics outside the scope of this study (e.g., food safety, financial security) or publications that were withdrawn by the journals were excluded from the group. At the end of the refinement process, five articles were excluded from the study, leaving **53 articles for further analysis**. Table 1 summarises the data collection and refinement process.

One of the criteria in the refinement process was also the **quality of publications**. Therefore, only those publications that underwent peer review met the criteria and were included in the final sample, which represents the core literature on this research topic.

Table 1: Data collection and refinement process.

Bibliographic database	Search field	Search string	Results	Filter	Final result
Web of Science Core Collection	TOPIC (title, abstract, author keywords, and Keywords Plus)	“safety commitment” OR “commitment to safety” AND “leade*”	58	Manual review	53

*Note.* The data are obtained from the “*Web of Science*,” by Clarivate, 2021 (<https://www.webofscience.com/wos/woscc/advanced-search>).

### 2.3.2 Methods

Based on the previously proposed research questions, we determined the **appropriate type of bibliometric analysis and software**. Bibliometric studies may include a wide range of various bibliographic methods. Researchers highlight **five main bibliometric methods** used by scholars (Donthu et al., 2021; Zupic & Čater, 2015). These are citation analysis, co-citation analysis, bibliographic coupling, co-author analysis, and co-word analysis. The first three use reference data to reveal influence and similarity among analysed units (document, author, and journal). They represent a dynamic measure; therefore, it is important when the data for the analysis are collected (Zupic & Čater, 2015). **Citation analysis** is the most basic type of analysis that uses the number of citations to determine the impact of publications in a particular research field. By looking at the important publications in a particular field, researchers can understand the dynamics of the research field (Donthu et al., 2021). **Co-citation analysis** is based on the number of times that two documents are cited together (Zupic & Čater, 2015). Co-citation analysis is based on the assumption that if publications are cited together, they also address a similar topic. If two publications are both cited by another paper, they are considered to be connected. This type of method can be used for the identification of thematic clusters that also reflect the intellectual structure of the field (Donthu et al., 2021). In contrast to co-citation analysis, the **bibliographic coupling** is based on the shared references between publications. It assumes that two publications that share common references deal with related content. It is appropriate for identifying niche or recent publications as clusters are created from the citing publications (Donthu et al., 2021). **Co-author analysis** builds on the co-authorship and shows the collaboration between units (Zupic & Čater, 2015). This type of analysis captures the scientific interactions between researchers in the analysed field. It reflects collaborations among authors. Such a network of collaboration is also called “invisible colleges” and can be represented across time periods (Donthu et al., 2021). **Co-word analysis** identifies connections among units (words) based on their co-occurrence in analysed documents (Zupic & Čater, 2015). Instead of publications, the co-word analysis focuses on words. In contrast to other aforementioned methods, the co-word analysis addresses the content of the publications. It is based on the premise that if words appear in several publications, these publications are thematically related. This type of analysis can either enrich the co-citation analysis and highlight the development in the past or be used together with the bibliographic coupling to forecast the development of the particular research field in the future (Donthu et al., 2021).

We decided to perform all three types of **co-citation analysis** (document, author, and journal), **bibliometric coupling** (document), and **co-word analysis** (words). According to Zupić and Čater (2015), the co-citation analysis is the most appropriate to identify the knowledge base of the particular research field under study and to determine the intellectual structure of the field. However, to identify recent research papers that embody the current “state of the art” in our research topic or research field, i.e., research front, the bibliographic coupling is the most appropriate method. Co-word analysis allows the creation of a semantic map and is best suited to identify the links between topics in a given scientific field and to describe the evolution. By applying the aforementioned bibliometric methods, **we aim to obtain the answers to the research questions** posed at the beginning of this analysis. Among several available software tools, we decide to use MS Excel (for basic analysis), VOSviewer, Bibexcel, Pajek, and a web-based word-cloud program.

## 2.4 Results and Discussion

### 2.4.1 Descriptive results

#### 2.4.1.1 Type of publication and research topics

In our analysis, we first focused on the different types of publications to obtain a general understanding of what type of articles constitute our core literature. Out of 53 publications included in the analysis, the predominant **type of publication** (50) represented articles. Out of those, 47 were general articles, 1 article was a review article, one was classified both as proceedings paper and article, and 1 was an “early access” article. The rest of the publications (3) were conference papers (proceedings). The conference papers were peer-reviewed by at least two reviewers from the relevant research field. Therefore, we considered that these papers met the quality criteria and included them in the analysis.

Web of Science also divided publications into **different scientific fields**. More than 60 % of the publications were categorised as engineering, 17 % as public and environmental occupational health, 16 % as operations research management science, 11 % as social sciences other topics, and also 11 % as transportation. The remaining categories followed with less than 10 %. The research fields with the corresponding number of documents are presented in Table 2.

Table 2: Research fields and number of documents.

Research area	Number of documents	% of 53 documents
Engineering	32	60.4
Public environmental occupational health	17	32.1
Operations research management science	16	30.2
Social sciences other topics	11	20.8
Transportation	11	20.8
Business economics	7	13.2
Health care sciences services	6	11.3
Psychology	4	7.5
Environmental sciences ecology	3	5.7
Nursing	3	5.7
General internal medicine	1	1.9
Science technology other topics	1	1.9

*Note.* The data are obtained from the “*Web of Science*,” by Clarivate, 2021 (<https://www.webofscience.com/wos/woscc/advanced-search>).

We have to point out that a publication may be classified in one or more research areas. Web of Science has assigned 112 research categories to 53 documents. As van Nunen et al. (2018) point out, a large number of research categories indicates that the documents **address different research topics** and at the same time reflects their **interdisciplinary nature**. Another aspect that illustrates the interdisciplinary aspect of these publications is the wide range of **various research areas**, ranging from engineering, business economics, psychology to environmental sciences ecology and even general internal medicine.

### 2.4.1.2 Journals publishing on the topic of safety commitment and leadership

The top five journals publishing on the topic of safety commitment and leadership are listed in Table 3 with their corresponding impact factors. However, impact factors should be interpreted with caution, as they vary greatly across research disciplines (Althouse et al., 2009). As we can see, most of the publications were published in the Safety Science journal. It covers more than 26 % of all publications. It is followed by the Journal of Safety Research with 15 % and the Accident Analysis & Prevention journal with 3.8 %. The International Journal of Environmental Research and Public Health, and the Journal of Nursing Management, also share the same percentage. The top 5 journals published more than 50 % of all papers, and 50 % of the remaining papers were published in 27 different journals. This indicates that half of the articles are fragmented across various journals. The complete list of all 32 journals is provided in Appendix A1.

Table 3: Top 5 journals and their impact factor.

Journals	Impact factor <sup>a</sup>	Number of documents	% of all journals
Safety Science	4.877	14	26.4
Journal of Safety Research	3.487	8	15.1
Accident Analysis & Prevention	4.993	2	3.8
International Journal of Environmental Research and Public Health	3.390	2	3.8
Journal of Nursing Management	3.325	2	3.8

*Note.* The data are obtained from the “*Web of Science*,” by Clarivate, 2021 (<https://www.webofscience.com/wos/woscc/advanced-search>).

<sup>a</sup> Impact factor was based on Journal Impact Factor Trend 2020 from the “*Journal Citation Reports*,” by Clarivate, 2021 (<https://jcr.clarivate.com/jcr/browse-journals>).

### 2.4.1.3 Countries and institutions

The publications that constitute our core literature were written by **various authors** from **different countries**. However, most of the publications are by authors from the United States of America. Their share is 26 %. They are followed by authors from China with 13 %, authors from the United Kingdom and Australia with 11 % each, and Taiwan with 6 %. Figure 2 depicts the number of publications per country. It should be noted that there are some authors that have several affiliations with different countries and that some publications have several authors. To avoid double-counting of countries and institutions, we considered only the first affiliation of the leading author for each publication.

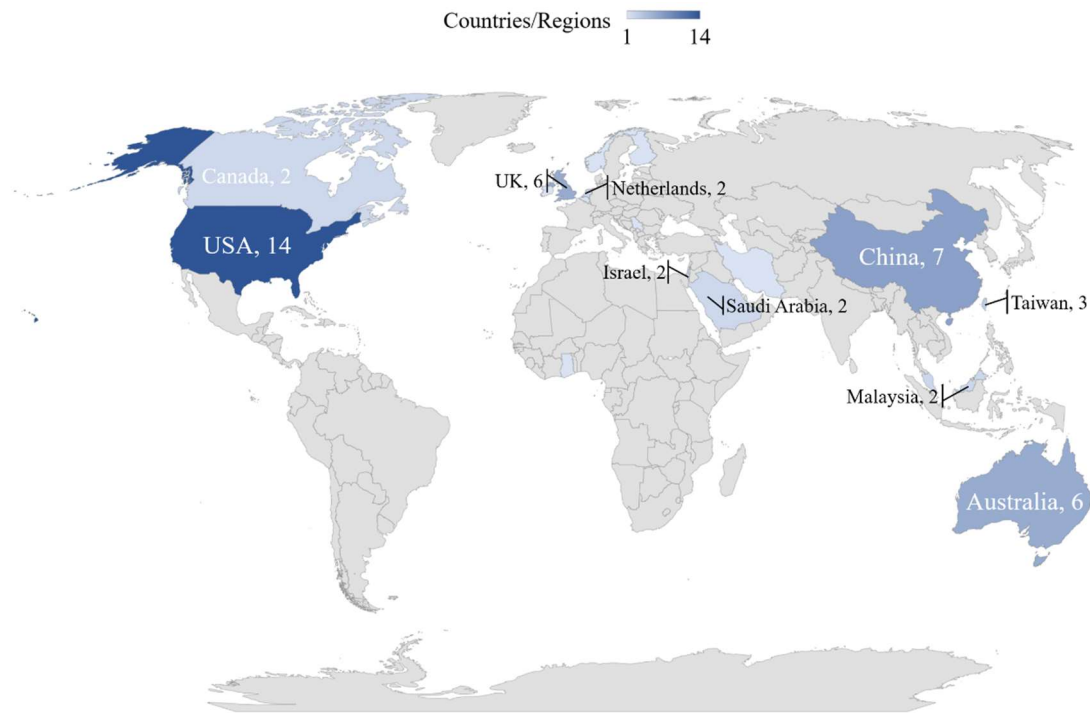


Figure 2: The number of publications distributed by country/region. The data for graphical representation are obtained from the “*Web of Science*,” by Clarivate, 2021 (<https://www.webofscience.com/wos/woscc/advanced-search>).

Among the **organisations with the most published papers** are four universities. Namely, the University of Aberdeen, UK, with 6 papers; the University of Colorado, USA, with 3 papers; Tsinghua University, China, with 2 papers; and Queensland University of Technology, Australia, also with 2 papers. This indicates that universities are a major source of publications and that other research institutions or industry contribute little. All countries with corresponding organisations are listed in Appendix A2.

#### 2.4.1.4 Publication trend

The analysis of the **distribution of the publications** revealed that publications gained momentum after 2010, when the number of publications began to rise. After 2015, there was a slight decrease in the number of publications, but this was followed by a significant increase in the period from 2015 to 2020. Figure 3 shows the distribution of publications from 1999 to 2020, which provides an initial insight into the evolution of the research topic of safety commitment and leadership over the last two decades.

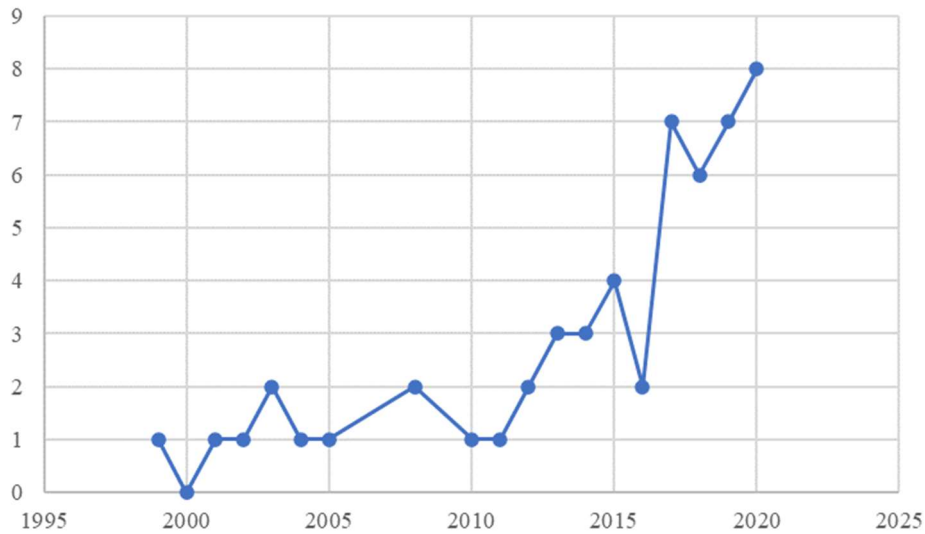


Figure 3: Number of publications per year. The data for graphical representation are obtained from the “*Web of Science*,” by Clarivate, 2021 (<https://www.webofscience.com/wos/woscc/advanced-search>).

Based on the initial findings, we **divide the publications into two separate time periods** to better understand the development of this research field. The first period includes publications published up to and including 2010, and the second period includes publications published after 2010, when an increase in the number of publications was observed. This allowed us to look at each period separately. First, we focused on the **first period**, when less than 20 % of publications were published. However, this period includes articles that represent the beginnings of research in this field and thus form the foundations. Then, we focused on the **second period** to better understand the evolution during the period that led to the development of this research area. During this period, more than 80 % of the publications were published.

#### 2.4.1.5 The most cited publications and most productive authors

If we look at the number of citations (for the combined periods), we can see that the number of **citations** has also **increased** (Figure 4). In the period from 1999 to 2020, a total of 1737 citations were recorded, of which 1669 did not include self-citations. Among the most cited publications, with 405 total citations (17.61 per year), was an article by Hofmann and Morgeson (1999), entitled: “Safety-related behaviour as a social exchange: The role of perceived organisational support and leader-member exchange”, published in the *Journal of Applied Psychology*. With 193 citations (9.65 per year), it is followed by an article from O’Toole (2002) entitled: “The relationship between employees’ perceptions of safety and organisational culture”, published in the *Journal of Safety Research*. The third most cited publication, with 185 citations (9.74 per year), is an article by Pronovost et al. (2003) entitled: “Evaluation of the safety culture: a survey of clinicians and managers in an academic medical centre”, published in the *BMJ Quality & Safety*.

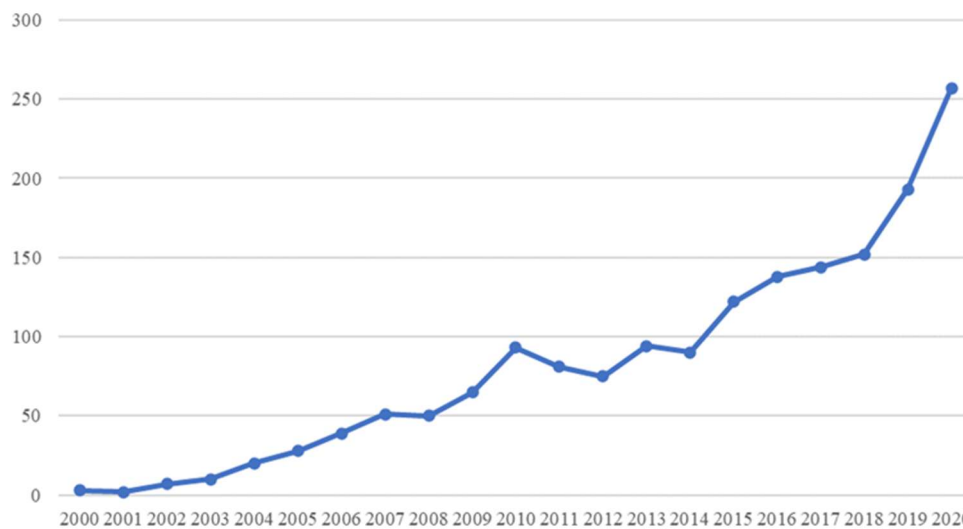


Figure 4: Number of total citations per year. The data for graphical representation are obtained from the “*Web of Science*,” by Clarivate, 2021 (<https://www.webofscience.com/wos/woscc/advanced-search>).

From the perspective of our two time periods predetermined earlier, the before-mentioned publications also represent the most cited articles in the **first period**, i.e., up to 2010. In the **second period**, after 2010, the most cited publication with 41 citations (4.56 per year) was the article from authors Bosak et al. (2013) entitled: “Safety climate dimensions as predictors for risk behaviour”, published in the *Accident Analysis & Prevention*. The second most cited article in this period is a paper from Biggs et al. (2013) entitled: “Safety leaders’ perceptions of safety culture in a large Australasian construction organisation”, published in the *Safety Science*. This paper was cited 36 times (4.0 per year). Next in line is the article with 31 citations (4.43 per year) from Wu et al. (2015) entitled: “Roles of owners’ leadership in construction safety: The case of high-speed railway construction projects in China”, published in the “*International Journal of Project Management*”. We can see that the most cited publications in the second period have considerably fewer citations than publications in the first period. To some extent, this can be expected as time is an important factor that can impact the number of citations. However, time is not the only factor affecting the number of citations. In their review article, Tahamtan et al. (2016) identified 28 factors that can play an important role in the number of citations of a particular publication. These factors include not only the quality of the publication, the importance of the subject, or the impact factor of the journal, but also factors such as the accessibility of the publication, the specificity of the particular research discipline, or even the reputation of the author, to name a few.

To complement the picture of the most cited publications, we also gathered the **most productive authors** of a particular period. The most productive author in the **first period** is Flin, with three publications. She is followed by Hofmann, Morgeson, O’Toole, and Pronovost, all with one publication. The top 5 authors are presented in Table 4, together with the corresponding number of citations.

Table 4: Top 5 most productive authors in the 1999 – 2010 period.

<b>Author</b>	<b>Publications</b>	<b>Citations</b>
Flin	3	327
Hofmann	1	405
Morgeson	1	405
O’Toole	1	193
Pronovost	1	185

*Note.* The data are obtained from the “*Web of Science*,” by Clarivate, 2021 (<https://www.webofscience.com/wos/woscc/advanced-search>).

In the **second period**, the most productive author is Fruhen, with four publications. Close by are Wu, Flin, and Schwatka, with three publications. Authors Fang, Li, Brown, Dally, Gao, and Turner published two publications. The top 10 authors, with the corresponding number of citations, are presented in Table 5.

Table 5: Top 10 most productive authors in the 2011 – 2020 period.

<b>Author</b>	<b>Publications</b>	<b>Citations</b>
Fruhen	4	37
Wu	3	41
Flin	3	33
Schwatka	3	31
Fang	2	40
Li	2	40
Brown	2	1
Dally	2	1
Gao	2	1
Turner	2	3

*Note.* The data are obtained from the “*Web of Science*,” by Clarivate, 2021 (<https://www.webofscience.com/wos/woscc/advanced-search>).

If we compare **both periods**, we can see that there are several authors with two or more publications in the second period. In the first period, there is only one such author. Also, authors such as Flin remained productive through both time periods. What is perhaps even more interesting is that authors with more publications do not always have the highest number of citations, as one might mistakenly assume. There are many factors that influence the number of citations, such as the visibility of the author or simply the amount of time that has passed since the work was published. As we can see from Table 4 and Table 5, the authors from the first time period have significantly more citations than the authors from the second period.

#### 2.4.1.6 Background setting of publications

During the analysis of both periods, we observed the **difference** in the **background settings** of publications. Articles in the **first period** are mostly positioned in the industrial setting, primarily in the manufacturing industry group. However, there are some articles

that address other sectors such as education or the health care sector, for example. Article “Leadership for safety: industrial experience” written by Flin and Yule (2004) attempts to apply the knowledge and lessons learned from the industrial to the medical setting.

In the **second period**, we can see that the background of the studies has changed considerably. Figure 5 represents the distribution of different industrial settings in which studies were placed in the first and second time period.

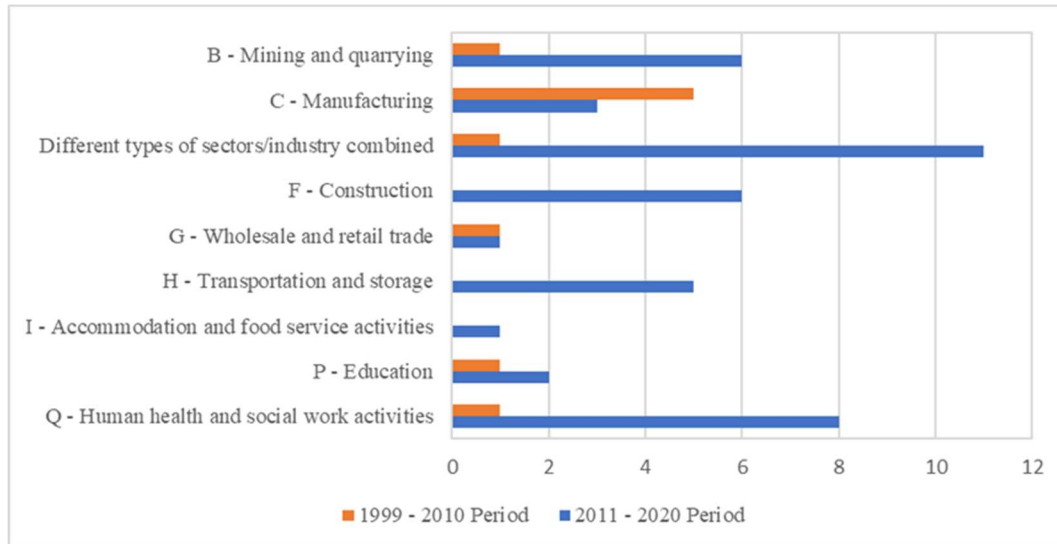


Figure 5: Comparison of different industrial settings in the first and second period. The data are obtained from the “*Web of Science*,” by Clarivate, 2021 (<https://www.webofscience.com/wos/woscc/advanced-search>). Classification is based on the “International standard industrial classification of all economic activities,” by United Nations. Statistical Division, (ISIC): Rev. 4, 2008, *Statistical papers*. Section B - Mining and Quarrying includes both B5 - Mining operations and B6 - Extraction of crude petroleum and natural gas.

**In contrast to the first period**, only a small proportion of all publications in **the second period** are positioned in industrial settings. Nearly one-quarter of articles are set in mixed settings, combining different sectors from energy, transportation, and public administration. To some extent, this can be explained with the call from researchers (e.g., Beus et al., 2019) for the cross-industrial measurement of safety climate. In addition, other authors from our core literature (e.g., Bosak et al., 2013; Hamid et al., 2015; Ye et al., 2020; Fruhen et al., 2014; Schwatka & Rosecrance, 2016) also argue that the research topic of safety commitment and leadership should be addressed in various industries to facilitate the generalizability of the findings across industrial settings. Consequently, the authors started to use diversified samples from organisations from different sectors.

Furthermore, to directly address the commitment of managers, studies must include a sufficient sample of participants to match the chosen unit of analysis. Due to this criterion, researchers sometimes gather the sample from several organisations to obtain a sample of a sufficient size. For example, to explore how managers’ safety commitment is manifested and how it can be measured, Fruhen et al. (2019) carried out two studies. The first qualitative study was conducted on a sample of managers from several organisations in different industries, including construction, mining, and petroleum. Similarly, the second quantitative study was conducted on a sample of managers from the aviation industry, mining, and petroleum.

Another important group in this second period is the health care sector, which has received a considerable number of articles. This also corresponds with the findings of other researchers that conduct bibliometric analysis on similar research fields, such as safety leadership and safety culture (e.g., Tao et al., 2020; van Nunen et al., 2018). Two sectors that emerged in this second period are mining and construction, followed by transportation. To some extent, these trends can also be seen in the structure of the journals in which these articles are published.

## 2.4.2 Results of bibliometric analysis

### 2.4.2.1 Co-citation analysis of documents

For the **co-citation analysis**, the data exported from the Web of Science database and cleaned by hand were then imported into VOSviewer software for further analysis (Eck & Waltman, 2021). In order to obtain the best possible visual information, different cut-off points for the references were tested. According to Zupić and Čater (2015), the decision of where to set a cut-off point is left to the researchers and depends on their judgment. Researchers set a cut-off point that provides the best interpretation of the results. By choosing the cut-off point, researchers determine how many times references must be used in the analysed publications to be included in the co-citation network (van Nunen et al., 2018).

Another important fact that we should take into account is the fact that **few articles** were published in the **first period**; this consequently results in the limited number of cited documents that could be analysed. Therefore, the cut threshold was adjusted accordingly. It was set at 3 cited references. It represents a minimum number of citations of a cited reference. Of the 415 cited references, 16 meet this threshold. The programme then calculates the total strength of co-citation connections (links) with other cited references. The cited references that have the highest total connection strength are selected. Before the network visualisation is created, the cited references must be verified and selected by researchers (Jan van Eck & Waltman, 2020). Figure 6 shows the visualisation created by the VOSviewer. There are 3 different clusters that can be distinguished: red, green, and blue. Each cluster consists of several nodes – circles. Each circle represents 1 article. The size of the circle corresponds to the number of citations of that specific article. The distance between them represents similarity. The closer the two circles are to each other, the more similarities there are between these two articles. Circles that belong to a particular cluster usually share some characteristics with the cluster (e.g., they cover the same topic) and have the same colour (van Nunen et al., 2018). However, the articles should be closely examined before we can determine their shared characteristics.

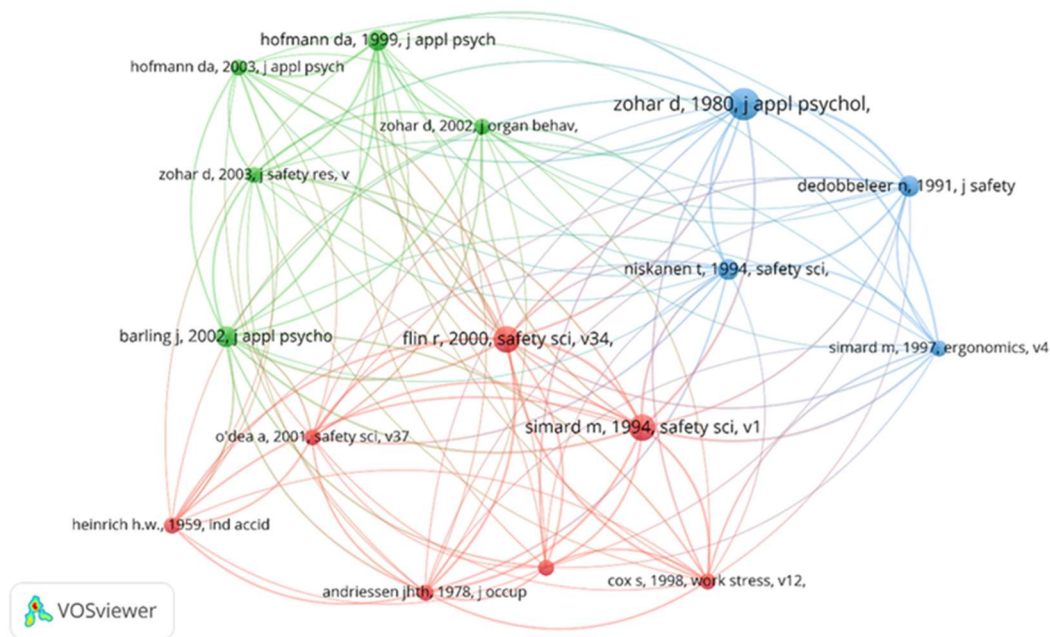


Figure 6: Co-citation analysis of the most cited document for the 1999 – 2010 period.

In the red cluster are articles by Flin (2000), Simard (1994), and Andriessen (1978). The articles in this cluster examined different scales for measuring safety climate; how can supervisors' behaviour, particularly their involvement in accident prevention, positively influence occupational safety; and explored the role of safety motivation in employee behaviour. The green cluster represents the work of Barling (2002), Hofmann (1999), and Zohar (2003). Here, the authors developed and tested a model linking transformational leadership and occupational injuries through perceived safety climate and relating leader-member exchange and perceived organisational support to safety commitment, communication, and accidents. Various approaches supervisors can use to promote the safety behaviour of employees were also explored. In the blue cluster are authors such as Zohar (1980), Dedobbeleer (1991), and Niskanen (1994). In their research, the authors focused on the theoretical and applied implications of safety climate, tested the safety climate model, and determined the most important factors of safety climate.

As we can see, the research topics are relatively closely related. The majority of articles addressed how safety climate, leadership behaviour, or both can influence safety performance and safety outcomes. This is to be expected since much of the literature on safety commitment and leadership is derived from these two constructs (Flin, 2003).

The **second period** we analysed includes a larger number of publications. Therefore, a higher cut-off threshold was chosen, setting the minimum number of citations of a cited reference at 5. Of the 1884 cited references, 44 meet this threshold. Figure 7 represents the network visualisation created by the program.

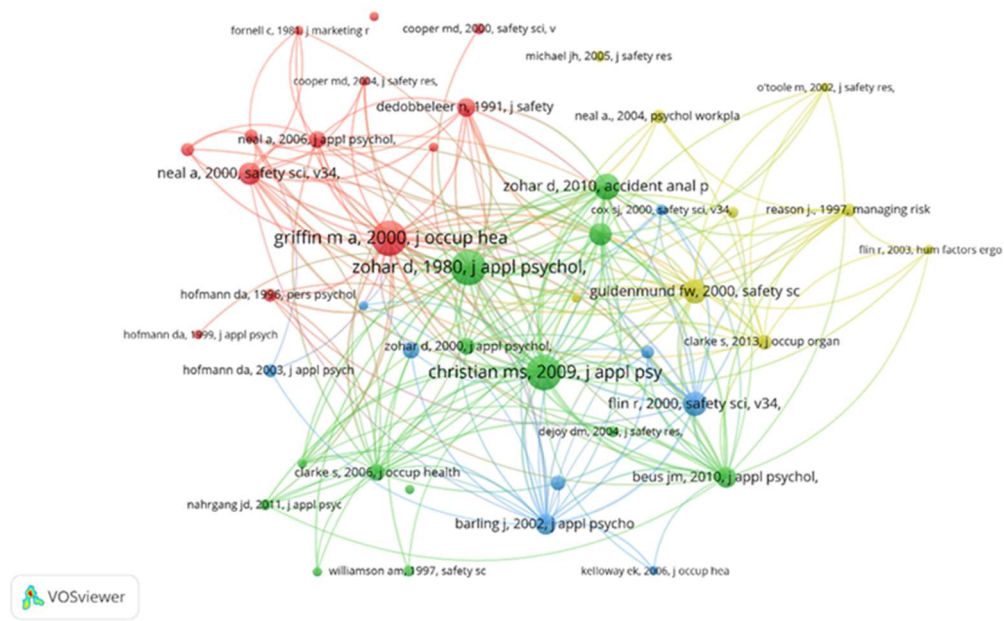


Figure 7: Co-citation analysis of the most cited document for the 2011 – 2020 period.

As we can see, the co-citation network for this period is denser than for the previous period, although we set the cut-off point much higher. This coincides with the higher number of published papers, as the number has increased by several times in the 2011-2020 period compared to the 1999-2010 period. The number of identified clusters is also higher. There is a red, green, blue, and yellow cluster.

In the red cluster are articles by Griffin (2000), Neal (2000), and Dedobbeleer (1991) that were already identified as important in the first period. The authors examined the influence of safety climate on safety performance and the effects of organisational climate on safety climate and safety performance. The authors also tested the proposed safety climate model. The green cluster includes articles by Zohar (1980), which is already known from the first period, and Christian (2009), which deals with the person-related (personal characteristics and attitudes) and situation-related (safety climate and leadership) factors related to safety performance and outcomes. Another study by Zohar (2010), which provides a review of safety climate research performed over the past 30 years and makes suggestions for the future, is also found in this cluster. In the third, blue cluster, are articles by Flin (2000) and Barling (2002). The work of these authors was recognised as important in the first period and continues to be important in the second period. Another article in this cluster is by Zohar (2002). In this article, the author addressed the relationship between leadership style, the priority given to safety, and the safety climate, and explored their influence on work-related injuries. The last cluster is yellow. Here we can find the articles by Guldenmund (2000), Clarke (2013), and Neal (2000). In their research, the authors addressed the nature of safety culture and climate and safety leadership, which includes transformational and transactional leadership styles. The authors proposed a model of safety climate that focuses on both the antecedents and outcomes of safety climate.

We can note that the articles of authors such as Zohar (1980), Dedobbeleer (1991), Flin (2000), and Barling (2002), who were present in the co-citation network in the first period, are also recognised as important articles in the second period. Even more, the number of their citations has actually increased significantly, reflecting their importance among

researchers working on the topic of safety commitment and leadership. Compared to the first period, there is also a large number of new articles by authors who have just joined the network; however, these articles are rapidly gaining citations. There has also been a slight change in the position of the articles. Authors such as Zohar (1980), who previously tended to be found on the outer edges of the network, are now positioned more towards the centre.

#### 2.4.2.2 Co-citation analysis in chronological order

To get a clearer picture of how the **co-citations networks** of the documents **look over time**, we performed another co-citation analysis that enabled us to map the co-citation network over time. However, to do this, we need to employ a different bibliometric software. As the first step, we imported data from the Web of Science into the Bibexcel software (Persson, 2021). We transformed the data to analyse it with the programme. Then we extracted the reference information from the data and cleaned it. We decided to limit the span of cited references to a frequency of 5 and then performed a co-citation analysis. Based on the result of the analysis, different files were created for further visualisation. In the second step, the files were imported into the Pajek software (Batagelj & Mrvar, 2021). We generated networks, vectors, and partitions, based on which the programme then created the visualisation. For the visualisation of the network, we used the Kamada-Kawai algorithm. Additionally, the complexity of the network was reduced by removing lines with values less than 4. The final visualisation is shown in Figure 8. Similar to the VOSviewer co-citation network, the size of the circles indicates the influence of the document (number of citations). The colour indicates the year in which the documents were published, and the lines between the circles represent the co-citation connections between the documents. Circles that have the same colour thus represent articles published in the same year. The corresponding labels include the name of the first author, the year of publication, the volume, the page, and the abbreviated name of the journal. The documents are arranged in chronological order according to the y-axis from the first publication downwards.

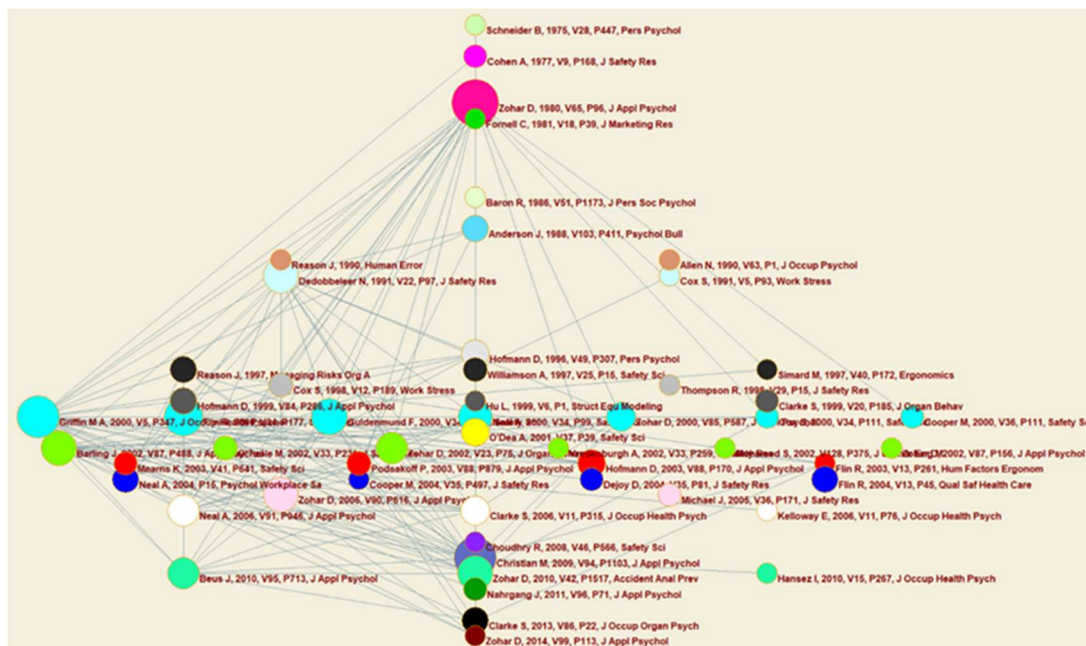


Figure 8: Co-citation analysis of documents in Pajek for the 1999 – 2020 period.

We can see that the publication by Zohar (1980), represented by a pink circle at the top of the network, is recognised as the first major important document that has an influence on this research area. This is not surprising since Zohar was recognised as the author of one of the most important articles in both periods of previous document co-citation analysis. Based on this visualisation, we can see that his later works are also important as Zohar (2014) is the last recognised document in this co-citation analysis. The co-citation network becomes denser between the years 1999 and 2006, as we can find the majority of the documents here. The cluster of light blue circles stands out in particular. It represents important works from the year 2000 by authors such as Griffin (2000), Flin (2000), Guldenmund (2000), Neal (2000), Zohar (2000), Cox (2000), and Cooper (2000). It seems that most of the articles relevant to our research topic are assorted around this timeline.

### 2.4.2.3 Co-citation analysis of authors

To familiarise ourselves with the **most important authors** who have shaped this field of research, we employ author co-citation analysis. Several cut-off thresholds were tested to get the most useful visual information. Ultimately, the cut-off threshold was set at 5 citations of an author for this **first period**. Of the 306 authors, 13 met this threshold. Three different clusters that were calculated by the programme are presented in Figure 9. There is a red, green, and blue cluster. When interpreting the network visualisation, we have to consider that only the first author of a cited publication is extracted from the Web of Science; therefore, other authors are not included in the author co-citation analysis (Jan van Eck & Waltman, 2020).

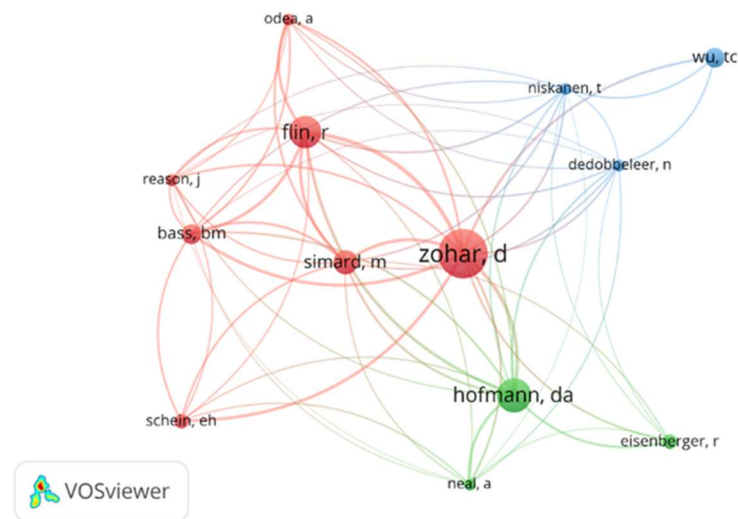


Figure 9: Co-citation analysis of the most cited author for the 1999 – 2010 period.

In the red field, the most cited author is Zohar. With 20 citations and 12 links, he is positioned at the middle of the network. The next author in this cluster is Flin, with 13 citations and 10 links. The remaining two clusters are smaller and consist of only three authors. In the green cluster, the most cited author is Hofmann, with 14 citations and 11 links. The most cited author in the blue cluster is Wu, with 8 citations and 3 links.

There are considerably more authors in this **second period**. The cut-off point was set at 10 authors, and 24 out of 1407 authors meet this threshold. Consequently, the number of identified clusters is also higher. In the network visualisation shown in Figure 10, we see a red, green, blue, and yellow cluster.

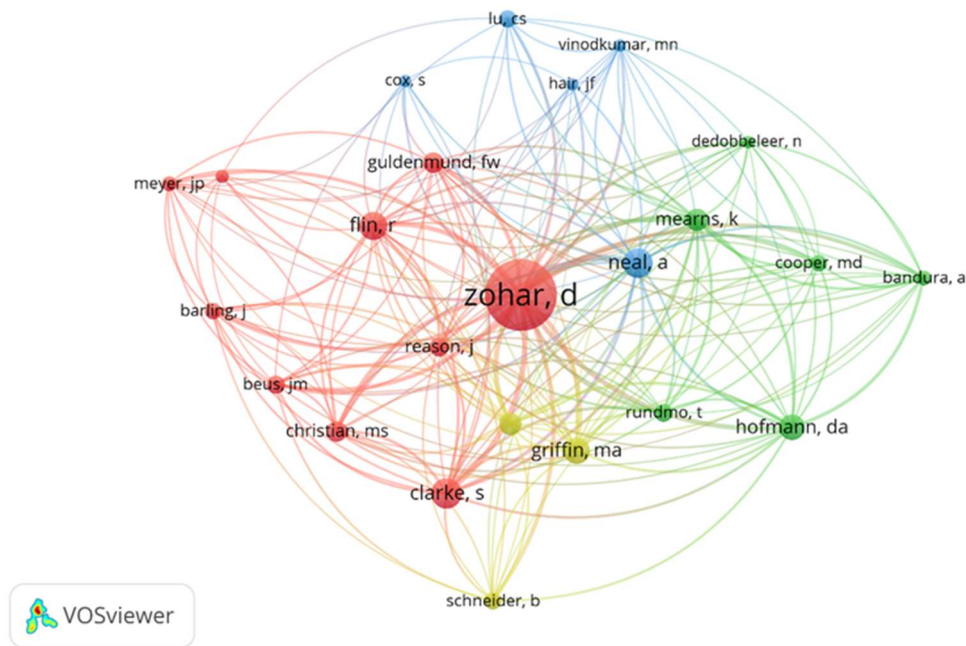


Figure 10: Co-citation analysis of the most cited author for the 2011 – 2020 period.

In the red cluster, Zohar is again the most cited author with 88 citations and 23 links. He is followed by Clarke with 31 citations and 23 links. The green cluster is represented by Hofmann (25 citations and 22 links) and Mearns (21 citations and 23 links). In the blue cluster, the most cited author is Neal (30 citations and 23 links), which is followed by Lu (15 citations and 22 links). The smallest is a yellow cluster with only three authors, among which Griffin (26 citations and 23 links) and Podsakoff (21 citations and 23 links) are the most cited authors.

If we **compare the two periods**, we can see that in the second period, the number of authors increased considerably. Several authors such as Zohar, Flin, and Hofmann were recognised as **influential authors** in both the first and second periods. Their position in the network visualisation remains similar in both periods. Around these already established authors, some **new authors** such as Mearns, Clarke, and Griffin appeared, moving the existing authors more towards the centre of the network. Although these new authors have only recently appeared on the author co-citation map, they are rapidly gaining citations.

Among the most cited authors, we find some authors such as Hofmann, Flin, O’Dea, and Wu, who belong to the group we studied in our bibliometric analysis. This means that this research field also **draws knowledge from its own base**. If we compare the two periods, it might seem at first glance that there are more authors building their colleagues’ research in the first period than in the second. However, if we look more closely, we can see that several authors such as Griffin, Flin, or Mearns are listed as second or third author and can be overlooked if we focus only on the first author. This highlights the inherent limitation of our co-citation analysis, as only the first author is included in the results of the analysis.

#### 2.4.2.4 Co-citation analysis of journals

To better understand where research on safety commitment and leadership **draws knowledge from**, we also conducted a co-citation analysis of the journals. Since different journals cover different topics and research areas, this analysis provides an insight into the

broader research community on which our research builds. It gives us a better understanding of how this research topic is positioned within this scientific research community and what the main streams of knowledge are.

To account for the journals in the **first period**, the cut-off threshold was set at a minimum of 5 citations of a source. Of the 252 sources, 10 meet this threshold. Based on the calculated total strength of co-citation links between sources, the sources with the highest total link strength were identified. The network visualisation that was created based on these journals is shown in Figure 11. There are three distinct clusters: red, green, and blue.

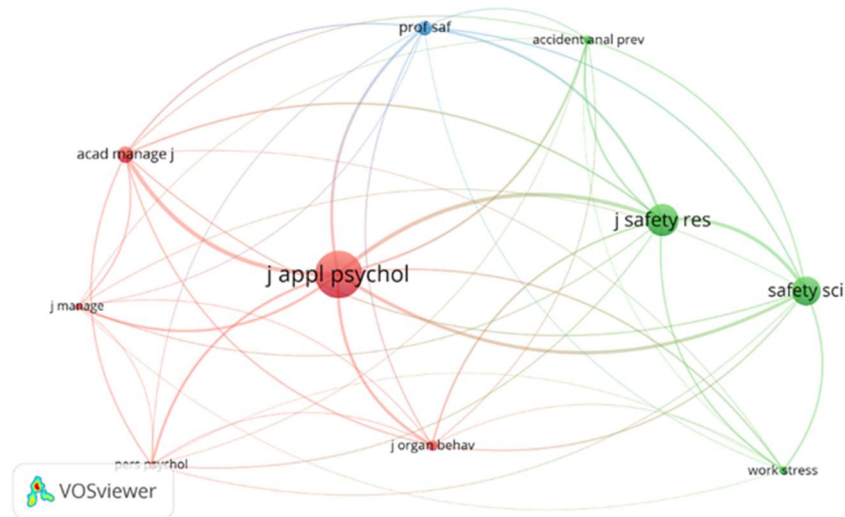


Figure 11: Co-citation analysis of the most cited journal for the 1999 – 2010 period.

We can see that the Journal of Applied Psychology is the most influential journal in the red cluster, with 56 citations and 9 links. The journal publishes original empirical and theoretical articles that address the field of applied psychology, with the exception of the clinical and applied experimental or human factors field. The main focus of the journal are publications that extend knowledge of different motivational, cognitive, behavioural, and affective phenomena and are positioned within organisational settings (Journal of Applied Psychology, 2021). Other journals in this cluster with a somewhat lower number of citations are the Academy of Management Journal (15 citations and 9 links) and the Journal of Organizational Behavior (9 citations and 9 links). Academy of Management Journal publishes articles that extend the understanding of management theory and at the same time contributes to practice. It focuses on publications that have a strong theoretical and empirical contribution. The journal emphasises the original, insightful, theoretically bold work that represents added value to the field of management (Academy of Management Journal, 2021). Similar to the previous journal, the Journal of Organizational Behavior publishes empirical and theoretical articles from the field of organisational behaviour. The journal focuses on publications that address various topics that relate to organisational behaviour across different levels of analysis, including individual, group, and organisational. It covers a broad range of topics from individual beliefs, attitudes, values to group size, leadership, power, and even organisational structure, change, and creativity (Journal of Organizational Behavior, 2021). Special emphasis is on the context that can have an important role in research done in the field of organisational behaviour (Ashkanasy, 2008).

In the green cluster, the most cited journal is the Journal of Safety Research, with 35 citations and 9 links. Journal of Safety Research is a multidisciplinary journal that

publishes articles that address various health- and safety-related topics from the traffic, workplace, or community field. In other words, this journal is primarily focused on occupational health and safety. The journal focuses on basic and applied publications that extend knowledge on illness prevention and unintentional injury. It brings together different stakeholders, including scientists, academics, as well as professionals, practitioners, corporate decision-makers, health professionals and also policymakers and government agencies (Journal of Safety Research, 2021). It is followed by Safety Science (31 citations and 9 links) and Accident Analysis & Prevention (7 citations and 9 links). Safety Science is another multidisciplinary journal that publishes original research articles, as well as review articles, accident and disaster cases, and discussions. The journal has a broad scope that covers research from work safety, infrastructure, energy, transport, and other hazardous activities. It focuses on publications that address safety from different views, including engineering, physics, as well as organisational, social and policy aspects. Special emphases are on the articles that address connections between the organisation, people, and technology (Safety Science, 2021). However, in contrast to the previous journal, the Accident Analysis & Prevention journal publishes empirical and theoretical articles from different research areas that aim to address accidental injuries and damage; therefore, it is focused primarily on the adverse events and their consequences. The broad scope of the journal brings together various aspects of transportation and other accidents, including legal, medical, educational, economic, and behavioural. The journal focuses on publications that explore different factors that can cause the accident, different types of accidents, the severity of accidents and injuries that they can cause. The attention is also directed towards the accident countermeasures, human tolerance to injury and other topics like accident data analysis, planning, policy, and decision making (Accident Analysis & Prevention, 2021).

The blue cluster consists of only one journal, positioned at the edge of the network, between two dominant clusters. This is Professional Safety, with 13 citations and 9 links. Journal of Professional Safety provides practical guidance and solutions for occupational health and safety professionals. It focuses on publications that address hazard identification, improvement of work environments, prevention of injuries, protection of employees, and financial aspects of safety. Its aim is to inform occupational health and safety specialists on the new developments in the topic of incident prevention, safety management techniques and best practices in the industry (Professional Safety Journal, 2021). The summary of the most influential journals in the first time period is presented in Table 6, together with the corresponding impact factors and designated research field.

From the visualisation network of the first period, we see that there are three predominant journals that fall into two different clusters. The first is the Journal of Applied Psychology, which is part of the red cluster. The other two journals belong to the second major, green cluster. These are the Journal of Safety Research and Safety Science. The journals that are in the red cluster, the largest out of the three clusters, provide the **flow of knowledge** from the fields of **psychology**, **management** and **organisation**. The second-largest is the green cluster. Here we find journals that provide knowledge from the field of **safety science**. In the blue cluster is the journal of Professional Safety, which addresses the topic of safety from a more professional perspective, as it is more oriented towards **practical issues** in the field of safety.

Table 6: Most influential journals for the 1999 – 2010 period.

Cluster	Journals	Impact factor <sup>a</sup>	Category <sup>b</sup>
Red	Journal of Applied Psychology	7.429	Psychology, Applied; Management
	Academy of Management Journal	10.194	Business; Management
	Journal of Organizational Behavior	8.174	Business; Psychology, Applied; Management
Green	Journal of Safety Research	3.487	Transportation; Ergonomics, Public, Environmental, and Occupational Health; Social Sciences, Interdisciplinary
	Safety Science	4.877	Operations Research and Management; Engineering, Industrial
	Accident Analysis & Prevention	4.993	Transportation; Ergonomics, Public, Environmental, and Occupational Health; Social Sciences, Interdisciplinary
Blue	Professional Safety <sup>c</sup>	–	–

*Note.* The table is based on the data obtained from the “*Journal Citation Reports*,” by Clarivate, 2021 (<https://jcr.clarivate.com/jcr/browse-journals>).

<sup>a</sup> Impact factor is based on the Journal Impact Factor Trend 2020. <sup>b</sup> Category is assigned to the specific journal by the Journal Citation Reports (each journal can be classified into one or more categories). <sup>c</sup>Not covered by the Journal Citation Reports.

For the analysis of journals from the **second period**, the cut-off threshold of at least 15 citations of a source was used. Of the 844 sources from this period, 19 met this threshold. The programme generated several different clusters, which are shown in Figure 12. The visualisation consists of a red, green, blue, and yellow cluster.

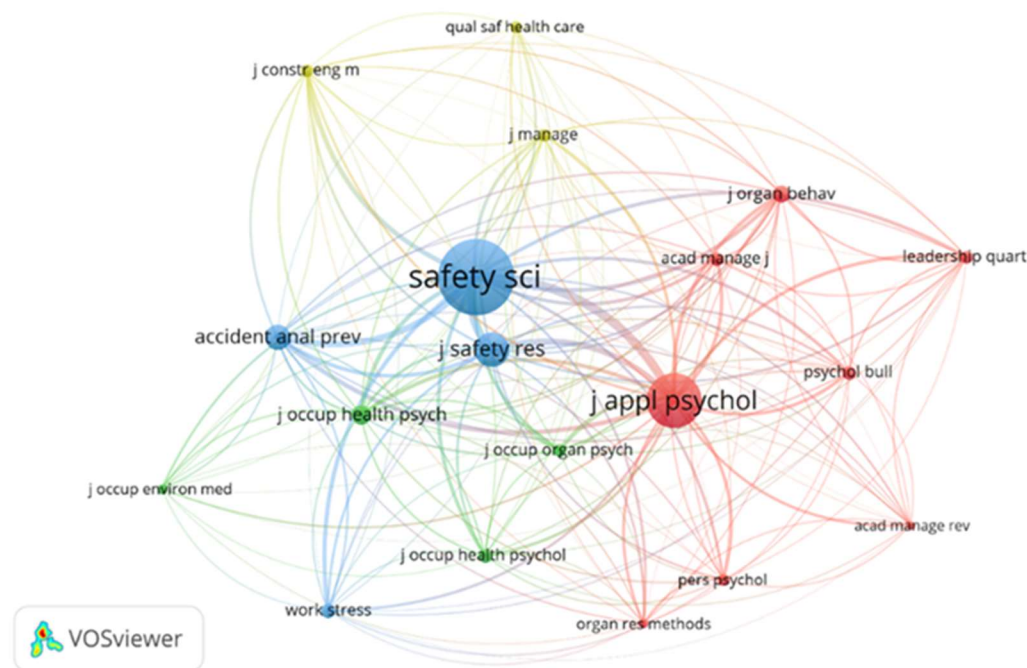


Figure 12: Co-citation analysis of the most cited journal for the 2011 – 2020 period.

In the red cluster is the Journal of Applied Psychology, with 211 citations and 18 links. It is followed by the Journal of Organizational Behavior (39 citations and 18 links) and the Academy of Management Journal (30 citations and 18 links). All three journals in this cluster were already recognised as important in the first period and have therefore already been described in more detail.

The green cluster is represented by the Journal of Occupational Health Psychology with 48 citations and 18 links. Journal of Occupational Health Psychology publishes theoretical, empirical and public policy papers from the interdisciplinary field of occupational health psychology. The journal focuses on publications that address individual psychological features, organisation of work, and work-life balance and wellbeing. Special emphases are on the promotion and prevention programmes in occupational health psychology and their financial and economic implications (Journal of Occupational Health Psychology, 2021). Other journals in this cluster are the Journal of Occupational and Organizational Psychology (26 citations and 18 links) and the Journal of Occupational and Environmental Medicine (19 citations and 15 links). Journal of Occupational and Organizational Psychology publishes articles that extend the understanding of this research field with a focus on people and organisations. The journal covers various research fields, including industrial, work, and organisational psychology, cognitive and behavioural features of work relations, human factors and ergonomics, and industrial psychology. Special emphasis is on innovative or interdisciplinary psychological contributions and papers that bridge together occupational and organisational psychology with other research fields like cognitive and social psychology (Journal of Occupational and Organizational Psychology, 2021). While the focus of both previous journals is relatively similar, the Journal of Occupational and Environmental Medicine is specialised in a different topic. The journal publishes clinical research articles and technical reports from the field of occupational and environmental medicine. As such, it covers diverse topics related to health in the workplace, with a focus on the prevention, diagnosis, and rehabilitation from different conditions, illnesses, and injuries that are work related or environmentally induced. Emphases are on the new

concepts, ideas, procedures, and techniques that can be applied industrially or commercially (Journal of Occupational and Environmental Medicine, 2021).

The blue cluster, which extends over the green cluster, includes journals such as Safety Science with 333 citations and 18 links and Journal of Safety Research (109 citations and 18 links) and Accident Analysis & Prevention (72 citations and 18 links). All top journals in this cluster were already recognised as important in the first time frame and have therefore already been described in that period.

The yellow cluster is the smallest and it includes only three journals. The most important is the Journal of Construction Engineering and Management, with 27 citations and 18 links. The journal publishes papers that consolidate together design theory and construction practice and further expand knowledge on construction engineering and management. The journal focuses on publications that address research topics like production planning, equipment, material handling, scheduling, inspection, quality control, cost control, labour productivity, construction management and environmental aspects (Journal of Construction Engineering and Management, 2021). The summary of the most influential journals in the second time period is presented in Table 7, together with the corresponding impact factors and designated research field.

From the network virtualisation, we can see that there are considerably **more journals** in the **second period**, even though the cut-off threshold was set much higher. This is partly to be expected, as the number of articles increased significantly in the second period. More interestingly, however, there was a **shift in the most-cited journal**. The first place was taken by Safety Science, which greatly increased its number of citations. Journal of Applied Psychology, which was the most cited journal in the first period, is now in the second place. The position of the Journal of Safety Research has not changed; it remains the third most cited journal. While the Journal of Safety Research and Safety Science had a relatively similar number of citations in the first period, there is now an obvious difference in favour of Safety Science. The growing role of the Safety Science journal in the second period shows that the journal has provided an important influx of knowledge to research on safety commitment and leadership. The analysis of journals publishing on safety commitment and leadership presented in Chapter 2.4.1.2 showed that more than a quarter of the publications in our core literature were published in the Safety Science journal. This indicates that the Safety Science journal is becoming not only an important source of publications on this topic, but also an important source of knowledge for these publications.

Table 7: Most influential journals for the 2011 – 2020 period.

Cluster	Journals	Impact factor <sup>a</sup>	Category <sup>b</sup>
Red	Journal of Applied Psychology	7.429	Psychology, Management
	Journal of Organizational Behavior	8.174	Business; Psychology, Management
	Academy of Management Journal	10.194	Business; Management
Green	Journal of Occupational Health Psychology	7.250	Public, Environmental, and Occupational Health; Psychology, Applied
	Journal of Occupational and Organisational Psychology	4.561	Psychology, Management
	Journal of Occupational and Environmental Medicine	2.162	Public, Environmental, and Occupational Health
Blue	Safety Science	4.877	Operations Research and Management; Engineering, Industrial
	Journal of Safety Research	3.487	Transportation; Ergonomics; Public, Environmental, and Occupational Health; Social Sciences, Interdisciplinary
	Accident Analysis & Prevention	4.993	Transportation; Ergonomics; Public, Environmental, and Occupational Health; Social Sciences, Interdisciplinary
Yellow	Journal of Construction Engineering and Management	3.951	Engineering, Civil; Engineering, Industrial; Construction and Building Technology

*Note.* The table is based on the data obtained from the “*Journal Citation Reports*,” by Clarivate, 2021 (<https://jcr.clarivate.com/jcr/browse-journals>).

<sup>a</sup> Impact factor is based on the Journal Impact Factor Trend 2020. <sup>b</sup> Category is assigned to the specific journal by the Journal Citation Reports (each journal can be classified into one or more categories).

Despite the slight change at the top of the most cited journals, other journals that were recognised as important in the first period retained their role in the second period. We see that the blue cluster of journals that provide the **knowledge flow** of the **safety science** discipline changed the least of all clusters in the second period. Most of the **new journals** that emerged in the **second period** are in the red cluster. Here we find journals such as *Organizational Research Methods*, *The Leadership Quarterly*, and *Academy of Management Review*, which contribute to the **knowledge flow** from the field of **management** and **organisation**. The new **influx of knowledge** from the field of

**psychology** and **medicine** adds a green cluster, which also emerged only in the second period and includes journals such as the Journal of Occupational Health Psychology, Journal of Occupational and Organisational Psychology, and Journal of Occupational and Environmental Medicine. Unlike other psychological journals from the red cluster, these journals focus on **occupational aspects**. In the yellow cluster, we find the Journal of Management, which was a part of another cluster in the first period. Besides this journal, there is Quality & Safety in Health Care and the Journal of Construction Engineering and Management. This indicates that safety commitment and leadership was **recognised** as an important research topic across **different research fields** as it started to draw knowledge from a variety of journals. Based on the co-citation analysis of journals, the influx of knowledge from three major disciplines can be observed, namely **safety science**, **management** and **organisation**, and **psychology**. The diverse knowledge base of publications on the commitment to safety and leadership indicates the **interdisciplinary nature** of this research topic.

#### 2.4.2.5 Co-occurrence analysis of terms

To gain a better understanding of the main topics and trends in research on safety commitment and leadership, we conducted the **term analysis** based on the abstracts of the publications. Compared to keywords, abstracts allow us to gather much richer data for analysis. The abstracts were first analysed using Bibexcel, which allows the analysis of larger texts (Persson et al., 2009). The next step was to import the data from Bibexcel into VOSviewer to create co-occurrence maps. For the first period, the cut-off point was set to at least 3 occurrences of a term. Of 345 terms, 23 meet the threshold. For these identified terms, the programme calculates the relevance score. We must point out that by default, only **60 % of the relevant terms** are selected. However, we chose to include all relevant terms and then manually review them to obtain the most relevant results. **General terms** such as “research”, “study”, “data”, “number”, “impact”, “job”, and “factor” **were excluded**. Similar to the document co-citation analysis, the term co-occurrence map consists of clusters. Circles forming clusters represent individual terms; the larger the circle, the more frequently the term occurs. The position and distance between the circles indicate how much these terms are related. The closer they are to each other, the more related they are. Van Nunen et al. (2018) explain the relatedness of terms by the frequency with which certain terms appear together in the abstracts of the analysed publications. In our analysis of the **first period**, the programme produced a map of terms, which is presented in Figure 13. Three main clusters can be clearly distinguished.

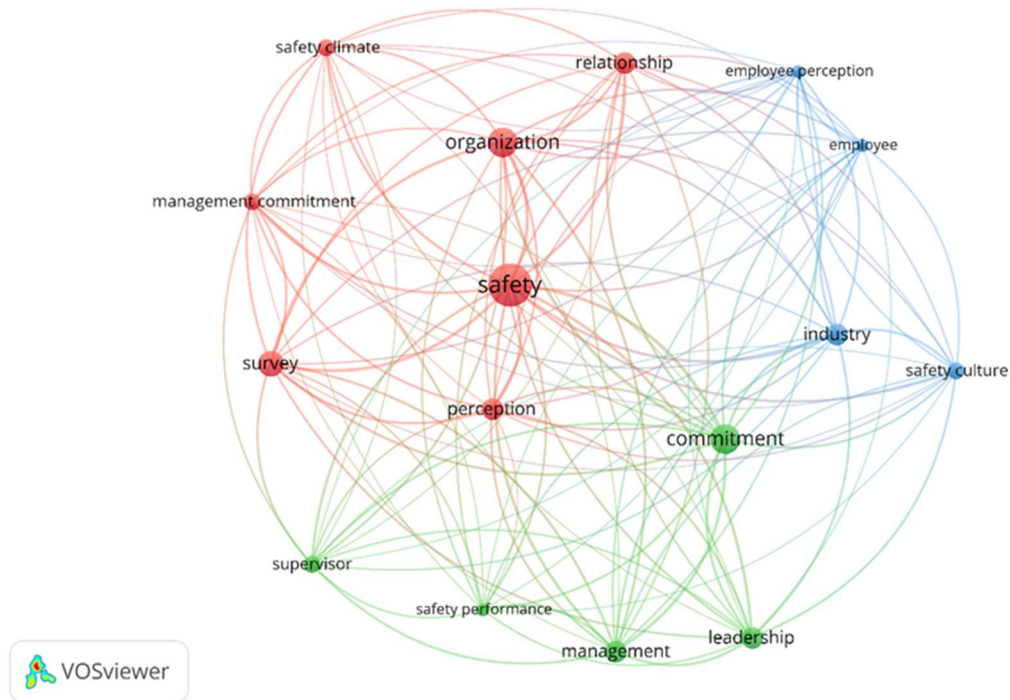


Figure 13: Co-occurrence analysis of the most frequent terms for 1999 – 2010.

In the red cluster, we find terms like safety, organisation, and survey. Other terms we can find in this cluster are safety climate, management commitment, and perception. The terms in this cluster seem to reflect articles that focus on employee perceptions of management commitment in safety climate surveys. This indicates that management commitment plays an important role in the safety climate of the organisation. The green cluster consists of terms such as commitment, management, leadership, safety performance, and supervisor. These terms seem to reflect articles that address the effects of management commitment and leadership on safety performance. The focus seems to be on managers in general and on the first-line managers such as immediate supervisors. The close relationship between management and leadership can also be seen in the position of both circles. The blue cluster is the smallest. Here we find terms such as industry, safety culture, employees, and employee perceptions. The terms seem to reflect articles that focus on safety culture and employees' perception, especially in an industrial setting.

For the **second period**, the cut-off point was set at a minimum of 5 terms. Out of 1207 terms, 42 met the threshold. All the most relevant terms were checked manually. Terms such as “part”, “addition”, “impact”, “influence”, “literature”, “paper”, “importance”, “type”, “effect”, “study”, “data”, and “research”, or the names of countries **were excluded**. Figure 14 shows the map of terms that was created. We can observe three slightly denser clusters.

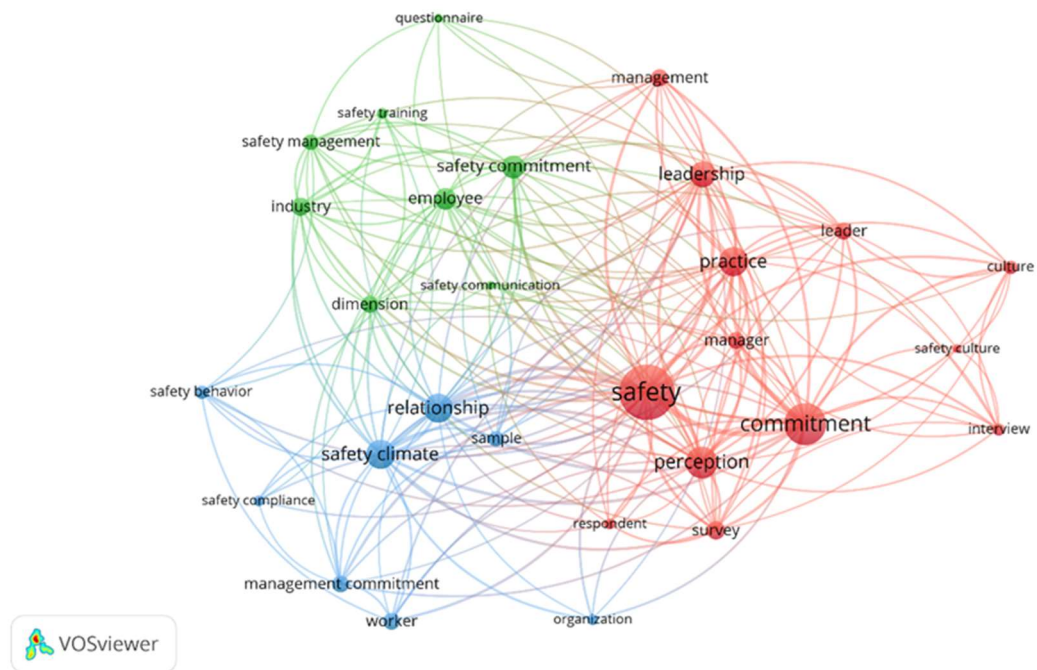


Figure 14: Co-occurrence analysis of the most frequent terms for 2011 – 2020.

The most common terms in the red cluster are safety, commitment, and perception. We also find terms like safety culture, leader, leadership, manager, and management. The terms in the red cluster seem to reflect studies that focus on the role of safety commitment of managers and leaders in safety culture. This suggests that leadership may also play an important role in ensuring safety. Terms such as interview and survey also indicate different research methods used in these studies. It seems that these are the predominant research methods used in these articles. In the green cluster, the most common terms are safety commitment, employee, and industry. The terms seem to reflect studies that focus more on safety commitment from the employees' perspective. In this regard, it represents the contrast to the red cluster. While the red cluster represents articles that focused on safety commitment from the perspective of managers, the green cluster represents articles that focused more on employees and their perceptions. Other terms in the green cluster, such as questionnaire, also indicate the research methods and data collection techniques most commonly used in these studies. The final cluster is blue. The most common terms here are safety climate, relationship, and management commitment. Other terms we find in this cluster are worker, safety behaviour, and safety compliance. The terms seem to reflect studies that focus on the role of management commitment in safety climate and its relationship to employee safety behaviour and safety compliance.

Based on the **most common terms** in the **first period**, we can see that the studies are primarily concerned with the role of management commitment in safety climate surveys. The role of management commitment and leadership in safety performance is not yet at the forefront of research. Interestingly, we can observe a shift in focus in the **second period**, as most common terms refer to studies that examine managers' commitment and leadership. Studies that focus on management commitment in relation to safety climate are still an important part of this research field, but they have migrated to the smaller cluster. This indicates that **research is gradually evolving** over time and taking a new direction.

### 2.4.2.6 Word cloud analysis

To get an even clearer picture of the **direction future research** might take, we created a word cloud to provide a meaningful graphical representation of the most commonly used terms. The word cloud was generated based on the abstracts of the articles published in recent years and corresponds to the period from 2016 to 2020. This time period was deliberately chosen as it represents the research front in recent years and also corresponds to the identified peak in the number of published publications presented at the beginning of this chapter. To generate a word cloud, abstracts were first extracted from the publications using Bibexcel software (Persson, 2021). Then, the extracted texts were manually reviewed and uploaded to the web-based tool to create the word cloud (Word Art, 2021). The results are shown in Figure 15.



Figure 15: Word cloud for the 2016 – 2020 period.

The words that appear most frequently in the abstract of recent publications from this research field include safety, committed, manager, leadership, behaviour, climate, and culture. This is consistent with the results of the co-occurrence analysis of frequently used terms in the second period. It suggests that recent research has linked safety commitment not only to climate and culture, which was common in the past, but also directly to the managers and leadership. This can be seen as a **new research direction** towards which this field is gradually shifting.

### 2.4.2.7 Bibliographic coupling

Co-citation analysis and term analysis allowed us to gain insight into the underlying structure and evolution of the field of safety commitment and leadership. We used the word cloud to provide an overview of the terms that have appeared most frequently in this research field in recent years. However, a different approach has been proposed in the literature to gain a better understanding of the current state of the art in the field: the **bibliographic coupling**. This approach allows the analysis of the citing documents. It is based on the references that two documents have in common and reflects the similarity between them (Zupic & Čater, 2015).

We perform the bibliographic coupling on an existing core database and limit our time frame to the period 2016-2020, as the use of shorter time intervals has been suggested in

the literature (Donthu et al., 2021). The data were then imported into VOSviewer, where we performed the analysis. The cut-off threshold was set to a minimum of 3 citations of a document. Of the 30 documents, 15 met this threshold. The programme created a network visualisation, which is shown in Figure 16. Four different clusters were created, each gravitating in its own direction.

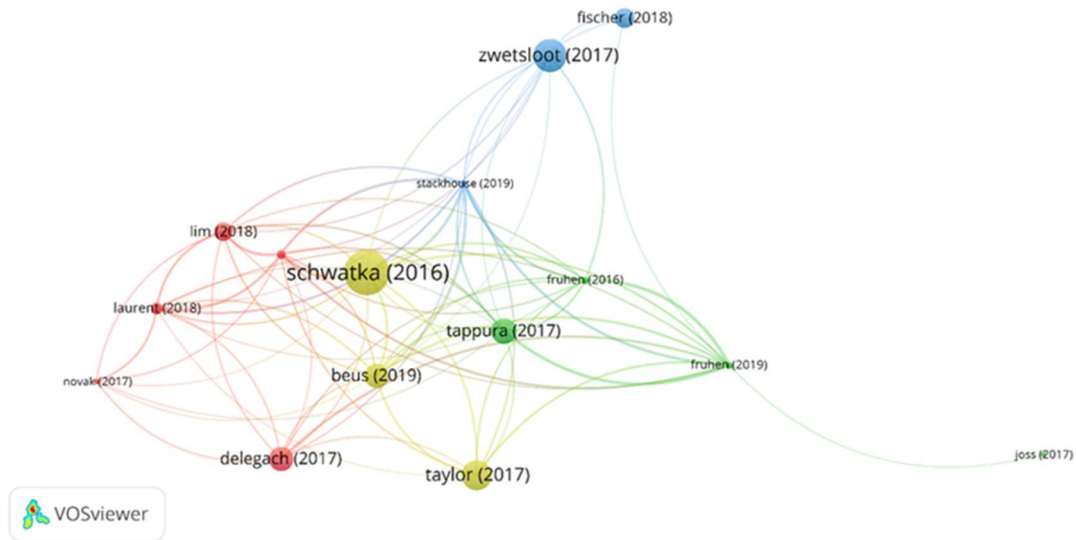


Figure 16: Bibliographic coupling analysis for the 2016 – 2020 period.

The red cluster includes articles by Delegach (2017) and Lim (2018). In their papers, the authors addressed the role of different types of leadership and self-regulatory focus on employee safety commitment, and the impact of safety climate on different types of safety motivation and performance (pointing to the relationship between leadership and motivation). In the green cluster are articles by Tappura (2017) and Fruhen (2019; 2016) that focus on the managers' perception of the factors that affect their commitment to safety and what safety commitment actually means to managers. This represents a shift in perception (introducing new units of observation), as papers in this research field have generally focused on the employees' perceptions of managers' commitment. In addition, another article stands out from the green cluster, not so much because of the citations or links, but because of its location. On the far right of the network is the article by Joss (2017). In their paper, the authors address the issue of an integrated approach to employees' health, safety and wellbeing, which is partly related to the main cluster. We see that some new concepts such as employees' health and wellbeing have been introduced in this paper. In the third, blue cluster, we find articles by Zwetsloot (2017) and Fischer (2018). In their research, the authors addressed the important role of different factors (commitment, communication, learning and culture) in preventing accidents and the influence of leadership on the safety climate. The last cluster is yellow. Here we find articles by Schwatka (2016) and Taylor (2017) that focus on the important role of co-worker safety commitment and on the influence of risk perception on safety. These papers introduced new units of analysis that were not previously covered by other publications.

From both the **term analysis** and the **bibliographic coupling**, we can conclude that there is a slight but important **movement** in the **research direction** in the research field of safety commitment and leadership.

## 2.5 Conclusion and Limitations

With bibliometric analysis, we aimed to obtain the answer to our research questions. By combining different types of co-citation analysis, we sought to gain a better understanding of the **knowledge base** and determine the **intellectual structure** of research on safety commitment and leadership. Dividing the publications into two separate time periods allowed us to provide a more detailed account of the **evolution** of our **research topic over time**. To identify recent publications that form the **research front** and to **forecast the future development** of our research topic, we employed bibliographic coupling and co-word analysis. The word cloud highlights the most important terms that represent recent publications and provide a preview of what the **future research field** might look like.

Perhaps the most obvious **difference between the two periods** examined is in the sheer number of publications. The number of articles published in the second period (2011 – 2020) is more than four times the number of articles published in the first period (1999 – 2010). However, the most significant increase in the number of new publications has been observed in the last years (2016 – 2020). The positive trend in the number of publications corresponds with the increase in publications in other closely related topics such as safety culture (van Nunen et al., 2018), safety leadership (Tao et al., 2020) and safety climate (Bamel et al., 2020). Authors who studied the development of these research topics also reported a significant increase in the number of publications. This trend is also consistent with Hale's (2006) observation that the focus of safety research is slowly shifting from technical challenges and human factors more towards organisational factors and management.

**Co-citation analysis of documents** reveals that publications in the first period generally address different ways in which safety climate, leadership behaviour, or both can affect safety performance and safety outcomes. In the second period, we can see several publications that were also highlighted in the first time period. Therefore, safety culture, safety climate, and safety leadership continue to be the focal topics of the publications. The **co-citation analysis of authors** shows that the number of authors increased significantly in the second period. There were also several authors that were recognised as influential in both periods. Among the most cited authors, we find some authors such as Hofmann, Flin, O'Dea, and Wu, who are part of our core literature on which we conduct the bibliometric analysis. This means that this research field also **draws knowledge from its own base**. From the **co-citation analysis of the most-cited journals**, we can see that there are considerably more journals in the second period than in the first. In addition, a shift took place in the most cited journal. The first place was taken by Safety Science, which greatly increased its number of citations and displaced the Journal of Applied Psychology, which now occupies the second place. The analysis also revealed that there are new journals in the second period that provide **a flow of knowledge** from different scientific disciplines. This indicates that the topic of safety commitment and leadership has been recognised as an important research topic across different research fields as it began to draw knowledge from a wide range of journals. The influx of knowledge can be observed from three major disciplines, namely **safety science**, **management** and **organisation**, and **psychology**. The diverse knowledge base of publications on commitment to safety and leadership publications indicates the interdisciplinary nature of this research topic.

The most common terms identified in the **co-occurrence analysis** in the first period indicate that publications are primarily concerned with the role of management commitment in safety climate surveys. The role of management commitment and leadership to safety performance has not yet been the focus of research. However, in the

second period, we can observe a shift in focus as most common terms refer to publications that address managers' commitment and their leadership. Studies that focus on management commitment in the context of safety climate are still an important part of this research field, but to a lesser extent. This indicates that research is **gradually evolving** and taking a new direction over time. The results of the **word cloud analysis** are consistent with the results of the co-occurrence analysis of commonly used terms. This suggests that recent research has explored the concept of safety commitment not only in the context of climate and culture, which was common in the past, but also directly with managers and leadership. The **bibliographic coupling** revealed publications focusing on the role of different leadership types on employee safety commitment and the impact of safety climate on different types of safety motivation and performance (Delegach et al., 2017; Lim et al., 2018). Other publications have focused on perceptions of factors affecting managers' commitment to safety or addressed what safety commitment actually means to managers (Fruhen et al., 2019; Fruhen & Flin, 2016; Tappura, Nenonen et al., 2017). This represents a shift in perception, as papers in this research field have generally focused on the employees' perceptions of managers' commitment. In addition, our analysis also identified publications by Schwatka (2016) and Taylor (2017) that focus on the important role of co-worker safety commitment and the influence that risk perceptions can have on safety. These publications introduced new types of commitment that had not been previously addressed. Based on both the **term analysis** and **bibliographic coupling**, we could argue that there is a slight, but important movement in the research direction in the research field of safety commitment and leadership.

Despite the aforementioned contributions, this research is not without limitations. As some researchers have pointed out (Zupic & Čater, 2015), we do not know the **reasons why** certain **publications are cited**. For example, publications may also be cited to criticise the work of their authors; or may simply be cited by authors to compile a presentable reference list that includes important authors in the particular research field. As Haddow (2018) notes, the limited access to publications may also result in fewer citations. Documents may also be cited by a colleague, self-cited by the author, or not being cited because the author is a competing researcher, or more trivially, due to an error in a citation (Haddow, 2018). Wallin (2005) argues that the number of citations of some methodological or review papers is also questionably high. On the other hand, some of the fundamental papers are not cited nearly as often as they should be.

Another limitation represents the **database** from which we export our data. For the bibliometric analysis, we obtained the necessary data from the Web of Science database. Although Web of Science is a rigorous database and frequently used as a data source by various researchers (Zupic & Čater, 2015), it includes fewer publications than, for example, the Scopus database or Google Scholar. Therefore, the exclusive use of the aforementioned database is a source of potential bias. Mongeon and Paul-Hus (2016) argue that using the Web of Science or Scopus as a source of data can lead to a bias in favour of research disciplines such as natural sciences, engineering, and biomedicine while leaving fields such as social sciences and humanities underrepresented. Therefore, the use of data from different databases may lead to different results in bibliometric analysis. This is particularly important when authors address a research topic that spans different research fields, as is the case in our research topic (Mongeon & Paul-Hus, 2016).

The last limitation is due to the nature of bibliometric analysis itself, as the **interpretation of the results** is still left to the researcher and, therefore, prone to bias (Zupic & Čater, 2015). Although bibliometric analysis can be conducted without prior in-depth knowledge of the field, Donthu et al. (2021) argue that researchers should have a good knowledge of the content they are analysing in order to fully exploit the potential of

bibliometric analysis. Understanding the research field would enable researchers to address the context and concepts in the analysed literature and would also facilitate the interpretation of findings and the development of insightful discussions. This would take bibliometric studies beyond a simple bibliometric report to a valuable piece of work that can provide useful insights for the research community at large.

## Chapter 3

# Systematic Review of Literature

### 3.1 Introduction

To obtain a conceptual overview of the literature and develop a deeper understanding of how safety commitment and leadership topics evolve over time, we conducted a systematic review of the literature on the aforementioned topic. Understanding the research that has been conducted on the research topic of interest is essential regardless of the research discipline. It enables researchers to build on and relate to existing knowledge in the field. As the production of knowledge continues to increase while being also extremely interdisciplinary and fragmented, this task becomes a major challenge (Snyder, 2019).

A systematic review of literature represents a different approach from the traditional literature review, which has several advantages. Despite the fact that it tends to take considerably more time and requires a great deal of attention to detail and a high level of perseverance, some authors consider a **systematic review** to be the **most appropriate method** for processing the literature (Tranfield et al., 2003). A systematic review of literature is a well-established method for literature review in medicine, healthcare, and some social sciences (Rojon et al., 2021). However, in recent years the advantages of systematic review have also become recognised in the interdisciplinary field of **safety science** (Pilbeam et al., 2020; Ranasinghe et al., 2020). Systematic review employs a systematic method in order to identify, determine, critically assess, and analyse literature that is relevant to the formulated review question. Through such an approach, potential bias and subjectivity from the researcher are also reduced. Building on a more methodical foundation, a systemic review is more transparent, comprehensive, and, if performed correctly, also replicable (Siddaway et al., 2018).

A systematic review can provide a transparent overview of the research literature on a particular research topic and produce a **map of the knowledge** generated in that scientific field. This knowledge map can cover literature from different disciplines and enables a more holistic view across the studied research field. It can help the researchers to identify a specific research niche and generate new research. In addition, it can also be used to recognise emerging trends in the research and future directions (Kraus et al., 2020). The synthesis of the results obtained during the systematic review can be used to critically evaluate the existing theory or even to formulate the new theory (Siddaway et al., 2018).

A systematic review can be used to provide an overview in fields where the research is **interdisciplinary** and **diverse** (Siddaway et al., 2018). Kraus et al. (2020) point out that, especially in the interdisciplinary fields, different researchers with different scientific backgrounds might address theories and concepts through their perspectives using different terminology. Different terminologies might be used for the same concept, or the same terminologies are used for different concepts. Consequently, such a field of research is less

transparent and scattered. A systematic literature review can be employed to overcome this challenge by synthesizing the literature and providing insight into the interdisciplinary research field. It can highlight current research perspectives even when the field of research combines different scientific disciplines and research backgrounds.

As pointed out by Bowman (2007), there is no right number of papers that should be included in the systematic review. Instead of the number of papers included in the review, what is important is the ability to offer new insights into the research area. The number of papers should be small enough that researchers can perform the systematic review in a manageable time; however, still large enough that the review can provide some new and meaningful results. In some research topics, the number of papers is scarce; however, researchers often limit the number of papers for pragmatic reasons (Rojon et al., 2021). In addition to the number of researchers working on the review and the time available for the review, the characteristics of the research field might also limit the number of articles available for systematic review (Bowman, 2007). The number of papers can differ whether the review is employed to explore mature or immature research fields. When a systematic review of the literature is conducted in a more mature research field, a much larger number of articles can be included in the analysis, and there are usually multiple research topics that can be examined. In a mature field, the systematic review of the literature is evidence-driven. Such review is based on a specific research question and can include several distinct research hypotheses that are addressed during the process. On the other hand, the systematic literature review can also provide important insights when a research field is less mature or mature but narrow. In this case, the number of papers is usually limited, and they could be more diverse. Thus, a systematic literature review can provide support for the development of a new theory or help to identify research gaps and provide directions for future research. Further, a systematic literature review on the new, emerging field can enable a better understanding of the research field and the development of more coherent definitions. In less mature research fields, systematic literature reviews are based on more general research questions and are less driven by specific research questions and hypotheses. Such systematic reviews are more centred on the synthesis of the basic foundations and the relevant insights into the developing research field (Kraus et al., 2020).

There are some important aspects that need to be considered prior to conducting the systematic review. **Researchers should determine** the appropriate type of review that corresponds to the aim of the research (systematic, semi-systematic, integrative); specific criteria for exclusion/inclusion of literature; specific review boundaries; decide which type of information needs to be extracted from the literature; and what would be the proposed contribution of the review (Snyder, 2019). In addition, there are some limitations that researchers should be aware of when conducting a systematic review of the literature. Rojon (2021), who has studied the use of the utilization of systematic reviews in management, points to **several** such **potential challenges** and limitations. The first arises from the selection of units of literature. The use of an appropriate search string determines which papers remained outside the search results. Through a combination of different keywords, researchers have influence over the papers included in the further analysis. Adding handpicked articles might yield additional findings and highlight otherwise hidden topics; however, it might also introduce bias and cause certain topics to become overrepresented. Researchers also have to make a decision whether to include grey literature into the review (e.g., conference proceedings or working papers) or focus only on papers that were verified by the peer-review process. Although the inclusion of grey literature would lead to a wider range of articles, Kraus et al. (2020) argue that systematic research should only include peer-reviewed papers obtained through the main research database, thereby improving the quality of the review. The second challenge represents the limitation criteria that might be too rigid and result in the exclusion of some important papers. In general, including a larger

number of papers from different research fields would enable better coverage; however, that is not always feasible nor sensible. Therefore, this is where the judgment of researchers comes to play an important role. In addition, the subjectivity of researchers can have an important influence in other stages, like when conducting a thematic analysis or during the interpretation of the results. This influence is partly mitigated through the rigorous process of the systematic review and comprehensive description of various decisions that are made during the process. The number and diversity of gathered papers also present a challenge for the integration and synthesis of information. The issue with a large number of papers can be resolved by focusing only on titles or abstracts. However, this introduces another issue since it can result in the exclusion of papers with poorly written titles and abstracts. Consequently, some important papers might be overlooked (Rojon et al., 2021). Compared to the classic literature review, the process of systematic review is somewhat more complex; nevertheless, when performed correctly, systematic conclusions can represent an important contribution to the research field.

Through the systematic review approach, **we aim to** achieve (Siddaway et al., 2018):

- robust and comprehensive conclusions that are based on an unbiased synthesis of the literature on safety commitment and leadership;
- determine relationships, gaps, potential contradictions, and inconsistencies in literature;
- identify current theories on which papers are built;
- identify potential future research directions on this research topic.

## 3.2 Process of the Systematic Review

We conduct the systematic review literature based on the four principles for systematic reviews in management and organisation outlined by Denyer and Tranfield (2009). The authors suggest that researchers should focus on the following when conducting a systematic review: **transparency**, which refers to clearly described processes and methods used, presentation of review findings, and clearly stated assumptions regarding relevant research; **inclusivity**, which emphasises on quality of the papers and acceptance of appropriate inclusion and exclusion criteria; **explanatory nature** of the review, which refers to the different procedures available for synthesizing findings; and on the **heuristic of the outputs** of a systematic review that can inform either theory or practice.

To apply those principles, we followed the **five-step process** of systematic review based on the recommendations of Denyer and Tranfield (2009) and Rojon (2021). The five steps consisting of question formulation, study retrieval, study selection and evaluation, analysis and synthesis, and reporting of results are summarised in Figure 17. The first three steps of the systematic review were performed during the bibliometric analysis and are, therefore, described in detail in the previous chapter. Further steps involving analysis and synthesis, as well as reporting of the results, are presented in the course of the next chapter.

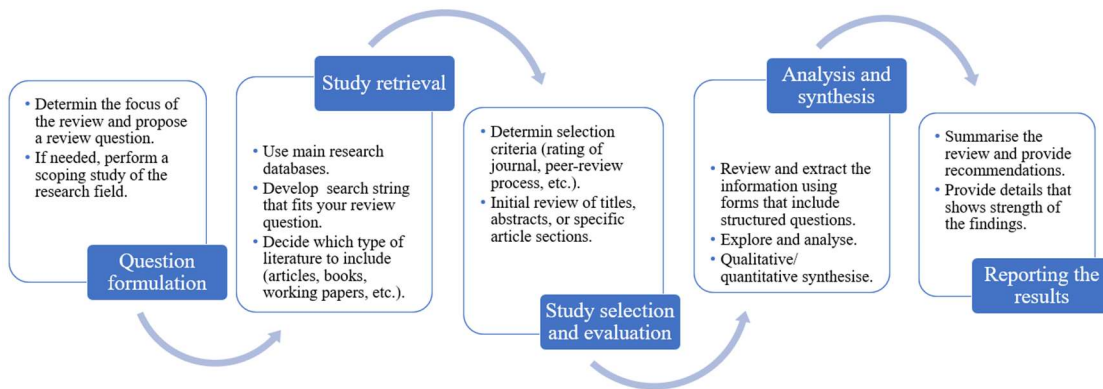


Figure 17: Five steps of the systematic review. Adapted from “Producing a Systematic Review, In D. Buchanan and A. Bryman (Eds.),” by D. Denyer and D. Tranfield, 2009, *The Sage Handbook of Organizational Research Methods*, 1st Edition, pp. 671–689; “Utilization and development of systematic reviews in management research: What do we know and where do we go from here?,” by C. Rojon, A. Okupe, and A. McDowall, 2021, *International Journal of Management Reviews*, 23(2), 191–223.

### 3.3 Analysis and Synthesis

After selecting the papers that represent the core literature on this research topic from the research database and evaluating them based on their quality (peer-reviewed papers in journals with impact factor) and appropriateness of their content (concepts and context), we began the **process of the analysis and synthesis**. First, we manually analysed papers, meticulously reading each paper in its entirety multiple times to gain a full understanding of the work. In the next step, we conducted a detailed analysis of each paper by breaking it down into its basic elements and extracting relevant information (Denyer & Tranfield, 2009). Tranfield (2003) suggests that researchers should use extraction forms to reduce bias. Such forms may include general information (e.g., title, journal, author, title of publication, year of publication), specific features of the study such as the context of the study, research methodology, and researchers’ notes on emerging themes, relationship with other concepts, and summary of findings. Extractions forms should also be flexible and can slightly differ depending on the study. Those forms represent a basis for the following analysis, constructing summary tables and synthesis. Bowman (2007) proposes that in addition to data forms, important information could be extracted from articles using codebooks (in the form of questionnaires) that set predetermined items that should be gathered in this process. The use of such an extraction tool would add to both **validity** and **reliability** of the review. Alternatively, researchers can also employ specially designed tables to extract data, where columns indicate what data need to be collected. Both approaches facilitate the further process of synthesis. During the synthesis, other tools such as charts, graphs or figures might also be used to visualise and compare gathered data (Bowman, 2007). We developed our data extraction form based on the group of interrelated questions proposed by Denyer and Tranfield (2009). These questions provided a supportive framework that guided the data collection process; however, the actual data collected from the papers varied depending on the analysed paper. The form consists of general details of the paper, type of research study and research methods, the context in which the study was conducted, theoretical foundations of the study, the main aim of the study, description

of how the study relates to our concepts of safety commitment and leadership, and future directions that can be deduced from the study. There was also additional space for the researchers' notes (see the example of the form in Appendix B) at the end of the form. To facilitate the analysis process of the core literature, we constructed the summary tables in order to group and analyse extracted information. Summary tables were developed based on the paper of Stephan (2018) and were used as a base for synthesising the findings.

Through the process of synthesis, **we aimed to** gain a deeper understanding of the relationships between the elements identified in the papers (Denyer & Tranfield, 2009). Based on the analysis of the core literature, we sought to identify the prevailing theoretical foundations, the characteristics of safety commitment and leadership concepts, their relationships to other concepts addressed in the papers, the major findings, and possible directions for future research. As Tranfield (2003) points out, synthesis refers to the process of summarising findings, integrating them, and accumulating knowledge from different studies.

According to Bowman (2007), in addition to summarising the findings from the analysed studies, synthesis also involves highlighting the similarities and differences in findings, forming new ideas, or bridging the gap among different disciplines. It can also involve critical evaluation of findings from the studied papers. Another approach is to analyse past research to derive ideas that can promote future studies or identify the main challenges that have hindered the development of past research (Bowman, 2007). The most common types of synthesis are narrative synthesis, which is used for the qualitative type of information, and meta-analysis, which focuses on the quantitative type of information (Baumeister, 2013; Tranfield et al., 2003). To bridge the gap between the aforementioned methods, two inductive and interpretive types of synthesis have been offered as an alternative approach, namely, meta-synthesis and realist synthesis (Tranfield et al., 2003). As Kraus et al. (2020) point out, the appropriate approach to synthesising the research literature depends largely on the **review question** and the **aim of the systematic review**; therefore, to achieve the aim of our systematic review, we adopted a narrative approach to synthesising gathered information.

**Narrative synthesis** is the most **appropriate choice** when researchers want to address various studies that have used different methods, built on different conceptualisations or explored different constructs or relationships. The narrative type of synthesis is particularly useful for linking different studies dealing with various topics in order to evaluate or build an overarching theory (Siddaway et al., 2018). This approach is suitable for the synthesis of various research topics that have been studied by different researchers coming from different scientific disciplines (Snyder, 2019). Such a narrative approach to synthesis is also helpful for a historical report on how research on a specific topic or theory developed through time (Siddaway et al., 2018). It allows us to explore how **research** in a particular scientific field has **evolved over time** or how a particular **topic** has been **shaped across different disciplines**. The process of synthesising findings is similar to other approaches in qualitative research. In general, content or **thematic analysis** can be used to identify, analyse, and summarise patterns. Narrative synthesis facilitates the identification of research themes, concepts, or theoretical perspectives within papers. It can also reveal the most prevalent issues and challenges within a scientific field (Snyder, 2019). Snyder (2019) points out that this type of synthesis can be used to create a map of research in a scientific field, capture the current state of knowledge in that research field, and provide research directions for future studies. It can also be used to create a timeline of how a particular research topic has evolved.

### 3.4 Descriptive Results of the Analysis

This chapter presents the descriptive analysis and outlines the research field of safety commitment and leadership. To better understand the research topic of safety commitment and leadership and to identify the research direction in which it is evolving, we have **divided the publications into two separate time series**, which is consistent with the previous chapter on bibliometric analysis. The first period includes papers published up to and including 2010 and the second period includes papers published after 2010, which corresponds to the period when the increase in the number of publications was observed.

As presented during the bibliometric analysis, out of 53 publications that formed our final sample, the majority (50) were categorised as articles, and the remaining publications (3) were categorised as conference papers (proceedings). As those papers met our quality criteria, we included them in the further analysis. The initial analysis of publication types based on the information from the Web of Science Core Collection database and initial review of publication title, keywords, and abstract indicated that there is only one review article and that the majority consists of empirical articles. However, a detailed analysis of the core literature revealed that there are four review articles in our sample. In the empirical articles, authors used a variety of research designs; surveys and interviews were the most common, followed by experiments, although to a smaller extent. In addition, we also analysed the research methods used in these studies. As shown in Figure 18, the majority (68 %) of the studies employed quantitative research methods. Qualitative research methods represent a much smaller proportion (21 %). However, some studies (11 %) also employed a mixed-methods approach, which is becoming increasingly popular among researchers.

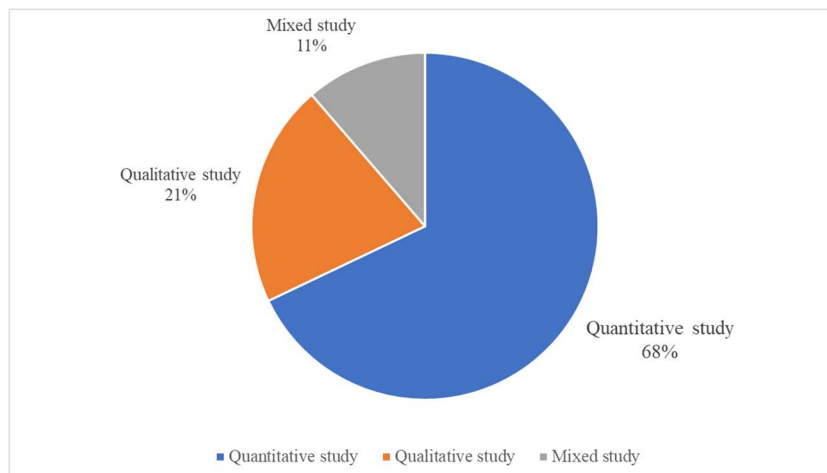


Figure 18: Type of research methods used in the sample (both periods combined).

To get a better picture of how the different types of **research methods varied between time periods**, we looked more closely at their distribution. In the first time period, 70 % of the studies used quantitative research methods, while in the second period, there were 67 % of such studies, indicating a slight decrease. On the other hand, the proportion of studies that used qualitative methods increased slightly in the second period, from 20 % to 21 %. The proportion of studies that applied mixed methods also increased slightly, from 10 % in the first period to 12 % in the second period. Figure 19 represents the proportion of different research methods in both periods.

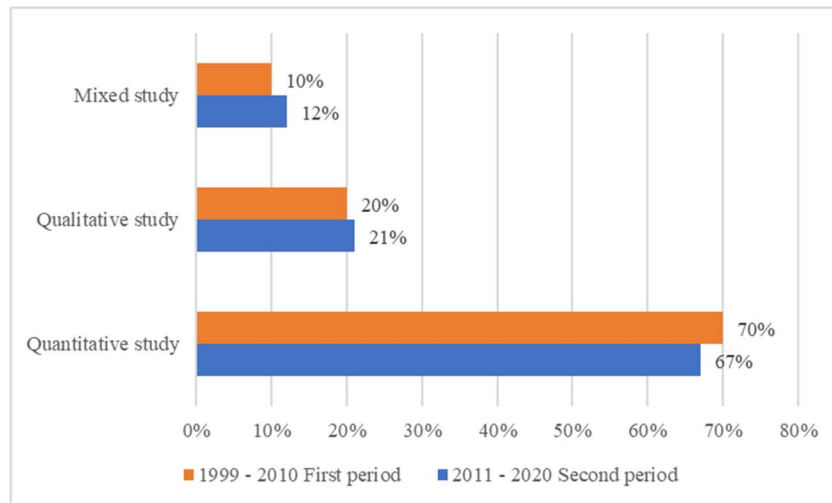


Figure 19: Type of research methods by the time period.

## 3.5 Synthesis of the Results

### 3.5.1 Theoretical foundation

This chapter presents a synthesis that summarises the results of the analysis of the core literature. The analysis of our core literature allowed us to identify the theories that were most frequently used by authors when addressing the research topic of safety commitment with relation to leadership. This provided us with an insight into the theoretical foundations upon which these papers were built. However, most articles did not explicitly refer to theories, which made it more difficult to infer the theoretical foundations upon which the authors were building. Theoretical sections in the articles were often sparse or omitted. Similar to the previous chapter, the results of the analysis are grouped thematically and presented across two separate time series.

#### 3.5.1.1 First time period

In the first time period, most authors drew on safety culture and climate literature; this can be attributed to the fact that managers' safety commitment is considered an essential element of culture and climate literature (Flin, 2003). The conceptual framework of safety culture and safety climate enables authors to highlight the important role of management and managers' safety commitment (O'Dea & Flin, 2001). Based on this, the authors propose and explore different **relationships** between **managers' safety commitment** and various **safety** and **non-safety-related concepts**. O'Toole (2002) used the aforementioned framework to explore how different factors related to safety culture, particularly managers' safety commitment and leadership, can have an important influence on how employees perceive the safety management system. The study by Flin (2003) addresses the organisational factors related to safety culture, focusing on the concepts of safety culture, climate, and safety management. Similarly, Pronovost et al. (2003) also build their conceptual framework on safety culture in conjunction with strategic planning and leadership. Luria and Rafaeli (2008) propose that an uninhibited view on organisational safety commitment can be captured through employee response to safety signs. Based on the projective test used in clinical psychology, they design a safety artefact interpretation

tool that can assess safety compliance and commitment, two main concepts of safety culture in the organisation that represent an alternative to safety climate measurement tools (Luria & Rafaeli, 2008).

However, the authors have also used other **theories** that are better known **from other scientific fields**, such as management and organisational behaviour, in order to address the relationship between safety commitment and other concepts. In their study, Hofmann and Morgenson (1999) build on the **social exchange theory** to explain observed relationships among safety constructs. Based on this theory, they proposed that two forms of social exchange: perceived organisational support and leader-member exchange, can have an important positive influence on safety. The study explored how organisational support and a positive exchange relationship with one's immediate supervisor manager are related to safety-related communication, safety commitment, and the occurrence of accidents (Hofmann & Morgenson, 1999). Michael et al. (2005) build on the previous work of Hofmann (1999) and extend it to address the relationship between managers' commitment to safety and **non-safety outcomes**. Based on the social exchange theory and organisational support, Michael et al. (2005) propose that employees develop positive attitudes and engage in desired behaviours to reciprocate treatment received from their managers. Therefore, managers should demonstrate that they care about employees' safety so that employees will reciprocate these actions by developing the desired attitudes and behaviours (Michael et al., 2005). Authors in our core literature also refer to other theories from the social sciences. In their review article, Flin and Yule (2004) address **leadership theory** in the context of industrial safety. More specifically, they focus on transformational, transactional, and laissez-faire leadership. Wu (2008) uses the **social system theory** to address connections between concepts of safety leadership, safety climate, and safety performance. Authors argue that a safety climate in the organisation can influence employees' behaviour through the group's behavioural norm, which results from the interplay between the organisation and its members. In this way, the behaviours result from interactions between individual and organisational factors (Wu et al., 2008).

The analysis of the core literature for the first time period also revealed McGonagle and Kath's article (2010) suggesting that **research should be steered away from the classical concepts** of safety climate and its constructs such as management safety commitment, as there is still a lack of agreement among researchers on safety climate dimensions, their number, and validity. Instead, attention should be focused on tensions that exist between safety and other organisational goals and on how employees perceive these tensions (McGonagle & Kath, 2010).

### 3.5.1.2 Second time period

Our analysis of the core literature for the second time period showed that authors continued to build their studies on the **theoretical foundations** of **safety culture** and **safety climate**. Similarly to the first period, authors extend and adapt the safety culture and climate framework with various safety and non-safety-related concepts or explore the relationship between the various elements of safety culture or climate. Hereinafter, we summarise the main theoretical foundations that were used in the articles from the second time period.

#### 3.5.1.2.1 Safety climate and culture

Wang and Liu (2012) explored safety commitment as one of the different dimensions of safety culture, proposed a model for the evaluation of safety culture and addressed the relationship between accidents at work and safety culture. Similarly, Beus et al. (2019) have explored the content of safety climate and identified seven elements that comprise

employees' perceptions of workplace safety priority, among which safety commitment of managers was highlighted as especially important. Authors described safety climate as one of the most important yet ambiguous concepts in safety research (Beus et al., 2019). Other authors built on the existing safety culture and climate literature to design a new safety climate measuring scale (Wu et al., 2019) or compared the perceptions of safety climate dimensions among employees in different job positions (Taher et al., 2014). Authors that extend and adapt safety culture and climate framework introduced different concepts like organisational change (Lofquist et al., 2011) or extended it to include safety behaviour, safety procedures, technology, and employees' personal awareness (Della et al., 2020). In the study of Bosak et al. (2013), three dimensions of safety climate, represented by management commitment to safety, safety priority, and production pressure, were addressed in relation to employees' risk behaviour. Similar to the aforementioned study, Amponsah-Tawiah and Anuka (2018) also address employees' safety-related behaviour when they are under pressure. However, in contrast to the previous study, the authors **addressed safety commitment** as an **independent concept** instead of a dimension of safety climate. The study was based on the theoretical framework that directly addressed the relationship between managers' safety commitment, managers' safety priority, pressure for production, and employees' safety participation and safety compliance behaviour (Amponsah-Tawiah & Anuka, 2018).

One group of authors focused on managers' safety commitment not only in the context of safety climate but also **health climate**. Shore et al. (2020) build on the concepts of managers' safety commitment, safety climate, and safety behaviour that represent safety environment; and concepts of managers' health commitment, health climate, and health behaviour that represent health environment. With this approach, the authors explored different climates in connection with each other (Shore et al., 2020). Schwatka et al. (2020) also address two similar yet distinct concepts of health and safety climate. The study proposes a conceptual framework that consists of health and safety strategies, commitment, and climate (Schwatka et al., 2020). Joss et al. (2017) focused on the implementation process of an integrated, holistic approach that would promote three important aspects: health, safety, and well-being of employees.

Our analysis of the core literature identified another group of authors that used the safety climate and culture framework and extended it to address the implementation of **safety programs** and **initiatives** into the organisation. For example, Zwetsloot et al. (2017) addressed the safety programme called "zero accident vision". It is based on a similar premise to the high-reliability theory, which proposes that accidents are in general preventable. "Zero" vision is manifested through the commitment of an organisation to provide a safe working environment and prevent all accidents (Zwetsloot et al., 2017). Igić et al. (2020) propose a conceptual framework that explores a relationship between the concept of ethical leadership, organisational commitment, and four factors that are essential for the implementation of the aforementioned safety programme, including safety commitment, climate, learning, and communication. This safety programme represents different policies, procedures and methods developed to improve safety in the organisation (Igić et al., 2020). Abdi and Ravaghi (2017) address the use of root cause analysis in order to identify potential problems and benefits of its application in practice. To facilitate the best results from its application, managers should clearly display their safety commitment. The study of Alfes (2020) also refers to the context of safety climate and culture. The author points out that in addition to a good training programme, there is also a need for strong safety commitment among all air medical professionals.

Hamid et al. (2015) explored how the concept of management safety commitment is addressed in the literature. The aim of the study was to identify elements that reflect the safety commitment of management and to highlight potential gaps in the literature.

Authors point out that a general focus of researchers on the commitment to safety in relation to safety climate and safety culture may impede the research on this concept (Hamid et al., 2015). Narrow theoretical focus can mean that the concept of **safety commitment is overlooked** in relation to other theories. Nevertheless, our systematic analysis revealed that some authors not only introduced new concepts to broaden the safety climate and culture framework, but also employed **other theories** from **different scientific fields**, primarily from the social sciences. Different theories were used to explain the relationship between safety commitment and various safety and non-safety concepts.

#### 3.5.1.2.2 Leadership theories

Safety commitment was also explored in relation to different **leadership theories** and **models**. In their study, Tappura, Nenonen et al. (2017) addressed the concept of safety commitment addressed in reference to concepts of safety management and leadership. Similar to other authors, Du and Sun (2012) also build on the theoretical background of safety culture and safety climate, extending it with the concept of safety leadership. The study addresses the relationship between safety leadership, comprised of both transformational and transactional leadership dimensions and safety climate dimensions, which includes safety awareness, safety training, safety involvement, and safety commitment (Du & Sun, 2012). A similar approach was also employed by Fischer et al. (2018); however, in addition to previously mentioned concepts, authors also add safety initiatives and safety outcomes into the conceptual framework to address the patient safety chain. Fruhen et al. (2014) explore concepts of skills (more specifically problem solving and social competence) and knowledge as determinants of behaviour that can demonstrate managers' safety commitment, which is considered a focal element of safety culture. Authors include concepts of skills and knowledge based on the **skill-based model of leadership** (Fruhen et al., 2014). Continuing with the focus on leadership, the ethnographic study of Wu et al. (2015) based on the theoretical framework of the **full-range leadership model** that includes transformational and transactional leadership. The grounded theory is used to identify four types of safety leadership that have an important role in the demonstration of senior manager commitment to safety in the organisation (Wu et al., 2015).

#### 3.5.1.2.3 Motivational theories

We also recognised another group of studies that focused on motivational theories to gain a better understanding of what drives employees to behave safer. Lim et al. (2018) build on the **self-determination theory**, which acknowledges both external and intrinsic sources of motivation that can have an important role in cognitive and social processes. The theory proposes that motivations range across the spectrum from a-motivation, which represents the absence of motivation, to controlled and autonomous motivation. The latter represents the most internalised form of motivation. Authors developed a conceptual framework consisting of safety climate elements (safety commitment, communication, competence, and environment), types of safety motivation (intrinsic, identified, introjected, and external), and safety performance represented by employees' safety behaviours (safety participation and compliance). The study by Taylor and Snyder (2017) also builds on motivational theory; however, the authors address the motivation of employees in relation to their risk perceptions. More specifically, the study is based on the **health belief model** and **protection motivation theory**. The premise is that employees' motivation to protect themselves is based on the expectancy of adverse health consequences and employees' inclination to avoid these consequences or limit their effect. In addition, protection motivation theory proposes that employees' safety behaviour depends on three

mechanisms: perceived seriousness of hazards, the efficacy of protective measures, and perceived likelihood of harm. The authors propose a theoretical framework that includes the concept of safety commitment, cognitive and affective risk perception, and safety compliance (Taylor & Snyder, 2017).

Al-Bsheish et al. (2019) build on **empowerment theory** and design a conceptual framework that includes the concept of psychological empowerment. Empowered employees are expected to be more efficient at work than other employees. In addition, the authors also draw on the **job performance theory** and introduce two types of safety performance in the proposed conceptual framework, namely safety compliance and safety participation. The final concept that brings this model together is managers' safety commitment, perceived from the employee's perspective. Employees' perceptions of managers' safety commitment are often used as one of the main components of safety climate; however, due to the importance of this concept, authors decided to address **managers' safety commitment** as an **independent concept** (Al-Bsheish et al., 2019). This represents an important shift in focus from safety climate and culture towards safety commitment. Tong et al. (2015) also build on the theoretical framework that includes leadership empowerment behaviour, psychological empowerment of health and safety officers/managers, safety commitment, organisational support, and teamwork safety.

There are also some other studies that focused on employees' individual characteristics in relation to managers' safety commitment. Fruhen and Flin (2016) proposed a conceptual framework that was based on the **theoretical model of occupational stress**. The chronic unease model consisted out of five components: pessimism, tendency to worry, flexible thinking, imagination, and vigilance. The model also included managers' risk perception and several contextual factors, and organisational barriers. The study revealed that chronic unease could have an important influence on various factors, including managers' safety commitment (Fruhen & Flin, 2016).

#### 3.5.1.2.4 Sociological and psychological theories

The analysis of our core literature revealed that a significant part of the authors **continues to build** on the **social exchange theory** in the second time period, which indicates that the role of this theory remains important for the research of safety commitment throughout both periods. For example, Novak et al. (2017) build their work on social exchange theory. Authors propose a framework to address relations between concepts of leader-member exchange, organisational commitment, commitment to safety, maintenance culture, and safety outcomes (Novak et al., 2017). In addition to the social exchange theory, Clark et al. (2014) also adopted the **instrumentality theory** to explain the relationship between theoretical concepts of safety climate and organisational citizenship behaviour. Thereby, the authors added a new concept that other studies have not yet addressed within this theoretical framework. The study proposes that through reciprocity, employees are compelled to specific behaviour when they receive benefits from their managers. When employees in hazardous environments perceive that management strives to keep them safe, employees reciprocate this by going beyond their job requirements. Besides the organisational safety policies, procedures, and practices, managers' safety-related actions importantly transmit managers' safety commitment to their subordinates that are then obligated and motivated to reciprocate. This reciprocity can go beyond mere compliance with safety standards and can even improve work performance (Clark et al., 2014). Laurent et al. (2018) build on the **job demands** and **resource model** adopted for safety violations. They further extend the model by introducing contextual elements of employees' safety participation and citizenship behaviour. In addition, the study also introduces the **social exchange theory** to explore different psychological processes that are fundamental for

safety behaviour. The newly proposed framework adopts social exchange theory based on the premise that safety participation can be stimulated through reciprocation, an important feature of the aforementioned theory. The perceived safety commitment of management is also a central component of this model. Authors argue that the safety commitment of management can be viewed through the rewards for safe behaviour, which is also an essential aspect of social exchange theory (Laurent et al., 2018). Hu et al. (2020) propose that safety compliance should be seen as a multidimensional concept. They develop **two new concepts** of **deep** and **superficial safety compliance** that distinguishes between different ways in which employees can comply with safety procedures and processes. Those forms of behaviour might look similar on the outside; however, they are fundamentally different. Authors propose that two dimensions of safety climate, employees' perceptions of managers' safety commitment and perceptions of punishment for not complying, can act as an antecedent of deep and superficial safety compliance. In addition, it is presumed that those two dimensions of safety climate can have a different effect on safety compliance. The proposed relationship is based on two theories, **social exchange theory** and **expectancy (valence) theory** (Hu et al., 2020).

Liang and Zhang (2019) build on the **social learning** and **social information processing theories**. Based on social learning, employees can imitate the safety violations of their supervisors directly by observational learning. According to social information processing, safety violations can be indirectly transferred through social interactions, like a leader-member exchange, and through the perceived environment, like safety climate perceptions. Therefore, the authors add the **leader-member exchange** concept, which is based on social exchange theory and safety climate concept consisting out of managers' safety commitment, implementation of safety procedures and rules, and employees' safety involvement to the proposed framework (Liang & Zhang, 2019). Similarly to the previous study, Cui et al. (2013) also draw on social literature; however, the authors took a slightly different approach and built on the social cognitive theory that developed on the aforementioned social learning theory. According to Mimiaga et al. (2009), this theory has frequently been used to address behaviour in the health context. It represents a bridge between learning and behavioural theories. The study builds on the theoretical framework of **social cognitive theory** and safety culture. Both theoretical approaches emphasise the environment, people and behaviour. In accordance with these theoretical foundations, authors develop their theory by focusing on the interactions between three main concepts; (1) safety climate represented by perceived managers' safety commitment and employees' safety beliefs, (2) safety behaviour that includes employees' safety behaviour and safety involvement, and (3) hazardous environment that refers to employees' perceptions of various threats at work (Cui et al., 2013). Ye et al. (2020) also used the social cognitive theory to propose a conceptual model that would explain how employees' perception of managers' safety commitment influences employees' safety compliance and safety participation. However, compared to the previous research, the concept of psychological capital is at the center of this study. The authors point out that employees' perceptions of managers' safety commitment are based on the employees' interpretations of safety cues; this represents a cognitive process that corresponds to the social cognitive theory. Through employees' psychological capital, the study describes how employees' perception of managers' safety commitment influences employees' safety behaviour. Contextual stimulus influences the individual's behaviour, as the individual uses cognitive resources to interpret and process those signals. This context does not consist only of the physical environment but also includes the deeper values and attitudes. When applying social cognitive theory to employees' safety behaviour, authors propose that self-regulatory functions of employees,

which support their behaviour, represent a link between employees' perceptions of managers' safety commitment and the safety behaviour of employees (Ye et al., 2020).

Building on **age-related resource selectivity theory**, Turner et al. (2020) propose that young employees are less able to recognise supervisors' safety commitment and less aware of the consequences of expressing their safety concerns when their supervisor is not safety committed. The authors designed a conceptual framework that consists of safety voice, age group, and supervisors' safety commitment. Authors point out that, according to the age-related resource selectivity studies, there are differences in the cognitive resources that are committed to the social interactions during the lifespan of the individual (Turner et al., 2020).

#### 3.5.1.2.5 Organisational theories

A systematic review of the literature revealed that some authors also explored managers' commitment to safety in relation to various organisational theories adopting different research designs and approaches. Similar to many other articles in our analysis of the core literature, Biggs et al. (2013) also build on the theoretical foundations of safety culture. However, unlike other authors, they consider the concept from the managerial perspective and compare managers' perceptions of safety culture with the current theoretical understanding of this concept in the literature. The authors point out that the concept of safety culture still does not have a generally accepted definition, which makes it difficult to operationalise and research. In addition to inconsistent definitions, a variety of different factors used to encompass safety culture presents another challenge to researchers. The study set the concept of safety culture within the **theory of organisational alignment**, which proposes that the alignment of different organisational elements can lead to the best performance (Biggs et al., 2013). Schwatka and Rosecrance (2016) focus on three dimensions that reflect safety commitment. Researchers addressed the concept of safety commitment at three distinct organisational levels: at the level of senior managers, immediate supervisors and employees/co-workers. Through this design approach, the authors explore how managers' and supervisors' commitment to safety is transferred into the safety behaviours of employees (Schwatka & Rosecrance, 2016). How managers convey their safety commitment to employees was also recognised as an important research direction by other authors. For example, Bowers and Fleming (2018) apply **signalling theory** to propose a framework that would illustrate how managers are signalling their safety commitment to the employees and how employees form a perception about the managers' commitment to safety. Authors propose that employees deduce managers' commitment to safety based on observation of signals through which managers demonstrate their commitment. Those signals usually represent the behaviours and decisions of managers (Bowers & Fleming, 2018). Similarly to previous authors, Stackhouse and Turner (2019) propose a conceptual framework in which psychological safety climate and co-worker safety commitment work as signals. The framework includes the concept of work-related practices, safety effectiveness of the system, co-worker safety commitment, and psychological safety climate. The designed moderated mediation framework includes both antecedents as well as outcomes of safety climate perceptions. The authors point out that the concept of psychological safety climate used in this study refers to individual perceptions of values and safety commitment of their managers and immediate supervisors. Therefore, the concept is measured solely in the form of perceived managers' safety commitment (Stackhouse & Turner, 2019). Fruhen et al. (2015) used the **attraction – selection – attrition model** to develop a theoretical framework. The model proposes that if the values of the organisation and the values of prospective employees match, job

candidates are more attracted to the organisation and have a higher probability of being hired by the organisation (Fruhen et al., 2015).

Another group of authors decided to deviate even further from the theoretical foundations of safety climate and culture literature and draw from **organisational commitment theory**. Delegach et al. (2017) propose a model that is based on the **self-regulatory theory**, which is one of the important motivational theories, a three-component model from **organisational commitment theory**, and **social categorisation theory** that suggest that a specific attitude predicts specific employee behaviour more accurately than general attitude. In the line of aforementioned theories, the study proposes a new concept of employees' commitment to safety that is distinct from others before, as it builds on the organisational commitment theory instead of safety culture and safety climate. In addition, the theoretical framework encompasses various leadership styles (e.g., transactional, transformational) and their influence on organisational and safety commitment of employees (Delegach et al., 2017). Also founded on **organisational commitment theory**, Fruhen et al. (2019) propose a new multidimensional framework of managers' commitment to safety. The authors draw the idea on the established conceptual framework of workplace commitment from the field of organisational behaviour. They propose a framework of managers' commitment to safety that is based on Meyer and Allen's commitment model (Meyer & Allen, 1991). Further, building on the **theory of social information process**, Fruhen et al. (2019) also address safety behaviour through which managers demonstrate their commitment to safety. The premise is that employees' perceptions of managers' safety commitment are based on the managers' actions that employees can observe. Based on the literature, they propose different categories of safety commitment demonstrations. Somewhat differently, the concept of safety commitment was addressed by Alingh et al. (2018), who draw from the **human resource literature**. The authors build on the two concepts of the management approach, namely **control** and **commitment management**. Although both concepts are usually addressed separately, the authors propose that two distinct management approaches should be combined when addressing high-level managers. The study proposes that the control and commitment management approaches are distinct concepts; however, they are both important for patient safety management. Authors consider the concept of safety commitment as a subdimension of the commitment management approach (Alingh et al., 2018). According to Li et al. (2019), safety commitment should be positioned within the concept of safety attitude. Employees' attitude that reflects the emotions and beliefs of employees regarding organisations' safety policies, practices, and procedures is represented by four dimensions: managers' commitment to safety, job stress, employee fatalism, and team safety climate (Li et al., 2019).

In addition to the overview of theories that were employed by various authors that researched the concept of safety commitment, we also focused on how the concept was framed in relation to other concepts and theories used in those studies. This enabled us to categorise the articles according to how they were positioned in the literature and their relation to other concepts and theories. Since safety climate and safety culture were recognised as predominant theoretical backgrounds, they were used as a reference point for further classification of articles. Proposed categories correspond to the degree to which the theoretical foundation of the articles departs from the safety climate and culture literature. However, we have to point out that the categorisation was rather difficult as there was a fine line between different papers and the way in which authors addressed the concept of safety commitment. Categories identified during our analysis are presented in Table 8.

Table 8: Categorisation of articles according to their theoretical foundation.

<b>Addressing the concept</b>	<b>Relating to safety climate and culture</b>	<b>Authors</b>
Safety commitment as a concept within the safety climate and culture	Building on existing theoretical foundation of safety climate and/or culture or adding a new concept	O'Dea & Flin (2001); O'Toole (2002); Flin (2003); Pronovost (2003); Luria & Rafaeli (2008); McGonagle & Kath (2010); Wang & Liu (2012); Du & Sun (2012); Bosak et al. (2013); Taher et al. (2014); Schwatka & Rosecrance (2016); Abdi & Ravaghi (2017); Joss et al. (2017); Tappura, Nenonen et al. (2017); Fischer et al. (2018); Beus et al. (2019); Wu et al. (2019); Alfes (2020); Della et al. (2020)
	Relating to the other theories	Flin & Yule (2004); Wu et al. (2008); Biggs et al. (2013); Clark et al. (2014); Fruhen et al. 2015; Novak et al. (2017); Taylor & Snyder (2017); Lim et al. (2018); Stackhouse & Turner (2019); Liang & Zhang (2019); Hu et al. (2020)
Safety commitment as an independent concept based on safety climate and culture	Building on existing theoretical foundation of safety climate and/or culture or adding a new concept	Lofquist et al. (2011); Hamid et al. (2015); Zwetsloot et al. (2017); Amponsah-Tawiah & Anuka (2018); Shore et al. (2020); Igić et al. (2020); Schwatka et al. (2020)
	Relating to the other theories	Hofmann and Morgerson (1999); Michael et al. (2005); Cui et al. (2013); Fruhen et al. (2014); Tong et al. (2015); Wu et al. (2015); Fruhen & Flin (2016); Bowers & Fleming (2018); Laurent et al. (2018); Al-Bsheish et al. (2019); Turner et al. (2020); Ye et al. (2020)
Safety commitment as a concept based on different theoretical foundations	Building on the new theoretical foundation	Delegach et al. (2017); Alingh et al. (2018); Li et al. (2019); Fruhen et al. (2019)

## 3.5.2 Addressing the concept of safety commitment

The studies in our core literature address safety commitment in different ways, highlighting its various roles. In the systematic review, we analysed how safety commitment has been addressed and identified different conceptual frameworks in which managers' safety commitment represents an important element.

### 3.5.2.1 Safety commitment as an important element of safety culture and climate

**Managers' commitment to safety** and managers' actions are recognised as **core elements** of an organisation's **safety culture** and its surface features – **safety climate** (Flin, 2003; Flin & Yule, 2004). Wu et al. (2008) showed that the relationship between concepts of safety leadership and safety performance is partially mediated by safety climate. Further, the study highlights that among the various elements of the safety climate that can positively influence safety outcomes, the safety commitment of high-level managers was found to be the most important. Without managers' safety commitment and actions that manifest the safety commitment, safety management can easily fail (Wu et al., 2008). Managers who visibly demonstrate safety commitment to employees represent the most important factor that can positively influence safety culture (Biggs et al., 2013). As an important factor of safety climate, managers' safety commitment has the ability to influence different types of safety motivation in employees, which, in turn, can lead to better safety performance (Lim et al., 2018). The study by Beus et al. (2019) explored the content of safety climate and identified seven elements that reflect the priority that is dedicated to safety. Findings showed that the safety commitment of managers represents an especially significant indicator of safety priority. Managers' safety-related actions that show their safety commitment can greatly influence both individual and group safety climate perceptions. Several other studies in our core literature also concur that managers' safety commitment represents one of the most important dimensions of safety climate that can influence employees' safety behaviour (Alfes, 2020; Clark et al., 2014; Taher et al., 2014; Wu et al., 2019).

In addition, managers' commitment is not limited to the context of safety climate but is also relevant in relation to **other organisational sub-climates** such as health climate. For example, Shore et al. (2020) focused on how employees' perceptions of managers' health and safety commitment can influence health and safety climate and (participatory) health and safety behaviour of employees (Shore et al., 2020).

### 3.5.2.2 Employees' perceptions of safety commitment

Continuing with **employees' perceptions** of managers' **safety commitment**, Bowers and Fleming (2018) address the important role of how employees perceive the safety commitment of their managers. If employees perceive that safety has a priority over other goals (e.g., productivity), employees are more willing to comply with safety procedures and even actively participate in safety programmes. This is perhaps even more important in safety-critical organisations, especially in settings where there is no direct supervision. Findings indicate that various factors can influence the employees' perceptions, including not only the nature of the message but also the sender and receiver (Bowers & Fleming, 2018). Similarly, perceived managers' commitment to safety can also have an influence on unsafe behaviour among employees. Bosak et al. (2013) point out that if actions and communication of high-level managers demonstrate their support towards safety and if managers create a perception among employees that the organisation prioritises safety above other organisational goals, employees are less inclined to behave riskily. The behaviour of high-level managers tends to be observed and adopted by other managers in

lower organisational positions with direct influence on employees (Flin, 2003). Wu et al. (2015) point out that high-level managers can demonstrate commitment to safety down the hierarchical structure to the middle managers and immediate supervisors. This represents an important way in which high-level managers can indirectly convey their commitment to employees.

Findings by Cui et al. (2013) indicate that employees' perceptions of managers' safety commitment can mediate the relationship between the way in which employees perceive the hazards in a work environment and employees' beliefs regarding safety. Another important finding is that no direct relationship between employees' safety beliefs and the hazardous environment was found. This is important as it indicates the essential role of managers in connecting employees' perceptions of the hazardous environment and their safety beliefs (Cui et al., 2013). Taylor and Snyder (2017) also focused on employees' perception of risk and safety commitment of managers; however, in addition to the previous study, authors also address employees' safety-related behaviour. Findings indicate that managers' safety commitment can increase perceived risk among employees, which, in turn, influences employees' behaviour (Taylor & Snyder, 2017). Cui et al. (2013) point out that employees' safety behaviour will remain passive in the event of potential safety threats if employees perceive that high-level managers are not committed to safety. Therefore, the safety commitment of managers presents a link between employees' perceptions of the environment, their safety beliefs and safety behaviour (Cui et al., 2013). The important mediating role of perceived managers' safety commitment is further recognised by Al-Bsheish et al. (2019) who explored the relationship between psychological empowerment, managers' safety commitment and safety performance, represented by employee safety commitment and participation.

However, it is not only the perceived commitment of managers that is important. Liang and Zhang (2019) propose that if employees perceive that their immediate supervisors violate safety procedures, they are also more inclined to violate them themselves. If employees observe supervisors' safety violations frequently, this might signal employees that safety violations represent appropriate behaviour. Since supervisors can be seen as mediators between managers and employees, their safety violations might signal to employees that high-level managers do not value safety and do not promote safe working behaviour (Liang & Zhang, 2019).

From the examples presented above, it is evident that the employees' perceptions of managers' safety commitment can significantly influence safety performance represented by employees' safety-related behaviours. This focus on employees' perceptions can be, at least partially, attributed to the theoretical framework of safety climate and culture in which the concept of safety commitment is positioned, and it is described in more detail in Chapter 3.5.1.

### 3.5.2.3 Supporting safety policies, procedures, and practices

The safety commitment of high-level managers is addressed as an important factor that can support **safety policies, procedures** and **practices**. Schwatka et al. (2020) address managers' safety commitment as a moderator that can influence the relationship between safety strategies and programmes and organisations health and safety climates. Organisation's policies, procedures, and practices can also be seen as a signal to employees that the organisation supports employees and puts forward their health, safety, and wellbeing. However, the way in which managers are implementing and supporting these strategies can have an important effect on the development of employee perceptions (Schwatka et al., 2020). In other words, we can say that both signals (in the form of policies and managers' behaviour) should interact harmoniously to influence the desired perceptions

of safety commitment among employees. Similarly, other researchers (Joss et al., 2017) also identified strong managers' safety commitment as a key determinant that would facilitate the implementation of an integrated health, safety, and wellbeing approach.

Managers' approach to safety that exhibits managers' safety commitment was also highlighted by researchers as the most significant factor that can influence the positive perception of **safety management system** among employees (O'Toole, 2002); support the application of **protocols** for accident investigation (Abdi & Ravaghi, 2017); and facilitate the implementation of **safety programmes** and **initiatives** (Igić et al., 2020; Zwetsloot et al., 2017). This is especially important when employees are under pressure, as they tend to abandon safety procedures and consequently jeopardise their own safety and the safety of other co-workers. The findings of Amponsah-Tawiah and Anuka (2018) showed that managers' safety commitment can have a positive influence on the employees' ability to follow safety procedures when they are under pressure. However, as pointed out by Pronovost (2003), it is not only that managers' safety commitment can support the implementation of organisations' safety strategies; these strategies also reflect managers' attitudes towards safety, which in turn influence employees' perceptions. Therefore, this should be seen as a two-way process.

Generally, management put in place a wide range of various safety procedures and practices to support safe behaviour and prevent adverse safety outcomes. It is proposed that if employees comply with these procedures and practices, this can improve the safety of the organisation. However, Hu et al. (2020) highlight that if employees comply with safety procedures only superficially, merely for the sake of the activity itself, this might achieve exactly the opposite effect on the safety outcomes. This only seemingly creates an impression that employees devote required attention to organisational procedures. Despite surface safety compliance might on the outside meet all requirements of safety task, superficial compliance might not actually accomplish the safety goal of this specific task. Even more, such employees' compliance defeats the goal of the safety procedures and even creates a false sense of safety. This is especially significant in safety-critical organisations that heavily rely on employees to comply with safety policies, procedures, and practices in order to enhance safety (Hu et al., 2020). Therefore, Hu et al. (2020) propose that managers should promote deep safety compliance among employees by conveying genuine safety commitment.

#### 3.5.2.4 Safety commitment as a signal

**Managers' commitment to safety** represents a **signal** to employees. According to researchers (Laurent et al., 2018; Ye et al., 2020), employees' perceptions of managers' safety commitment represent **contextual cues** for employees, indicating what safety behaviours are promoted and what goals employees should pursue. By observing managers' safety commitment, employees develop a clearer understanding of what activities and responsibilities are expected from them, which facilitates employees' safety compliance. Managers that are committed to safety also represent safety role models for employees and therefore motivate them to participate in voluntary safety activities and engage in safety behaviour that exceeds formal requirements. If safety is perceived as a priority, this also signals to employees that managers care for their safety, encouraging them to reciprocate this back to managers and participate in safety behaviour (Ye et al., 2020). Those cues, which are based on the behaviour of managers, also indicate what are organisations' safety norms, and consequently shape employees' safety perceptions (Bosak et al., 2013). To enhance cues that signal managers' safety commitment, Laurent et al. (2018) propose that managers communicate and demonstrate their safety commitment. Authors argue that managers' commitment to safety can be signalled through their **actions** (what managers

do) as well as their **words** (what managers say). However, if the actions and words of managers are not consistent, this might lead to loss of trust among employees and consequently to negative perceptions of managers' safety commitment (Lofquist et al., 2011). Stackhouse and Turner (2019) propose that work-related practices (procedure, training, and work pressure) can influence perceived managers' safety commitment, which, in turn, acts as a signal through which high-level managers show how important safety is for the organisation.

Focusing on work environments where employees are not in direct contact with managers, the study of Schwatka and Rosecrance (2016) showed that co-workers' commitment to safety could help to explain how managers' and immediate supervisors' commitment to safety is transferred into the safety behaviour of employees. Nevertheless, it is also important to consider the **interaction** of the aforementioned signals **with other signals** from the local environment. The co-worker safety commitment is proposed as a possible moderator that can influence the safety commitment that managers signal to employees (Stackhouse & Turner, 2019).

However, it is also important how **clearly** and **un-ambiguously** the **signal** is conveyed to the employees. Turner et al. (2020) highlight the important role of clear and consistent signals of safety commitment. Authors argue that supervisors that signal their safety commitment clearly and those that are conveying ambiguous signals of their safety commitment affect the intentions to express a safety voice among young and adult employees differently. Authors propose that older employees would be more reluctant to speak up about safety issues than younger employees if supervisors did not show clearly that they are committed to safety (Turner et al., 2020). In addition, conveying a clear commitment to safety may also play an important role when an organisation tries to attract new employees. The study by Fruhen et al. (2015) addresses the question of how the organisation can attract new employees with specific personal characteristics that are associated with desired safety behaviour by emphasising safety importance in job advertisements. The study implies that it is not enough to signal the safety orientation of the organisation through the job advertisement. Authors point out that safety commitment might have an important role in attracting employees with desired safety attributes (Fruhen et al., 2015).

### 3.5.2.5 Managers' ability to convey safety commitment

Since managers' safety commitment was recognised as important, some studies focused on **factors** that can promote or hinder **managers' ability to convey safety commitment**. Fruhen et al. (2014) explore the characteristics that enable managers to demonstrate their commitment to safety through safety behaviour. More specifically, the study addresses the role of social competencies, problem-solving abilities, and safety-specific knowledge in this type of behaviour. Fruhen and Flin (2016) propose that the experience of chronic unease amongst managers can have a positive influence on their safety commitment. More specifically, the study explores the applicability of five components of chronic unease to the experience of chronic unease in senior managers and address the corresponding behaviours and following consequences. Another interesting aspect of managers' safety commitment has been highlighted by Tappura, Nenonen, et al. (2017); authors point out that despite managers' commitment to safety, managers might not have the power to act or perceive that some organisational factors hinder their ability to address safety issues. The study identified different organisational factors that can have an important influence on the managers' safety commitment and proposed several organisational approaches and measures that can contribute to managers' safety commitment (Tappura, Nenonen, et al., 2017).

Analysis of our core literature revealed that managers' safety commitment is most often addressed through the perceptions of employees. Generally, safety commitment is positioned in the context of safety culture or climate. As such, it represents the link between managers' values and care for safety and employees' attitudes toward safety. In other words, managers' safety commitment can, through employees' perceptions, influence employees' safety commitment. Commitment is generally manifested in managers' actions. These observable actions represent cues that signal employees that managers care for their safety and indicate what type of safety behaviour is desired and promoted in the organisation. Consequently, the safety commitment of managers can lead to better safety performance of employees and positive safety and non-safety outcomes. Regarding our time frame, we can see that the majority of conceptual frameworks in which safety commitment was addressed remained relevant **throughout both time periods**. The exception are only studies where authors addressed safety commitment as a signal or explored the managers' ability to convey their safety commitment. Systematic analysis showed that these two aspects started to attract the attention of researchers **only in the second period**.

### 3.5.3 Addressing the concept of leadership

Our analysis of the core literature revealed that the concept of leadership had been addressed in various ways in relation to the managers' safety commitment. While some studies directly addressed the concept of leadership in relation to managers' safety commitment, other studies only referred to the concept indirectly.

#### 3.5.3.1 Various safety roles of leadership

In our core literature, the concept of **leadership** was related to various **safety roles**. In their study, Wu et al. (2008) establish that safety leadership can have two important roles for organisation's safety. First, it can positively influence employees' perceptions of high and middle level managers' safety commitment and actions that can, in turn, have a positive influence on safety performance. Second, safety leadership can also have a direct influence on safety performance. Wu et al. (2008) define safety leadership as the relationship between managers and employees in which managers use their influence on employees to attain organisation's safety-important goals. Safety controlling was recognised as the most important dimension of safety leadership. It includes the monitoring of employees' performance, comparison of performance against established safety goals, and in the case of serious deviations, implementation of corrective actions. The other two dimensions of safety leadership proposed by Wu et al. (2008) are safety caring and safety coaching. Wang and Liu (2012) define safety leadership as managers' care for safety that involves reminding and encouraging employees to engage in safe behaviour, participating in periodical safety inspection, safety monitoring, and promoting active participation of employees in proposals for safety improvements (Wang & Liu, 2012). Du and Sun (2012) argue that managers' safety leadership, which represents an example for employees, and managers' safety commitment are essential if the organisation strives to develop a safety culture. Cui et al. (2013) argue that managers' commitment to safety also includes safety leadership roles like providing support, coordinating and planning. Wu et al. (2015) highlight four distinct leadership practices in relation to safety commitment. The first out of four safety leadership categories represents controlling and performance management that establishes trust with employees and forms a foundation for the other three categories of managers' safety leadership; namely, motivation and coaching, influence and role modelling, and caring and respect. The first category of safety leadership corresponds to

the transactional leadership style, and all of the following three categories correspond to the transformational leadership style (Wu et al., 2015). In addition, the consistency of leadership behaviour is also important. Michael et al. (2005) point out that, when it comes to safety, managers should demonstrate consistent leadership as it promotes perceptions of managers' safety commitment among employees.

However, **not all authors agree on the concept of leadership** and its suitability to address different actions that convey managers' safety commitment to employees. Alingh et al. (2018) propose that managers' behaviour and actions should be better described with the management approach rather than their leadership style. The management approach is a broad concept that covers not only managers' behaviour but also managers' personality and a wide range of managerial practices used to influence workforce behaviours. In addition, the authors argue that a combination of two management approaches, control and commitment management, would yield the best results. A management approach that is control-based is characterised by formal, top-down procedures and regulation, monitoring of employees, and control of their safety behaviour. On the other hand, a management approach based on commitment emphasises employees' safety awareness and internalisation of the organisation's safety vision, goals, and strategy (Alingh et al., 2018).

### 3.5.3.2 Leadership that conveys safety commitment

In some studies, type of **leadership** was regarded as a **means through which managers demonstrate their safety concern** to the employees (O'Dea & Flin, 2001). Flin (2003) suggest that together with managers' behaviours that demonstrate safety commitment, managers' leadership style should also be considered. The specific role of high-level managers and their leadership has been highlighted as especially important by various researchers (Flin & Yule, 2004; Biggs et al., 2013). However, the knowledge of which leadership style would be the most effective for high-level managers in the context of safety is still limited. Despite that, the leadership approach to safety should not be particularly different from the leadership that strives to achieve other business objectives (e.g., achieve job satisfaction or increase productivity); it might require a slightly different approach since it lacks appeal for employees.

Different types of leadership are connected to different perceptions of safety climate among employees; those perceptions, in turn, predict the safety performance of the organisation (Flin & Yule, 2004). Leadership has been identified as an important factor that can further promote the safety commitment of employees (O'Toole, 2002). Flin and Yule (2004) connect transformational, transactional, and laissez-faire leadership with the various safety roles that managers can have at a different organisational level. Authors propose that a safety climate that includes managers' safety commitment can be seen as a mediator between the leadership style of managers and safety performance. The positive influence of the **transformational** leadership style has been shown at all levels of management; however, at the supervisory level, the **transactional** style that monitors and reinforces employees' safety behaviour has also been effective (Flin & Yule, 2004). Similarly, Flin (2003) suggests that transformational and transactional (with reward) might be effective for safety management. This is also supported by a later study by Ye et al. (2020) who highlight that transformational and transactional (management by exception active) leadership style can have an important influence on the safety behaviour of employees. Luria and Rafaeli (2008) confirmed a relationship between the interpretation of organisations' safety artefacts that indicate safety commitment and managers' type of leadership. Employees that interpreted the safety artefacts as a sign of organisational safety commitment scored their managers higher on the transformational leadership scale. Conversely, employees that interpreted safety artefacts as a sign of organisational safety

compliance with rules rated their managers with lower scores. It is proposed that managers with a transformational style of leadership are more safety-committed and manifest a clearer safety orientation (Luria & Rafaeli, 2008). The transactional and transformational style of leadership was recognised by other authors (Du & Sun, 2012; Fruhen et al., 2014) who also highlight the potentially important role of **authentic** (Fruhen et al., 2014) and **ethical** leadership (Igić et al., 2020).

However, there are also **negative types of leadership** that have to be considered. Liang and Zhang (2019) point out that safety violations of immediate supervisors can be seen as a specific type of unsafe leadership that can cause further expansion of unsafe behaviour among employees. Supervisors and their managers should be aware of their unsafe behaviour, no matter how trivial, as they can promote general unsafe behaviour among employees (Liang & Zhang, 2019).

Delegach et al. (2017) propose that **different leadership styles** promote the development of **different components of safety commitment** in employees. The study showed a positive relationship between transformational and transactional (active) leadership style and employees' promotion and prevention focus, which were positively related to employees' organisational and safety commitment. Promotion and prevention focus represents an important motivational mechanism that mediates the relationship between managers' behaviour and the commitment of employees. However, the results of the study also showed that the passive form of transactional leadership was not related to either type of employee regulatory focus. Authors attribute this to a stronger connection between components of active transactional or transformational leadership styles and self-regulatory focus. On the other hand, the inactive component of passive transactional leadership might not be effective enough to motivate employees and influence their commitment (Delegach et al., 2017). In contrast to previous research on safety leadership that considered managers' behaviours and different styles of leadership, Fruhen et al. (2019) focused on managers' mindsets that are behind the leadership actions through which high-level managers can enhance organisational safety. Thus, the concept of safety commitment becomes integrated with leadership concepts. The authors establish a foundation for the research that addresses managers' experience of their commitment to safety and explores how **safety commitment can be translated into managers' actions** that are important for safety. Those actions subsequently shape employees' perceptions of their managers' safety commitment (Fruhen et al., 2019).

Leadership also plays an important role in developing the **leader-employee relationship**; for example, in the case of leader-member exchange dyads, a high-quality exchange relationship was positively related to safety commitment, which was then negatively related to work accidents (Hofmann & Morgeson, 1999). Further, building on the findings of the aforementioned study, Michael et al. (2005) proposed that if managers demonstrate a high level of concern for employees' safety, this would be reciprocated by their employees in lines of safe work behaviour (Michael et al., 2005). Novak et al. (2017) extend this to include the safety commitment of employees and propose that a positive leader-member exchange relationship that supports safety can positively influence employees' commitment to safety, which are then, in turn, willing to go beyond mere compliance with basic safety standards.

The thematic analysis of core literature showed that the concept of leadership was closely related to safety commitment **in both time periods**. Most of the above descriptions of leadership roles strongly resemble various safety-related actions that managers use to demonstrate their commitment to safety. From this, we can infer that leadership plays an important role in conveying managers' commitment to safety to employees. Through leadership, managers' safety commitment is transferred to employees

and, in turn, can improve employees' perceptions of managerial safety commitment and promote the development of safety commitment among employees.

### 3.5.4 Characteristic of safety commitment and leadership

#### 3.5.4.1 Definitions of safety commitment

The analysis of the core literature revealed that authors used **various definitions of safety commitment**. In the majority of studies, authors did not specifically define safety commitment, which may indicate that authors presume that readers are familiar with the precise meaning of the concept, as its important role in the safety culture and climate literature is widely recognised (Flin, 2003; Flin & Yule, 2004; Hofmann & Morgeson, 1999; O'Toole, 2002; Pronovost et al., 2003). Other authors, like O'Dea and Flin (2001), used descriptive definition in which they use the term managers' safety commitment to broadly describe a wide span of managerial safety activities and roles. The term represents safety-important elements over which managers have direct and indirect control (O'Dea & Flin, 2001). In a similar manner, Luria and Rafaeli (2008) describe safety commitment as organisation's efforts to assure and maintain safety throughout its operations. Flin and Yule (2004) describe safety commitment and the way in which managers demonstrate this commitment to employees as an important component of safety culture. Such explicit or implicit reference to safety culture or safety climate can be found in most studies in our core literature sample. In reference to our two time periods, we can see that such a broad description of safety commitment is common throughout the **first time period**.

The use of such a descriptive definition also continued **in the second time period**, with the definition of Wang and Liu (2012) that defined safety commitment as managers' safety attitudes and safety behaviour that involves addressing safety issues, supporting safety, and resolving safety problems. Zwetsloot et al. (2017) describe the safety commitment of an organisation as the extent to which the organisation is engaged in preventing accidents and promoting safety. However, in addition to different descriptive definitions that varied from author to author, **one definition began to emerge** more and more frequently. Several authors (Al-Bsheish et al., 2019; Fruhen et al., 2014; Hamid et al., 2015; Liang & Zhang, 2019; Tappura, Nenonen, et al., 2017) build on the definition by Neal and Griffin (2004) that define safety commitment of management as "the extent to which management is perceived to place a high priority on safety and communicate and act on safety issues effectively" (p. 27). In addition, Tappura, Nenonen et al. (2017) argue that managers' engagement can also be seen as a synonym for commitment. In their study, therefore, they also relate to the definition of engagement by Schaufeli and Bakker (2004) who define the concept of engagement "as a positive, fulfilling, work-related state of mind that is characterised by vigour, dedication, and absorption" (p. 298). Hu et al. (2020) built on the work of Hansez and Chmiel (2010) and defined managers' safety commitment as "the extent to which management values the importance of safety" (p. 270).

Perhaps the most **important development in the definition of safety commitment** that has shaped this research field in the second period is represented by studies that attempt to redefine the concept of safety commitment. Delegach et al. (2017) proposed a new concept of employees' safety commitment and described it as a "new specific form of commitment" that consists of affective and continuance components. Affective safety commitment is defined as "a desire to support and invest in workplace safety" and "it reflects personal involvement with, and attachment to the goals and values of safety". On the other hand, continuance safety commitment is founded "on a recognition that there are costs associated with violation of safety procedures and instructions." Continuance safety commitment "reflects the individual's recognition of the costs

associated with discounting safety” (p. 2). In a similar manner, Fruhen et al. (2019) define the safety commitment of managers as an “action commitment that reflects their mindset and drive to support organisational safety” and propose that managers’ commitment to safety should be seen as a psychological state (p. 204). Corresponding to this definition, managers’ commitment to safety encompasses affective, calculative, and normative components. According to Fruhen et al. (2019), the affective safety commitment represents “an emotional and sometimes passionate sense of personal care for keeping individuals in and outside of the organisation safe”; calculative safety commitment represents “a transactional or rational requirement to prioritise safety as an obligation to business survival as well as other external pressures”; and normative safety commitment represents “a moral obligation for safety as a core human and social value and as the right thing to strive for” (p. 205).

According to the aforementioned definition, safety commitment can be considered as a specific type of commitment directed towards a specific goal. In this approach, managers’ safety commitment is considered as a specific attitude, that affects managers’ safety-related actions to achieve a specific goal. Although safety is a specific goal with particular characteristics that make it difficult to measure (Lofquist, 2010), researchers argue that focusing on safety commitment as a particular form of action commitment to a specific goal is highly appropriate for safety research (Fruhen et al., 2019; Delegach 2017).

### 3.5.4.2 Manifestation of safety commitment

From the definitions of safety commitment described in Chapter 3.5.4.1, we can infer that it is generally the attitude of managers towards safety, as demonstrated by their safety activities as managers. These safety activities, in turn, demonstrate managers’ safety commitment to employees. **Demonstration of safety commitment** is important as it **signals employees** that managers give **high priority to safety**. If management values safety, considerable effort is directed towards safety issues to ensure safety and prevent future accidents. Therefore, we focus our analysis on various ways in which the safety commitment of managers can be demonstrated and conveyed to employees.

Thematic analysis performed as part of a systematic review revealed **eight categories of actions** through which **managers demonstrate their safety commitment** to employees. Those categories are presented in Table 9. Authors classified in each category of safety commitment manifestation are listed in chronological order. We can see that articles in our core literature recognised allocation of resources and communication, followed by managers’ involvement and support and guidance, as the most important actions through which managers demonstrate their safety commitment.

In relation to our time frame, we can see that various actions through which managers can show their commitment to safety are relatively evenly **represented in both time periods**, especially considering that significantly fewer articles (10) were published in the first period than in the second period (43). The rest of this chapter describes in more detail the different ways in which managers’ commitment is manifested.

Table 9: How safety commitment is manifested.

<b>Category of manifestation</b>	<b>Description of elements</b>	<b>Authors</b>
Communication	Personal communication, clear communication, articulate safety vision, provided feedback, communicate safety strategies, clearly state that safety is a priority and is viewed as a desired outcome, clearly and visibly state organisations safety policy.	Hofmann & Morgerson (1999); O’Dea & Flin (2001); Wu et al. (2008); Bosak et al. (2013); Fruhen et al. (2014); Hamid et al. (2015); Fruhen & Flin (2016); Lim et al. (2018); Fruhen et al. (2019); Ye et al. (2020); Shore et al. (2020); Schwatka et al. (2020)
Involvement of managers	Involvement and participation in safety programmes or activities, interaction with employees, participation in safety rounds, taking a visible role in the safety committee, personal involvement in safety training.	O’Dea & Flin (2001); Wu et al. (2008); Fruhen et al. (2014); Hamid et al. (2015); Fischer et al. (2018); Fruhen et al. (2019); Ye et al. (2020)
Support and guidance	Support employees or provide guidance, role modelling, understand and support the needs of employees, monitor and reward safety performance, provide safety instructions.	Flin (2003); Wu et al. (2008); Hamid et al. (2015); Fruhen & Flin (2016); Lim et al. (2018); Fruhen et al. (2019); Shore et al. (2020); Schwatka et al. (2020);
Participation of employees	Encourage employees to make suggestions and participate in decision making.	Wu et al. (2008); Bosak et al. (2013); Fruhen et al. (2019)
Resources	Provide financial and non-financial resources, dedicate sufficient time to address safety issues (time is the most important resource), provide equipment, consider safety as an important element in job design.	Hofmann & Morgerson (1999); Flin (2003); Luria & Rafaeli (2008); Wu et al. (2008); Cui et al. (2013); Bosak et al. (2013); Hamid et al. (2015); Fruhen & Flin (2016); Bowers & Fleming (2018); Fruhen et al. (2019); Al-Bsheish et al. (2019); Ye et al. (2020); Shore et al. (2020); Schwatka et al. (2020)

*(Table continues)*

Table 9: How safety commitment is manifested (*Continued*).

Category of manifestation	Description of elements	Authors
Safety decisions	Make safety-important decisions, prioritize safety during production, address safety issues, do not compromise safety in the face of other organisational problems.	Fruhen et al. (2014); Fruhen & Flin (2016); Fischer et al. (2018); Fruhen et al. (2019); Ye et al. (2020)
Safety policies, procedures, practices	Approve and implement safety policies and procedures, implementation of safety strategies, comply with safety regulations, implement a certified safety management system, ensure that safety changes are analysed and that safety-important processes are followed.	Luria & Rafaeli (2008); Cui et al. (2013); Lim et al. (2018); Bowers & Fleming (2018); Fruhen et al. (2019); Schwatka et al. (2020)
Safety activities and programmes	Provide safety training, support safety programmes, continuously improve safety programmes.	Hofmann & Morgerson (1999); Luria & Rafaeli (2008); Hamid et al. (2015); Lim et al. (2018); Fischer et al. (2018); Al-Bsheish et al. (2019); Ye et al. (2020)

Analysis of the core literature showed that **safety commitment can be manifested** through managers' decision-making and various safety-related actions. Bowers and Fleming's (2018) study indicates that employees interpret managers' safety commitment either directly, through personal interactions and observable decisions of managers, or indirectly, based on information they receive from other sources, such as work colleagues. The distinction is based on the difference between **direct** and **indirect observation** of managers' behaviour. The study also showed that high-level managers' commitment to safety is perceived as more authentic when managers promote safety through a personal relationship with employees. Managers' safety commitment is also perceived as more credible if managers' behaviours that signal commitment are consistent (Bowers & Fleming, 2018). Fruhen et al. (2019) also argue that the ways in which managers demonstrate their safety commitment can be captured by six categories of safety behaviours. Similar to the previous study, the authors propose that demonstration of safety commitment can be categorised into two broad groups: direct and indirect. However, unlike previous studies, the distinction is based on the difference between **direct** and **indirect interactions** between managers and employees. Four categories of actions through which managers convey their safety commitment require direct interaction between managers and employees, those are: personal communication, managers' involvement and participation in safety programmes or activities, supporting employees or providing guidance, and promoting employees' involvement in the decision-making process. The other two categories require different types of actions that do not necessarily involve interaction

between managers and employees, those are the following: providing necessary resources and making safety-related decisions or approving and implementing safety policies (Fruhen et al., 2019).

Another approach how to address the demonstration of managers' safety commitment is proposed by Ye et al. (2020). The authors point out that managers' commitment can also be distinguished according to whether the commitment is demonstrated and perceived at the **individual** or **group level**. At the individual level, managers' commitment is based on employees' individual perceptions of how important safety is to managers. At the group level, the safety commitment is based on the support managers provide for safety (e.g., safety training, policies that prioritise safety during production, providing resources for safety). Ye et al. (2020) also argue that focus on both the individual and group levels is needed to achieve desired safety results. The authors suggest that when managers who are committed to safety implement formal safety policies and programmes in the organisation, managers should also ensure that employees perceive their commitment to safety at the individual level. A clearly defined strategy to promote managers' perceptions of their commitment to safety when they seek to implement safety programmes can significantly improve the performance of those programmes. In addition, managers should formulate and clearly articulate their safety vision. Regular interaction with employees is also vital to strengthen the effect of the safety message conveyed (Ye et al., 2020).

Other authors have not proposed a similar explicit distinction between the safety behaviours through which the commitment of managers can be manifested. Nevertheless, the **authors have been consistent in their descriptions** of the various ways in which managers can convey their safety commitment. Most authors agreed on the most important ways in which managers can demonstrate their commitment to safety. Several authors indicated that managers' commitment is best demonstrated through their **personal involvement** in safety activities, their visible role in safety programmes, their active participation in safety committees, their involvement in safety training, or their participation in safety rounds (Fruhen et al., 2014; Hofmann & Morgeson, 1999; Lim et al., 2018; O'Dea & Flin, 2001). It is also important that managers interact regularly with employees and that they clearly express the organisation's safety policy whenever they are in personal contact with employees (Bowers & Fleming, 2018; Wu et al., 2008). As Ye et al. (2020) have pointed out, managers should interact with their employees as much as possible to increase the impact of the safety signals they are trying to convey to employees. By demonstrating their commitment to safety, managers can be safety role models for employees (Schwatka et al., 2020; Shore et al., 2020). Therefore, it is important that managers understand their own values and attitudes towards safety and clearly articulate their safety vision (Schwatka et al., 2020; Ye et al., 2020). It is also important that managers believe that higher safety standards are achievable and that they are aware of safety-related issues (O'Toole, 2002). Further, Fischer et al. (2018) point out that consistency and coherence of managers' actions are also important. For example, if some issues are identified during their safety rounds, managers should also ensure that these safety issues do not go unaddressed; otherwise, this could negatively affect the employees' perception of managers' safety commitment.

Another important aspect is clear, consistent, and regular **safety communication** between employees and managers that demonstrates managers' safety concerns (Fruhen et al., 2014; O'Dea & Flin, 2001; Ye et al., 2020). Therefore, managers should develop a safety communication strategy that effectively transfers important safety information to employees (Lim et al., 2018). Bosak et al. (2013) argue that managers at all organisational levels should participate in safety talks with employees. Another important part of communication that reflects managers' commitment is the quick and clear feedback employees receive from their managers (Shore et al., 2020). However, Bosak et al. (2013)

point out that it is also important that there is consistency between managers' actions and words.

Good communication is closely related to another aspect that reflects managers' safety commitment; namely, the implementation of **safety-related policies, procedures, and programmes** (Bowers & Fleming, 2018; Lofquist et al., 2011; Luria & Rafaeli, 2008; Ye et al., 2020). Managers should pay sufficient attention to the implementation of organisational safety strategies and communicate these strategies to employees (Schwatka et al., 2020). The commitment of high-level managers is best demonstrated by their support to safety management and the status it has in the organisation (Flin, 2003). According to Luria and Rafaeli (2008), safety commitment is demonstrated by the organisation's efforts to ensure and maintain safety throughout its operations. Therefore, managers should strive to successfully translate the organisation's safety policies, strategies, and rules into daily operational activities (Lim et al., 2018). In addition, other organisational activities (e.g., selecting new employees) that may seem unrelated to safety can demonstrate that safety is important and valued in the organisation (Luria & Rafaeli, 2008). Cui et al. (2013) suggest that managers' commitment can also be demonstrated through administrative aspects such as compliance with relevant safety regulations, adoption, and implementation of a certified safety management system.

Perhaps one of the most important safety-related responsibilities of high-level managers is to create a **work environment** that supports employees and promotes safer performance. Lim et al. (2018) point out that high-level managers have a particularly important role to play because they can provide safety training that addresses and develops employees' safety awareness. Other researchers have also highlighted that providing safety training programmes is an important way for managers to demonstrate their safety commitment to employees (Al-Bsheish et al., 2019; Hofmann & Morgeson, 1999; Luria & Rafaeli, 2008; Ye et al., 2020). In addition to safety training, Schwatka et al. (2020) argue that managers should **understand** and **support** employee needs. Managers' support can be demonstrated by providing safety instruction when employees face safety-related challenges (Flin, 2003; Fruhen & Flin, 2016). In addition, managers should encourage **involvement of employees** in safety-important decisions and consider their views on various safety matters (Bosak et al., 2013; Wu et al., 2008).

Safety commitment of managers can also be demonstrated by planning and allocating sufficient **resources to safety activities** (Bowers & Fleming, 2018; Cui et al., 2013; Schwatka et al., 2020; Shore et al., 2020; Wu et al., 2008; Ye et al., 2020). Managers can demonstrate their safety commitment by providing the resources necessary for a safe work environment, considering safety as an important element in job design, and providing protective equipment for employees (Bosak et al., 2013; Hofmann & Morgeson, 1999; Luria & Rafaeli, 2008). The resources that managers allocate to safety can be both financial and non-financial (Al-Bsheish et al., 2019). Some researchers suggest that giving an adequate amount of time to safety issues is the strongest signal managers can send to their employees, as time is generally a scarce commodity (Flin, 2003; Fruhen & Flin, 2016).

Flin (2003) highlights another important aspect in which managers' commitment is evident. The author points out that when there is a conflict between the **safety** and **production goals**, a clear demonstration of safety commitment is even more important. Managers should clearly state that safety is a priority and considered as the desired outcome. Thus, managers should not compromise on safety when other organisational problems arise (Fruhen & Flin, 2016). To promote safety behaviours among employees, Ye et al. (2020) suggest that managers should consolidate productivity and safety goals, as these goals are not mutually exclusive. It is important that safety goals are not treated differently from other organisational goals. This is especially important during various

disturbances (internal or external) that can affect the day-to-day operations of organisations and test managers' commitment to safety. When organisations undergo important changes, managers who are committed to safety should ensure that important safety changes are adequately analysed, and the necessary measures are taken to ensure that important safety processes continue to be implemented (Lofquist et al., 2011).

In their review study, Hamid et al. (2015) aimed to identify elements that reflect the safety commitment of management. Their analysis revealed 19 elements that reflect managers' safety commitment and play an important role in preventing accidents. The results of this review concur with the findings of the studies presented above. The authors highlighted managers' involvement in safety, their ability to allocate organisational resources, communicate with employees, continuously improve safety programmes and monitor safety performance, and the support represented by the time they devote to safety as the five elements of managers' commitment to safety most frequently discussed in the literature (Hamid et al., 2015).

### 3.5.4.3 Whose commitment is being addressed – Units of analysis

Researchers (Flin, 2003; O'Dea & Flin, 2001) point out that there is a general **lack of clarity in the literature** on managers' safety commitment regarding the level of management that these studies actually address. Terms like “management”, “leadership”, “leaders”, or “managers” is used to address everything from immediate supervisors to high-level manager. Schwatka and Rosecrance (2016) add to this that focusing on general management commitment to safety might not be sufficient. As pointed out by Flin and Yule (2004), managers' responsibilities and roles can vary depending on their hierarchical position in the organisation. Managers on various organisational levels have different roles in relation to safety; therefore, managers' safety commitment should be addressed at the specific level of management (Schwatka & Rosecrance, 2016). We took a closer look at **which management level was investigated** in studies from our sample of the core literature. The largest part represents studies that explored the safety commitment of general managers, followed by those that focused on the safety commitment of senior managers and supervisors. In relation to our time frame, we can see that there are **no major differences** in the level of management that was explored in our core literature across **both time periods**. However, we identified some studies in the second period that also focused on the safety commitment of co-workers' (Schwatka & Rosecrance, 2016) or the safety commitment of employees (Delegach et al., 2017; Novak et al., 2017).

Although authors generally agree that all employees should strive to improve safety outcomes (Du & Sun, 2012), the promotion of safety commitment in the organisation is recognised as the focal obligation of managers (Wu et al., 2015). Different levels of managers have different roles in achieving organisational safety goals; however, the role of **high-level managers** might be the most important (Flin, 2003; Wu et al., 2015) as they can have the most significant influence on workforce perceptions (Bowers & Fleming, 2018). High-level managers are in the position to create a safe work environment that motivates employees to adopt safe behaviour (Du & Sun, 2012). This organisational position enables high-level managers to support other managers on lower organisational levels and, in turn, promote their safety commitment. They can promote safety as an important and integral part of business and also provide organisational support and help other managers to develop new skills. High-level managers that are committed to safety can support lower-level managers' commitment to safety through their active involvement in safety meetings, their communication about important safety issues, by providing material or financial resources and opt for the implementation of safety management system or by investing in safety initiatives and programmes (Tappura, Nenonen, et al., 2017). However, high-level

managers cannot always directly convey their safety commitment to all employees. Although the safety commitment of high-level managers is important, the behaviour of high-level managers might be less visible to employees since they are more distant than other managers on lower organisational levels that have more direct interaction with employees (Bosak et al., 2013). Consequently, employees might have fewer opportunities to interact with high-level managers than with their immediate supervisors (Liang & Zhang, 2019). This may explain why employees generally describe their immediate supervisors and department managers as more committed to safety than managers on higher organisational levels (Bowers & Fleming, 2018).

#### 3.5.4.4 Addressing various perspectives on safety commitment – Units of observation

In addition to “whose commitment” is being researched, it is also important “whose perspective” is taken. In studies throughout both time periods, safety commitment is generally addressed through **upward perspective** based on the **employees’ perceptions** (Al-Bsheish et al., 2019; Alingh et al., 2018; Beus et al., 2019; Bosak et al., 2013; Bowers & Fleming, 2018; Clark et al., 2014; Cui et al., 2013; Du & Sun, 2012; Laurent et al., 2018; Li et al., 2019; Liang & Zhang, 2019; Michael et al., 2005; O’Toole, 2002; Pronovost et al., 2003; Schwatka & Rosecrance, 2016; Stackhouse & Turner, 2019; Taher et al., 2014; Taylor & Snyder, 2017; Wu et al., 2008), which is also indicated by the conceptualisation of the concept. This can be attributed to the fact that the perceived commitment of managers to safety represents one of the most important factors that reflect the organisation’s safety climate, which is generally measured through employees’ perceptions (O’Dea & Flin, 2001; Wu et al., 2008). Fruhen et al. (2014) pointed out that researchers generally address managers’ commitment to safety from employees’ perceptions of managers’ behaviours that reflect how much they care for safety. Analysis of theoretical foundation performed in Chapter 3.5.1 revealed that a major part of studies build on safety climate literature where shared perceptions of the employees represent the focal point of this multidimensional concept (Griffin & Curcuruto, 2016). Consequently, this has also influenced the authors’ decision about which unit of observation to include in their studies.

However, exploring managers’ commitment through the perception of employees is only one way to address this concept. In the **second time period**, some studies tried to capture managers’ safety commitment through **self-assessment** of **managers’ safety commitment** (Biggs et al., 2013; Fruhen et al., 2019; Fruhen et al., 2014; Fruhen & Flin, 2016; Tong et al., 2015). For example, Tappura, Nenonen et al. (2017) examined middle and low-level managers to identify different organisational factors that can have an important influence on the managers’ safety commitment. In their paper, Fruhen et al. (2019) address the concept of managers’ safety commitment from a **different perspective** than other previously published studies. The authors present a commitment to safety as a leadership concept and address it from the **managers’ perspective**. In other words, they shift the focus from employees’ perceptions towards managers that actually experience and exert commitment to safety. Fruhen et al. (2019) explore how (high, middle, and frontline) managers perceive their commitment to safety and through which behaviours managers demonstrate safety commitment to employees. Those studies provide a fresh view on the concept that was generally addressed only from an employee perspective.

In some studies, however, the safety commitment of managers is also assessed by their **supervisors** (Hofmann & Morgeson, 1999), or the sample includes **managers from various levels**, such as senior managers, middle managers, and immediate supervisors (Wu et al., 2015).

Studies that addressed safety commitment of employees or co-workers based their assessment of safety commitment on employees’ own perceptions (Delegach et al., 2017;

Novak et al., 2017; Schwatka & Rosecrance, 2016; Stackhouse & Turner, 2019). In addition, some authors **combined participants** from various organisational levels (employees, supervisors, managers) and addressed their perception of managers' safety commitment (Della et al., 2020; Schwatka et al., 2020; Shore et al., 2020; Lim et al., 2018; Wu et al., 2019).

#### 3.5.4.5 Dimensions of safety commitment

The majority of studies covered in our analysis addressed safety commitment as a **unidimensional construct** (e.g., Flin, 2003; Flin & Yule, 2004; Hofmann & Morgeson, 1999; Michael et al., 2005; O'Dea & Flin, 2001; O'Toole, 2002; Pronovost et al., 2003). This, in turn, affected the operationalisation of the safety commitment and the way in which the aforementioned concept was researched. However, in the **second time period**, some authors drew from the field of organisational science and proposed that safety commitment should be addressed as a multidimensional concept.

First, a study by Delegach et al. (2017) built on a model from organisational commitment theory and introduced a new concept of employees' safety commitment. The concept consists of **two distinct dimensions** of safety commitment, affective and continuance safety commitment. Shortly after the first two-dimensional concept of safety commitment was proposed, a study from Fruhern et al. (2019) also built from the organisational commitment research. The study addresses the specific safety commitment dimensions and the way those dimensions manifest themselves in managers' behaviours that demonstrate safety commitment. The authors proposed a **three-dimensional** framework of managers' commitment to safety that includes affective, calculative, and normative safety commitment. This can have an important influence not only on the way in which employees' safety commitment is addressed in the future but also on the way in which the managerial part of this relationship is researched.

#### 3.5.4.6 Measuring the concept of safety commitment

In addition to studies that employed **qualitative** research methods (e.g., Bowers & Fleming, 2018; Fruhen et al., 2014; Fruhen & Flin, 2016; Tappura, Nenonen et al., 2017; Wu et al., 2015), the majority of studies in our core literature applied **quantitative** methods, where the primary focus was on questionnaire-based surveys. In relation to measurement scales and items that were used, we can see that studies that address managers' commitment to safety as an **independent factor** generally use adapted items from safety climate (e.g., Amponsah-Tawiah & Anuka, 2018; Cui et al., 2013; Laurent et al., 2018; Lofquist et al., 2011; Michael et al., 2005; Schwatka et al., 2020; Shore et al., 2020; Ye et al., 2020) or develop new items (e.g., Hofmann & Morgeson, 1999; Tong et al., 2015) to measure the concept. Studies that address safety commitment as an **important dimension** of safety **climate** and **culture** also tend to either adapt the items from the existing scales (e.g., Bosak et al., 2013; Clark et al., 2014; Liang & Zhang, 2019; Novak et al., 2017; Pronovost et al., 2003; Schwatka & Rosecrance, 2016; Stackhouse & Turner, 2019; Taher et al., 2014; Lim et al., 2018) or develop new scales appropriate to their requirements (e.g., Beus et al., 2019; Du & Sun, 2012; Della et al., 2020; Taylor & Snyder, 2017; Wu et al., 2008; Wu et al., 2019). As we can see, there are no considerable differences in measuring scales between our two time periods.

### 3.5.5 Antecedents of safety commitment

#### 3.5.5.1 First time period

Analysis of the core literature revealed that there are several concepts that can have either positive or negative effects on safety commitment. Starting with the first time period, the study of Hofmann and Morgeson (1999) showed that in positive leader-member relationships, employees are more inclined to freely communicate to their supervising managers and express their safety concerns. This open communication is then positively related to safety commitment (Hofmann & Morgeson, 1999). The findings of Wu et al. (2008) indicate that safety leadership can have a significant effect on employees' perceptions of managers' safety commitment. More specifically, safety controlling was recognised as the most important factor of safety leadership that can influence the perceived safety commitment of managers, which was the main factor of safety climate (Wu et al., 2008).

#### 3.5.5.2 Second time period

##### 3.5.5.2.1 Leadership level

In the second period, we found that several authors explored the influence of **leadership** on **safety commitment**. For example, Du and Sun (2012) showed that safety leadership can have a positive influence on several dimensions of safety climate, including safety commitment. More specifically, the leadership dimension of safety motivation was positively related to perceived safety commitment. Based on those findings, authors (Du & Sun, 2012) propose that elements of transformational leadership style could have a particular influence on safety climate. Similarly, the study by Biggs et al. (2013) identified leadership as the most important factor that can positively influence safety culture. The relationship between leadership and safety commitment was found to be especially important (Biggs et al., 2013). Delegach et al. (2017) found that, in a safety context, transformational leadership could positively relate to employees' promotion focus that can influence both continuance and affective components of commitment to safety. This means that if managers are perceived as transformational, they can motivate employees to either engage in safety complying behaviour as a result of their continuance safety commitment or exert safety initiatives due to their affective safety commitment. On the other hand, the active transactional leadership style can positively relate to employees' prevention focus that can influence only the continuance component of commitment to safety. This can be attributed to increased awareness of potential negative future outcomes, as the prevention focus of employees promotes cautious and calculated commitment (Delegach et al., 2017).

##### 3.5.5.2.2 Individual level

Fruhen et al. (2014) explore how the social competencies, problem-solving abilities, and safety-specific knowledge of managers can support managers to demonstrate their safety commitment. Findings show a positive relationship between **managers' problem-solving abilities** and their ability to demonstrate commitment to safety. Similarly, **managers' social competencies**, i.e., the ability to understand the intentions of other people but not persuade them, was positively related to managers' demonstrations of commitment. However, results did not support the association between managers' safety knowledge and behaviours that reflect their commitment to safety. Although safety knowledge is generally related to better safety performance at lower organisational levels, this might not be the case for high-level managers (Fruhen et al., 2014). Results from Fruhen and Flin (2016)

indicate that different behaviours, like a demonstration of managers' commitment to safety, information retrieval, and transformational and transactional style of leadership, can be related to chronic unease sensed by managers. Chronic unease can have an important positive influence on safety; however, negative influences on organisation's performance and managers' individual outcomes were highlighted (Fruhen & Flin, 2016). Findings from a study published by Al-Bsheish et al. (2019) indicate that the psychological empowerment of employees can influence perceived managers' safety commitment. Managers' safety commitment functions as a mediator between psychological empowerment and safety performance of employees. Results clearly show that psychological empowerment can have an important effect on safety performance and that high-level managers play an essential role since managers' safety commitment represents a key element in this relationship.

### 3.5.5.2.3 Organisational level

The hazardous working environment also represents an important factor. The study by Cui et al. (2013) showed that hazards in the work environment could have an important influence on managers' safety commitment. Liang and Zhang (2019) highlighted that there is a negative relationship between both routine and situational safety violations of immediate supervisors and the perceived safety commitment of managers. Findings by Stackhouse and Turner (2019) indicate that all three **organisational practices** (procedure, training, and work pressure) can influence safety commitment that is used to represent safety climate.

In the study of Laurent et al. (2018), job resources were recognised as an antecedent of perceived managers' safety commitment among employees. Employees' perception that the **organisation provides needed resources** is also related to a higher perception of managers' safety commitment. This can consequently result in a lower number of situational violations and higher safety participation. Job resources represent a form of support that employees receive from the organisation and encourage them to reciprocate by exerting contextual behaviours (safety participation and citizenship). In addition, job resources can importantly influence job demands. Even in a demanding working environment with high production goals, resources can provide additional support for employees to work safely. Since high-level managers have a central role, the organisations should encourage managers to communicate and demonstrate their safety commitment (Laurent et al., 2018). Further, the perceived safety commitment of managers also mediates the relationship between organisational practices and the perceived effectiveness of the safety system among employees. In addition, the study showed that co-worker safety commitment could also have a further moderating influence on this indirect relationship (Stackhouse & Turner, 2019).

The analysis of our core literature revealed that a major part of studies that addressed concepts that can influence safety commitment is positioned in the **second time period**. In the first period, we identified only two studies that focused on factors that can influence safety commitment, limiting the possible comparison between both time periods. In the second time period, **leadership was the predominant concept** that was addressed most frequently. This can be attributed to the important influence that leadership style can have on employees' perception of managers' safety commitment. In both time periods combined, seven studies addressed safety commitment from employees' perspectives, three adopted managers' self-assessments, two studies used employees' self-assessment and one study based their findings on the assessment of supervisors. A summary of all concepts that can influence safety commitment is presented in Table 10 in chronological order. This enables a clear representation of how research on safety commitment antecedents developed over time.

Table 10: The concepts that can influence perceived managers' safety commitment.

Concept	Effect on SC	Author
Quality leader-member exchange relationship	Positive <sup>c</sup>	Hofmann & Morgerson (1999)
Safety communication	Positive <sup>c</sup>	Hofmann & Morgerson (1999)
Safety leadership (Safety controlling)	Positive <sup>a</sup>	Wu et al. (2008)
Safety leadership (Safety motivation)	Positive <sup>a</sup>	Du & Sun (2012)
Leadership	Positive <sup>b</sup>	Biggs et al. (2013)
Hazardous environment	Positive <sup>a</sup>	Cui et al. (2013)
Problem-solving skills	Positive <sup>b</sup>	Fruhen et al. (2014)
Social competences	Positive <sup>b</sup>	Fruhen et al. (2014)
Experience of chronic unease	Positive <sup>b</sup>	Fruhen & Flin (2016)
Transformational leadership	Positive <sup>d</sup>	Delegach et al. (2017)
Transactional leadership	Positive <sup>d</sup>	Delegach et al. (2017)
Organisational maintenance culture	Positive <sup>d</sup>	Novak et al. (2017)
Positive leader-member relationship	Positive <sup>d</sup>	Novak et al. (2017)
Job resources	Positive <sup>a</sup>	Laurent et al. (2018)
Procedure	Positive <sup>a</sup>	Stackhouse & Turner (2019)
Training	Positive <sup>a</sup>	Stackhouse & Turner (2019)
Work pressure	Negative <sup>a</sup>	Stackhouse & Turner (2019)
Psychological empowerment	Positive <sup>a</sup>	Al-Bsheish et al. (2019)
Supervisors' routine violations	Negative <sup>a</sup>	Liang & Zhang (2019)
Supervisors' situational violations	Negative <sup>a</sup>	Liang & Zhang (2019)

*Notes.* <sup>a</sup> Perceived managers' commitment (assessed by employees). <sup>b</sup> Managers' commitment (self-assessment). <sup>c</sup> Perceived managers' commitment (assessed by supervisors). <sup>d</sup> Employees' commitment (self-assessment).

### 3.5.6 Consequences of safety commitment

#### 3.5.6.1 First time period

Our systematic literature review also highlighted several important consequences of safety commitment. Studies in the first period showed that safety commitment could have a direct negative effect on the **occurrence of accidents** (Hofmann & Morgeson, 1999). Managers' safety commitment is also one of the important factors that can promote employees' perceptions of the **safety management system** (O'Toole, 2002). Wu et al. (2008) found that the perceived safety commitment of managers was the most important factor of safety climate that can influence safety performance in the organisation. Among the most important components of safety performance affected by managers' safety commitment were safety organisation and management, accident investigation, and safety equipment and measures (Wu et al., 2008). Michael et al. (2005) showed that managers' safety commitment could also positively influence **non-safety outcomes**. In their study,

employees' perceived managers' safety commitment as a form of organisational support. Managers' safety commitment was related to higher job satisfaction, job-related performance, and organisational commitment. Further, managers' commitment to safety was negatively related to the withdrawal behaviours of employees. Safety commitment of managers was also negatively related to employees' perception of danger at work. If employees perceive that their managers are personally concerned for their wellbeing, this can yield positive results beyond safety performance (Michael et al., 2005).

### 3.5.6.2 Second time period

#### 3.5.6.2.1 Safe behaviour of employees

In the second period, a study by Lofquist et al. (2011) indicated that managers' safety commitment could have an even stronger influence on the safety perceptions of employees than safety climate. Based on the demonstration of managers' commitment, employees form a perception of the safety priorities of the managers, which can consequently influence the cognitive process of employees and change their **safety behaviour** (Lofquist et al., 2011). Findings from Cui et al. (2013) indicate that managers' safety commitment can have a positive influence on employees' safety beliefs. This is important since employees' safety beliefs can, in turn, have a positive influence on their safety-related behaviours and safety involvement (Cui et al., 2013). Schwatka and Rosecrance (2016) also argued that safety commitment dimensions of safety climate are related to positive safety behaviours of employees, namely safety **participation** and **compliance**. More specifically, the study confirmed that the co-workers' safety commitment functions as a mediator between high-level managers' and immediate supervisors' safety commitment and safety behaviours of employees. The safety commitment of high-level managers has a cascading effect that advances down the organisational levels (Schwatka & Rosecrance, 2016). The study by Amponsah-Tawiah and Anuka (2018) also provides evidence that the safety commitment of managers is positively related to employees' safety behaviour (participation and compliance). This reflects the premise that managers that are committed to safety are also more engaged in their safety role and at the same time provide more resources for safety activities and equipment. Consequently, managers' safety commitment can motivate employees to behave safely (Amponsah-Tawiah & Anuka, 2018).

In their study, Lim et al. (2018) found that safety commitment was one of the factors of safety climate that was most significantly related to intrinsic motivation among multicultural employees. Further, intrinsic motivation was related to both employees' safety participation and compliance. In the sample of employees that were of the same nationality, safety commitment was also related to two types of motivation, identified and introjected. Identified type of motivation was related to safety participation, and introjected motivation was related to safety compliance. Overall results showed that autonomous motivation, the most internalised form of motivation, was related to the higher safety performance of employees (Lim et al., 2018). Al-Bsheish et al. (2019) found that managers' safety commitment also mediates the relationship between the psychological empowerment of employees and the dimensions of employees' safety performance, compliance and participation (Al-Bsheish et al., 2019). The study performed by Ye et al. (2020) revealed that perception of managers' safety commitment was positively related to both types of employees' safety behaviour, safety compliance and safety participation. Further, all four dimensions of psychological capital (i.e., hope, self-efficiency, optimism, and resilience) mediated the effect between employees' perceptions of managers' safety commitment and employees' safety behaviour. However, out of four dimensions, employees'

resilience was recognised as the most important dimension that explained how perceived managers' safety commitment influenced employees' safety compliance (Ye et al., 2020).

Results from Shore et al. (2020) also showed that employees' perception of managers' safety commitment was positively related to safety climate and employees' **participatory safety-related behaviour**. The same relationship was also found between employees' perception of managers' wellness (health) commitment, health climate, and employees' **participatory health-related behaviour**. Despite health and safety being distinct concepts, findings also indicate some correlation exists between them (Shore et al., 2020). However, Hu et al. (2020) went even further and differentiated between safety compliance. Their study showed that both perceived managers' safety commitment and employees' perception of punishment for non-compliance were positively related to the **deep compliance** of employees. Further, managers' safety commitment was also negatively related to employee **surface compliance**. However, the employees' perception of punishment for non-compliance was not related to the surface compliance of employees. The role of managers' safety commitment is especially important since findings indicate that while a deep type of compliance can have a negative influence on accidents and near misses in the organisation, surface type of compliance can have a positive effect on those unwanted outcomes. The study highlights that motivation based on rewards and punishment is not always the best approach to enhance safe behaviour or prevent unsafe behaviour of employees. The influence of highly committed managers may be more valuable for the organisation that strives to encourage safe and limit unsafe behaviour at the same time (Hu et al., 2020).

Li et al. (2019) showed that managers' commitment to safety could negatively influence job stress and employee fatalism. Therefore, managers should promote the commitment to safety, communication, and resource allocation. This will, in turn, reduce production pressure on employees and reduce the experience of fatalism among employees. Li et al. (2019) also found some results that **differ from previous studies**. More specifically, managers' commitment to safety was not significantly related to safety participation and was negatively related to safety compliance. Taylor and Snyder's (2017) findings show that the way risk perception questions are phrased can make an important difference. In addition to risk perception, immediate supervisor safety commitment was also related to the safety compliance behaviours of employees. Thus, employees' perceptions of work risk can influence employees' safety behaviour; the opposite could also be true, as employees that behave unsafely without adverse consequences have lower perceptions of risk. Findings also indicate that managers' safety commitment can increase perceived risk among employees (Taylor & Snyder, 2017). In relation to the safety behaviour of employees, the intention to express safety concerns is also important to consider. The study by Turner et al. (2020) showed that the way in which immediate supervisors convey their safety commitment to employees can also have an important influence on their intentions to express a safety voice. When supervisors' safety commitment was clear to employees, younger employees did not differ from adult employees in their safety voice intentions. However, when supervisors did not clearly signal their safety commitment to the employees, adult employees were less likely to express their safety concerns compared with young employees (Turner et al., 2020).

#### 3.5.6.2.2 Unsafe behaviour of employees

In addition to promoting positive safety behaviour, our analysis also revealed that safety commitment could also have an important role in preventing unsafe behaviour among employees. In their study, Bosak et al. (2013) found that there was a negative relationship between the safety commitment of high-level managers and the **risk behaviour** of

employees. In addition, the negative connection between the managers' safety commitment and safety behaviour was recognised when production pressure was high, regardless of the safety priority in the organisation. However, in the case of low production pressure, the connection between managers' safety commitment and safety behaviour was recognised as important only when safety priority in the organisation was low. This highlights the important role of managers' safety commitment when there is a conflict between high production pressure and organisations' safety priority. In such circumstances, signals from managers tend to be especially important for employees (Bosak et al., 2013). Regarding psychological processes that are fundamental for safety behaviours, the study by Laurent et al. (2018) indicates that job resources also promote reciprocal processes in addition to the rewards for safety behaviour and engagement. Job resources promote the social exchange process through employee perception of managers' safety commitment, indicating acceptable safety behaviour and through rewards that could be anticipated by employees. Findings show that perceptions of managers' safety commitment were, directly and indirectly, related to **situational violations**; the latter was mediated by safety participation. Authors also point out that managers' safety commitment was not directly related to **routine violations** and might not be a cognitive energetical process; therefore, the social exchange theory should be employed (Laurent et al., 2018). The study by Liang and Zhang (2019) also showed significant relationships between managers' safety commitment and employees' routine violations; however, the relationship between the safety commitment of managers' and employees' situational violations were not recognised as significant. Findings also indicate that routine-type safety violations can influence managers' commitment to safety that, in turn, influences employees' behaviour. Therefore, perceived managers' safety commitment can function as an important mediator (Liang & Zhang, 2019).

#### 3.5.6.2.3 Non-safety behaviour

In addition to employees' **positive** and **negative** types of **safety behaviours** manifested through safety participation or compliance and safety violations, the analysis also identified that managers' commitment could have an important influence on **non-safety behaviours**. Findings by Clark et al. (2014) show that employees' perceptions of managers' safety commitment, as an integral part of safety climate, can influence employees' non-safety organisational citizenship behaviour. If employees perceive that managers care for their safety, they are likely to reciprocate the favour. In work environments that are safe, employees are more willing to help their co-workers and to put in the extra effort. Further, the aforementioned relationship was mediated by role definitions specific to organisational citizenship behaviour. The identified correlation was significant only in the case of narrow role definitions (Clark et al., 2014).

#### 3.5.6.2.4 Safety programmes and adverse outcomes

Findings from Stackhouse and Turner (2019) indicate that a combination of high perception of managers' safety commitment and co-workers' safety commitment enhanced the relationship between organisations' practices and the effectiveness of the safety system. However, when signals (demonstration of safety commitment) were inconsistent, the indirect relationship was weakened or not significant (Stackhouse & Turner, 2019). Results obtained by Igić et al. (2020) showed that ethical leadership at work could have an important influence on the **implementation of safety programmes**. Among factors that facilitate the implementation of the Zero Accident Vision programme, results highlight the safety commitment (both organisational and individual) as the most important factor, followed by learning, communication and safety climate. Findings indicate that ethical

leadership at work promotes confidence among workers and establishes a culture that supports commitment (Igić et al., 2020). Results from Novak et al. (2017) showed that the employee-supervisor relationship and maintenance culture are related to employees' safety commitment and outcomes such as the **unplanned shutdown** of the manufacturing process or **serious accidents** due to human errors and equipment failure. The findings highlight that organisational maintenance culture that promotes a proactive approach to maintenance can, in combination with safety-committed employees, result in positive safety outcomes and at the same time increase durability of assets in organisations. This is especially important for those organisations that provide essential services and are recognised as critical infrastructure (Novak et al., 2017).

#### 3.5.6.2.5 Health, safety, and wellbeing

Safety commitment of managers was also related to teamwork safety. The findings of Tong et al. (2015) indicate that psychological empowerment partially mediated the relationship between empowerment behaviour and safety commitment of health and safety managers, which can have an important influence on safety teamwork between health and safety managers and the manufacturing team. In their study, Schwatka et al. (2020) showed that managers' safety commitment positively influenced the safety climate. Findings indicate that after the effect of managers' safety commitment was accounted for, organisations' policies, procedures, and practices that support the safety, health, and wellbeing of employees were not significantly related to the safety climate. The findings highlight that managers' commitment positively relates to the health and safety climate in the organisation. Therefore, if an organisation strives to improve safety or health climate, the focus should be directed towards improving the managers' commitment (Schwatka et al., 2020).

In relation to our time framework, we can see that there were only four studies that addressed the potential consequences of safety commitment in the **first time period**. Studies address various factors, including accidents and injuries, employees' perceptions of the safety management system, and also outcomes that were not directly related to safety, like job satisfaction, work performance, and organisational commitment. In the **second time period**, the most frequently addressed concept was employees' safety behaviour. Studies address managers' safety commitment in relation to both safety compliance and safety participation as well as to undesired behaviour, like engaging in safety violations. We have to point out that the number of studies was much smaller in the first time period; however, we can observe that in the second time period, the focus evidently shifted towards employees' **safety behaviour**, especially safety compliance and participation. In both time periods combined, nineteen studies addressed safety commitment from employees' perspectives, one adopted managers' self-assessment, one study used employees' self-assessment, and one study drew their findings on managers' commitment assessed by their supervisors. In addition, there were also three studies that used a combination of managers' and employees' assessments. A summary of all consequences of safety commitment is presented in Table 11. Similarly to the previous chapter, possible consequences of safety commitment identified during our analysis are summarised in chronological order.

Table 11: The consequences of safety commitment.

<b>Consequences of SC</b>	<b>Concept</b>	<b>Author</b>
Negative <sup>c</sup>	Accidents	Hofmann & Morgerson (1999)
Negative <sup>a</sup>	Injury rates	O'Toole (2002)
Positive <sup>a</sup>	Safety management system	O'Toole (2002)
Positive <sup>a</sup>	Job satisfaction	Michael et al. (2005)
Positive <sup>a</sup>	Job-related performance	Michael et al. (2005)
Positive <sup>a</sup>	Organisational commitment	Michael et al. (2005)
Negative <sup>a</sup>	Withdrawal behaviours	Michael et al. (2005)
Negative <sup>a</sup>	Perceived danger at work	Michael et al. (2005)
Positive <sup>a</sup>	Safety performance	Wu et al. (2008)
Positive <sup>a</sup>	Change attitudes	Lofquist et al. (2011)
Positive <sup>a</sup>	Safety perceptions	Lofquist et al. (2011)
Positive <sup>a</sup>	Employees' safety beliefs	Cui et al. (2013)
Negative <sup>a</sup>	Risk behaviour of employees	Bosak et al. (2013)
Positive <sup>a</sup>	Citizenship behaviour	Clark et al. (2014)
Positive <sup>b</sup>	Safety teamwork	Tong et al. (2015)
Positive <sup>a</sup>	Co-worker commitment to safety	Schwatka & Rosecrance (2016)
Positive <sup>a</sup>	Safety compliance behaviour	Schwatka & Rosecrance (2016); Taylor & Snyder (2017); Amponsah-Tawiah & Anuka (2018); Lim et al. (2018); Al-Bsheish et al. (2019); Ye et al. (2020)
Positive <sup>a</sup>	Safety participation behaviour	Schwatka & Rosecrance (2016); Amponsah-Tawiah & Anuka (2018); Laurent et al. (2018); Lim et al. (2018); Al-Bsheish et al. (2019); Li et al. (2019); Ye et al. (2020); Shore et al. (2020)
Negative <sup>d</sup>	Safety outcomes	Novak et al. (2017)
Positive <sup>a</sup>	Perceived risk	Taylor and Snyder (2017)
Positive <sup>a</sup>	Intrinsic motivation	Lim et al. (2018)
Positive <sup>a</sup>	Identified motivation	Lim et al. (2018)
Positive <sup>a</sup>	Introjected motivation	Lim et al. (2018)
Negative <sup>a</sup>	Situational violations	Laurent et al. (2018)
Negative <sup>a</sup>	Situational violations (mediated by safety participation)	Laurent et al. (2018)

*(Table continues)*

Table 11: The consequences of safety commitment (*Continued*).

Consequences of SC	Concept	Author
Negative <sup>a</sup>	Routine violations (mediated by safety participation)	Laurent et al. (2018)
Positive <sup>a</sup>	Safety management system	Stackhouse & Turner (2019)
Negative <sup>a</sup>	Safety compliance	Li et al. (2019)
Negative <sup>a</sup>	Job stress	Li et al. (2019)
Negative <sup>a</sup>	Employee fatalism	Li et al. (2019)
Negative <sup>a</sup>	Employees' routine violations	Liang & Zhang (2019)
Positive/ negative <sup>a</sup> (depends on signals and age)	Safety voice intentions	Turner et al. (2020)
Positive <sup>a</sup>	Psychological capital	Ye et al. (2020)
Positive <sup>e</sup>	Safety climate of the organisation	Shore et al. (2020)
Positive <sup>e</sup>	Implementation of safety policies and procedures (ZAV)	Igić et al. (2020)
Positive <sup>e</sup>	Safety climate	Schwatka et al. (2020)
Positive <sup>a</sup>	Deep safety compliance	Hu et al. (2020)
Negative <sup>a</sup>	Superficial safety compliance	Hu et al. (2020)

*Notes.* <sup>a</sup> Perceived managers' commitment (assessed by employees). <sup>b</sup> Managers' commitment (self-assessment). <sup>c</sup> Perceived managers' commitment (assessed by supervisors). <sup>d</sup> Employees' commitment (self-assessment). <sup>e</sup> Perceived managers' commitment (assessed by employees and managers).

### 3.5.7 Future research directions

During the systematic review, we also identified various propositions for future research from our sample of the core literature. Thematic analysis revealed different groups of future research proposals. Findings are grouped into categories that consist of research design and methods, the relationship between safety commitment and leadership, and mechanisms of conveying safety commitment. Identified categories are represented in Table 12. Authors classified in a specific category are listed in chronological order.

Table 12: Directions for future research.

<b>Group 1 – Research design and methods</b>	
<i>Future research</i>	<i>Authors</i>
More diverse research methods (e.g., structural equation modelling, experimental approach, developing new scales) to address the relationship between safety concepts.	Flin (2003); Michael et al. (2005); Wu et al. (2008); (Luria & Rafaeli, 2008); Delegach et al. (2017); Stackhouse & Turner (2019)
Address the concept of safety commitment at different levels of analysis and explicitly determine units of the analysis.	O’Dea & Flin (2001); Flin (2003); Michael et al. (2005); Cui et al. (2013); Bosak et al. (2013); Fruhen et al. (2014); Hamid et al. (2015); Wu et al. (2015); Lim et al. (2018); Stackhouse & Turner (2019)
Obtain the perceptions of high-level managers’ commitment to safety from different units of observation. This would enable the assessment of the alignment between employees’ and managers’ perceptions. Perceptions of high-level managers should receive additional attention.	Biggs et al. (2013); Cui et al. (2013); Fruhen et al. (2014) Bowers & Fleming (2018); Fruhen et al. (2019)
Use of longitudinal research design. Research would benefit if causality relationships between safety concepts were addressed. Based on longitudinal research, the order in which constructs occur could be determined.	Michael et al. (2005); Cui et al. (2013); Bosak et al. (2013); Fruhen et al. (2014); Hamid et al. (2015); Schwatka & Rosecrance (2016); Delegach et al. (2017); Ye et al. (2020)
Different research approaches (e.g., collecting data from several sources) would reduce the risk for the common method bias in future studies.	Bosak et al. (2013); Stackhouse & Turner (2019); Ye et al. (2020)
Comparing organisations across different industry types, in different countries, and with different sample sizes would establish the generalisability of findings.	Bosak et al. (2013); Fruhen et al. (2014); Hamid et al. (2015); Schwatka & Rosecrance, 2016; Ye et al. (2020)

*(Table continues)*

Table 12: Directions for future research (*Continued*).

<b>Group 2 – Role of leadership in safety commitment</b>	
<i>Future research</i>	<i>Authors</i>
Focus on the relationship between leadership and safety commitment would improve the understanding of leadership roles.	Wu et al. (2008); Shore et al. (2020)
Relationship between safety commitment and different leadership factors (e.g., leader-member exchange and various leadership styles).	O'Toole (2002); Schwatka & Rosecrance (2016)
The extent to which managers' commitment determines leadership style and to which leadership style shapes the safety commitment of employees.	Delegach et al. (2017); Fruhen et al. (2019)
<b>Group 3 – Conveying safety signals</b>	
<i>Future research</i>	<i>Authors</i>
Factors that support managers' ability to convey or signal their commitment to other managers or employees.	Fruhen et al. (2014); Taylor and Snyder (2017); Delegach et al. (2017); Tappura, Nenonen et al. (2017); Ye et al. (2020); Shore et al. (2020)
Factors that influence employees' perceptions of managers' safety commitment.	
Factors that can influence managers' and employees' safety commitment.	
How managers on lower organisational levels can transfer the commitment of high-level managers down on the organisational structure to employees.	Flin (2003); Michael et al. (2005)
Supervisor and co-worker safety commitment should be researched.	

### 3.5.7.1 First time period

In the first time period, the substantial part of studies highlights the need to improve **research design** and **methods** that would facilitate future research. Future research directions include the application of different research methods (Flin, 2003; Wu et al., 2008), research designs (Michael et al., 2005) and measuring approaches (Luria & Rafaeli, 2008). Authors call for the development of a new **methodology for measuring** safety culture in organisations, in which the safety commitment of managers represents an important factor. Such a methodological approach would represent a contrast to the safety climate approach and would enable insight that managers and workers would not reveal otherwise (Luria & Rafaeli, 2008). Michael et al. (2005) also point out that future research should focus on longitudinal outcomes of safety commitment and adopt a **longitudinal research design**. Research would benefit if the causality relationship between managers' safety commitment and other factors were addressed. Wu et al. (2008) argue that future studies should also employ different methods like structural equation modelling to investigate the relationship between safety concepts. Future studies should clearly specify at which level the safety commitment is addressed. Perceptions of high-level managers'

attitudes and behaviours that reflect their safety commitment should be systematically measured at different levels of the organisation, including both a workforce and a managerial level. In this way, it would be possible to assess whether the high-level managers' commitment was actually transmitted to other employees (Flin, 2003). Addressing the concept at the group level would also be important for future research (Michael et al., 2005). The term "management" often used in past research makes it difficult to **distinguish which management level is actually addressed**. As pointed out by O'Dea and Flin (2001), different levels of management have different safety roles and responsibilities; therefore, researchers should differentiate between different managerial levels.

Another important cluster of studies highlights that future research should focus on the **relationship** between **safety commitment** and **leadership**. O'Toole (2002) points out that future research should identify factors that can influence the positive safety perception of employees, with a special focus on the leadership as it is especially promising (O'Toole, 2002). Wu et al. (2008) propose that future studies explore elements of safety leadership that might exist in managers' safety commitment and actions that show their commitment in the context of safety climate.

Despite the role of managers being recognised as important, a limited number of studies has been performed on how managers, especially high-level managers, can **signal their commitment** to other **managers** and the **workforce**. Managers on lower organisational levels can transfer the commitment of high-level managers down on the organisational structure to employees (Flin, 2003). Michael et al. (2005) argue that it might also be prudent to investigate supervisor safety commitment and co-worker safety commitment as they can also have an important influence on employees' perceptions of managers' safety commitment.

### 3.5.7.2 Second time period

In the second time period, the trend of studies that propose future research should focus on **research design** and **methods** continued. Biggs et al. (2013) argue that future research should further study managers' commitment (from their view) in the process of creating a safe working environment. **Managerial view** on safety commitment tends to be **overlooked** as employees are most often used as **units of observation**. Cui et al. (2013) point out that future research should address the managers' commitment to safety from both workforce and managerial levels. More specifically, how managers perceive their safety commitment and how safety commitment is perceived by employees (Cui et al., 2013). This proposition is supported by other authors (Fruhen et al., 2014). Fruhen et al. (2019) propose that future studies should complement research on managers' perspectives of safety commitment by adding the employees' perspective of managers' safety commitment experience and managers' behaviours that demonstrate a commitment to safety. Authors point out that research on other forms of commitment indicates that managers' perceptions of their own commitment are not always aligned with employees' perceptions (Fruhen et al., 2019). Bowers and Fleming (2018) point out that obtaining different perceptions of high-level managers' commitment to safety in order to determine the degree of alignment between employees' and managers' perceptions can add to further understanding of this topic.

Future research should address different hierarchical levels (Lim et al., 2018), which would enable **different levels of analysis** (Stackhouse & Turner, 2019). Specific focus should be directed towards different managerial levels as their work tasks and responsibilities in relation to safety might differ. Bosak et al. (2013) propose that future research would also benefit from the approach that would examine employees' perceptions

of both high-level managers' and immediate supervisors' commitment to safety since managers on different organisational levels can influence the behaviour of employees differently. Wu et al. (2015) also point out that future research should address high-level managers as they are under-researched in comparison to other managerial levels (e.g., immediate supervisors). The shortfall of research that would address higher levels of management represents an opportunity for future researchers (Hamid et al., 2015). Cui et al. (2013) also call for a **longitudinal research design** that would address the relationship between managers' safety commitment and the safety behaviour of employees. The longitudinal design of studies would also provide new insights and additional validation of findings (Bosak et al., 2013) and confirm relationships between managers' commitment to safety and different constructs (Fruhen et al., 2014). Research that would address both cause and effect of managers' commitment to safety is also needed (Hamid et al., 2015; Schwatka & Rosecrance, 2016; Ye et al., 2020). Delegach et al. (2017) propose that future research should use longitudinal research design that would also enable experiment manipulation of leadership styles and their relations with safety commitment in the natural setting on a sample of real employees.

Stackhouse and Turner (2019) point out that future research would benefit from the **different methodological approaches**. Experimental research design would help to strengthen the casual relationships between managers' safety commitment and different concepts (Stackhouse & Turner, 2019). Acquiring other data sources in addition to self-assessment data from surveys would also provide better insights and reduce the risk for the common method bias in future studies (Stackhouse & Turner, 2019; Ye et al., 2020; Bosak et al., 2013). Testing the consistency of the findings across different types of industries would also yield new insights about the generalizability of identified relationships between concepts (Bosak et al., 2013). Future studies should also include a larger sample and gathered data from different countries to attain the generalizability of the results (Ye et al., 2020). As Hamid et al. (2015) pointed out, research is usually conducted in specific industrial settings; consequently, the importance of managers' commitment to safety in other industrial contexts is still under-researched and represents an opportunity for future research. Researchers should explore if specific findings of studies can be generalised to the rest of the high reliability and high-risk industry (Fruhen et al., 2014). Future research should also address the influence of different factors like organisational size or geographical location (Schwatka & Rosecrance, 2016).

Schwatka and Rosecrance (2016) point out that future research could also address the relationship with **different leadership factors**, like a leader-member exchange and transformational leadership. Delegach et al. (2017) propose that future studies should explore the effects of various styles of leadership on promotion and preventive focus and address the order in which they can influence employees' commitment. The role of personality characteristics of employees, such as personality traits and attachment styles that can moderate the influence that managers have on the employees' self-regulatory focus, and their commitment, represent another interesting venue for future research (Delegach et al., 2017). Shore et al. (2020) propose that managers who clearly display their support for health and safety and interact openly with employees are essential for programmes and initiatives, which then helps meet organisations' business goals. Future research should focus on the managers' interventions that would improve the understanding of managers' roles and help managers to create a safe and healthy working environment for their employees (Shore et al., 2020). Future research should also focus on the extent to which different dimensions of safety commitment shape the leadership style. Fruhen et al. (2019) point out that the normative dimension of safety commitment might be related to the development of a better safety vision, which is consistent with the transformational type of leadership. Similarly, it might be proposed that the affective

dimension of safety commitment can lead to higher engagement of managers with their employees and can reflect in managers' care and consideration of the employees' needs. On the other hand, the calculative dimension of safety commitment might be related to managers being focused on setting safety performance standards and managing deviations from those standards. Such behaviour would be consistent with the transactional type of leadership. Here the managers' safety focus is based on external standards and initiatives and is seen as a means to achieve other goals, which is inherent to the calculative dimension (Fruhen et al., 2019).

Future research should address different ways in which **managers** can **convey** their **safety commitment** to employees. The important role of supervisors' commitment in conveying the commitment of high-level managers to employees also represents an interesting direction for future research. Taylor and Snyder (2017) point out that there is a need for future studies that address exact mechanisms through which immediate supervisors influence employees' safety behaviour, as it was found that managers' behaviour and co-workers' risk perceptions can have an important role (Taylor & Snyder, 2017). It is also important to consider factors that can influence managers' ability to convey their safety commitment and also affect the alignment between views of employees and managers on managers' commitment to safety. Those factors can derive either from managers, employees or might be the result of the working environment (Fruhen et al., 2019). Fruhen et al. (2014) point out that the role of different **organisational factors** (e.g., organisational structure) should also be addressed by future research to determine their influence on how high-level managers can convey their safety signals. It can be presumed that not all factors support and promote the transition of managers' commitment to safety throughout the organisation (Fruhen et al., 2014). Therefore, future studies should also examine how identified organisational factors foster managers' safety commitment and how precisely proposed organisational measures support their commitment (Tappura, Nenonen, et al., 2017). On the other hand, factors that can influence perceived managers' safety commitment among employees should also be researched (Ye et al., 2020). Studies should address the extent to which managers' commitment to safety shapes the safety commitment of their employees (Fruhen et al., 2019). Further, it might also be important to explore how different safety commitment dimensions would be perceived by employees and how they would influence the safety behaviour of employees and other safety-important outcomes (Fruhen et al., 2019).

### 3.6 Discussion and Conclusion

The results of the systematic literature review were separated into **two time periods** to illustrate the development of the topic over the last two decades. Our systematic review revealed that **safety commitment** was studied either as an important **dimension of safety climate** (e.g., Beus et al., 2019; Bosak et al., 2013; Clark et al., 2014; Du & Sun, 2012; Liang & Zhang, 2019; Pronovost et al., 2003; Schwatka & Rosecrance, 2016; Taher et al., 2014; Taylor & Snyder, 2017; Lim et al., 2018; Wu et al., 2008; Wu et al., 2019) and a **component of safety culture** (e.g., Biggs et al., 2013; Della et al., 2020; Luria & Rafaeli, 2008; Novak et al., 2017; O'Toole, 2002) or as an **independent factor** derived from a safety culture and safety climate (e.g., Amponsah-Tawiah & Anuka, 2018; Bowers & Fleming, 2018; Cui et al., 2013; Hofmann & Morgeson, 1999; Laurent et al., 2018; Lofquist et al., 2011; Michael et al., 2005; Tappura, Nenonen et al., 2017; Tong et al., 2015; Ye et al., 2020) that can influence organisations' safety performance and outcomes. As an independent factor, the safety commitment of managers remains **closely related to safety culture** and **climate** (e.g., Cui et al., 2013; Lofquist et al., 2011; Michael et al.,

2005). This is expected given that the concept of safety commitment originates from the safety climate and safety culture literature, and as pointed out by Flin (2003), managers' safety commitment and their actions can be seen as an essential element of culture and climate. Managers' safety commitment is often used by researchers to represent safety climate as it is generally regarded as its most influential dimension (Cui et al., 2013; Ye et al., 2020) and have the strongest influence on safety performance (Bosak et al., 2013). Researchers (Beus et al., 2019; Fruhen et al., 2014; Schwatka & Rosecrance, 2016) pointed out that managers' attitudes and behaviours regarding safety are the most often addressed factor of safety climate. In some cases, safety climate directly refers to employees' perceptions of managers' safety commitment (Stackhouse & Turner, 2019). As highlighted by Hamid et al. (2015) in his review article, this consequently results in other aspects of managers' safety commitment being overlooked or under-researched. Another important issue is highlighted by Schwatka and Rosecrance (2016); the authors point out that various safety climate dimensions are at least to some extent dependent on the safety commitment of managers, like a safety training programme, for instance. According to Beus et al. (2019), a large part of safety climate measurement scales either directly or indirectly addresses the managers' commitment to safety.

We can see this **trend continuing across both time periods**; however, our systematic review has also shown that while a significant proportion of studies firmly embedded the concept of safety commitment in safety climate and culture (e.g., Biggs et al., 2013; Taher et al., 2014), others only loosely refer to these concepts (e.g., Bowers & Fleming, 2018; Hamid et al., 2015; Turner et al., 2020; Wu et al., 2015). Al-Bsheish et al. (2019) go even further and call for managers' safety commitment to be, due to its importance, **addressed as an independent concept** and explored separately from the concept of safety climate and culture. This indicates that the safety commitment is gradually becoming recognised as an important concept in safety research that warrants special attention. Consequently, this might lead to a shift in the research of safety commitment.

In the last years, some **studies deviated** from the theoretical framework of **safety culture** and **climate** to a larger extent and built on organisational commitment. Delegach et al. (2017) proposed that safety commitment should be seen as a distinct type of commitment, with a specific focus on safety. In a similar manner, Fruhern et al. (2019) also build on the established conceptual framework of organisational commitment from the field of organisational behaviour, where the concept is addressed as mindsets or drives of individuals with a direct focus on managers' commitment to safety. The authors propose that the action commitment approach from the organisational literature that proposes commitment towards a particular goal can also be used to address the concept of managers' commitment to safety. In the proposed approach, the focus is also directed on how managers perceive their safety commitment, rather than on how employees perceive the commitment of managers based on the observed behaviour. This positions managers and their experience of safety commitment in the centre of the research (Fruhen et al., 2019). Other authors (e.g., Alingh et al., 2018) positioned the concept of managers' safety commitment within the concept of commitment-based safety management that is better known from the human resource management literature. In addition, perceived managers' safety commitment was also addressed as one of the dimensions of employees' safety attitude (Li et al., 2019).

Analysis of our core literature revealed that managers' **safety commitment** is most frequently **addressed through perceptions of employees**. As such, it represents the link between managers' values and care for safety and employees' attitudes toward safety. Managers' safety commitment can, through employees' perceptions, influence employees' safety commitment (Laurent et al., 2018; Ye et al., 2020). Managers' safety commitment

is generally **conveyed** through managers' safety **actions** and their **decisions** (Bowers & Fleming, 2018; Fruhen et al., 2019; Ye et al., 2020). These observable behaviours represent important cues that signal employees that managers care for their safety. At the same time, those signals show employees what type of safety behaviour is desired and promoted in the organisation (Bosak et al., 2013; Lofquist et al., 2011; Stackhouse & Turner, 2019). The analysis of the core literature showed that identified **leadership roles** closely resemble various safety-related actions through which managers demonstrate their safety commitment. Through leadership behaviour, managers' safety commitment can be transferred to employees. If safety commitment is **conveyed clearly** and **regularly**, it can enhance employees' perceptions of managerial safety commitment and promote the development of safety commitment among employees (Cui et al., 2013; Flin, 2003; Flin & Yule, 2004; O'Dea & Flin, 2001; Wu et al., 2008).

During the systematic review, we also analyse various **concepts** that can **influence safety commitment**. A small number of studies in the first time period did not allow a close comparison between both time periods. However, findings showed that the concept of **leadership** was addressed most frequently in both periods (Biggs et al., 2013; Du & Sun, 2012; Hofmann & Morgeson, 1999; Wu et al., 2008). This can be attributed to the important influence that leadership style can have on employees' perception of managers' safety commitment. On the other hand, our analysis also covered the potential **consequences of safety commitment**. Again, there were only a few papers in the first time period. Nevertheless, we can see that safety commitment can have an important influence on various concepts, such as **adverse events** in the form of accidents or injuries and also on outcomes that were not directly related to safety, such as job satisfaction or work performance (Hofmann & Morgeson, 1999; Michael et al., 2005; O'Toole, 2002). In the second time period, the concept of employees' **safety behaviour** was most frequently addressed. Safety behaviour included both safety compliance and safety participation as well as undesired, risk-taking behaviour (e.g., Bosak et al., 2013; Laurent et al., 2018; Lim et al., 2018; Taylor & Snyder, 2017). We have to point out that the number of studies was much smaller in the first time period; however, we can observe that in the second time period, the focus evidently shifted towards employees' safety behaviour, especially safety compliance and participation.

Regarding **future research directions**, three different avenues were identified. The first represents **research designs** and **methods** that are adopted to explore the concept of managers' safety commitment. There is a need to address safety commitment at different levels of analysis (e.g., Fruhen et al., 2014; O'Dea & Flin, 2001; Stackhouse & Turner, 2019). At the same time, it is important to consider different units of observation since there might be a difference between employees' and managers' perceptions on safety actions, which demonstrate managers' safety commitment (e.g., Biggs et al., 2013; Cui et al., 2013). Determining the degree of alignment between employees' and managers' perceptions can add to further understanding (e.g., Bowers & Fleming, 2018; Fruhen et al., 2019). Second, the **role of leadership** should be further addressed since managers convey their safety commitment through various safety-related actions (e.g., Delegach et al., 2017; Wu et al., 2008; Ye et al., 2020). This leads to the third opportunity for future research; to better understand how **managers convey their safety signals** (e.g., Bowers & Fleming, 2018; Taylor & Snyder, 2017) to employees and how managers' commitment to safety shapes the safety commitment of their employees (e.g., Fruhen et al., 2019).

A systematic review of the literature provides answers to the research questions that were developed at the beginning of the study. We addressed the question of how the research on the commitment to safety and leadership developed and evolved through time; what are the main theories that are prevalent in this research field; what is the main focus

of these studies; what are the most important relationships between concepts of commitment and leadership; and what directions for future research can be inferred from this literature. A systematic review of literature provides not only a map of the current state on the topic of safety commitment and leadership but also builds a foundation for informed further research.

## Chapter 4

# Safety-Critical Organisations in the Context of Crisis: A Qualitative Study

### 4.1 Introduction

A review of the literature has shown that safety-critical organisations already face the challenge of successfully implementing safety processes during normal operations, but in times of crisis, this can become an even greater challenge. One such crisis that has had a significant impact on the implementation of safety processes is certainly the COVID-19 pandemic that has caused a disruption that affected established business practices around the world (Nicola et al., 2020; Seetharaman, 2020). The pandemic affected various business functions by challenging the established ways in which organisations perform their day-to-day activities (Alam, 2020). Since almost all organisations were affected to some degree by COVID-19, safety-critical organisations were no exception. To address the new health-related hazard and mitigate the consequences of the COVID-19 pandemic, governments introduced various restrictions ranging from the mandatory use of protective masks, physical distancing, quarantines, restricted mobility of citizens, to the partial or even complete shutdown of public life (Bruinen de Bruin et al., 2020). The new health risk combined with government restrictions forced organisations to adopt various prevention and mitigation measures, make necessary adjustments, and change the conventional ways organisations manage their business activities (Anderson et al., 2020; Bruinen de Bruin et al., 2020; Haigh & Gandhi, 2021). The combination of new health risks, government restrictions, and measures organisations have taken to mitigate the impact of the pandemic poses additional challenges to process safety management. The COVID-19 pandemic has affected organisations' daily functions and increased the pressure on organisations and their management. This has created circumstances that could directly or indirectly affect the organisations' ability to maintain control over hazardous operations and could lead to a series of events resulting in a major accident.

An important aspect of the COVID-19 crisis relates to human resources and represents the lack of employees, which could lead to a possible shortage of qualified workforce. This is important not only for safety-critical organisations, but also for all organisations that are expected to operate continuously despite the pandemic. To address this hazard, organisations should pay particular attention to preventing the transmission of SARS-CoV-2, as employee health and safety are essential to uninterrupted work operations. Ambarwati et al. (2022) argue that managers should develop policies and procedures and allocate

resources to minimise contact between employees, quickly identify new cases, and promote the consistent use of personal protective equipment. Ashraf et al. (2022) point out that the COVID-19 pandemic could affect the ability of organisations to keep their hazardous operations under control in several ways. The authors identified causes such as reduced number of employees due to either the illness, mandatory isolation, or the number of employees allowed on the premises; reduced employee performance, which may be related to prolonged working hours, socio-economic pressures, or working from home; budget cuts as organisations minimise financial losses; or unavailability of external contractors, as a consequence of pandemic restrictions (Ashraf et al., 2022). Similar to the above authors, Bragatto et al. (2021) argue that organisations should pay particular attention during the COVID-19 pandemic to challenges such as a reduced number of employees, stress that could affect employee performance; the inability of organisations to conduct planned safety inspections and employee training; and the unavailability of equipment or parts for maintenance. This requires that organisations and their management quickly adapt and implement changes in their operational processes, procedures, and facilities (Bragatto et al., 2021).

Therefore, various changes that organisations have had to make in an extremely short period of time to adapt and maintain their business functions represent an important aspect of the COVID-19 pandemic. These changes could have important implications for process safety. In the past, several authors have pointed out that organisational changes, even if unrelated at first glance, can significantly affect process safety management (e.g., Grote, 2008; Lofquist et al., 2011). Organisations have usually overlooked the need to examine the potential impact that various changes, such as altered work shifts, employee roles and responsibilities, or the loss of key employees, could have on process safety (e.g., Davidson & Mooney, 2010; Levovnik & Gerbec, 2018; Wincek et al., 2015). Therefore, to avoid undesirable consequences, organisations should evaluate how various organisational changes might affect process safety management (e.g., Grote, 2008; Davidson & Mooney). However, as noted earlier, the COVID-19 pandemic forced organisations to quickly reorganise and adapt to new and unknown circumstances. If change management was already a challenge for organisations prior to the pandemic, the COVID-19-related health crisis only increased the pressure on organisations' management.

Based on the arguments presented above, we propose that the COVID-19 pandemic could have a significant impact on safety-critical organisations and their ability to ensure process safety. The **aim of this chapter**, therefore, is to explore how the COVID-19 pandemic and associated mitigation measures have affected safety-critical organisations.

In what follows, we first present the research approach used in this study. We then describe the data collection method, research context, and sample, focusing on sample selection, size, and the data collection process. Next, we detail the data analysis process and support it with examples from the analysis which provides insight into how the data were coded and how themes and relationships were identified. We then synthesise the findings and provide the interpretation. Finally, we discuss the findings and limitations of the study and highlight some possible avenues for future research.

## 4.2 Methods

To address the aforementioned aim of the dissertation, we performed an exploratory qualitative study. Qualitative research design generally involves an **inductive research approach** that is used to either develop a new theory or to gain a more elaborate theoretical perspective (Saunders et al., 2016). Gephart (2004) pointed out that qualitative research applies an interpretative approach to the addressed phenomena or issue.

Qualitative research generally explores a specific phenomenon in the natural environment in which it occurs; therefore, it is often described as a naturalistic approach. It offers a narrative of the individual's reality as it is based on the individual's view on the subject. Based on these interpretations provided by participants, researchers seek to understand the studied phenomena (Gephart, 2004). Using qualitative data can be especially appropriate when researchers try to gain a better understanding of the new empirical context that is yet under-researched, which the COVID-19 pandemic certainly is. Qualitative data can have various forms, most often they are in the form of texts (e.g., documents or researchers notes) and audio or video recordings. Researchers have to observe and interpret data to determine potential patterns and gain new insights. By focusing directly on the problem or the phenomenon, the qualitative approach promotes the development of knowledge that would otherwise not be possible to obtain through the deductive approach (Bansal et al., 2018).

There are various approaches and methods that can be used in qualitative research. We conducted an **exploratory study** as it allows researchers that explore the chosen topic through the various questions to gain new insights and obtain answers to proposed research questions. The exploratory purpose of the study facilitates a better understanding of the research problem, issue or phenomenon, particularly if not much is known about it. Therefore, an exploratory research approach would be the most suitable to address new circumstances related to the COVID-19 pandemic. The main advantage of this approach is that it is adaptable and flexible; therefore, it can change during the research process if needed. As pointed out by Saunders et al. (2016), exploratory research is especially appropriate for answering “how” or “what” type of questions; therefore, it represents an appropriate approach to answer our **first research question**, which states – *RQ1: “How did COVID-19 and the related mitigation measures affect the process safety management in safety-critical organisations?”*.

During the qualitative research, we referred to the general research process recommended in the literature (Bansal & Corley, 2012; Gopaldas, 2016; O’Brien et al., 2014). Because of the dynamic nature of qualitative research, the detailed guidelines cannot provide step-by-step directions on how to conduct this type of research (Bansal et al., 2018). As pointed out by Torrance (2008), such an attempt would only limit the research potential of the qualitative study.

### 4.2.1 Data collection method

To obtain the best possible insight into how the COVID-19 pandemic and the related mitigation measures affected the process safety management in safety-critical organisations, we conducted a series of **qualitative interviews** with the organisations’ management. Qualitative interviews represent a flexible approach that enables the interviewers to adapt and change the interview process if needed. In the interview process, the emphasis is on the participants and their view on the subject that is being explored. This approach is especially useful if interviewers strive to obtain rich, in-depth data (Bryman, 2016). It allows interviewers to further explore or “probe” answers they found interesting and gain new insights or add depth to the gathered data. Qualitative interviews can also lead interviewers to a completely unexpected yet important direction that can add to the understanding of the research topic (Saunders et al., 2016). The complexity of the situation that is going to be explored (i.e., COVID-19 pandemic) also indicates that qualitative interviews are the most suitable approach for the data collection. More specifically, we choose to use **semi-structured interviews** as a method to gather our primary data. Saunders et al. (2016) point out that semi-structured interviews are, together with in-depth interviews, the most appropriate method to gather data for the **exploratory study**.

Further, Bryman (2016) argues that when researchers have a relatively **clear idea** of the **research subject** that they want to explore, semi-structured interviews are the most appropriate choice as they enable the researcher to **examine a specific problem**. Therefore, semi-structured interviews represent a suitable method for our exploratory study that allowed us to gather the data needed to gain a better understanding of how did COVID-19 and the related mitigation measures affect the process safety management in safety-critical organisations. In addition to providing some degree of structure, semi-structured interviews also enable interviewers to exclude a question if it is not applicable for the specific interview. This type of interview, at the same time, allows researchers to adjust the order of the questions and, where necessary, ask additional in-depth questions (Saunders et al., 2016). In other words, this type of interview represents the “middle ground” between structured and unstructured interviews.

To facilitate data collection through semi-structured interviews, we developed an **interview protocol** or **guide** based on Bryman’s (2016) general directions. The interview protocol included seven main topics, along with an introductory section that initiated the start of the interview and a concluding section where potential additional questions were addressed. The main topics consisted of a series of open-ended key questions that served as a guide for the interviews. Topics included governmental measures taken at the national level to contain the COVID-19 pandemic, mitigation measures that were implemented at the organisational level by safety-critical organisations, the influence of these measures on the organisations’ operational activities and the organisations’ ability to maintain control over hazardous processes, and the key challenges the organisations faced to sustain their business activities during this health crisis. In addition, a special section was dedicated to organisations’ resilience and change management during the COVID-19 pandemic. The seven main topics covered in the protocol are summarised in Table 13. We revised the interview protocol several times before we agreed that it was prepared for use (see Appendix C for the final version of the interview protocol). A pilot interview was then conducted with managers from one safety-critical organisation. After the pilot interview, we reviewed the research protocol and implemented some minor changes (e.g., rewording the questions to improve clarity, revising the format of the interview protocol to improve readability, adding some additional probing questions). We then proceeded to the main interviewing phase and conducted interviews with the remaining managers in our sample organisations. The data obtained during the pilot interview were also included in further analysis.

Table 13: Main sections of the interview protocol.

<b>Section</b>	<b>Short description</b>
Section A	Mitigation measures adopted at the national level that were related to the safety-critical organisations
Section B	Mitigation measures implemented by organisations as a response to the COVID-19 pandemic
Section C	Influence of mitigation measures on organisations' daily activities
Section D	Influence of mitigation measures on organisations' ability to ensure process safety
Section E	Key challenges that organisations faced during the COVID-19 pandemic
Section F	Organisations' response to the pandemic and related measures
part (a)	through the perspective of (a) resilience and (b) management
and (b)	of change

The nature of our research question and the encompassing circumstances related to COVID-19 also influenced another important decision – to conduct **group interviews** with the managers from our sample organisations. According to Thompson and Demerath (1952), group interviews generally include one or more researchers conducting the interview and at least two or more individuals participating in the interview. Participants are selected in relation to the purpose of the research study. Group interviews should include **individuals** who can **provide rich information** to help answer the proposed research question (Saunders et al., 2016). This type of interviews has several advantages when compared with other types of interviews. First, group interviews are generally less time-consuming. During the pandemic, time was an especially scarce commodity for managers; therefore, organisations generally preferred to participate in one group interview in contrast to several individual interviews. Second, such a setting can highlight the research subject from various sides that would otherwise remain hidden in the individual interview. Participants can complement each other during the interview and provide additional details regarding a particular event or a problem which adds much needed depth to the information. The COVID-19 pandemic presented a complex challenge to the organisations that required a diverse team of managers and experts from different departments (e.g., general managers, operations managers, heads of human resource departments, safety managers, legal experts). Therefore, we used group interviews as this allowed us to gain a holistic insight into how organisations addressed different challenges of the pandemic. Since the roles of team members were closely intertwined, interviewing only one team member would not provide a complete picture. The third important advantage is that once the first participant starts to talk, this motivates other participants to contribute to the conversation. Another important aspect of group interviews is that they facilitate more detailed answers as they provide more specific descriptions. Participants can help each other to clearly articulate what they have in mind or provide additional details. In addition, the participants can also correct or prompt each other to rethink what may be overlooked. This allowed us to gain a more detailed understanding of how organisations dealt with the COVID-19 pandemic and the impact it has on organisations' daily activities and their ability to ensure process safety. The sixth advantage is that this type of interview can uncover the assumptions behind the participants' remarks and help highlight basic premises

that are not explicitly stated. Group interviews also have the edge when it comes to the observation of the participants. In the case of co-workers, researchers can observe how they work as a group and assess their dynamics (Thompson & Demerath, 1952). However, group interviews can be more challenging compared to individual interviews; therefore, we followed the recommendation of Saunders (2016) which suggests that more than one interviewer participates in the group interview.

## 4.2.2 Research context and sampling

In the qualitative study, we focused on **safety-critical organisations**. During their operation, safety-critical organisations have to manage various safety hazards (Reiman & Oedewald, 2009). If those hazards are not addressed appropriately, they could result in major accidents with serious consequences that are not limited to the organisation where they occur but can also have significant impacts on the public and the environment. Therefore, the ability of safety-critical organisations to maintain the safety of their operations during the COVID-19 pandemic is especially important. More specifically, we focused on organisations covered by the EU directive The Control of Major-Accident Hazards Involving Dangerous Substances (Directive 2012/18). As the Directive is commonly named also as “Seveso III” directive, these organisations are also known as the “Seveso organisations”. The directive includes organisations where dangerous substances are present (processed/stored) in quantities above a specific threshold. Depending on the amount of the dangerous substances, organisations are classified as upper or lower tier organisations related to the pertaining formal obligations. At the time we conducted our research, there were 60 “Seveso organisations” registered in Slovenia (Agencija Republike Slovenije za okolje, 2020).

### 4.2.2.1 Sample selection approach

We gathered our sample by using the **non-probability sampling** technique. During the COVID-19 crisis, one of the research challenges was getting access to the management of safety-critical organisations. Organisations were under pressure as they had to act quickly to adapt to new pandemic circumstances, which left the management of organisations with little time for other, un-urgent activities. Thus, we selected a sample of organisations to which we had access at the time of the COVID-19 pandemic. The familiarity with managers in these organisations also facilitated the data collection process as there was a higher level of trust between researchers and participants, which is especially important in qualitative research. Trust and the personal credibility of the interviewer are related to the higher value of the gathered data (Saunders et al., 2016).

As described by Saunders (2016), this type of sampling approach corresponds to **convenience sampling**. However, we also followed the criteria for the **heterogeneous purposive sampling** approach. In this sampling approach, researchers select various sample units with diverse characteristics. Collected data can facilitate the identification of key themes and provide their explanation. This approach enables researchers to observe potential patterns that may emerge from the sample (Saunders et al., 2016). The aim is to select the sample that could provide the information needed to the best answer to the proposed research questions (Farrugia, 2019). We sought to obtain a sample that would include various organisations that are subject to the national major-accident prevention legislation, as this would allow us to examine how the various “Seveso organisations” responded to the COVID-19 pandemic and overcame the various challenges. Thus, we included organisations that differed in terms of their size (i.e., number of employees), their

“Seveso classification” (upper and lower tier), and their economic activity (e.g., manufacture of industrial gases, cargo handling).

#### 4.2.2.2 Sample size

Although we defined specific criteria for the sample selection, **we did not have a predetermined number of cases**. Farrugia (2019) points out that the sampling process in qualitative studies is generally iterative and is developing and changing during the research. It can be seen as a spiral process, where initially collected data are interpreted and analysed by researchers, and then consequently further shape researchers’ decisions about sampling methods and sampling size. When adding new units to the sample yields no additional information, codes, concepts, or themes, the **sample has reached saturation**, meaning that no additional cases are needed. Therefore, the final size of the sample is usually hard to predict at the beginning of the research. Although some approaches such as statistical calculation, empirical guidelines, conceptual models, or rule of thumb enable the determination of sample size in advance, Sim et al. (2018) argue that this may not be completely compatible with inductive research approaches used, for example, in exploratory studies. In these types of studies, decisions regarding the sample size should be based on the sample saturation.

Saunders et al. (2018) point out that the following saturations approach helps establish **rigour in the qualitative research**. There are various models of sample saturation that differ according to the basis on which the saturation is determined. Data saturation is focused on the number of data (e.g., interviews) that have to be collected until saturation is reached, and nothing new can be deduced from the data. In other words, the new data becomes redundant when descriptions and comments begin to duplicate. At this point, the data collection process ceases, and the analysis starts. In contrast to this is the theoretical saturation, where saturation is reached when during the process of analysis, the theoretical category is sufficiently developed. Here the process of data collection and analysis are intertwined. As can be seen from these examples, the models of saturation also differ by the level of research at which saturation is determined. In addition, Saunders et al. (2018) point out that there are two other saturation models that are often used, namely inductive thematic saturation, which defines adequate saturation based on the emergence of new codes and themes, and a prior thematic saturation that focuses on codes or themes that correspond to predetermined categories.

In our research, we employed a **hybrid approach** to establish the degree of sample saturation by combining **data saturation** and **inductive thematic saturation** on the level of preliminary codes determined in the initial phases of the analysis. This approach enabled us to determine the level of sample saturation relatively early in the research process and at the same time not rely only on the similarity of gathered data. This is important since initially, collected data might seem similar; however, some previously unobserved differences may appear when these data are then further analysed (Saunders et al., 2018). Therefore, we decided to cease the sampling when we reached an agreement that the appropriate degree of sample saturation was achieved, considering both data and thematic saturation criteria. Although we made this decision at a relatively early stage of the research process, we argue that this suffices to adequately answer our exploratory research question.

#### 4.2.2.3 Description of the sample

To gather the data needed to get a better understanding of how the COVID-19 pandemic and related mitigation measures affect the aforementioned organisations, we conducted **six**

**group interviews** in industrial organisations in Slovenia. More specifically, we conducted a set of interviews with **22 managers** from **six organisations** that constitute our final sample. We focused on managers at **high** and **middle-level** positions as they were in the “first line” where hard decisions had to be made in a short amount of time. Management’s fast actions enable organisations to appropriately respond and adapt to the changed circumstances due to the COVID-19 pandemic. To get a more holistic understanding of the situation in organisations during the pandemic, we strive to include managers from various positions. Generally, our group interviews consisted of chief operations or technology officers and various directors or heads of departments such as health and safety, human resource, public relations, maintenance, investments, and production. The number of managers who participated in each interview, their position in the organisation, and the duration of each interview are summarised in Table 14.

Table 14: Participants’ position in the organisation and duration of the interview.

<b>Organisation</b>	<b>Number of participants</b>	<b>Position in the organisation</b>	<b>Duration of the interview</b>
1	6	Director of health, safety, and quality department; head of the insurance department; two safety managers; head of the storage facility; project manager	51 min
2	3	Head of public relations; member of the management board; head of operations	1 h and 51 min
3	3	Quality, environment, health and safety department manager; technology and investment manager; director of human resources department	1 h and 26 min
4	3	Head of the production; assistant to the head of the production; safety manager	1 h and 55 min
5	4	Technical director; two directors of different business units; human resource manager	2 h and 2 min
6	3	Head of the production; head of technical operations and maintenance; safety manager	1 h and 46 min

Managers worked in organisations that either process, store, handle, or use different types of dangerous substances. We primarily focused on the organisations that were, according to the legislation, classified as the upper-tier organisations, as these organisations are the most relevant in the context of major accident prevention. In addition, the size of organisations defined by the number of employees was also considered (OECD, 2021). According to international standard industrial classification (United Nations. Statistical Division, 2008), the organisations in our sample can be classified into various categories of economic activities. Organisations included in our final sample are anonymously presented by their economic activity, size, and classification that corresponds to the relevant national and EU legislation in Table 15.

Table 15: Classification of organisations included in the sample.

Organisation	Class <sup>a</sup>	Description	Size <sup>b</sup>	“Seveso” Classification <sup>c</sup>
1	G 47.30 H 52.24	Retail sale of automotive fuel in specialised stores; Cargo handling	Large	Upper-tier
2	H 52.24	Cargo handling	Large	Upper-tier
3	C 20.16	Manufacture of plastics in primary forms	Medium	Upper-tier
4	C 20.13	Manufacture of other inorganic basic chemicals	Medium	Upper-tier
5	C 20.11	Manufacture of industrial gases	Medium	Upper-tier
6	D 35.11	Production of electricity	Medium	Lower-tier

*Note.* <sup>a</sup> Classification is based on the “International standard industrial classification of all economic activities,” by United Nations. Statistical Division, (ISIC): Rev. 4, 2008, *Statistical papers*. <sup>b</sup> Based on the number of employees from the “Enterprises by business size,” by OECD, 2021, OECD Library (<https://www.oecd-ilibrary.org>). Size: medium – from 50 to 249 employees, large – 250 or more employees. <sup>c</sup> Classification is based on the national legislation implementing the “Directive 2012/18. *The Control of Major-Accident Hazards Involving Dangerous Substances*,” by European Parliament, Council of the European Union (<http://data.europa.eu/eli/dir/2012/18/oj>).

### 4.2.3 Process of data collection

We started our data collection process by contacting managers from organisations to which we had access at the time of the COVID-19 pandemic. The potential **organisations were selected** based on the **specific criteria** described in Chapter 4.2.2.1. First, one of the researchers (that had the longest relationship with the contact) contacted the organisations, briefly described the background of the study, explained the aim, and proposed if the management of their organisation is prepared to participate in the group interview. In the second step, we sent the official email with the invitation to participate in the study to the management of the organisation. In this invitation, we also explained the purpose of this interview and how we intend to use the collected data. Full confidentiality was also assured to all participants. If the management agreed, we then coordinated all the necessary details and arranged a meeting with managers from this organisation. A set of semi-structured group interviews were conducted in the period from **May to August 2020**. The time frame corresponds with the end of the first official epidemic of COVID-19 in Slovenia, which was officially declared from 12 March 2020 to 15 May 2020 and represented the so-called “first wave” of the COVID-19 pandemic. This enabled us to explore the organisations’ response to the COVID-19 pandemic in its first few months. The group interviews were conducted by one of the platforms for video meetings, such as Zoom or Microsoft Teams. The interviews were led by a researcher who knew the majority of participants well as they collaborated together in the past. This facilitated the interviews as participants were more willing to share their information and

express their opinions on the particular matter. The other two researchers were also present during the interviews, which increased the **internal reliability** as researchers have to reach an agreement on what they hear and observe (Bryman, 2016). To further facilitate the interview process and obtain the most genuine responses possible from our participants, we conducted the interviews in Slovenian, the native language of the participants. The interviews lasted between one and two hours, with an average duration of 1 hour and 35 minutes.

To facilitate later analysis, we **obtained permission to record interviews**. This not only enabled the further study of the conversation but also allowed for the examination of the non-verbal communication of the participants. During each interview, we gathered notes of specific observations and thoughts, as recommended by literature (Saunders et al., 2016). Those short records included observations of specific non-verbal signs, the dynamic of conversation between participants (e.g., were there any disagreements between participants, or whether any of the participants had a particularly dominant role), and other observations that we deemed that could be important for our study.

#### 4.2.4 Data analysis

We chose this specific type of research study to answer our research question as it builds on the qualitative data that is rich in meaning and allows the exploration of the research topic as directly as possible. Such data facilitated a much **deeper understanding** of how the COVID-19 pandemic and the related mitigation measures affected organisations and their ability to maintain control over hazardous processes. However, qualitative data (generally in the form of words or observed actions) can have complex, unclear, or even multiple meanings. Therefore, the **quality of findings** from this type of research is strongly related to both the data **collection** and data **analysis** process that facilitate understanding of gathered data (Saunders et al., 2016). The nature of qualitative data has an important influence on the approach to data analysis. The information richness and vast volume (notes, documents, or records) of qualitative data can represent a serious challenge when researchers attempt to analyse gathered data (Bryman, 2016). In the process of data analysis, data obtained during the collection have to be summarised, coded, and classified into related meaningful themes and categories that enable researchers to answer their research questions. Without undertaking this process, the findings may represent a distorted view of these data (Saunders et al., 2016).

As already mentioned, we adopted an **inductive approach** in our qualitative data analysis. This is also in accordance with the exploratory purpose of the study. In the inductive approach to analysis, researchers search for the meaning in the data and strive to understand both perceptions of the participants and the social context. The process of data analysis is often intertwined with processes of data collection and verification, where propositions based on data are verified by additional data. In the process of analysis, data sometimes needs to be re-coded to fit them into newly emerged themes. It is a time-consuming, interactive process that goes back and forth; however, when performed correctly, insights obtained during this process deepen the understanding of the topic (Saunders et al., 2016).

In our analysis of qualitative data gathered during the interviews, we followed the process of basic **thematic analysis** outline in the literature (Bryman, 2016; Saunders et al., 2016; Schutt, 2012). This fundamental method is often an essential part of other types of qualitative analysis, such as narrative analysis, grounded theory, or qualitative content analysis (Bryman, 2016). Thematic analysis helps researchers systematically examine data and identify recurring themes, relationships, or patterns in a logical manner. Based on the analysed data, researchers can generate rich descriptions that support elaborative

explanations and enable further theorising (Saunders et al., 2016). Although various guidelines exist in the literature that outlines important steps of the analysis, Schutt (2012) points out that there is no universal recipe and that every research process is unique. Our thematic analysis process is divided into basic steps that are briefly described below.

Following the recommendations of Saunders (2016), we first **familiarised** ourselves with the **collected data**. The process of familiarisation with the collected data involves immersing into data, as researchers re-read data several times during the process of analysis, searching for themes, patterns, and meanings. This enables researchers to start with the analysis. Familiarisation usually begins with the transcription of interviews; however, we decided that we would perform the analysis directly from the video recordings of group interviews. Therefore, we started by watching the recordings closely. After each interview, we composed a summary and noted all our observations and ideas. Saldaña (2009) also proposes that prior to actual coding, researchers should start with “pre-coding”. In this process, researchers mark specific parts of interviews that are particularly interesting for coding that follows. Therefore, during the process of familiarisation with data, we also highlighted specific parts of interviews for further analysis.

In the next step, we started to **examine** our **recordings** and **code** our **data**. Saldana (2009) proposes that researchers should code their data manually when interviews are manageable in size. In this process, the codes are attributed to the specific units of data that can represent a paragraph, specific lines in the paragraph or a sentence. Coded sets of data can include a description of various behaviours, events, actions, beliefs, or outcomes that are potentially interesting for further analysis. Codes illustratively describe the specific unit of data or can shortly summarise its meaning. Codes can be in the form of one or more words that can also be abbreviated. In the process of coding, units of data with similar meanings are coded with the same code. However, it is expected that different units can overlap or are coded with multiple codes during this process (Saunders et al., 2016). Bryman (2016) points out that researchers should review their codes in relation to their data, check for duplicates of codes, or re-code them if needed. This coding is an ongoing process with several stages; therefore, we first started with preliminary codes (Saldaña, 2009). We used preliminary codes in the form of simple words to describe sections of interviews that we found interesting. When a specific segment or line in the paragraph was marked with preliminary code, the transcript of this particular content was made, labelled with the number of the particular organisation, the anonymised name of the participant, and the corresponding key question from the interview protocol. Through this process, we created a database that facilitated further analysis. Table 16 provide two examples of how sections of the interview were labelled with preliminary codes. The first is from the section of the interview, where we asked participants how the work process (including durations of shifts and number of employees) was organised during the first months of the COVID-19 pandemic; and second is from the section where we asked about the measures at the organisational level.

Table 16: Examples of preliminary coding of the data.

Organisation/ section/ participant	Raw data from the interview	Preliminary codes
Organisation 6/ Section D/ Manager F	<i>“If we are talking about production, we did not change the number of employees that are present in our power plant; however, we did reorganise the duration and the rotation of our work shifts.”</i>	Change in duration and rotation
Organisation 2/ Section C/ Manager R	<i>“Communication, it went down from the management; the biggest part took over [name of the manager] through established communication channels. We had a workgroup that gave directions, civil protection, security officers the field ... plus what we put out in common rooms, personal contacts, communication with supervisors at the terminals, health and safety representatives.”</i>	Providing information and communication with employees

We coded the interviews separately, each researcher for himself. After the first phase of coding was complete, we compared and discussed our preliminary findings. Saumure and Given (2008) point out that **including more than one researcher** in the coding process and frequent discussions of the results allow researchers to assess their interpretation of the data and consequently **contribute to the reliability** of the qualitative research study.

In the next step, we performed **another round of coding**. We reviewed the recording once again and examined the preliminary codes in relation to the interview. This enabled us to develop our final codes. Building on the aforementioned examples, where we labelled specific sections with the preliminary code “change in duration and rotation”, we then re-coded the section under the code “job design”. The preliminary code labelled “providing information and communication with employees” was re-coded as “communication”. During this process, several preliminary codes were grouped together under the new codes. All new codes were linked with the preliminary codes and corresponding sections of the transcript. Both preliminary and new codes were labelled with the same colour, which also facilitated their traceability. After the second round of coding, we had another discussion where we debated about the appropriateness of our final codes. This enabled us to compare different views and reach an agreement on which codes to use.

The next step was the **identification of themes and relationships**. A theme can represent a large category of several codes that are in some way connected to each other or can include only one code that has an important meaning for the proposed research question. Saunders (2016) points out that although this is generally addressed as a separate stage in the process of the analysis, it is closely intertwined with other stages of data collection and coding. Researchers constantly search for patterns, relationships and themes in the data as a study evolves. Thus, after the coding, we re-examined the codes and categorised them into themes. During this process, we were constantly referring back to our research question. Several codes were grouped together under a specific theme. For example, codes such as “reporting”, “instructions”, “communication” were categorised under a larger theme of “information”, and codes such as “maintenance”, “certification of

equipment”, “safety training”, and “safety procedures” were grouped under the theme of “process safety”. During the process of analysis and development of themes, we also referred to the relevant literature to capture the meaning from the qualitative data and label it with a meaningful label that is in accordance with theory. The example of the coding process and classification of themes are presented in Table 17. It represents a part of the coding that was performed on a segment of the interview (i.e., section B) from the organisations in our sample (i.e., organisation 5).

In the final step, we **refine** the **themes** and **address the relationships** between them. Some themes were merged or deleted. Where needed, sub-themes were created to organise coded data. For example, the code “support of management” was generally categorised under the theme “role of management”; however, when the “support of management” was related to the resilience, this code was categorised under the sub-theme of “role of management – resilience”, which was listed under the theme of “resilience”. During this process, the relationships between themes, codes, and data units were also reassessed. In other words, we examined if there was a sufficient connection between our data, codes, and themes. Each theme must be based on meaningful codes that draw from the data. After this part of the analysis, we discussed the results of the analysis and how these findings can help to answer our research question.

Table 17: Example of coding and classification of themes.

No. <sup>a</sup>	Raw data from the interview	Preliminary codes	Final codes	Categorisation into themes
Org.5/ Sec.B/ MJ	<i>“The chairman of the management board cares a lot about safety, so there was no mucking about, in a way that we would simply be testing the boundaries. It was all about safety, safety, and again safety.”</i>	Support of the board chairman	Support of management	Role of management
Org.5/ Sec.B/ ML	<i>“The work processes were prolonged as particular fail-safes were built into the process, which logically, consequently meant that we did not work with full capacity.”</i>	Additional measures in the work processes	Job design	COVID-19 prevention measures

(Table continues)

Table 17: Example of coding and classification of themes (*Continued*).

No. <sup>a</sup>	Raw data from the interview	Preliminary codes	Final codes	Categorisation into themes
Org.5/ Sec.B/ MJ	<i>“The communication started before, before the actual pandemic was declared ... starting with guidelines, preparations.”</i>	Communication prior to the pandemic was declared	Communication	Planning and preparation
Org.5/ Sec.B/ ML	<i>I don't think we had any problems with the funding; I don't know, thank God. ... There were no problems with any formal papers and classic approval processes. In these emergency circumstances, it was approved [by management] in an emergency way.</i>	Obtaining the financial resources	Financial resources	Role of management
Org.5/ Sec.B/ MJ	<i>“There was also a lot of information exchange with other companies nearby.”</i>	Exchanging information	Gathering the information	Information

*Note.* <sup>a</sup> Indicate the organisation, the specific section of the interview, and the anonymised name of the participant.

### 4.3 Synthesis of the Findings and Interpretation

Based on the thematic analysis presented in Chapter 4.2.4, we then **synthesised findings** in relation to the proposed research question. The synthesis process enabled us to summarise the data and focus on the specific meaning of the data that corresponds to the aim of our research. As pointed out by Saunders (2016), there are various approaches and methods to accomplish this; however, the main goal of all is to identify the **patterns** and **relationships** that enable researchers to **draw conclusions** and successfully **answer the research question**. Using innovative ways of displaying data, either in the form of tables or networks, can also facilitate this process (Miles et al., 2014). In the course of this chapter, we outline the main findings obtained from the thematic analysis and provide the

interpretation of how those findings inform our research question proposed at the beginning. The **findings are aggregated and described** in relation to the main **overarching themes** (measures for preventing the spread of COVID-19 disease, crisis management, main challenges in the crisis management, ensuring process safety) that were identified during our analysis of the data.

#### 4.3.1 Measures for preventing the spread of COVID-19 disease

The analysis showed that organisations from our sample did not detect any employees **positive for the SARS-CoV-2** virus during the first few months of the pandemic. Organisations identified only a few high-risk contacts with the SARS-CoV-2 positive individuals. One of the managers from organisation 2 stated: *“In our organisation, no, there were no cases [positive for SARS-COV-2].”* Another manager from the same organisation added: *“We encouraged workers to report if anything is wrong or could go wrong, or maybe they were somewhere else in some other area [with higher COVID-19 risk levels].”* Although it was possible to sense that some managers were worried about the situation in the coming months when the spring and summer months would end and the next wave of the pandemic would come, the managers were generally optimistic. Participant from organisation 4 pointed out: *“We are already preparing, meaning, the first next measure is that we do not recommend our employees to travel abroad”.*

The aforementioned optimism is based on the **various mitigation measures** that organisations adopted to prevent the spread of SARS-CoV-2. Most of the measures were aimed at **reducing close contact** between employees (both with other employees and with customers). Organisations implemented paperless solutions into their operations and modified some of their work processes. One manager from organisation 2 described: *“We tried to achieve a minimum contact between different shifts; we tried to limit the time that employees spent in closed quarters; we established new walking corridors.”* Another manager from organisation 5 pointed out: *“The production process is relatively automatised; therefore, a relatively small number of our employees is present; consequently, they can maintain that 1.5 to 2 meters of distance between them. ... There was a much bigger challenge with maintaining the distance on other organisational levels.”* Another manager from the same organisation added: *“Regarding our outside [contacts], meaning, visitors, external contractors ... we tried to limit their number as much as possible. Those that were coming into our organisation had to wear their mask on their face constantly. The same goes with the drivers; they were coming from various places.”*

In addition to reducing personal contact among employees, measures were also aimed at providing adequate **personal protective equipment** and **disinfectants**. Due to increased demand, most organisations faced **difficulties in the procurement** of personal protective equipment. The manager from organisation 3 explained: *“In the beginning, the key challenge was to provide basic protective equipment, masks, disinfectants for employees.”* The manager from organisation 5 similarly described the situation: *“At the beginning, it was surely the biggest challenge providing all this protective equipment.”*

However, the mitigation measures to prevent the spread of infections also influenced the **number and duration of work shifts**. Namely, the organisations were forced to reduce the number of employees in each shift and adjust the time of arrival at work. The manager from organisation 6 explained: *“We reorganised the time and rotation of shifts.”* Another manager from the same organisation added: *“Yes, the duration, actually we went from an 8 to a 12-hour working schedule.”* The intention was to lower the frequency of rotations. The manager from organisation 2 stated: *“On the organisational level, this means that we reorganised working schedules; this was a relatively major measure.”* Nevertheless, the work content and circumstances changed only in some cases.

Wherever possible, organisations introduced **work from home** and used a special form of “**waiting for work**”. In the case of shift work, some organisations organised a **reserve shift** that remained at home. The manager from organisation 4 explained: “*We also combined with the option of waiting for work so that they were at work for 4 hours, and then rotated [with other employees].*” The manager from organisation 5 stated: “*For those crucial processes, we had a backup team. Meaning that when one was at work, the other was on hold. However, the second team was always a little weaker, so that it could not cover all tasks 100 per cent.*” The pandemic circumstances especially highlighted the ability of organisations to ensure a **sufficient number of qualified employees** with specific skills in each shift. The manager from organisation 6 highlighted this problem: “*The situations, such as a pandemic, can very quickly shut down the entire organisation. Meaning if you do not have a sufficient number of qualified personnel available.*”

### 4.3.2 Crisis management

All organisations from our sample established a **crisis management group** responsible for **planning, adopting and implementing** the measures. Crucial to the successful work of this crisis group was its ability to **quickly respond to changing circumstances**, which was possible due to its structure. As explained by the manager from organisation 2: “*We established a crisis group that started preparing the measures and reviewing the situation around the world.*” Another manager from this organisation added: “*Our workgroup [crisis group] had all authorisations, knowledge, information to adopt necessary measures, adjust those measures, or withdraw the measures.*” Thus, the crisis group generally included experts from several departments, the organisation’s management, and members of the management board. As pointed out by the manager from organisation 3: “*This was around 10 people from various sectors of our organisation.*” In some cases, the representatives of the employees were also part of the crisis group. As the manager from organisation 2 explained: “*You know, we also included representatives of employees in this decision-making process ... so that we prepared and started with these measures in the real spirit of cooperation.*” This highlights the important involvement of employees or their representatives in the process of safety-related decision-making; it also further facilitates the implementation of the adopted measures.

Participants pointed out that the personal **involvement and commitment of high-level management** was particularly important, as it allowed important decisions to be made in a very limited time frame. The manager from organisation 5 stated: “*Our chairman of the management board puts a lot of emphasis on safety, and he was involved, meaning he was engaged ... we had meetings [crisis group], regular meetings in specific segments, let us say in the supply department, in all the production departments and so on, so he was involved in practically everything.*” Another manager from the same organisation emphasised: “*He [chairman of the management board] was willing to shut down half the operations, just to prevent, I would say, irreversible, I would say, long-lasting damage.*” The manager from organisation 3 expressed similar sentiments, saying: “*The management of our organisation was very proactive. ... They took the initiative.*” This also enabled the crisis groups to immediately authorise needed financial resources and implement the adopted measures. As the manager from organisation 3 described: “*Because high-level managers were involved [in the crisis group], getting the financial resources was not a problem.*” The situation was similar in other organisations. The manager from organisation 4 also stated: “*If we decided that we needed to buy disinfectants, for example, we simply bought them. ... Our director confirmed it. He even suggested that we distribute disinfectants to our employees, for home use.*”

The exploratory study revealed that the **proactiveness** of organisations and **well-timed planning** of the measures played a key role in managing the crisis circumstances at the start of the pandemic. The manager from organisation 1 pointed out: *“During the first days, we very intensively worked to prepare the specific documents which we already predicted that we would need.”* The manager from organisation 5 also highlighted the importance of fast response: *“We took this matter [pandemic] seriously and started to act quickly.”* In their implementation of measures, most organisations were one step ahead of official government acts (2 to 4 weeks). As one of the managers from organisation 1 described: *“We emptied our business quarters overnight.”* Another manager from the same organisation added: *“It was very important that we started dealing with this [pandemic] early. At the end of February, we had already established our crisis group; we considered our options.”* The proactive behaviour of the organisations also stemmed from their close contacts with other countries; thus, the organisations tried to ensure that their day-to-day operations were disrupted as little as possible. The manager from organisation 2 explained: *“We are involved in international trade. ... We learned about the COVID-19 pandemic problem back in early January. Therefore, we started preparing preventive measures in February ... at least in theory.”*

The mitigation measures were designed based on the **existing plans** that organisations already had developed (e.g., for containing the H1N1 pandemic, caused by the (H1N1)pdm09 virus, during the 2009 and 2010 or other respiratory infections, such as seasonal influenza), in cooperation with **professional organisations**, and relying on the **experience from abroad**. The manager from organisation 1 pointed out that: *“We had to develop some new measures. ... Regarding business continuity, we had some plans already developed for the event of H1N1 [H1N1 pandemic, caused by the (H1N1)pdm09 virus] in the past, and we drew from that.”* The manager from organisation 2 also pointed out: *“We cooperated with the epidemiologist, which is also the doctor in our organisation ... he is also a member of the National Institute of Public Health.”*

Organisations also recognised the end of the first pandemic wave as an opportunity to **integrate preventive measures** into their **internal policies** and adapt their crisis management plans for the event of a global pandemic. The manager from organisation 2 explained: *“Yes, definitely ... we will review and adjust the crisis response system for such [pandemic] events.”* Other organisations also recognised this opportunity. The manager from organisation 3 stated: *“Exactly these procedures, our system for reporting potential hazards in which we had gathered documents that were created during this time. We have to analyse these documents.”* Similarly, the manager from organisation 5 pointed out: *“We already started, we have a template ... now we have to think how we will arrange this, that it would actually become a central document for such situations.”*

### 4.3.3 Main challenges in the crisis management

The analysis of gathered data also showed that most **government measures** had either **direct** or **indirect influence** on the organisations. The manager from organisation 2 stated: *“Every day we gathered at the meeting, reviewed the situation from the previous day, and we also had government decrees on our daily agenda.”* The manager from organisation 1 pointed out that all measures adopted at the level of government affected their organisation: *“All, but absolutely all, it is impossible to rank them.”* At the same time, the organisations were also affected by the **preventive measures** adopted by **other countries**. The participants especially highlighted the measures of the countries in which they have business units. The manager from organisation 1 explained: *“Not only government measures in our country, but the other countries also. ... For example, in Serbia they had an official curfew and then you just can't work.”*

Gathered data suggest that the most **important challenge** presented the **lack of relevant information** from the government and competent institutions (e.g., the National Institute of Public Health and Civil Protection). The manager from organisation 6 pointed out: *“At the beginning, we were left on our own.”* Further, the information was often **unclear, incomplete** or even **contradictory**. The manager from organisation 4 stated: *“At the beginning of the pandemic, we received information from civil protection that we, as an organisation, are of some key importance and that our operation is very important. ... I still do not know what this meant.”* The fast and **constant change** of information, which made it difficult to follow, also added to the overall confusion. The manager from organisation 2 described the situation: *“Too much different information, fast change of information, meaning information from the government, ministry, National Institute of Public Health, National Laboratory of Health, Environment and Food.”* The manager from organisation 5 explained: *“The government at one time ordered the use of protective masks, and then the next time, [masks] were not mandatory anymore.”*

Our participants emphasised that, in addition to obtaining **relevant information, communication** with employees and other stakeholders outside the organisation was one of the **biggest challenges** organisations faced during the COVID-19 pandemic. The manager from organisation 3 stated: *“We communicated very clearly and openly with all employees.”* The manager from organisation 2 also noted the importance of communicating with all stakeholders: *“We also met with the representatives of the municipality and other organisations in the area.”* Clear, consistent, and open communication was extremely important because employees feared for their health due to the general lack of information about the COVID-19 disease. The manager from organisation 3 described the situation: *“They [employees] were afraid for their health, for their own, I would say, relatives and they would leave their work posts. But we managed to address this by frequently communicating with our employees. ... The director devoted his attention directly to the employees. We used internal communication channels, such as bulletin boards, emails, and internal notifications to inform our employees regarding adopted measures.”*

Therefore, during the first few months of the pandemic, the **key role** was played by the **crisis group** that actively **gathered information** from various sources (e.g., from the government, competent institutions, or external experts) and then **forwarded information** through communication channels to employees. As explained by the manager from organisation 6: *“Every day we had a meeting, an emergency meeting, we had a crisis group for the pandemics. We reviewed the situation in the field or what were the circumstances.”* Another manager added: *“We [crisis group] prepared and approved everything, and we were also gathering information from the field or from other organisations.”* Similarly, the manager from organisation 5 stated: *“We were in touch with the Institute for Safety at Work, so we got some useful advice from their side as well ... and we also exchanged information with other organisations in our surrounding area.”* The manager from organisation 3 emphasised the importance of conveying information further to employees: *“I believe that the formation of an internal crisis group was crucial ... and then that this crisis group effectively communicated with lower-level [employees].”*

The **return communication** of employees with the crisis group was also essential for the successful management of COVID-19. It enabled the direct path of information from the operative level to the crisis group, which allowed the organisations to adapt their mitigation measures as needed. The manager from organisation 3 stated: *“We also had feedback. Meaning that employees from specific business functions in our organisation sent constant daily reports regarding the presence at work, situations, and so on. ... Meaning that we did not communicate only in the direction from the top-down but also from the bottom-up.”*

Although organisations were proactive and responded fast to adopt necessary measures, the **consistent implementation** of these measures represented a significant challenge. As explained by the manager from organisation 2: *“The biggest challenge for us was not so much the development of measures, the adoption of measures, no, we managed it perfectly, but the field implementation. How to convince people that they have to comply with these measures.”*

Here, the key role had the **trust of employees** in the management and effectiveness of measures, the constant **communication**, and **motivation** of employees to comply with preventive measures. The manager from organisation 5 pointed out: *“If the head of the department walks around the office without a mask, it is then hard to demand from our employees that they should wear masks.”* This highlights the importance of **leading by example** during the COVID-19 pandemic. If high-level managers represent an example for their employees, this can positively affect their safety behaviour. An additional challenge for the organisations represented control over the **incorrect** or **misleading information** among employees that spread through social networks. As one manager from organisation 3 summed up: *“It is extremely important what employees hear and what they believe. A lot was said, but it was not all true.”*

#### 4.3.4 Ensuring process safety

The study also showed that organisations were able to **perform** all necessary **process safety activities** during the COVID-19 pandemic. In most organisations, the only exception represented periodical training (due to avoidance of physical contacts), and regular external inspections of safety equipment, which were delayed until the end of the epidemic would be officially declared. Based on the collected data, we can infer that management generally recognised the **importance** of assuring **process safety** in their organisations regardless of the situation. One of the high-level managers from organisation 1 emphasised: *“Oh, no, this is a different story. Seveso organisations have to maintain their operations, no matter what is going on.”* Managers from other organisations also shared this view. The manager from organisation 4 stated: *“Safety was extremely important for us; we would not continue with operations for any price. We focused on the safety of employees and processes.”*

When implementing the pandemic mitigation measures, organisations also took into account their **potential effects** on the **process safety**; however, the potential effects were **not assessed** in accordance with the internal procedures for the **management of change**. As one of the managers from organisation 2 pointed out, they assessed the potential effect on process safety for every change that they made; however: *“I would say that our change management was not so extensive that it could have any consequences or risks that could importantly affect our operations or process safety.”* Another manager from organisation 3 explained that they did not use their internal procedures for the management of change as: *“It would take much more time, more than it has been since the beginning of the pandemic until today.”*

All the organisations that participated in our research have **quickly adapted** to the new pandemic circumstances, introduced the necessary mitigation measures, and adjusted their business activities accordingly. During the first months of the COVID-19 pandemic, safety-critical organisations in our sample managed to **operate uninterrupted**. The manager from organisation 2 stated: *“We managed to maintain our normal business activities; there were only minor changes in the work process, together with mitigation measures. ... There were no major problems.”* The manager from organisation 3 similarly described their situation: *“We tried to work as normally as possible in these crisis*

*circumstances; we continued with normal business activities.*” In some cases, organisations reduced the extent of their business operations due to the reduced demand on the market.

The **lack of** appropriately **trained employees** with **key knowledge** and sufficient **experiences** was recognised as one of the **biggest threats** that could endanger the ability of safety-critical organisations to maintain control over hazardous processes. As one of the managers from organisation 1 described: *“If we ran out of people, for supply, to carry out basic activities, this would be a key problem. ... Before everything started, it was always a question of would we run out of people ... key knowledge, that everything is done by the rules, that everyone has certificates that are needed.”* One of the managers from organisation 6 stated: *“We cannot simply pick up [skilled employees] off the side of the road; we need several years for one trained operator.”* However, based on gathered data, it is **not evident** that the COVID-19 pandemic would **affect** the **availability of employees**, which would, in turn, directly affect the business operations or even result in a forced shutdown. The manager from organisation 6 pointed out: *“We did not have any sick-leave related to COVID-19; actually, the overall number of sick days actually decreased during this time.”*

Our participants pointed out that the **key factor** that enabled organisations to successfully maintain the **continuity of business operations** during the beginning of COVID-19 was the **cooperation** between **employees** and **management** of the organisations. The manager from organisation 2 stated: *“Actually everyone that works in our organisation.”* Another manager from the same organisation added to this: *“It was teamwork.”*

#### 4.4 Discussion, Limitations, and Directions for Future Research

The COVID-19 pandemic posed an unknown threat that required organisations to respond quickly and employ various measures to mitigate the effect of COVID-19 on their activities and survive in the face of adverse conditions. The findings enabled us to **advance knowledge** of how COVID-19 and associated mitigation measures affected the process safety management in safety-critical organisations. We employed an **exploratory qualitative approach** to our research as it facilitates a **better understanding** of the research problem, particularly if the topic is either **new** or **under-researched**, as the effect of the COVID-19 pandemic on the safety-critical organisation certainly was. Thus, the design of our study enabled a flexible way to explore our research question. **Qualitative data** obtained through a series of group interviews with the managers of safety-critical organisations from our sample provided **rich** and **meaningful information** on how organisations faced the challenges imposed by the COVID-19 pandemic. This type of data can facilitate a (new knowledge) much deeper understanding of the following research topics: how the COVID-19 pandemic and related measures adopted by the government at the national level affected safety-critical organisations; how organisations adapted to the changed circumstances, and what measures they implemented to maintain their operational activities; and how safety-critical organisations maintain control over hazardous processes and ensure process safety in times of crisis. We focused on the high and middle-level managers as they were responsible for hard decisions that had to be made to quickly respond to the uncertain circumstances. During the process of thematic analysis, we meticulously examined the interviews, identified codes, and categorised them into themes. Based on those meaningful themes, we looked for the potential relationships

between them that would allow us to **deepen our understanding** of how safety-critical organisations responded to the COVID-19 pandemic and its associated challenges.

The **results** of our **exploratory study** showed that organisations adopted various mitigation measures to prevent the spread of SARS-CoV-2, which were primarily aimed at reducing close contact between employees and providing adequate personal protective equipment. However, the mitigation measures to prevent the spread of SARS-CoV-2 also influenced the number and duration of work shifts, as organisations were forced to reduce the number of employees in each shift and adjust the time of arrival at work. The pandemic circumstances especially highlighted the ability of organisations to ensure a sufficient number of qualified employees with specific skills in each shift. This has encouraged organisations to organise an additional reserve shift. Organisations formed crisis management teams responsible for planning, adopting, and implementing the measures. Crisis teams included various experts and managers from different departments, including the members of the management board, which enabled them to respond to the changing circumstances quickly. The study showed that the proactiveness of organisations and well-timed planning of the measures played a key role in managing the crisis circumstances. The thematic analysis identified various challenges organisations faced at the beginning of the COVID-19 pandemic. The main challenges include obtaining relevant information, as information was often unclear, incomplete or even contradictory, communicating with various stakeholders both inside and outside the organisation, and addressing the incorrect or misleading information that circled among employees. Although organisations were proactive and responded fast to adopt necessary measures, the consistent implementation of these measures represented a significant challenge.

Our exploratory study also showed that organisations were able to **perform** most of their usual **process safety activities** during the COVID-19 pandemic. The only exception represented periodical training and regular external inspections of safety equipment. This indicates that management generally recognised the importance of assuring process safety during the COVID-19 pandemic. The lack of appropriately trained employees with key knowledge and sufficient experiences was recognised as one of the biggest threats that could endanger the ability of safety-critical organisations to maintain control over hazardous processes. However, based on gathered data, it is not evident that the COVID-19 pandemic would affect the availability of employees. The thematic analysis also revealed that while organisations considered the potential impact of pandemic mitigation measures on process safety, the potential impact was not assessed according to internal change management procedures. Change management is an integral part of managing process safety. Therefore, it is important that organisations comprehensively address all changes (organisational and technical) that could affect the organisations' ability to ensure process safety (Gerbec, 2017). However, we must bear in mind that in the early days of the pandemic, organisations had to react quickly to take the necessary preventive measures. Therefore, managers had a very limited time frame to perform all the necessary activities. The data collected in the interviews also did not allow any conclusions to be drawn as to whether the internal procedures included both organizational and technical changes.

The study also revealed that high-level **managers** can play an **important role** in process safety through their ability to adopt safety policies and safety regulations, provide funding for their implementation, and promote safe working procedures through clear and open communication with employees and leading by an example. Our findings are consistent with those of other authors who have highlighted that managers can have an important impact on safety performance and safety outcomes either by creating a safe work environment for employees or through their direct safety behaviours (Gravina et al., 2017; Levovnik et al., 2019a; Roger et al., 2009). Further, our findings also indicate that the important role of managers is perhaps even more evident in **times of crisis**. During

uncertain times, managers have a vital role when it comes to making fast decisions, providing the necessary financial resources, and communicating with various stakeholders. Our exploratory research also shows that high-level managers can, by providing an example and their direct involvement in safety matters, importantly promote trust among employees and motivate employees to implement adopted safety measures consistently. Because of the uncertainty during times of crisis, **assuring trust** between employees and other stakeholders outside the organisation can be essential. Organisations that aim to foster trust, promote a sense of safety and successfully manage uncertain situations in the time of crisis should give special attention to providing adequate **information**, acting **proactively**, and quickly **responding to changes** in circumstances.

Thus, our **exploratory study contributes** not only to a better understanding of the impact of the COVID-19 pandemic and associated mitigation measures on process safety management, but also provides a **foundation for future research** addressing safety-critical organisations under adverse circumstances. The results of the exploratory study provided in-depth insight into how the COVID-19 pandemic may have **affected safety-critical organisations**, what the **main challenges** were, and what were the most **important factors** that enabled organisations to thrive during these times of crisis. Building on this knowledge, safety-critical organisations can adopt internal policies and develop contingency plans that will enable them to prepare for the challenges that future pandemic events may bring. The findings of our exploratory study can help safety-critical organisations to focus on the most important factors that can improve their ability to quickly adapt and respond in the future.

However, this study also has some **limitations** that have to be mentioned. One type of limitation comes from the **data collection method**. Although interviews have several advantages as they can obtain reach and in-depth data, this approach has its limitations. The interview process requires close interaction between researchers and participants, which can **influence the collected data**. It is especially important in what manner the questions are asked (Saunders et al., 2016). Even the smallest things like the tone of voice or nonverbal communication can have an important effect. Further, as pointed out at the beginning of this chapter, semi-structured interviews also introduce some structure to the interview process; however, they are not standardised; therefore, semi-structured interviews have **lower reliability**. There are also **several types of biases** that have to be considered, such as interviewer bias, response bias, and participation bias (Saunders et al., 2016). We tried to mitigate these biases as much as possible during the exploratory study by careful sampling, preparing for the interview, ensuring confidentiality, and establishing trust with all participants; however, the aforementioned biases can never be completely eliminated. Hadi (2016) points out that the cooperation of several researchers, which can be seen as the type of triangulation, can help to **reduce** the single researcher **bias** and strengthen the **validity of the qualitative study**. Thus, three researchers participated in the study to improve the validity. In addition, we also followed Saunders's (2016) recommendation that the use of different probing and clarifying questions can improve the validity of semi-structured interviews. This allowed us to further explore the information provided by our participants and strengthen the validity of the study. However, the limitations of interviews as a data collection method cannot be completely eliminated. Therefore, future research should either employ data triangulation or use another method of data collection to overcome the limitations of this particular method of data collection (Saunders et al., 2016).

Another limitation comes from the **type of interview**. Group interviews are an effective choice for gathering data when researchers want to explore how members of this group faced a particular challenge or how they performed in changed circumstances, for

example, during the pandemic of COVID-19. However, they would not reveal the **personal attitudes** that participants have towards each other. Before starting the interview process, researchers must also decide what **type of candidates** would be most appropriate to participate in the group interviews. We focused on the high and middle-level managers because they were usually included in a crisis group that had to make tough decisions and take quick actions that enabled organisations to respond and adapt to the COVID-19 pandemic. However, this is difficult to determine in advance, and we may fail to include participants who could provide additional information, which limits the study's findings. The **interview flow** can also be disrupted if one of the participants has to leave the interview before it is finished. This may prevent researchers from obtaining important information or even lead to an early end of the interview. Although this situation was not very common in our case, it might potentially prevent us from collecting all available data. In addition, the **formal status** of the participants can also have an important effect on the group dynamics over which researchers do not have control (Thompson & Demerath, 1952). Future studies should therefore put additional emphasis on the process of selecting the candidates to participate in the interview, group together participants according to their status, or employ a different type of interview (e.g., individual interview) to overcome the limitations associated with group interviews.

In our qualitative study, we explored how the COVID-19 and the related mitigation measures affected the process safety management in safety-critical organisations. We collected our data through a set of semi-structured group interviews, starting in May 2020, which corresponds with the end of the first officially declared epidemic of COVID-19 in Slovenia. This enabled us to obtain a “snapshot” of organisations’ response to the COVID-19 pandemic in its first few months. Although this gives us valuable insight into how organisations responded to the new threat posed by the COVID-19, the **cross-sectional design** of our study **limits** us to examine how organisations further adapt throughout the pandemic, taking into account the dynamic of the pandemic (different waves and their intensity), new medical knowledge, and additional options for preventive measures. Therefore, we propose that future research adopts a longitudinal design, which would allow researchers to account for these factors.

As COVID-19 remains an ongoing threat, **new challenges** may arise. Thus, in the future, organisations will have to face challenges that would **require different responses** from the organisations and their management. Researchers point out that the crisis caused by the COVID-19 has induced a major disturbance in the macroeconomic environment, extending from the changes in global supply-chains to the changes in demand, and may require organisations to revise and adjust their business activities in order to persevere (Mohsin et al., 2021; Ruel & el Baz, 2021). In other words, organisations would have to further adapt to the changing circumstances, and here safety-critical organisations are no exception. Another important aspect is the effect of the COVID-19 pandemic on employees, such as the effect of prolonged stress on employees; the occurrence of “pandemic fatigue” as a result of the pressure resulting from adherence with preventive measures; or long-lasting sick leaves due to the medical issues related to “long COVID-19” (Petherick et al., 2021; Saleem et al., 2021; Westerlind et al., 2021). This calls for **additional studies** that would **further explore** how the ongoing COVID-19 pandemic is influencing organisations, how organisations are adapting, and how this is affecting the process safety management in safety-critical organisations.



## Chapter 5

# Examining the Relationship Between Managers' Commitment to Safety, Leadership Style, and Employees' Perception of Managers' Commitment: A Quantitative Study

### 5.1 Introduction

Findings from both the systematic literature review and the qualitative exploratory study underlined the need to further explore the role of managers' commitment to safety in safety-critical organisations. Specifically, the systematic literature revealed that safety commitment is an important yet under-researched concept that can influence the prevention of major accidents (Flin, 2003; Fruhen et al., 2014; O'Dea & Flin, 2001). Further, the results from our qualitative study highlight the important role of managers during the COVID-19 pandemic. The decisions and actions of high-level managers played an essential role in addressing various challenges faced by safety-critical organisations during the first few months of the COVID-19 pandemic. Managers' ability to make quick decisions enabled organisations to adopt necessary measures and make adjustments to withstand uncertainty and maintain their operational activities. Managers facilitated the adoption of safety policies and procedures and provided financial resources for their implementation. The results of our exploratory study showed that high-level managers set an example for employees through their behaviour and demonstrate what is expected in the organisation. Together with clear and active communication, this enabled managers to build trust with their employees. Thus, managers have been recognised as key to successfully managing the COVID-19 pandemic. In this chapter, we therefore focus on the managers' safety commitment in safety-critical organisations during COVID-19. More specifically, we examine the influence of managers' safety commitment on the perceived safety commitment of managers among employees.

Safety commitment has been recognised as an important concept that plays a central role in preventing major industrial accidents even before the COVID-9 pandemic (Flin, 2003; O'Dea & Flin, 2001). Although researchers agree that major accidents can be prevented only by a collective commitment of all employees in the organisation, existing research suggests that the commitment of high-level managers may be especially important

(Bowers & Fleming, 2018; Du & Sun, 2012; Flin, 2003). Due to their role in the organisation, managers make decisions that can directly or indirectly affect safety (Fruhen et al., 2019). In addition, the actions of managers also send an important signal to employees, showing them that safety is important for the organisation and its management (Bosak et al., 2013). Through their behaviour, managers show employees what kind of safety behaviours are acceptable and promoted in the organisation (Laurent et al., 2018; Ye et al., 2020).

Studies show that managers' commitment to safety can lead to various important safety outcomes. Among other things, managers' commitment to safety can help to improve employees' safety behaviour as it can influence safety compliance and safety participation (Lim et al., 2018; Schwatka & Rosecrance, 2016). Further, managers' safety commitment has also been identified as important when it comes to unsafe behaviours of employees, such as different types of rule violations or risk-taking behaviours (Bosak et al., 2013; Liang & Zhang, 2019). In addition, the positive influence of managers' commitment to safety has also been acknowledged in relation to safety management systems and various safety programmes and initiatives (Igić et al., 2020; Levovnik et al., 2019b; Nwankwo et al., 2020; Stackhouse & Turner, 2019).

In the safety literature, managers' commitment to safety is acknowledged as a core element of safety culture and climate (Flin, 2003; Flin & Yule, 2004). Wu et al. (2008) point out that without managers' commitment to safety reflected in their actions, safety management would not yield the expected results. Clear and visible demonstration of managers' safety commitment to employees is thus recognised as one of the most important factors that can positively influence safety culture (Biggs et al., 2013). At the same time, managers' safety commitment represents a central factor of safety climate, which can positively influence different types of employee safety motivation, which in turn can lead to better safety performance (Lim et al., 2018).

One of the most important aspects of managers' commitment to safety is employees' perceptions of managers' commitment. Bowers and Fleming (2018) argue that employees who perceive that safety has a priority over other goals (e.g., productivity) are more likely to comply with safety procedures and even actively participate in safety programmes. This is perhaps even more important in safety-critical organisations, especially in settings where there is no direct supervision (e.g., remote process operators). When employees perceive that their managers are committed to safety, this can have an important influence on employees' safety beliefs, perceived hazards, and safety-related behaviours (Al-Bsheish et al., 2019; Bosak et al., 2013; Cui et al., 2013).

However, the aforementioned studies primarily focus on how employees perceive managers' commitment to safety; therefore, the concept of safety commitment is addressed only from the employees' perspective. This can be attributed to the theoretical foundation of the safety commitment, as the concept originates from the safety climate and culture literature (Flin, 2003). As most studies build on the safety culture and climate, the main focus is usually on the employees' "shared perceptions" (Griffin & Curcuruto, 2016). However, this means that the managerial side of this relationship remains under-researched (Fruhen et al., 2014; Fruhen & Flin, 2016). Although researchers have recently begun to focus directly on managers' commitment to safety and their perceptions, these studies are still scarce (Fruhen et al., 2019; Tappura, Nenonen et al., 2017; Tong et al., 2015). Therefore, addressing the concept from a managers' perspective can add new insights to the existing body of knowledge on safety commitment.

Another step forward in the research of safety commitment would be to examine both sides of the relationship between managers' safety commitment and employees' perceptions of managers' safety commitment. Some researchers addressed how managers signal their commitment to employees and how managers can enhance the cues that they send to

employees by focusing on what they say as well as what they do (Laurent et al., 2018; Lofquist et al., 2011; Ye et al., 2020). However, Taylor and Snyder (2017) pointed out that further research is needed to deepen our knowledge on the mechanisms through which managers influence employees' safety behaviour. The holistic approach that would explore how managers experience safety commitment, how safety commitment manifests in their safety-related decisions and actions, and how employees perceive managers' commitment to safety is still missing. This would add to the understanding of how the demonstration of managers' commitment to safety can shape employees' perceptions of managers' commitment, which is known to have an important influence on safety performance (Al-Bsheish et al., 2019; Bosak et al., 2013; Cui et al., 2013).

Some researchers refer to leadership as a means through which managers can demonstrate their safety concerns to the employees (O'Dea & Flin, 2001). Similarly, Flin (2003) suggests that leadership style should be considered together with behaviours that demonstrate managers' safety commitment. Researchers connected different leadership styles to employees' perceptions of safety climate and consequently to safety performance. For example, Flin and Yule (2004) suggest that a safety climate that includes perceived managers' safety commitment can function as a mediator between managers' leadership style and safety performance. Flin (2003) proposes that transformational and transactional (with reward) leadership style may positively affect safety management. However, understanding how leadership style helps managers convey safety commitment to employees is still limited.

Based on the aforementioned arguments, there is a need to deepen the understanding of the mechanism through which managers convey their commitment to employees and how this shapes employees' safety perceptions. Therefore, the **aim of this chapter** is to explain the relationship between managers' commitment to safety, leadership style and employees' perceptions of managers' commitment to safety during the COVID-19 pandemic (see Figure 20). Gaining additional knowledge on this subject may be especially important in a time when safety-critical organisations have to tackle additional challenges posed by the COVID-19 pandemic. This positions the concept of managers' commitment to safety into a new context.

In the following chapter, we draw on the safety culture and climate, as well as organisational commitment and leadership literature to explain the proposed relationship. First, we present the theoretical foundations for the relationship between managers' commitment to safety and employee perceptions. Further, based on theoretical arguments, we propose that leadership mediates the relationship between managers' commitment to safety and employees' perceptions. We present the research approach used in this study and describe the data collection method, sample, data collection, and adopted measurement scales. We then present the results of the proposed hypotheses, which we empirically tested in safety-critical organisations during the COVID-19 pandemic. Finally, we discuss the results and limitations of the study and provide some potential directions for future research.

## 5.2 Theory and Hypotheses Development

### 5.2.1 Managers' commitment to safety and employees' perceptions

Researchers describe managers' commitment to safety by referring to a wide span of managerial activities and roles. The term generally represents safety-important elements over which managers have direct and indirect control (O'Dea & Flin, 2001). Similarly, Luria and Rafaeli (2008) describe safety commitment as organisation's efforts to assure and

maintain safety throughout its operations. Wang and Liu (2012) defined the concept as managers' safety attitudes and safety behaviour that involves addressing safety issues, supporting safety, and resolving safety problems. The **most often used definition** of managers' commitment to safety is the one by Neal and Griffin (2004) that define safety commitment of management as "the extent to which management is perceived to place a high priority on safety and communicate and act on safety issues effectively" (p. 27). This definition indicates that a great number of studies positioned the concept of safety commitment within safety climate and culture literature with the focus on "shared perceptions" of employees (Griffin & Curcuruto, 2016).

However, recently some authors (Delegach et al., 2017; Fruhen et al., 2019) proposed a definition that **departs from the prevailing definitions** of managers' safety commitment. Drawing from the organisational behaviour literature, authors characterised safety commitment as a commitment toward a specific (safety) goal. Fruhen et al. (2019) define the safety commitment of managers as an "action commitment that reflects their mindset and drive to support organisational safety" and propose that managers' commitment to safety should be seen as a psychological state (p. 205). Building on the organisational commitment model, the authors propose that managers' commitment to safety can be described by three dimensions; normative, affective, and calculative. According to Fruhen et al. (2019), the normative dimension represents "a moral obligation" of managers as safety is recognised as a basic social value, or it can be seen as a "right thing to do"; calculative dimension represents "a requirement to prioritise safety as an obligation to business survival" or due to "the external pressures"; and affective dimension represents "an emotional sense of personal care for the safety of the individuals" (p. 205).

From the definitions of safety commitment, we can infer that managers show their attitude towards safety through safety related activities. These **safety activities**, in turn, **demonstrate managers' safety commitment** to employees. Demonstration of safety commitment is important as it signals to employees that managers give high priority to safety (Bowers & Fleming, 2018; Ye et al., 2020). The safety commitment of managers can be **manifested** in various **decisions** and **safety-related actions**, which can directly or indirectly affect employees' perceptions of managers' commitment. Bowers and Fleming (2018) propose that distinction is based on the difference between employees' direct or indirect observation of managers' behaviour and decisions. Similarly, Fruhen et al. (2019) argue that the difference should be based on the direct and indirect interaction between managers and employees. Generally, researchers are relatively consistent in their description of different ways in which managers can convey their safety commitment. Most often, they highlight the importance of communication with employees, participation of managers in safety programmes or interaction with employees, providing guidance for employees, encouraging them to participate in making important safety decisions, providing financial and non-financial resources, implementing safety policies and procedures, or prioritising safety during production (e.g., Bosak et al., 2013; Fischer et al., 2018; Hofmann & Morgeson, 1999; Lim et al., 2018; Schwatka et al., 2020; Shore et al., 2020; Wu et al., 2008).

These aforementioned ways in which managers demonstrate their commitment to safety represent a signal to employees. These **signals represent cues for employees**, indicating what safety behaviours are promoted and what goals employees should pursue (Laurent et al., 2018; Ye et al., 2020). Managers' behaviour indicates organisations' safety norms and consequently shape employees' safety perceptions (Bosak et al., 2013). However, it is also important that these signals that managers send to employees are clear and consistent; otherwise, they will not achieve the desired effect (Turner et al., 2020). In addition, various work-related practices also signal how important safety is for the organisation and, in turn, affect employees' perceptions (Stackhouse & Turner, 2019).

As we pointed out at the beginning of this study, employees' perception of managers' commitment to safety has an important influence on safety performance, including employee safety compliance and participation (Al-Bsheish et al., 2019). In addition, the commitment of high-level managers can be observed and adopted by others, especially younger managers that work in lower organisational positions and have a direct influence on employees (Flin, 2003). In this way, the **safety commitment** of high-level managers is **transferred down the organisational structure** to middle managers and immediate supervisors (Wu et al., 2015). On the other hand, if employees perceive that their supervisors violate safety procedures, they are also more inclined to violate them themselves. If employees observe supervisors' safety violations frequently, this might signal employees that safety violations represent appropriate behaviour (Liang & Zhang, 2019).

Some authors even suggest that how employees perceive the safety commitment of their managers is more important than the actual safety commitment of managers as it can have a greater effect on safety (Lofquist et al., 2011). Nevertheless, based on the arguments presented above, we argue that it is important to further explore the relationship between managers' commitment to safety and employees' perception of managers' commitment. Managers that are committed to safety demonstrate their commitment through various safety decisions and actions. Managers signal to employees either indirectly (e.g., by providing a safe work environment for employees) or directly (e.g., through their safety behaviours) that safety is important to the organisation (Fruhen et al., 2019; Gravina et al., 2017). When managers are committed to safety, their safety-related decisions and actions are consistent and perceived by employees as genuine (Bowers & Fleming, 2018). This, in turn, influences employees' perceptions of managers' commitment to safety. Thus, we propose the following hypothesis:

*Hypothesis 1a: Managers' commitment to safety is positively related to employees' perceptions of managers' commitment to safety.*

Further, some researchers suggest that addressing the concept of managers' commitment to safety from both sides of the relationship would enable **assessing the alignment** between **managers'** and **employees'** perceptions (Biggs et al., 2013; Bowers & Fleming, 2018; Fruhen et al., 2019). Fruhen et al. (2019) note that research on other forms of commitment indicates that managers' perceptions of their own commitment do not always match employees' perceptions, as various factors can lead to higher or lower levels of alignment. The differences in perceptions between managers and employees could also be an indicator of how successful and effective managers are in conveying their safety commitment to employees. In the second part of the first hypothesis, we therefore propose the following:

*Hypothesis 1b: There is a difference between managers' commitment to safety and employees' perceptions of managers' commitment to safety.*

### 5.2.2 The mediation role of leadership style

Zuofa and Ocheing (2017) argue that managers' safety commitment is most clearly expressed through their leadership. Different leadership styles related to safety have been studied. Transformational, transactional, and laissez-faire leadership are among the leadership styles that have been most frequently researched (Lekka & Healey, 2012; Pilbeam et al., 2016; Sandhåland et al., 2017). In recent years, authentic, ethical, and servant leaderships have also been recognised as important leadership styles that can influence safety performance and outcomes (Borgersen et al., 2014; Chughtai, 2015; Roger et al., 2009).

Among the aforementioned leadership styles, **transformational leadership** has been recognised as the most important leadership style in the context of safety. Various

researchers suggested that transformational leadership can help promote safety in the organisation. Managers with transformational leadership style are seen as role models who promote the safe behaviour of employees. Such managers show genuine care for the safety of their employees, support employees in adopting new safety procedures, and encourage employees to internalise higher standards (Lekka & Healey, 2012; Levovnik et al., 2019a; Vignoli, 2018). In addition, the transformational leadership style has been recognised as particularly important for employee **safety commitment** (Flin, 2003; Flin & Yule, 2004; Ye et al., 2020). Although past studies showed that leadership style has an influence on various safety issues, the understanding of the relationship between concepts of safety commitment and leadership style remains to be limited, and much empirical research has yet to be done (Delegach et al., 2017; Fruhen et al., 2019).

Managers with the **transformational leadership style** are known to motivate their employees through the transformation of beliefs, values, and attitudes. Employees are then able to exceed the expected goals and go beyond mere compliance (Rafferty & Griffin, 2004). In terms of the various ways managers can demonstrate their commitment, the transformational leadership style would allow managers to motivate employees to exceed the minimal safety goals and go beyond mere compliance with relevant legislation and industry standards. Managers would demonstrate their commitment and motivate employees to engage in voluntary safety activities and exhibit safety behaviour that goes beyond formal requirements (Ye et al., 2020).

Bass and Riggio (2006) argue that managers develop relationships with their employees that exceed a simple exchange relationship. The transformational leadership style comprises **four components**. First, through **idealised influence**, managers represent role models for their employees, as employees identify with their managers (Bass & Riggio, 2006). Thus, by demonstrating their commitment to safety, managers can serve as safety role models for their employees (Schwatka et al., 2020; Shore et al., 2020). The second component is **inspirational motivation**. Managers are able to motivate employees and inspire them. Such managers clearly communicate their expectations and demonstrate their commitment to the specific goals (Bass & Riggio, 2006). Since safety commitment can be seen as a commitment to a specific (safety) goal (Delegach et al., 2017; Fruhen et al., 2019), inspirational motivation could help managers demonstrate their safety commitment and motivate employees towards a common goal: improving safety in safety-critical organisations. Third, through **intellectual stimulation**, managers encourage employees to question existing assumptions and propose new ideas (Bass & Riggio, 2006). Intellectual stimulation is especially important when managers demonstrate their commitment to safety by encouraging employees to make suggestions and participate in important safety decisions (Bosak et al., 2013; Wu et al., 2008). The final component of the transformational leadership style is the **individualised consideration** in which managers devote time and attention to each employee. Such managers encourage two-way communication and practice "management by walking around" (Bass & Riggio, 2006). The positive effect of individualised consideration would be most evident when managers demonstrate their safety commitment through individual interaction and guidance of employees. This would also enable managers to clearly and visibly state organisations' safety policy whenever they are in personal contact with employees (Fischer et al., 2018; Lim et al., 2018; Wu et al., 2008). Therefore, a transformational leadership style can manifest safety commitment and influence employees' perceptions that managers are committed to safety and that safety is valued in the organisation (Laurent et al., 2018; Ye et al., 2020). These cues would indicate organisations' safety norms and consequently shape employees' safety perceptions (Bosak et al., 2013).

### 5.2.2.1 Managers' commitment to safety and leadership style

Although the role of transformational leadership has been widely researched in various contexts and studies that have highlighted several positive outcomes of this leadership style, considerably less is known about the antecedents of transformational leadership. Nevertheless, some researchers set out to explore this side of the transformational leadership concept as well (e.g., Barbuto & Burbach, 2006). In their review study, Sun et al. (2017) highlight **managers' values** as potential antecedents to transformational leadership style. Managers with a transformational leadership style would have a specific value system and prioritise moral and social values compared to other managers (Sun et al., 2017). This could also apply to safety, as it is argued that managers who are committed to safety value safety and prioritise safety goals over other organisational goals (Bosak et al., 2013; Bowers & Fleming, 2018). Further, Jin et al. (2016) showed that **managers' psychological states**, such as emotions and attitudes, can have an important influence on managers' transformational behaviours. More specifically, the authors showed that managers' affective experience is a significant direct antecedent of transformational leadership. As mentioned in Chapter 5.2.1, Fruhen et al. (2019) define the safety commitment of managers as an "action commitment that reflects their mindset and drive to support organisational safety" and propose that managers' commitment to safety should be seen as a psychological state (p. 205). Therefore, we propose that managers' commitment to safety can demonstrate safety commitment to employees through their leadership, which in turn influences employees' perceptions of managers' safety commitment.

Similarly, Fruher et al. (2019) argued that managers' commitment to safety can shape the managers' leadership style and proposed that future research should examine the relationship between managers' commitment to safety and managers' leadership style. Further, Levovnik and Gerbec (2020) presented a conceptual model in which they proposed that managers who are committed to safety may develop different leadership styles in their relationships with employees. However, to the best of our knowledge, the proposed relationships have not been empirically examined in any previous study.

### 5.2.2.2 Transformational leadership style and employees' perceptions of managers' commitment to safety

In the leadership literature, **transformational leadership** has been linked to various **positive outcomes**. For example, Bronkhorst et al. (2015) highlight that transformational leaders can, through goal setting, positively increase the work motivation of employees. Researchers recognised an important effect of transformational leadership on the managers' ability to set **specific goals** for their employees. At the same time, managers were able to successfully reduce the employees' perceptions of the procedural constraints, which, in turn, can have an important influence on the goal-setting (Bronkhorst et al., 2015). The study by Pillai et al. (1999) has found that transformational leadership positively affects the **trust of employees** and perceived **procedural justice** that can then have a further positive effect on the organisational citizenship behaviour of employees (Pillai et al., 1999). Exploring the dissemination of the strategic goals, Berson and Avolio (2004) showed that the transformational leadership style could help high-level managers **articulate** and **disseminate strategic goals** consistently throughout the organisational structure. Their findings showed the connections between leadership style, communication, and increased awareness of strategic goals among managers on lower organisational levels. The study pointed out that transformational leaders could adjust messages to employees' understanding through the interaction between managers and employees (known as

individualised consideration). This would allow high-level managers to convey their message more successfully, especially in uncertain times (Berson & Avolio, 2004).

Transformational leaders can also have a positive **indirect effect** on employees. Avolio et al. (2004) point out that the transformational leadership style may be especially important for high-level managers as the study showed that high-level managers had a more positive effect on the employees' organisational commitment than the immediate supervisors despite the structural distance. This means that managers can also have an important indirect influence on employees' perceptions.

The **transformational leadership style** of high-level managers may have an important influence on **employees' perceptions** of managers' safety commitment. Flin and Yule (2004) proposed that employees' perceptions of managers' safety commitment (as a part of safety climate) can be seen as a mediator between the leadership style of managers and the safety performance of employees. The positive influence of the transformational leadership style has been shown at all levels of management. Similarly, Shore et al. (2020) also point out that transformational leadership can have a positive influence on safety climate (including perceived managers' safety commitment) and employee safety compliance and safety participation. The study of Luria and Rafaeli (2008) showed that employees, who interpret the safety artefacts as a sign of organisational safety commitment, score their managers higher on the transformational leadership scale. Authors propose that managers with a transformational style of leadership are more safety committed and manifest a clear safety orientation (Luria & Rafaeli, 2008). Transformational leadership was also recognised as important by other authors (Du & Sun, 2012; Fruhen et al., 2014). In addition, Delegach et al. (2017) also suggested that different leadership styles, including transformational, can further promote the development of safety commitment in employees. The results of the study showed a positive relationship between transformational leadership style and employees' promotion and prevention focus, which were positively related to employees' safety commitment (Delegach et al., 2017). When safety is a value to managers, they place a high priority on safety and direct a significant effort to safety issues to ensure safety and prevent future accidents. Through their **leadership style**, managers can **demonstrate** to employees their **commitment to safety** and show that safety is valued in their organisation. Therefore, the leadership style enables managers to clearly demonstrate their commitment to safety, which in turn has an important influence on employees' perceptions of managers' commitment. Thus, we propose a second hypothesis that reads:

*Hypothesis 2: Leadership style mediates the relationship between managers' commitment to safety and employees' perceptions of managers' commitment to safety.*

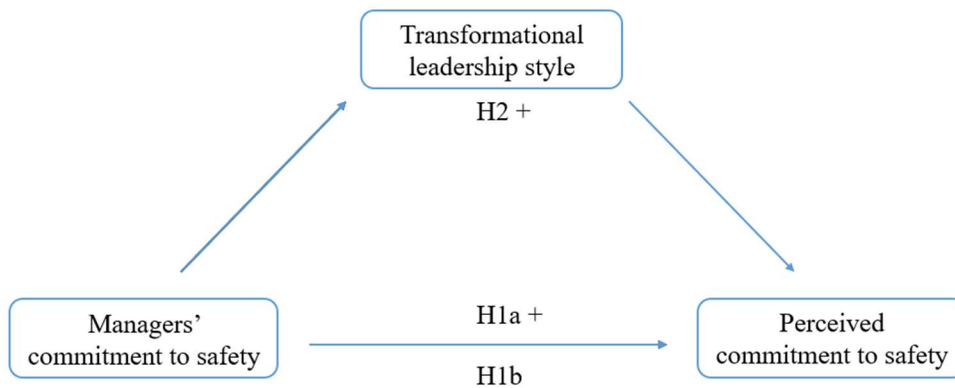


Figure 20: Summary of proposed hypotheses.

**Core concepts** used in the proposed model and their definitions:

- Managers' commitment to safety is defined as “an action commitment that reflects their mindset and drive to support organizational safety” (Fruhen, et al. 2019, p. 204).
- Transformational leadership is defined as “the leader’s effect on followers, and the behaviour used to achieve this effect” (Yukl, 1999, p. 286).
- Perceived commitment to safety is defined as “an inferential judgment made by employees about leaders’ internal psychological states based on the perceived actions of the leaders” (Fruhen, et al. 2019, p. 204).

### 5.3 Methods

To follow the aim that we set at the beginning of this chapter, we performed an **explanatory quantitative study**. Quantitative research design generally involves a **deductive research approach** that is used to test a specific theory. This type of research enables scholars to explore the relationship among numerical variables that are analysed with various statistical techniques. Quantitative research can include different combinations of data collection and analysis techniques (Saunders et al., 2016). Generally, the gathered data are analysed with corresponding quantitative, statistical analysis (Bryman, 2016).

The explanatory approach of the study allows researchers to explore a particular research problem and **explain the relationships** among studied variables (Saunders et al., 2016). According to Gliner et al. (2017), the relationship between variables can be explored by an **experimental** (e.g., randomised experiment, quasi-experiment) or **non-experimental** research (e.g., comparative, associational). The main difference between the non-experimental and experimental research is that in the case of the latter, the researcher has control over the independent variable, which enables the manipulation of the variable. This also means that the experimental research is more suitable for determining the causal relationship. Nevertheless, non-experimental research can also provide some indication about the **causal relationship** between variables by applying linear regression analysis and structural equation modelling (Gliner et al., 2017).

Generally, non-experimental research can be employed to answer various types of research questions. For example, survey research can combine research questions that can

be categorised as associational or comparative (Gliner et al., 2017). Saunders et al. (2016) point out that survey strategy is one of the most often used research strategies. By employing the survey strategy, researchers can gather quantitative data that can be later analysed with the use of the corresponding statistical techniques. This research strategy is particularly suitable to collect data that can be used to construct models and address the relationships between variables. It corresponds to the deductive approach and allows researchers to obtain an **answer** to various types of **research questions**, including “what”, “where”, “how much”, or “who” (Saunders et al., 2016). Therefore, it represents an appropriate research strategy to answer our research questions.

The **questionnaires** were used as a **collection method** to obtain the data needed to explore the relationship between constructs presented in the model. Questionnaires are the most often used data collection method by researchers that employ the survey strategy. They can be applied to gather quantitative data from a large sample in a relatively short period of time. Questionnaires are especially suitable for **explanatory research**, as they can include standardised questions which facilitate consistent interpretation by participants. They allow researchers to examine the relationship among concepts and infer causality between them (Saunders et al., 2016). We used a **self-completion** or self-administered type of questionnaire in which respondents that participate in the survey complete a questionnaire on their own. Since participants can complete it whenever and wherever they choose, without the researcher's presence (e.g., in the case of the interview), there is a smaller chance for bias that participants would provide socially desirable answers. As there is no interviewer, there is also no variability related to the interviewer (e.g., interviewer asking questions in a different order or with a different voice). Anonymous questionnaires also reduce the problem of under-reporting on sensitive subjects (e.g., drug problems, sex life). Although assessment of managers is not considered a “sensitive subject”, we argue that the use of questionnaires can facilitate less biased responses in our research study (Bryman, 2016).

To address the proposed research question and test the hypotheses, we had to obtain quantitative data from the **two specific groups** inside the organisations, namely, managers and employees. Therefore, we constructed two slightly modified questionnaires. Based on their position in the organisation, the corresponding version of the questionnaire was provided to the participants. We based our questionnaires on the **web-based platform** IKA, which provides support for online surveys developed by the Centre for Social Informatics at the Faculty of Social Sciences, University of Ljubljana (2021). This web-based service allows users to design and set an online questionnaire, implement the survey (e.g., sent invitations with links to the questionnaire, sent reminders, monitor the response rate), collect and prepare the data or paradata for the exportation, and even (to some extent) analyse the gathered data. The web-based platform also enables several researchers to work on their questionnaire simultaneously, exchanging ideas while developing the questionnaire, and even pre-test the questionnaire prior to distributing it to their sample of participants.

We used already established measuring scales to collect data that we needed to address the relationship between the variables. The scales are presented in more detail in the course of this study. We translated the scales from English to Slovenian. After the translation, we examined and compared both English and Slovenian version to ensure the correct meaning was retained. In addition, the translated questionnaire was, together with the original scales, sent to another researcher (not involved in the research) with extensive knowledge in designing and developing questionnaires for the parallel translation. We made **several revisions** to the **questionnaire** to ensure that instructions were comprehensibly explained and that questions were clearly worded and presented before the questionnaire was

prepared for distribution. Then, the final version of the questionnaire was sent to two other researchers that were also not involved in this research study to obtain the comments and suggestions regarding the clarity, appropriateness, or potential omission of questions and the layout of the questionnaire. After we considered received suggestions and implemented some minor changes, the questionnaire was activated on a web-based survey platform.

### 5.3.1 Sample and data collection process

To collect data needed to assess the hypotheses, we **distributed questionnaires** to participants from the sample of **safety-critical organisations** that we used in our exploratory qualitative study (see previous Chapter 4.2.2.3 for more details). More specifically, we focused on participants from the organisations covered by the EU directive The Control of Major-Accident Hazards Involving Dangerous Substances (Directive 2012/18). In these organisations, dangerous substances are present (processed/stored/handled) in quantities above a specific threshold.

We started the **data collection process** by reaching out to our contact managers in organisations. In most cases, these were the same managers that were also our contacts in the exploratory qualitative study. We followed several techniques that can, according to Saunders et al. (2016), positively influence the response rate. The most senior researcher sent an official e-mail with the **invitation to participate** in the survey and asked our contact managers to distribute the e-mail to their employees. In this invitation, we briefly described the background of the research and explained the aim of this survey. In addition, we also explained how we intend to use the gathered data and ensure that the questionnaire is anonymous. The covering e-mail also included the link to the web-based platform that hosted the questionnaire. The aforementioned e-mails were sent to our contacts in the middle of **December 2020**. In addition to sending the e-mails, we contacted our contact managers by phone to personally ask them to distribute the link to the questionnaire to their employees. Two weeks after our contact managers distributed the link to the questionnaire to their employees, we sent an official reminder to our contacts, asking them to distribute the reminder to their employees. After another week, we performed an unofficial phone conversation with some of our contacts. The described data collection process is presented in Figure 21. The time frame in which questionnaires were distributed to the respondents corresponds to the beginning of the second major increase (wave) of COVID-19 cases in Slovenia. The second epidemic was officially declared from 19 October 2020 to 15 June 2021.

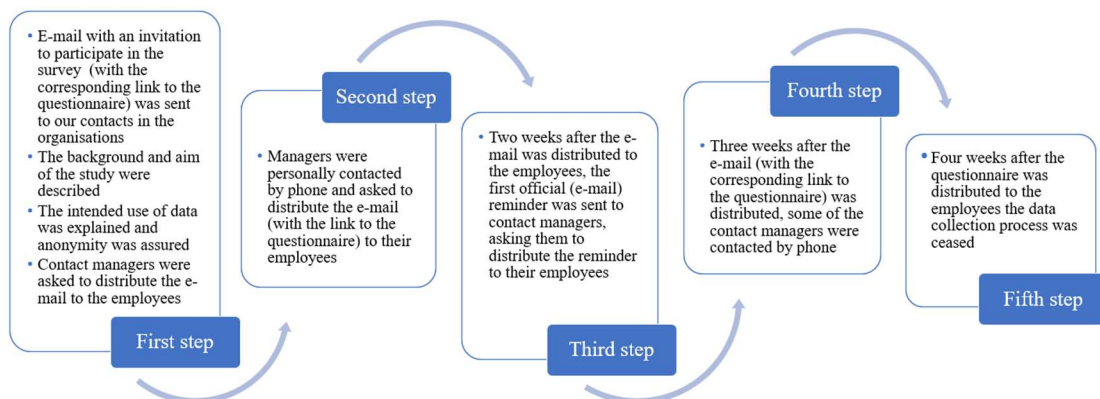


Figure 21: The data collection process.

We recorded 247 responses to the survey. Out of these, 220 respondents completed the survey (this also includes partially completed surveys). After we examined partially completed surveys, 73 surveys were excluded from further analysis as too many values were missing (item nonresponse). After this process, the **final sample** consisted of 147 participants from six organisations that were included in further analysis.

In our final sample, 27 respondents were high-level managers (e.g., members of the management board, executive directors, managing directors, directors of various sectors, business units, or major departments) and 120 respondents that were not part of the higher management (e.g., managers at lower organisational levels and employees on non-managerial positions). In the **first group** (managers), 92.6 % were male, and 7.4 % were female. Half of the respondents in the first group were older than 49 years ( $M = 49.93$ ,  $SD = 5.86$ ). Most of the respondents have been employed in the organisation for more than 25 years (25.9 %), followed by managers that were employed in the organisation between 11 and 15 years (22.2 %). One-third of the managers were at their current position from 6 to 10 years (33.3 %). Most managers reported that they have a bachelor's degree or equivalent master's degree – second-cycle degree programme (44.4 %), and postgraduate degree – third-cycle degree programme (22.2 %).

In the **second group** (employees), 65 % were male, and 28.3 % were female. The rest of the respondents either did not want to answer this question (2.5 %), skipped the question (0.8 %) or left the survey (3.3 %). Half of the respondents in the second group were older than 44 years ( $M = 43.86$ ,  $SD = 9.77$ ). The youngest among our respondents was 23 years old and the oldest 63 years old. Most of the respondents have been employed in the organisation for between 1 and 5 years (21.7 %), followed by employees that were employed in the organisation for more than 25 years (20.8 %). The 43.3 % of respondents worked under their current manager for 1 to 5 years. The majority of respondents (35.8 %) in our sample reported obtaining bachelor's degree – first-cycle degree and bachelor's degree or equivalent master's degree – second-cycle degree programme (20 %), followed by respondents that have a high school degree (18.3 %), or a college degree (15.8 %). The demographic characteristics of respondents from both samples are summarised in Table 18.

Table 18: Demographic characteristics of respondents.

<b>Characteristic</b>	<b>Managers (N = 27)</b>		<b>Employees (N = 120)</b>	
<b>Age</b>	<i>Mean (range)</i>	<i>SD</i>	<i>Mean (range)</i>	<i>SD</i>
Age in years	49.93 (39 – 62)	5.86	43.86 (23 – 63)	9.77
<b>Gender</b>	<i>Frequency (n)</i>	<i>Percent (%)</i>	<i>Frequency (n)</i>	<i>Percent (%)</i>
Male	25	92.6	78	65
Female	2	7.4	34	28.3
Missing	–	–	8	6.7
<b>Employed in organisation</b>	<i>Frequency (n)</i>	<i>Percent (%)</i>	<i>Frequency (n)</i>	<i>Percent (%)</i>
Less than 1 year	1	3.7	9	7.5
1-5 years	3	11.1	26	21.7
6-10 years	1	3.7	23	19.2
11-15 years	6	22.2	16	13.3
16-20 years	4	14.8	14	11.7
21-25 years	5	18.5	7	5.8
More than 25 years	7	25.9	25	20.8
<b>At current position</b>	<i>Frequency (n)</i>	<i>Percent (%)</i>	<i>Frequency (n)</i>	<i>Percent (%)</i>
Less than 1 year	1	3.7	52	43.3
1-5 years	5	18.5	33	27.5
6-10 years	9	33.3	13	10.8
11-15 years	6	22.2	6	5.0
16-20 years	2	7.4	7	5.8
More than 20 years	4	14.8	52	43.3
<b>Education</b>	<i>Frequency (n)</i>	<i>Percent (%)</i>	<i>Frequency (n)</i>	<i>Percent (%)</i>
Missing value	–	–	5	5.1
Vocational degree or lower	–	–	1	0.8
High school degree	2	7.4	22	18.3
College degree	1	3.7	19	15.8
Bachelor's degree (1st cycle)	6	22.2	43	35.8
Master's degree (2nd cycle)	12	44.4	24	20.0
Postgraduate degree (3rd cycle)	6	22.2	6	5.0

### 5.3.2 Measurement

As pointed out earlier, we adopt measurement items from already established scales. Where needed, we adapted and modified items so that they corresponded with the specific concepts that we were trying to measure. We used a **5-point Likert type scale** of agreement. This type of scale is applied to measure the degree of agreement of respondents with the given statements. The 5-point scale included answers from 1 (strongly disagree) to 5 (strongly agree). Here we briefly describe the measurement scales and present some examples of items that we used in the questionnaires. The original and translated versions of measurement scales used in the survey can be found in Appendix D.

**Managers' commitment to safety** was self-reported and measured with a scale developed by Fruhen et al. (2019). This measurement scale was developed to measure three dimensions of safety commitment, namely normative, affective, and calculative commitment, by using 9 items. Some examples of these items were: "*Safety is my moral responsibility.*" for normative dimension, "*I am passionate about safety.*" for affective dimension, and "*I might lose my job if I don't.*" for a calculative dimension of managers' safety commitment (p. 209). However, we decided to exclude one of the items in the normative dimension, as we argue that it would appear to be similar to other items in this dimension when translated from English. Aggregated together, these dimensions reflect the managers' commitment to safety.

For measuring **transformational leadership style**, we adopted four items from the Moors's (2012) measurement scale that used a smaller number of items that correspond to a transformational style of leadership from the Multifactor Leadership Questionnaire. The opening statement reads: "*My boss ...*". The used items included statements like: "*[My boss ...] Is an example to me.*" and "*Makes me proud to work with him/her.*" (p. 298).

To assess **employees' perceptions of managers' commitment to safety**, we adapted both opening statement and items from the managers' safety commitment measurement scale developed by Fruhen et al. (2019) so that they were in an appropriate form for employees. The adapted opening statement that corresponds to the employees' perceptions of managers' commitment to safety reads: "*My boss makes safety a priority because ...*". Some examples of these items were: "*His moral compass tells him to do so.*" for a normative dimension; "*Safety has a great deal of personal meaning for him.*" for an affective dimension; and "*Doesn't want to lose his reputation.*" for a calculative dimension of managers' safety commitment (p. 209).

### 5.3.3 Analysis

To analyse the gathered data, we employed various quantitative methods and techniques. The proposed hypotheses were assessed by applying regression analysis, independent samples test, and mediation analysis. All analyses were conducted by IBM SPSS Statistic software, version 25 (2017). Before we started to test the proposed hypotheses, we addressed the common method bias (variance) by applying Harman's one-factor test and examined the reliability (internal consistency) of the questionnaire by calculating Cronbach's alpha coefficients.

The quantitative data were collected by the same data collecting method, using a self-administered questionnaire in the same time period. Therefore, the **common method bias** should be addressed before further analysing the data. This type of bias occurs when the participants' answers do not reflect their actual attitudes towards the topics addressed in the questionnaires, as participants are affected by the data collection method (Gorrell et al., 2011). In other words, the relationships between constructs may be biased because the same method was used to collect the data on both independent and dependent variables

in the same time period. The common method bias can be caused by the structure of the questionnaire, the wording of questions, the way it was administered, or the participant's tendency to provide socially desirable answers. Consequently, the surveys with cross-sectional design are especially susceptible. The common method bias can affect the validity and reliability of the questionnaires and can even lead to distorted estimates of the relationship between constructs (Jordan & Troth, 2020). Thus, we conducted Harman's one-factor test to assess the potential common method bias, as it is one of the most often used post hoc statistical measures. It is based on the exploratory factor analysis and uses an unrotated method, with a fixed factor for all the items that compose the scale. The test applies the criteria that there is an issue of a common method if one factor accounts for more than 50 % of the variance (Kock et al., 2021; Podsakoff et al., 2003). The analysis showed that one factor did not account for all the variance either in the employee (35.5 %) or the manager questionnaire (27.5 %). Therefore, we can assume that common method bias does not present an issue in our study.

Another important aspect that we had to address prior to testing the research hypotheses is **reliability**. Cronbach's alpha coefficient is one of the most often used methods to measure the reliability of the scales used in the survey studies. It represents the internal consistency of multiple questionnaire items. Bonett and Wright (2015) argue that there are no universally accepted reliability values that would determine the minimum value of Cronbach's alpha and that the acceptability of Cronbach's coefficient depends on the nature of its application. The size of the sample and the number of items and dimensions can also have an important influence on the value of Cronbach's alpha. Therefore, Oosterwijk et al. (2019) suggest that researchers should also report the confidence intervals for each alpha coefficient and provide more comprehensive results. There are several methods that can be used to calculate confidence intervals, which can also account for different sampling distributions and missing data (Iacobucci & Duhachek, 2003; Tsagris et al., 2013). Hence, results may vary to some extent, depending on the applied procedure (Bonett & Wright, 2015). We used the approach proposed by Zhang and Yuan (2016), which offers a robust estimation of Cronbach's alphas and calculation of confidence intervals. This procedure also accounts for missing data and potential outline values. Cronbach's alpha coefficients and corresponding confidence intervals are summarised in Table 19.

Table 19: Cronbach's alpha coefficients.

Subscale	Cases	Items	Cronbach's Alpha	SE	p-value	95 % CI <sup>a</sup>	
						LL	UL
Managers' commitment to safety	27	8	0.734	0.075	> .001	0.587	0.881
Transformational leadership style	120	4	0.944	0.010	> .001	0.924	0.964
Perceived managers' commitment to safety	120	8	0.730	0.042	> .001	0.647	0.813

Note. <sup>a</sup> CL = 95 % Confidence Interval; LL = Lower Limit; UL = Upper Limit.

Bryman (2016) states that researchers generally consider coefficients higher than 0.6 or 0.7 to be acceptable. However, scales with alpha values below the generally acceptable levels may still provide meaningful results, depending on the study (Taber, 2018). Given the characteristics of the above method, we argue that the calculated Cronbach's alphas are in the acceptable range, indicating the internal consistency of the scales used in the questionnaires, which in turn supports their reliability.

The most appropriate method for analysing the collected data from different organisational levels would be the **multilevel analysis** (Peugh, 2010). However, our sample from the managerial level was not large enough for this type of analysis (Maas & Hox, 2005). Therefore, we grouped the data collected at the managerial level and averaged them at the level of the organisation for further analysis.

## 5.4 Results

After we conducted all initial analyses to assess the potential common method bias and the reliability (internal consistency), we started analysing collected data. The descriptive statistics and correlations for the variables that were used in our research study to assess the proposed hypotheses are presented in Table 20.

Table 20: Correlations, mean values, standard deviations.

Variable	Mean	SD	1	2	3
1. Safety commitment – Managers	3.891	0.242	–		
2. Transformational leadership style	3.567	1.019	0.242 $p = .008$	–	
3. Safety commitment – Perceived	3.619	0.628	0.209 $p = .022$	0.273 $p = .003$	–

Note. N = 120

To test the proposed **hypothesis H1a**, we explore the relationship between managers' commitment to safety (i.e., independent variable X) and perceived managers' commitment to safety by employees (i.e., dependent variable Y). The proposed model was significant ( $F(1,118) = 5.41, p = .022$ ) and explained 4.4 % of the variance in the perceived commitment to safety. As presented in Figure 22, the regression analysis showed that there is a positive, significant relationship ( $B = 0.544, t(118) = 2.33, p = .022$ ) between the independent variable (managers' commitment to safety) and dependent variable (perceived commitment to safety by employees). Thus, this supports hypothesis H1a.

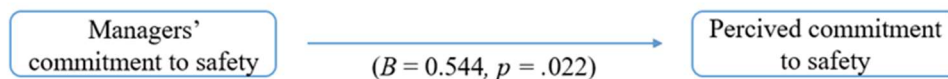


Figure 22: Regression model.

In addition, the **existence of the association** between the two studied variables is also generally considered as a first condition that has to be met according to the traditional association approach to conduct an analysis of the mediation model (Gelfand et al., 2009).

In other words, if there is no relationship between X and Y, there is no reason to search for the mediation effect. However, researchers are gradually parting from this line of reasoning, as the correlation between independent and dependent variables is no longer a precondition for the mediation analysis (Hayes, 2018).

To test the second part of the first **hypothesis H1b**, stating that there is a difference between managers' commitment to safety and employees' perceptions of managers' commitment to safety, we conduct an independent samples test (t-test) to explore the differences between our two data samples and to assess the probability that the differences between managers ( $N = 27$ ) and employees ( $N = 120$ ) occurred by coincidence (Saunders et al., 2016). The results of the independent samples test showed that there is a difference between managers' commitment to safety ( $M = 3.903$ ,  $SD = 0.532$ ) and employees' perceptions of managers' commitment to safety ( $M = 3.619$ ,  $SD = 0.628$ ) that is statistically significant. More specifically, the Levene's Test ( $F(145) = 0.621$ ,  $p = .43$ ) supported assumed homogeneity, and the **difference between groups was statistically significant**  $t(145) = -2.180$ ,  $p = .031$ . Thus, the findings provide support for hypothesis H1b.

To test the second **hypothesis H2** that proposed a **mediation relationship** between managers' commitment to safety, transformational leadership style, and employees' perceptions of managers' commitment to safety, we applied a mediation model. The mediation model presumes that the independent X variable (i.e., managers' commitment to safety) causes the mediator M (i.e., transformational leadership style), which, in turn, causes the dependent Y variable (i.e., perceived managers' commitment to safety by employees). The effect of the independent variable on the mediator and the effect of the mediator on the dependant variable partially or completely explains the influence of the independent variable on the dependant variable (Gelfand et al., 2009). To conduct a mediation analysis, we used a PROCESS macro, developed by Andrew F. Hayes. The macro can be installed on SPSS statistics software and allows researchers to explore both indirect and direct effects in various mediation, moderation, or moderated mediation models (Hayes, 2021). We used a simple mediation model, which includes one intervening variable (mediator) in order to empirically test the second hypothesis H2. The mediator represents a potential mechanism by which the X variable affects the Y variable, as shown in Figure 20. This model enabled us to explore two pathways by which the X variable can influence the Y variable (Hayes, 2018). The direct pathway, by which managers' commitment influence employees' perceptions, and the indirect pathway, through the mediator, which represents transformational leadership style.

The Hayes mediation model uses two linear models. These models enable the estimation of the direct effect of X on Y (represented by path c') and the indirect effect that includes the effect of X on M (represented by path a) and M on Y (represented by path b). In addition, the mediation model also supports the estimation of the total effect of the independent variable on the dependant variable (represented by a path c). The mediation model uses the bootstrapping approach with 5000 samples (Hayes, 2018). The coefficients of the mediation model are summarised in Table 21.

Table 21: Mediation model coefficients.

Antecedent		Consequent						
		Transformational leadership style (M)			Perceived managers' commitment (Y)			
		<i>B</i>	<i>SE</i>	<i>p</i>	<i>B</i>	<i>SE</i>	<i>p</i>	
Managers' commitment (X)	<i>a</i>	1.02	0.376	.008	<i>c'</i>	0.395	0.235	.095
Transformational leadership style (M)	–	–	–	–	<i>b</i>	0.146	0.056	.01
Constant	<i>iM</i>	-0.401	1.466	.785	<i>iY</i>	1.562	0.890	.082
		$R^2 = 0.059$				$R^2 = 0.096$		
		$F(1,118) = 7.35,$				$F(2,117) = 6.24,$		
		$p = .008$				$p = .003$		

The mediation analysis revealed that the first model is significant ( $F(1,118) = 7.35$ ,  $p = .008$ ,  $R^2 = 0.059$ ) and that path *a* is positive and significant. If we look at the mediation results schematically presented in Figure 23, we can see that there is a significant positive relationship ( $B = 1.02$ ,  $t(118) = 2.71$ ,  $p = .008$ ) between managers' commitment to safety and transformational leadership style. The second model is also significant ( $F(2,117) = 6.24$ ,  $p = .003$ ,  $R^2 = 0.096$ ) and path *b* is also positive and significant. There is a positive relationship ( $B = 0.146$ ,  $t(117) = 2.61$ ,  $p = .01$ ) between the leadership style and the perceived managers' commitment to safety. The results indicate that the effect of the independent variable is mediated through path  $a*b$ , which represents the **indirect effect of the mediation model**. This indirect effect is positive ( $B = 0.148$ ) and significant, assessed by using bootstrapping approach with the 95 % confidence interval (BootLLCI 0.0323 to BootULCI 0.3221). In this mediation relationship, the independent variable affects the dependent variable indirectly through the mediator. In other words, the effect of the managers' commitment to safety is transmitted on the employees' perceptions of managers' commitment through the leadership style.

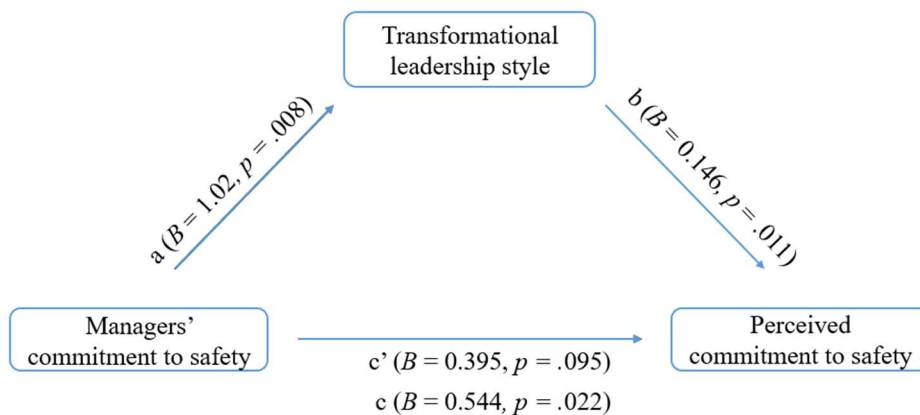


Figure 23: Results of the mediation model.

The **direct effect** of the independent variable on the dependent variable represents path  $c'$ . We can see that there is a positive, marginally significant relationship ( $B = 0.395$ ,  $t(117) = 1.68$ ,  $p = .095$ ) between managers' commitment to safety and perceived managers' commitment to safety. The direct effect is also assessed by using the bootstrapping technique with the 95 % confidence interval (BootLLCI -0.0703 to BootULCI 0.8609). The mediation model also estimates the **total effect** of the independent variable on the dependent variable that represents path  $c$ . The moderation analysis showed that there is a positive and significant relationship ( $B = 0.544$ ,  $t(118) = 2.33$ ,  $p = .022$  or BootLLCI 0.0810 to BootULCI 1.0063) between managers' commitment to safety and perceived managers' commitment to safety by employees. If we compare  $c$  and  $c'$ , we can see that the  $c'$  path is no longer statistically significant when the leadership style was added into the model as a mediator. In addition, the effect of the independent variable on the dependent variable is reduced in comparison to part  $c$ . Thus, the presented results **provide support for the second hypothesis H2**. The mediation analysis showed that the transformational leadership style positively and significantly mediates the relationship between managers' commitment to safety and employees' perceptions of managers' commitment to safety.

## 5.5 Conclusion, Limitations, and Future Research

We conducted the explanatory quantitative research study to obtain the answers to the research questions and test the proposed hypotheses. The result from the regression analysis showed that there is a **positive and significant relationship** between managers' commitment to safety and employees' perceptions of managers' commitment to safety, which **supports the proposed hypothesis H1a**. Further, we also found support for the second part of the first hypothesis H1b, which proposes that there is a difference between managers' commitment to safety and employees' perceptions of managers' commitment to safety. We apply the independent samples test to address the differences between our two data samples and assess the probability that the differences result from coincidence. The analysis showed a **statistically significant difference** between managers' commitment to safety and employees' perceptions of managers' commitment to safety, which **supports the proposed hypothesis H1b**.

To assess the second hypothesis H2 that proposed a mediation relationship between managers' commitment to safety, transformational leadership style, and employees' perceptions of managers' commitment to safety, we used a mediation model and conducted a mediation analysis. The results showed that the independent variable affects the dependent variable indirectly through the mediator. In other words, the influence of the managers' commitment to safety is transferred on the employees' perceptions of managers' commitment through their leadership style. Further, after introducing the leadership style as a mediator variable, the direct positive effect of managers' commitment to safety on the perceptions of managers' commitment was reduced, and the relationship became only marginally significant. Therefore, the results of the mediation analysis showed that **transformational leadership style** could function as a **mediator** between the managers' commitment to safety and employees' perceptions of managers' commitment, which **supports the second hypothesis H2**.

However, there are also some **limitations to this study** that have to be mentioned. The results show that there is a statistically significant difference between managers' and employees' perceptions of managers' safety commitment, highlighting the lack of alignment between perceptions. However, we did not further explore what might be the **reason for this discrepancy**, and what factors (e.g., personal characteristics, environmental factors)

might be positively related to managers' ability to clearly and visibly convey their commitment to employees. This, in turn, may promote employee perceptions of managers' commitment and lead to better safety performance (Laurent et al., 2018; Ye et al., 2020).

We focused only on **transformational leadership style**; however, future studies can explore whether other leadership styles act as a mediator between managers' commitment to safety and employees' perceptions as well. Fruhen et al. (2019) suggest that managers' commitment to safety may also be related to other leadership styles (e.g., transactional leadership). Therefore, other leadership styles may also mediate the relationship between managers' safety commitment and employees' perceptions of managers' commitment.

In our explanatory study, we employed a **cross-sectional design**. During the survey, we simultaneously collected data for all variables in four weeks, which means that all data were collected at a specific point in time. Therefore, the direction of the causal relationship between independent and dependent variables is only inferred in the cross-sectional design (Bryman, 2016). Thus, to further extend the results of this study, the longitudinal research design should be employed as it would enable researchers to determine the direction of a causal relationship among concepts of managers' commitment to safety, leadership style, and employees' perceptions of managers' commitment to safety. Further, another related limitation is that the **survey research strategy** does not allow the manipulation of the independent variable. Thus, this type of research provides only limited evidence about the causal relationship between concepts. Future research should employ experimental research to further confirm our findings. Gliner et al. (2017) argue that experimental research is the most suitable choice for determining the cause due to active independent variables.

Another important threat to the questionnaire surveys is the presence of the **common method bias** that can affect the validity and reliability of the questionnaires and can even lead to distorted estimates of the relationship between constructs. To address this issue, we conducted Harman's one-factor test, which showed that common method bias does not represent a major issue. In addition to the post hoc statistical test we also used some procedural measures to reduce the potential common method bias. For example, we assured anonymity to the respondents. The web-based design of questionnaires allowed respondents to complete the questionnaires whenever they chose. We also examined the questionnaires several times to ensure that the questions were easy to understand and that the accompanying instructions were informative and clear. However, future research should further address the potential bias by applying additional procedural measures prior to the data collection process. Jordan and Troth (2020) point out that the procedural approach to the common method bias has several advantages compared to the statistical approach. Perhaps the most obvious reason is that statistical measures only highlight the potential common method bias; however, as they are conducted post hoc, they cannot prevent the occurrence of the bias (Kock et al., 2021). Therefore, future studies should use scales with the reverse-coded items, enable the random appearance of questions, collect data for the dependent and independent variables at different points in time, or use different data sources.

Further, the **small sample size** at the managerial level prevented us from applying multilevel analysis, which would otherwise be the most appropriate choice to explore the nested structure of the multilevel data (Peugh, 2010). The multilevel analysis enables the researchers to address the dependency issue of the observations with multilevel data, which could lead to overestimated statistical significance (Leyland & Groenewegen, 2020; Peugh, 2010). Maas and Hox (2005) point out that one of the most common barriers to multilevel modelling is the sample size. Generally, the main challenge is to ensure a sufficient sample size at the higher levels (e.g., second or third level), as the sample size can be constrained by the availability of the sample or the population at the higher level. If the sample size is

not sufficient, it can lead to biased analysis results (Maas & Hox, 2005; Hox, & McNeish, 2020). Therefore, future studies should collect data from a sufficient sample that would allow for multilevel analysis.

Another limitation is related to the **units of analysis**. Although we argued in our study that high-level managers may have an especially important role when it comes to safety, the commitment of all employees in the organisation is needed to successfully prevent major industrial accidents (Du & Sun, 2012; Gerede, 2015). Therefore, future research should also address not only how managers' commitment to safety influences employees' perceptions, but also how perceptions influence employees' commitment to safety. This would add to the more holistic understanding of how managers' commitment to safety affects employees' commitment.

Further limitation represents the **generalisation of the findings**. According to Bryman (2016), generalisation refers to the ability to generalise the finding of the research beyond the sample that was used in the study. The study was based on managers and employees from safety-critical organisations. More specifically, we focused on a specific category of organisations that are covered by the EU directive The Control of Major-Accident Hazards Involving Dangerous Substances (Directive 2012/18). These organisations are generally referred to as "Seveso organisations". In our case, this would mean that the results are not only relevant for the organisation from our sample but can also be generalised on other organisations classified as "Seveso organisations". However, the generalisability of our findings is limited as we obtained our data from a sample of organisations that correspond to the heterogeneous purposive sampling approach. Bryman (2016) points out that probability sampling should be used to obtain the most representative sample that would facilitate the generalisability of findings on all organisations from the sampled population. Therefore, future studies should use a sampling approach that would facilitate better generalisability of the findings to all "Seveso organisations". Further, future researchers should explore if the results of this study are also relevant beyond the safety-critical organisations and address the relationship between managers' safety commitment, leadership style, and employees' perceptions on the more diverse sample of organisations.



## Chapter 6

# General Discussion

### 6.1 Summary of the Main Findings of the Doctoral Dissertation

This dissertation strives to extend the current understanding of the relationship between safety commitment and leadership. In the introductory chapter, we presented the main thesis and proposed the research questions that we aimed to address in this dissertation. In the second chapter, we conducted a bibliometric analysis to better understand the research on safety commitment and leadership and shed some light on its evolution over the past two decades. In other words, we used the bibliometric analysis to outline the state of the research on this topic. However, to gain a deeper and more detailed understanding of safety commitment and leadership, we conducted a systematic review, which is presented in the third chapter. It enabled us to obtain an insight into the main theories, the relationships between the concepts, and their evolution. In the fourth chapter, we conducted an exploratory qualitative study to examine how COVID-19 and its associated mitigation measures affected the process safety management in safety-critical organisations. To examine the relationship between managers' commitment to safety and employees' perceptions of managers' commitment to safety and the potential mediating effect of leadership style, we also conducted an explanatory quantitative study, which is described in the fifth chapter. In the course of this chapter, we summarise the main findings of the doctoral dissertation, present the theoretical and practical contributions, outline the limitations of the doctoral dissertation, and suggest potential avenues for future research. To provide a better overview, we have summarised the findings and contributions in Tables 22, 23, 24, 25.

In the second chapter, we performed a **bibliometric analysis** that revealed the evolution of safety commitment and leadership topic over the past two decades. The analysis showed a major distinction between the two time periods. More specifically, in the second time period (2011 – 2020), four times more articles were published than in the first period (1999 – 2010). However, the number of publications most significantly increased in the last years (2016 – 2020). Different types of co-citation analysis enabled us to obtain an understanding of the knowledge base and outline the intellectual structure of research on safety commitment and leadership. Co-citation analysis of documents showed that safety culture and climate, and leadership behaviour represented the main topics throughout both time periods. The co-citation analysis of authors revealed that some of the most cited authors were also part of our core literature on which we conducted the bibliometric analysis. This means that this research field also draws knowledge from its own base. Co-citation analysis of the most-cited journals showed that new journals appeared in the second time period that provided a flow of knowledge from diverse scientific disciplines.

This indicates that the topic of safety commitment and leadership has become recognised as an important topic in various research fields. Moreover, the analysis showed that safety science, management and organisation, and psychology represent three major disciplines that form the main influx of knowledge. The diverse knowledge base of publications on the commitment to safety and leadership denotes the interdisciplinary nature of this topic.

Applying the bibliographic coupling and co-word analysis enabled us to determine publications that form the research front and estimate the direction in which the research on this topic might develop. The findings of the co-occurrence analysis of the most common terms indicate that the role of management commitment and leadership has not yet been at the forefront of research during the first time period, as studies were primarily focused on the role of management commitment in safety climate. However, we can observe a shift in focus in the second period as most common terms started to refer to managers' commitment and their leadership. This indicates that research is gradually evolving over time and slowly taking a new direction. The word cloud analysis also provided results that were consistent with the co-occurrence analysis of commonly used terms. The bibliographic coupling revealed that a focus of publications slowly started to shift from what employees observe (perceptions of managers' commitment) to what managers experience and feel (managers' view on their commitment).

The **systematic literature review** aimed to obtain deeper insight into the findings outlined by the bibliometric analysis. The analysis focused on two time periods identified by the bibliometric analysis to illustrate the development of the topic over time. Our findings showed that safety commitment was studied either as an important component/dimension of the safety culture and climate or as an independent factor derived from the previous concepts that can influence organisations' safety performance and outcomes (Biggs et al., 2013; Bosak et al., 2013; Du & Sun, 2012; Lofquist et al., 2011; Luria & Rafaeli, 2008; Tappura, Nenonen, et al., 2017). Since the concept of safety commitment is founded in the safety culture and climate literature, the concept remains closely related to safety culture and climate even when addressed as an independent factor (Flin, 2003). However, the systematic review has also shown that while a significant proportion of studies firmly positioned the concept of safety commitment within the safety climate and culture, others only loosely refer to these theoretical foundations (Biggs et al., 2013; Turner et al., 2020). Further, the analysis also indicates that recently some studies deviated from the theoretical framework of safety culture and climate to a larger extent and started to build on the organisational commitment theory (Delegach et al., 2017; Fruhen et al., 2019). Analysis of our core literature revealed that managers' safety commitment is most frequently addressed through perceptions of employees. Employees' perceptions represent the link between managers' values and care for safety and employees' attitudes toward safety (Laurent et al., 2018; Ye et al., 2020). Managers' safety commitment is generally conveyed through various safety-related decisions and actions (Bowers & Fleming, 2018; Fruhen et al., 2019; Ye et al., 2020). These observable behaviours represent important cues that signal employees that managers care for their safety which, in turn, impacts the employees' perceptions of managers' commitment to safety (Bosak et al., 2013; Lofquist et al., 2011).

In the systematic review, we also analysed various antecedents and consequences of safety commitment. Findings showed that the concept of leadership was the most frequently addressed antecedent of employees' perception of managers' safety commitment in both time periods (Delegach et al., 2017; Du & Sun, 2012; Wu et al., 2008). Regarding the consequences of safety commitment in the first period, a systematic review showed that managers' commitment to safety can have an important influence not only on accidents and injuries, but also on other outcomes that are not directly related to safety, such as job satisfaction and work performance (Hofmann & Morgeson, 1999; Michael et al., 2005;

O'Toole, 2002). However, we can observe that in the second time period, the focus evidently shifted towards employees' safety behaviour, especially safety compliance and participation (Lim et al., 2018; Schwatka & Rosecrance, 2016; Ye et al., 2020). Moreover, the systematic review of our core literature revealed various aspects of research on safety commitment that should be addressed in the future. The study highlighted various methodological (e.g., different levels of analysis) and conceptual (e.g., the role of leadership) avenues that should be further addressed in future research (Cui et al., 2013; Delegach et al., 2017; Fruhen et al., 2019; Stackhouse & Turner, 2019).

The aim of the fourth chapter was to explore how COVID-19 and the associated mitigation measures affected the process safety management in safety-critical organisations. The combination of new health risks, government restrictions, and measures organisations have taken to mitigate the impact of the pandemic increased the pressure on safety-critical organisations and their management. Therefore, we conducted an **exploratory qualitative study**. The results of the study provided in-depth insight into how the COVID-19 pandemic may have affected safety-critical organisations, what the main challenges were, and what were the most important factors that enabled organisations to endure during these times of crisis. Specifically, the study showed that organisations adopted various mitigation measures that prevent the spread of SARS-CoV-2, which were primarily aimed at reducing close contact between employees and providing adequate personal protective equipment. These measures subsequently influenced the number and duration of work shifts. Organisations formed crisis management teams responsible for planning, adopting and implementing the measures. The study showed that the proactiveness of organisations and well-timed planning of the measures played a key role in managing the crisis circumstances. The thematic analysis identified that the main challenges organisations faced at the beginning of the COVID-19 pandemic were obtaining relevant information, communicating with various stakeholders, and addressing incorrect or misleading information. Although organisations were proactive and responded fast to adopt necessary measures, the consistent implementation of these measures represented an important challenge. Nevertheless, an exploratory study also showed that organisations were able to perform most of their usual process safety activities during the COVID-19 pandemic. The only exception represented periodical training and regular external inspections of safety equipment. This indicates that management generally recognised the importance of assuring process safety during the COVID-19 pandemic. The lack of appropriately trained employees with key knowledge and sufficient experiences was recognised as one of the biggest threats that could endanger the ability of safety-critical organisations to maintain control over hazardous processes. However, based on the findings of our study, it is not evident that the COVID-19 pandemic would affect the availability of employees.

The study also revealed that, due to their position, high-level managers played an important role during the COVID-19 pandemic. Managers were personally involved in the work of the crisis teams and provided support for managers on lower organisational levels. Their personal involvement also allowed managers to make quick decisions and allocate financial resources, which enabled organisations to act proactively to adapt and sustain in the face of numerous challenges. By communicating openly and clearly, managers fostered employees' trust in management and motivated them to follow the adopted measures. Further, the high-level managers were setting the example for employees through their safety behaviours, which may have a positive impact on employees' safety behaviours. These findings are consistent with the literature and highlight the important role of managerial commitment and leadership in safety (e.g., Flin, 2003; O'Dea & Flin, 2001; Tappura, Nenonen et al., 2017; Wang & Liu, 2012; Ye et al., 2020).

In the fifth chapter, we therefore conducted an **explanatory quantitative study** to explore the mechanism through which managers convey their safety commitment to employees and how this shapes employees' perceptions. More specifically, we explored the relationship between managers' commitment to safety, transformational leadership style, and employees' perceptions of managers' commitment to safety during the COVID-19 pandemic. First, we proposed that managers' commitment to safety would positively relate to employees' perceptions of managers' commitment. The results showed a positive and significant association between managers' commitment to safety and employees' perceptions of managers' commitment to safety, which provided evidence to confirm the first part of the proposed hypothesis H1a. Further, to assess the alignment between employees' and managers' perceptions, we proposed that there would be a difference between managers' commitment to safety and employees' perceptions of managers' commitment to safety. We found a statistically significant difference between managers' and employees' perceptions, which supports the second part of the proposed hypothesis H1b. Further, we also proposed that transformational leadership style would mediate the relationship between managers' commitment to safety and employees' perceptions of managers' commitment to safety. The findings of the mediation analysis confirmed the proposed mediation relationship; thus, providing support for the second hypothesis H2. In other words, the influence of the managers' commitment to safety was transferred to the employees' perceptions of managers' commitment through their leadership style.

Table 22: Summary of the main findings and contributions – Chapter 2.

<b>Bibliometric analysis of safety commitment and leadership</b>	
Research objective	<p>To gain a better understanding of the knowledge base and determine the intellectual structure of research on safety commitment and leadership.</p> <p>To map the evolution of safety commitment and leadership topic over the years.</p> <p>To identify the research front and forecast the future development of our research topic.</p>
Type of study	Quantitative literature review.
Methods	Co-citation analysis (document, author, journal), bibliographic coupling, co-word analysis.
Main findings	<p>Identification of two main periods (1999 – 2010 and 2011 – 2020).</p> <p>Identification of main topics studied throughout both time periods (e.g., safety culture and climate, and leadership behaviour).</p> <p>Identification of the main influx of knowledge from three major disciplines (e.g., safety science, management and organisation, and psychology) indicating the interdisciplinary nature of this topic.</p> <p>Identification of the direction in which the research on this topic could develop (a small shift in focus was observed towards managers' commitment and leadership).</p>
Theoretical contributions	<p>Outline the knowledge base and the intellectual structure of research on safety commitment and leadership.</p> <p>Highlight the most important changes in publications throughout the last two decades and recap the evolution of the research on the topic over time.</p> <p>Describe the current state of the research and provide a preview of what the future research field might look like.</p>

Table 23: Summary of the main findings and contributions – Chapter 3.

<b>Systematic review of literature</b>	
Research objective	To obtain deeper insight into the findings outlined by the bibliometric analysis and to illustrate the development of the topic over time.
Type of study	Qualitative literature review.
Methods	Literature review, thematic analysis.
Main findings	<p>Identification of theoretical foundation on which the research on safety commitment and leadership is based (e.g., the safety culture and climate literature, leadership theory, sociological and psychological theories).</p> <p>Identification of how safety commitment and leadership concepts were addressed in the literature.</p> <p>Identification of the main characteristic of the concept of safety commitment.</p> <p>Identification of the antecedents and consequences of the safety commitment.</p> <p>Identification of the main issues and challenges that should be addressed in the future.</p>
Theoretical contributions	Providing a map of the current state on the topic of safety commitment and leadership and forming a foundation for informed further research.

Table 24: Summary of the main findings and contributions – Chapter 4.

<b>Qualitative study</b>	
Research objective	To explore how COVID-19 and associated mitigation measures influenced the process safety management in safety-critical organisations.
Type of study	Qualitative exploratory study.
Methods	<b>Data collection:</b> semi-structured (group) interviews – 22 managers from 6 safety-critical organisations covered by the EU directive The Control of Major-Accident Hazards Involving Dangerous Substances (Directive 2012/18). <b>Analysis:</b> thematic analysis of the interviews.
Main findings	Identification of how the COVID-19 pandemic and associated measures adopted by the government at the national level affected the safety-critical organisations. Identification of how organisations adapted to the changed circumstances and what measures organisations implemented to maintain their operational activities. Identification of how safety-critical organisations maintain control over hazardous processes and ensure process safety during times of crisis.
Theoretical contributions	Providing an overview of the main challenges organisations faced during the COVID-19 pandemic and proposing how the organisations could respond to similar future events. Providing a better understanding of managers' role during these adverse events – recognising managers' ability to make fast decisions, personal involvement, and communication with various stakeholders as essential during crisis events.
Practical implications	Providing a foundation on which managers can adopt internal policies and develop emergency plans that would allow organisations to prepare for challenges that future pandemic events may pose. Managers should ensure that a sufficient number of essential personnel with the key knowledge is available. Managers should focus on obtaining relevant information and establish clear and open communication with employees as this fosters trust among employees and motivates them to comply with measures.

Table 25: Summary of the main findings and contributions – Chapter 5.

<b>Quantitative study</b>	
Research objective	To address the relationship between managers' commitment to safety, transformational leadership style, and employees' perceptions of managers' commitment.
Proposed hypotheses	Hypothesis H1a: Managers' commitment to safety is positively related to employees' perceptions of managers' commitment to safety – supported. Hypothesis H1b: There is a difference between managers' commitment to safety and employees' perceptions of managers' commitment to safety – supported. Hypothesis H2: Leadership style mediates the relationship between managers' commitment to safety and employees' perceptions of managers' commitment to safety – supported.
Type of study	Quantitative explanatory study.
Methods	<b>Data collection:</b> Survey – a self-administered type of questionnaire completed by 147 respondents (27 managers and 120 employees). <b>Analysis:</b> Common method bias (variance) analysis, reliability (internal consistency) analysis, regression analysis, independent samples test, mediation analysis.
Main findings	There was a positive and significant association between managers' commitment to safety and employees' perceptions of managers' commitment to safety. The managers' commitment to safety and employees' perceptions of managers' commitment to safety were not aligned. Transformational leadership style can mediate the relationship between managers' commitment to safety and employees' perceptions of managers' commitment.
Theoretical contributions	Providing empirical evidence for a positive relationship between managers' safety commitment and employees' perceptions of managers' safety commitment. Providing empirical evidence of the absence of alignment between employees' and managers' perceptions of managers' commitment. Providing empirical evidence of mediation relationship between managers' commitment to safety, leadership style, and employees' perceptions of managers' commitment to safety in the context of safety-critical organisations.

(Table continues)

Table 25: Summary of the main findings and contributions – Chapter 5 (*Continued*).

<b>Quantitative study</b>	
Practical implications	<p>As managers' and employees' perceptions of managers' commitment to safety are not aligned, managers should consciously signal their commitment to employees. Even if managers perceive themselves to be committed to safety, they should not assume that employees will recognise them as such. Organisations should promote the transformational leadership style of managers as leadership style plays an important role in conveying managers' commitment to employees.</p> <p>Organisations should promote managers' commitment to safety as it is positively related to transformational leadership style, which is known to have other positive non-safety outcomes.</p>

## 6.2 Contributions of the Doctoral Dissertation

This doctoral dissertation strives to contribute to a better understanding of managers' safety commitment and leadership. Therefore, by performing the **bibliometric analysis**, we contribute to the safety commitment literature as we outline the knowledge base and the intellectual structure of research on safety commitment and leadership. We highlight the most important changes in publications throughout the past two decades and recap the evolution of the research on the managers' commitment and leadership topic over time. By identifying recent publications that form the research front, we describe the current state of the research and provide a preview of what the future research field might look like.

The bibliometric analysis is further supplemented with the **systematic literature review** that provides a deeper insight into the research on safety commitment and leadership. Thus, this allowed us to obtain a better understanding and contribute to the literature on safety commitment and leadership by identifying the theoretical foundations of the past research, highlighting the development in the conceptualisation of safety commitment, and describing how the concepts of safety commitment and leadership are addressed in various studies. In addition, we provide an overview of various antecedents, characteristics, and consequences of safety commitment and propose what directions for future research can be deduced from the literature. A systematic review of literature provides not only a map of the current state on the topic of safety commitment and leadership but also builds a foundation for informed further research.

Another important contribution represents the findings of our **exploratory study** that provides an insight into how the COVID-19 pandemic and the related mitigation measures affected process safety management in safety-critical organisations. More specifically, we identified the main challenges organisations faced during the COVID-19 pandemic and proposed how the organisations could respond in the future to manage these challenges successfully. Further, we also add to the understanding of managers' role during these adverse events. We identified and described how managers can ensure the normal, uninterrupted operation of the safety-critical organisation during events, such as the COVID-19 pandemic. The findings from the qualitative exploratory study are consistent with the findings of other authors who have highlighted the unavailability of key employees

as one of the main potential threats to process safety in critical-safety organisations during the COVID-19 pandemic (e.g., Ashraf et al., 2022; Bragatto et al., 2021). However, in contrast to previous studies, the findings also shed some light on the crucial role of managers during crises. Managers' ability to make quick decisions enabled organisations to adopt necessary measures and make adjustments to withstand uncertainty and maintain their organisational activities. The results also showed that active involvement and communication further strengthened employees' trust in the management and the effectiveness of the adopted measures. This provides valuable insight into the important role that managers in safety-critical organisations had during the COVID-19 pandemic. Therefore, we contribute to both leadership and process safety management literature.

Obtained in-depth insight into how the COVID-19 crisis affected critical safety organisations, what were the main challenges, and what were the most important factors that enabled organisations to survive the first months of the pandemic may also have valuable practical implications for organisations. Findings from this exploratory study can provide a foundation that safety-critical organisations can use to adapt or develop contingency plans and internal policies to quickly respond and adapt to future pandemic events.

As the availability of key employees was identified as the main threat to safety-critical organisations during the COVID-19 pandemic, these organisations could develop detailed plans that could be rapidly implemented in the event of a similar situation. Elaborated protocols could include adjusted work schedules, the possibility of additional shifts, or a minimal number of key personnel with the knowledge critical to uninterrupted operational activities and would thereby enable organisations to maintain control over the hazardous process. As the ability to obtain relevant information and establish clear and open communication with various stakeholders was identified as an important challenge during the COVID-19 pandemic, organisations could also consider these aspects in their plans. Organisations could determine what information channels should be established during such events and establish communication protocols to enable communication with various stakeholders. Because of the uncertainty during the pandemic, it is critical to ensure trust between employees and other stakeholders outside the organisation.

One of the most important contributions of the doctoral dissertation is exploring the relationship between managers' commitment to safety, leadership style, and employees' perceptions of managers' commitment in the context of safety-critical organisations. The **explanatory study** adds three important contributions to the literature. First, we examined the relationship between managers' commitment to safety as experienced by managers and managers' commitment perceived by employees. As most studies address commitment to safety from the employee's perspective and focus on how employees perceive managers' commitment to safety, the managerial side of this relationship is under-researched. Therefore, we answer the call of researchers that the managerial side of this relationship should also be explored (e.g., Cui et al., 2013; Fruhen et al., 2019). In doing this, we addressed both sides of the relationship between managers' safety commitment and employees' perceptions of managers' safety commitment which adds new insights to the existing body of knowledge on safety commitment. The result showed that there is a positive and significant relationship between managers' commitment to safety and employees' perceptions of managers' commitment to safety. Thus, we contribute to the safety commitment theory. Second, we answer the call of the researchers proposing that determining the degree of alignment between employees' and managers' perceptions can add to further understanding of safety commitment (e.g., Bowers & Fleming, 2018; Fruhen et al., 2019). Hence, we propose that there is a difference between managers' commitment to safety and employees' perceptions of managers' commitment to safety. Based on the results, we confirmed the difference between the two groups, showing that managers'

perceptions of their own commitment to safety were not aligned with employees' perceptions.

Third, we contribute to both safety commitment and leadership literature by exploring the proposed mediation relationship between managers' commitment to safety, transformational leadership style, and employees' perceptions of managers' commitment to safety. This adds to the understanding of how managers convey their commitment to safety through their leadership and how managers' leadership style helps to shape employees' perceptions (Bowers & Fleming, 2018; Fruhen et al., 2019). The results of the mediation analysis showed that the transformational leadership style functions as a mediator between the managers' commitment to safety and employees' perceptions of managers' commitment. The explanatory study also showed that managers' commitment to safety influences the transformational leadership style. This is consistent with the findings of researchers who have highlighted that managers' values and psychological states (i.e., feelings and attitudes) can significantly influence managers' transformational behaviours (Jin et al., 2016; Sun et al., 2017). By providing evidence for the positive relationship between managers' commitment to safety as a psychological state and the transformational style of managers, we also contribute to the leadership literature.

Findings also have important practical implications as they highlight the importance of leadership style in conveying managers' commitment to safety and shaping employees' perceptions that are recognised as antecedents of safety performance and outcomes (Cui et al., 2013; Taylor & Snyder, 2017). Transformational leadership plays an important role as managers strive to clearly and consistently signal to employees that safety is a high priority in the organisation. Managers with a transformational leadership style would be able to signal to the employees that safety is an important organisational goal that precedes other goals. If employees perceive that safety is important for the organisation and its management, employees are more likely to follow safety procedures and even actively participate in safety programmes (Bowers & Fleming, 2018). Safety commitment of managers is related to transformational leadership style, which is known to have other positive non-safety outcomes (Bronkhorst et al., 2015; Pillai et al., 1999). Thus, process safety performance would not be the only positive outcome.

### 6.3 Limitations and Suggestions for Future Research

There are also several limitations to this doctoral dissertation that have to be mentioned. The first limitation is related to the **bibliometric analysis**. More specifically, to the reason behind the citations. For example, although the citation analysis of the documents is based on the specific number of citations, we cannot actually know why these publications were cited (Zupic & Čater, 2015). There can be various reasons for the citation of a particular publication. The researcher may cite the publication to criticise it or compile a presentable reference list that includes important authors. The publication may also be cited by a colleague or self-cited by the researcher itself. In addition, some publications may also have fewer citations due to the limited access or may not be cited because of a simple error in the citation or even because of rivalry between the researchers (Haddow, 2018).

The second limitation is related to the nature of the **systematic literature review**. In the process of the systematic review, the researcher has to make several decisions based on subjective judgments. This includes decisions regarding which publication to include or exclude, the quality of the publications and their relevance, or how wide or narrow the focus of the study should be. However, as pointed out by Rojon et al. (2021), the subjectivity of researchers also plays an important role in other stages, such as during the

thematic analysis or when the researcher interprets the results of the analysis. Although this effect is partly mitigated through the rigorous systematic review process and comprehensive and detailed description of various decisions that the researcher made during the process, this limitation should not be overlooked.

Another limitation of this doctoral dissertation stems from the data collection. In the **exploratory qualitative study**, we applied semi-structured interviews to obtain rich and in-depth data. However, the way in which the interview is conducted can have an important effect on the collected data, as it requires close interaction between the researcher and participants. Small changes in the tone of the researcher's voice or non-verbal signs that the researcher may send to the participant can have an important influence on what the participant is willing to disclose in the interview. Moreover, although we used semi-structured interviews that introduce some degree of structure to the interview process, such interviews are not standardised; thus, they have lower reliability (Saunders et al., 2016). Further, several types of potential biases such as interviewer, response, or participation bias must also be considered. Although we tried to minimise these biases by carefully sampling, preparing meticulously for the interview, establishing trust with the participants, ensuring confidentiality, and pointing out voluntary participation, the aforementioned biases can never be completely eliminated. As such, they represent a threat to reliability and validity (Saunders et al., 2016). Further, the cross-sectional design used in this study has not allowed us to explore how managers addressed the challenges that arose through the course of the COVID-19 pandemic. Therefore, future research should adopt a longitudinal design, which would allow researchers to observe how managers adapted their behaviour and what decisions they have taken to mitigate the effect of the ongoing pandemic. Another limitation stems from the circumstances related to the COVID-19 pandemic. As we have already mentioned, these new circumstances placed additional pressure on organisations to adapt and maintain their operational activities. Thus, time was an especially scarce resource during the COVID-19 pandemic. Consequently, this impacted the ability to access the management of the safety-critical organisations and the available time that our participants had to participate in the study.

When interpreting the research findings from our **explanatory quantitative study**, the context of COVID-19 should also be taken into account. Specific (crisis) circumstances may have influenced the results to some extent. As the results of our qualitative study show, managers were often personally involved in the crisis group that developed and adopted mitigation measures. Managers communicated regularly with employees and expressed concern for their safety. This clearly showed to employees that managers are committed to safety.

Further, the cross-sectional design also represents an important limitation in the explanatory quantitative study as it affects the ability of the study to show causality. Hence, the direction of the causal relationship between independent and dependent variables can therefore only be inferred. Thus, future research should employ a longitudinal research design. This would enable researchers to observe changes in the variables over time and determine the direction of the relationship among them. In addition, another related limitation is that the survey research strategy does not allow the manipulation of the independent variable. Thus, future research should further extend the results of this study and employ experimental research that uses an active independent variable and is the most suitable type of research design to determine the causal relationship (Gliner et al., 2017).

Another limitation also arises from the data collection method. We conduct a survey based on the self-completion questionnaires, which are especially susceptible to the common method bias (variance). This type of bias can have an important effect on the validity and reliability of the questionnaires and can even result in distorted estimates of the

relationship between constructs. We employ both statistical and procedural measures to address this issue. Among available post hoc statistical approaches, we used Harman's one-factor test. The results suggest that common method bias does not represent a major threat to the study. Before conducting a survey, we also introduced some procedural measures to reduce the potential common method bias. To this end, we assure complete anonymity to all of the participants. As we used a web-based survey platform, respondents were able to complete their questionnaires whenever and wherever they chose, even on their mobile devices outside the work. In addition, we examined and adapted the questionnaires to make sure that the questions were easy to understand and that the accompanying instructions were clear. However, before collecting the data, future research should employ additional procedural measures to address the potential common method bias. Therefore, studies should use scales with reverse-coded items, randomly introduce questions to respondents, collect data for explored variables at different times or use various sources (Jordan & Troth, 2020).

The final limitation we would like to highlight relates to sample size and its impact on further data analysis. We collected data for two samples, one from employees and one from managers, so we had two hierarchical levels. Peugh (2010) suggests that to analyse such multilevel data with nested structure, multilevel analysis is the most appropriate approach. The multilevel analysis allows the researchers to address the independence assumption problem associated with multilevel data (Leyland & Groenewegen, 2020; Peugh, 2010). However, the small sample size on the managerial level did not allow us to apply multilevel analysis. Maas and Hox (2005) point out that sample size is one of the most common barriers to multilevel modelling. If the sample size is insufficient, this can lead to biased analysis results. Therefore, future studies should plan their data collection accordingly to obtain a sufficient sample to allow multilevel analysis.



## Appendix A

### Core Literature Data

#### A.1 Journals Publishing on the Topic of Safety Commitment and Leadership

Table A.1: Journals and impact factor.

Journal Title	Number of Documents	Impact Factor <sup>a</sup>	% of All Journals
Safety Science	14	4.877	26.4
Journal of Safety Research	8	3.487	15.1
Accident Analysis & Prevention	2	4.993	3.8
International Journal of Environmental Research and Public Health	2	3.390	3.8
Journal of Nursing Management	2	3.325	3.8
Quality and Safety in Health Care	2	— <sup>b</sup>	3.8
2012 International Symposium on Safety Science and Technology	1	— <sup>c</sup>	1.9
Advances in Human Aspects of Transportation	1	— <sup>c</sup>	1.9
Advances in Intelligent Systems and Computing	1	— <sup>c</sup>	1.9
Applied Mechanics and Materials	1	— <sup>b</sup>	1.9
Australian Journal of Primary Health	1	1.307	1.9
BMJ Quality & Safety	1	7.035	1.9
European Journal of Work and Organizational Psychology	1	3.968	1.9
Human Factors and Ergonomics in Manufacturing	1	— <sup>d</sup>	1.9
International Journal of Health Planning and Management	1	1.517	1.9

*(Table continues)*

Table A.1: Journals and impact factor (*Continued*).

<b>Journal Title</b>	<b>Number of Documents</b>	<b>Impact Factor <sup>a</sup></b>	<b>% of All Journals</b>
Safety Science	14	4.877	26.4
Journal of Safety Research	8	3.487	15.1
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Journal of Nursing Management	2	3.325	3.8
Quality and Safety in Health Care	2	– <sup>b</sup>	3.8
2012 International Symposium on Safety Science and Technology	1	– <sup>c</sup>	1.9
Advances in Human Aspects of Transportation	1	– <sup>c</sup>	1.9
Advances in Intelligent Systems and Computing	1	– <sup>c</sup>	1.9
Applied Mechanics and Materials	1	– <sup>b</sup>	1.9
Australian Journal of Primary Health	1	1.307	1.9
BMJ Quality & Safety	1	7.035	1.9
European Journal of Work and Organizational Psychology	1	3.968	1.9
Human Factors and Ergonomics in Manufacturing	1	– <sup>d</sup>	1.9
International Journal of Health Planning and Management	1	1.517	1.9

*Note.* The data are obtained from the “*Web of Science*,” by Clarivate, 2021 (<https://www.webofscience.com/wos/woscc/advanced-search>).

<sup>a</sup>Impact factor was based on Journal Impact Factor Trend 2020 from the “*Journal Citation Reports*,” by Clarivate, 2021 (<https://jcr.clarivate.com/jcr/browse-journals>).

<sup>b</sup> Discontinued. <sup>c</sup> Proceedings. <sup>d</sup> No longer indexed in the Journal Citation Report.

## A.2 Distribution of Publications

Table A.2: Publications by country, region, and organisation.

Country	Region/City	Organisation
Saudi Arabia	Jeddah	Batterjee Medical College BMC
China	Beijing	Beijing Jiaotong University
Norway	Bergen	BI Bergen
China	Beijing	China University of Geosciences
China	Beijing	China University of Geosciences
China	Xuzhou	China University of Mining and Technology
Ireland	Dublin	Dublin City University Business School
Netherlands	Rotterdam	Erasmus University Rotterdam
China	China	Henan Institute of Engineering
USA	Alexandria, Virginia	Human Resources Research Organization
Taiwan	Shalu, Taichung County	HungKuang University
Saudi Arabia	Riyadh, Saudi Arabia	King Saud Bin Abdulaziz University for Health Sciences
USA	Baton Rouge, Louisiana	Louisiana State University
Australia	Melbourne	Monash University
Malaysia	Melaka	Multimedia University
Taiwan	Kaohsiung	National Kaohsiung First University of Science and Technology
Taiwan	Keelung	National Taiwan Ocean University
Netherlands	Leiden	Netherlands Organisation for Applied Scientific Research TNO
USA	Hammond, Indiana	Purdue University Calumet
Australia	Queensland	Queensland University of Technology
Australia	Brisbane	Queensland University of Technology
Canada	Halifax	Saint Mary's University
Israel	Hof Ashkelon	Sapir Academic College
Australia	East Lismore	Southern Cross University
Finland	Tampere	Tampere University of Technology
Iran	Tehran	Tehran University of Medical Sciences

*(Table continues)*

Table A.2: Publications by country, region, and organisation (*Continued*).

<b>Country</b>	<b>Region/City</b>	<b>Organisation</b>
Saudi Arabia	Jeddah	Batterjee Medical College BMC
China	Beijing	Beijing Jiaotong University
Norway	Bergen	BI Bergen
China	Beijing	China University of Geosciences
China	Beijing	China University of Geosciences
China	Xuzhou	China University of Mining and Technology
Ireland	Dublin	Dublin City University Business School
Netherlands	Rotterdam	Erasmus University Rotterdam
China	China	Henan Institute of Engineering
USA	Alexandria, Virginia	Human Resources Research Organization
Taiwan	Shalu, Taichung County	HungKuang University
Saudi Arabia	Riyadh, Saudi Arabia	King Saud Bin Abdulaziz University for Health Sciences
USA	Baton Rouge, Louisiana	Louisiana State University
Australia	Melbourne	Monash University
Malaysia	Melaka	Multimedia University
Taiwan	Kaohsiung	National Kaohsiung First University of Science and Technology
Taiwan	Keelung	National Taiwan Ocean University
Netherlands	Leiden	Netherlands Organisation for Applied Scientific Research TNO
USA	Hammond, Indiana	Purdue University Calumet
Australia	Queensland	Queensland University of Technology
Australia	Brisbane	Queensland University of Technology
Canada	Halifax	Saint Mary's University
Israel	Hof Ashkelon	Sapir Academic College
Australia	East Lismore	Southern Cross University
Finland	Tampere	Tampere University of Technology
Iran	Tehran	Tehran University of Medical Sciences

*Note.* The data are obtained from the “*Web of Science*,” by Clarivate, 2021 (<https://www.webofscience.com/wos/woscc/advanced-search>).

## Appendix B

# Data Collection Form

Table B.1: Form for collecting data from core literature.

Main points	Notes
Date	
General topic	
Title	
Journal	
Author	
Type of study/research method	
Context of the study	
Theoretical foundations	
The aim and main findings	
Relation to safety commitment and leadership	
Directions for future research	
Researchers notes	



## Appendix C

# Semi-Structured Interview Protocol

Impacts of the COVID-19 pandemic outbreak-related measures on the business performance and process safety management of the industrial organisations and sites

### **Data on the conducted interview**

Consecutive interview number:

Place, date and time of the interview:

Interview duration:

### **Data on the interviewed persons**

Interviewee:

Interviewee work position:

Organisational unit/area:

Work time on this position or organisation:

### **Data about the organisation**

Organisation:

Organisation's »Seveso« classification: "lower" or "upper" tier

Organisation's type of the business activity:

Organisation's size (number of employees):

Is organisation, or its part, categorised as a national critical infrastructure?

### **Introduction of the researchers and the research topic**

Introduction of the researchers and their research organisations.

Introduction of the purpose of the research work, the organisations invited into the research and how the collected data will be used.

Introduction of the interview structure.

### **Obtaining the permit to record the interview**

Interviewee: agree / do not agree

### **Additional questions**

Possible additional questions before the start of the interview:

### SET OF INTRODUCTION QUESTIONS

- 1) Please explain how the pandemic impacted your organisation?
- 2) Have you noticed any changes related to sick leave of employees during the pandemic?
  - a) Does your organisation have the data on the number of employees that were infected, or in contact with those infected, or were put into isolation (at home or in hospital) or quarantine?

### SET A – MEASURES ADOPTED BY THE NATIONAL AUTHORITIES TO RESPOND TO THE PANDEMIC

- 1) Which measures adopted by the national authorities influenced the operations of your organisation?
  - a) Can you describe examples of the measures?

### SET B – MEASURES ADOPTED BY YOUR ORGANISATION

- 1) Which measures and adaptations were implemented in your organisation as a response to the pandemic?
  - a) Can you describe examples of the measures?
- 2) When were the aforementioned measures introduced and what was the time span of their introduction?
  - a) Did you prepare the measures before the pandemic was declared by the authorities?

### SET C – INFLUENCE OF THE ADOPTED MEASURES ON ORGANISATION AND EMPLOYEES (GENERAL PART)

- 1) If, and if yes, how did the adopted measures influence the various business functions in your organisations?
  - a) Which topics or functions required most work, or presented largest challenges?
- 2) If you compare the scale of the production (work) before, during and after the pandemic, do you notice any differences?
  - a) Can you estimate what was/is the scale of change?
- 3) Have the measures influenced your suppliers and contractors?
  - a) Can you describe an example how the measures influenced them?
- 4) Have the measures influenced your clients (customers)?
  - a) Can you describe an example how the measures influenced them?
- 5) Does your organisation have a Business Continuity Management plan adopted to ensure non-interruption or continuity of operations?
  - a) If the answer is yes, was it activated?

- b) Why did you decide to activate or not to activate the plan?
  - c) Can you tell us more about the plan itself (what does it cover, its structure, etc.)?
- 6) How did the measures adopted during the pandemic influence your work or the work of your co-workers?
- a) Have the contents, scope, time or location of your work changed compared to the period before the pandemic?
- 7) During this time, did you get used to the changed circumstances and the new way of working?
- a) How much time did you need or expect you will need for that?

#### SET D – INFLUENCE OF THE ADOPTED MEASURES ON THE MANAGEMENT OF PROCESS SAFETY IN ORGANISATION (FOCUSED PART)

- 1) How did the measures adopted during the pandemic influence the activities or system procedures related to the management of process safety in the organisation at the managerial or operational levels?
- 2) How was the work process organised during the measures related to prevent and manage the pandemic?
  - a) Did you adjust or reshape the work shifts due to the measures (type, number, shift length, etc.)?
  - b) Did you adjust the number of employees in work shifts due to the measures?
- 3) How was the availability or accessibility of the experts important for ensuring process safety regulated during the pandemic?
- 4) How did you carry out the planned inspections, certification and maintenance of the equipment in the organisation during the pandemic?
- 5) How did you carry out the planned periodic trainings for the safe work, drills and monitoring of safety activities in the organisation during the pandemic?
- 6) Did you personally follow all usual/standard safety procedures in your work during the pandemic?
  - a) Have safety-related procedures changed due to the current pandemic circumstances (please provide examples)?
- 7) Did you personally have access to the safety-relevant information and co-workers (superiors/subordinates) which you could contact during the pandemic?

#### SET E – FINDINGS AND RECOGNITIONS

- 1) What were the key challenges you faced during the implementation of the pandemic-related measures?
- 2) How would you prepare or intend to prepare for potential further waves of the pandemic?

- a) What would or will you do differently in preparation for the next wave in comparison to the first wave of the pandemic?
- 3) Do you intend to incorporate the acquired experiences, knowledge and recognitions into the formal procedures of the organisation?
  - a) What exactly – examples?

#### SET E – SUPPLEMENT

##### **Management of safety-relevant changes**

The management of change is an integral part of the process safety management. To ensure process safety, it is extremely important to properly address both organisational and technical changes that could influence the safety of the organisation.

- 1) Did you consider measures and adjustments related to the pandemic in the same way as other changes that can influence the process safety? Thus, did you analyse the meaning of each change/adjustment and take care that its implementation is safe enough?
  - a) Due to the pandemic you implemented various measures and adjustments. Did you implement/use any additional measures and adjustments with which you checked and assured that the pandemic-related technical and organisational changes are safe enough?
  - b) If yes, was the analysis and implementation done within the procedures for the management of safety-related technical or organisational changes (involves, e.g., record of proposal, evaluation, approval, implementation and maintaining of the records)?

##### **Organisational resilience**

Resilience of the organisation is its inherited capacity to maintain or restore stable conditions that allow it to normally operate at expected or unexpected event or longer stress. The key phases of resilience are the ability of an organisation to: i) understand and assess risks, ii) anticipate and prepare for stress, iii) adapt to and withstand changing conditions, iv) respond to stress, v) and recover rapidly to a normal or improved state after stress.

- 1) How would you assess the resilience of your organisation during the pandemic?
- 2) How did you deal with the situation and what were the key challenges in ensuring or restoring normal business operations?
- 3) How successful have you been in meeting the challenges?
- 4) How long did it take the organisation to implement the measures and adjustments necessary to maintain or restore normal business operations?
- 5) What should be done to make your organisation even more resilient in the future?

##### **Social resilience**

Social resilience is the ability of the members of the society to adopt sensible, systematic and collective measures to mitigate the consequences of the disruptive event. It is the

ability of the group to prepare for, cope with, and survive the disruptive events. Social resilience reflects the society's ability to survive the difficulties as intact as possible, as well as in its ability to cope with the changing environment and adapt to it in new, innovative ways.

- 1) Who played a key role during the pandemic in maintaining and restoring the organisation's operations to normal?
- 2) What was the role of the management and what was the role of the employees?
- 3) How long did it take the employees to get used to the new situation?
- 4) What should employees be like in order to face a similar situation even more successfully in the future?

THANK YOU FOR YOUR COOPERATION!



## Appendix D

# Measurement Scales

### D.1 Safety Commitment Dimensions Scale

Table D.1: Measurement scale for safety commitment – managers' perspective.

<b>For managers</b>		<b>Za managerje</b>
<i>I make safety a priority because ...</i>		<i>Varnost je zame pomembna prioriteta, ker</i>
		...
<b>Items</b>	<b>Statement</b>	<b>Trditev</b>
1	I am passionate about safety.	Sem navdušen nad varnostjo.
2	Safety has a great deal of personal meaning to me.	Mi varnost osebno zelo veliko pomeni.
3	I care about safety.	Mi je mar za varnost.
4	It will help me get promoted.	Mi bo to pomagalo pri napredovanju.
5	I don't want to lose my reputation.	Ne želim izgubiti svojega ugleda.
6	I might lose my job if I don't.	Bi drugače lahko izgubil službo.
7	My moral compass tells me to do so.	Mi moj moralni kompas tako pravi.
8	Safety is my moral responsibility.	Je varnost moja moralna odgovornost.

*Note.* Table is adapted from “What does safety commitment mean to leaders? A multi-method investigation,” by L.S. Fruhen, M. A. Griffin, and D. M. Andrei, 2019, *Journal of Safety Research*, 68, p. 203–214.

Table D.2: Measurement scale for safety commitment – employees' perspective.

<b>For employees</b>		<b>Za zaposlene</b>
<i>My boss makes safety a priority because ...</i>		<i>Varnost je pomembna prioriteta za mojega nadrejenega, ker ...</i>
<b>Items</b>	<b>Statement</b>	<b>Trditev</b>
1	He is passionate about safety.	Je navdušen nad varnostjo.
2	Safety has a great deal of personal meaning for him.	Mu varnost osebno zelo veliko pomeni.
3	He cares about safety.	Mu je mar za varnost.
4	It will help him get promoted.	Mu bo to pomagalo pri napredovanju.
5	He doesn't want to lose his reputation.	Ne želi izgubiti svojega ugleda.
6	He might lose his job if he doesn't.	Bi drugače lahko izgubil službo.
7	His moral compass tells him to do so.	Mu njegov moralni kompas tako pravi.
8	Safety is his moral responsibility.	Je varnost njegova moralna odgovornost.

*Note.* Scale is adapted from “What does safety commitment mean to leaders? A multi-method investigation,” by L.S. Fruhen, M. A. Griffin, and D. M. Andrei, 2019, *Journal of Safety Research*, 68, p. 203–214.

## D.2 Transformational Leadership Scale

Table D.3: Transformational leadership.

<b>For employees</b>		<b>Za zaposlene</b>
<i>My direct supervisor ...</i>		<i>Moj neposredno nadrejeni ...</i>
<b>Items</b>	<b>Statement</b>	<b>Trditev</b>
1	To me, he/she is a symbol of success and expertise.	Je zame simbol uspeha in strokovnosti.
2	Is an example to me.	Mi predstavlja zgled.
3	Makes me proud to work with him/her.	Ponosen sem, da delam z njim.
4	Shows extraordinary competence in whatever he/she undertakes.	Je izredno sposoben, uspešno opravi vse, česar se loti.

*Note.* Scale is adapted from “The effect of response style bias on the measurement of transformational, transactional, and laissez-faire leadership,” by G. Moors, 2012, *European Journal of Work and Organizational Psychology*, 21(2), p. 271–298.

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## Publications Related to the Thesis

### Journal Articles

- Levovnik, D., & Gerbec, M. (2018). Operational readiness for the integrated management of changes in the industrial organizations – Assessment approach and results. *Safety Science*, *107*, 119–129. <https://doi.org/10.1016/j.ssci.2018.04.006>
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## Other Publications

### Journal Articles

Levovnik, D., & Molan, M. (2012). Postopek oblikovanja varnostne kulture - poti in pasti. *Delo + Varnost: Revija Za Varstvo Pri Delu in Varstvo Pred Požarom* [Journal of Occupational Safety and Fire Safety], 57(4), 44-51. <http://www.zvd.si/info/narocila-prijave/drugo/arhiv-revije/>

### Independent scientific component part or a chapter in a monograph

Gerbec, M., & Levovnik, D. (2019). Management of technical and organizational changes in major hazard industries. In M. C. Leva, T. Kontogiannis, M. Gerbec, & O. Aneziris (Eds.), *Total safety and the productivity challenge* (pp. 226-250). Routledge, Taylor & Francis Group.

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## Biography

I have obtained my bachelor's and master's degree at the University of Ljubljana, Faculty of Chemistry and Chemical Technology (study programme Technical Safety). I continue my postgraduate studies at the Jožef Stefan International Postgraduate School (study programme Ecotechnologies). During my postgraduate studies, I have attended several postgraduate courses and two doctoral summer schools at the University of Ljubljana, School of Economics and Business. This allowed me to acquire additional knowledge to conduct my research in the interdisciplinary field of safety science. I have started my research work as a young researcher at the Jožef Stefan Institute, in the research area of safety. I am currently exploring the role of management in the prevention of major industrial accidents whose consequences can have significant impacts on various stakeholders and the environment. My research interest includes topics such as process safety management, change management, commitment to safety, leadership, and organisational behaviour.