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Offen im Denken

Understanding the determinants of safety-related rule violations –

Integration of ergonomic, organisational and cognitive perspectives and discovering empirical evidence regarding the impact of the framing of production outcomes, goods at stake, personality and the communication and implementation of audits on rule-related behaviour

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Erstgutachterin: Prof. Dr. Annette Kluge
Zweitgutachter: Prof. Dr. Christian Rietz

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Dipl. - Psych. Ananda von der Heyde

ananda.vonderheyde@googlemail.com

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The studies, which will be described in this dissertation, were conducted in the scope of a project of the German Research Foundation (Deutsche Forschungsgemeinschaft; KL2207/2-1). On the date of submission of the dissertation, three of the four studies reported in the empirical evidence section were in the following states of the publication process

1. The impact of Goods at Stake (only published within the present investigation)

von der Heyde, A., & Kluge, A. Social norms and their impact on safety-related rule violations: It doesn't matter if people are harmed

2. The impact of personality *(main study findings are based on the personality-related aspects of the data of the study described in the section "Impact of audit probability")*

von der Heyde, A., Miebach, J., & Kluge, A. (2014). Counterproductive work behaviour in a simulated production context: An exploratory study with personality traits as predictors of safety-related rule violations. *Journal of Ergonomics, 4(2), 130.* *http://omicsgroup.org/journals/counterproductive-work-behaviour-in-a-simulated-production-context-an-exploratory-study-with-personality-traits-as-predictors-of-safetyrelated-rule-violations-2165-7556.1000130.pdf*

3. The impact of audit probability *(personality-related aspects of the results already reported in the section "Impact of personality")*

von der Heyde, A., Brandhorst, S., & Kluge, A. (2015). The impact of the accuracy of information about audit probabilities on safety-related rule violations and the bomb crater effect. *Safety Science, 74, 160-171.* *http://www.sciencedirect.com/science/article/pii/S0925753514003191*

4. The impact of audit timing

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1 Structure of the Dissertation

The present investigation consists of a theoretical and an empirical part. The theoretical part comprises an introduction to the topic of safety-related rule violations (cf. section 2), the definition and distinction of different rule types (cf. section 3), a description of the incidence of rule violations in different industrial sectors (cf. section 4) and a general theory part (cf. section 5). The general theory can be further subdivided into three parts: in the first part, the Human Factors Perspective (cf. section 5.1), the theories and findings of the Human Factors research are described; in the second part, the Industrial and Organisational Psychology Perspective (cf. section 5.2), the relevant concepts and theories in the area of Industrial and Organisational Psychology are outlined and in the third part, the Decision-Making Perspective (cf. section 5.3), the relevant decision-making theories and their correlation with the decision-making process of rule violations are depicted. Finally the different perspectives are integrated into a holistic understanding of safety-related rule violations (cf. section 5.4).

The empirical evidence part consists of four distinct sections, which concentrate on the reporting of studies that were conducted within the scope of the present investigation, to identify the impact of several determinants of safety-related rule violations in a process control environment.

The first study, which was conducted to investigate the impact of *goods at stake* and the *framing* of the production outcome (cf. section 6.1), showed no significant effect of the *goods at stak*e and the *framing* on the amount of safety-related rule violations. However, the data revealed significant negative correlations between the skills and knowledge regarding the operation of the simulation and the violation of safety-related rules.

The second study (cf. section 6.2), which addresses the impact of personality traits on safety-related rule violations, began with a questionnaire-based prestudy which found significant associations between *cautiousness, self interest* and *injustice sensitivity* and the intention to violate rules. In the main investigation only the integrity subscale *cautiousness* correlated with safety-related rule violations in process-control environment.

The third study (cf. section 6.3) deal with the impact of the *accuracy of information about audit probability* and the impact of just experienced audits on the amount of rule violations. Furthermore the *framing* of the production outcome and salary as gain or loss was again investigated. The *framing* as well as the *accuracy of information about audit probability* was found to have a significant impact on the amount of rule violations: When

the participants had accurate information about the audit probability, they violated significantly more often than if they had no or only vague information about the audit probability; and they violated more often in the loss-framed conditions than in the gain-framed conditions. Moreover violations occurred significantly more often when an audit had just been experienced (bomb crater effect).

The fourth study (cf. section 6.4) investigated the *framing* of the production outcome and salary and the impact of *audit timing* on safety-related rule violations. In the early audit group the audits were implemented early on, and moreover, only conducted in the first half of the production year. In the late audit group the same amount of audits was conducted, but they were placed only within the second half of the year. The early audit group initially violated the rule less often, but the amount of rule violation increased after audits stopped in the second half of the year. In the late audit group, participants violated the rule at the same level of frequency; they did not adapt their behaviour, when audits were implemented in the second half of the year.

In the final part, the general discussion (cf. section 7), the results of all investigations are discussed as a whole. The internal validity, practical relevance and usefulness of the findings were assumed to be high. Although the external validity of the findings is estimated as quite low, it is assumed that due to the high internal validity, the findings can be transferred to other contexts. The findings corroborate the importance of a proper design of performance feedback systems (impact of framing); the relevance of highly skilled people with good knowledge about their work tasks for maintaining and improving safety; the usefulness of measuring certain personality traits in the personnel selection process to enhance rule compliance (impact of personality); the significance of the extent and type of information which is provided about audits and audit probabilities and the relevance of considering the timing of audits within a certain time span or with respect to the gap between audits (bomb crater effect) in order to reduce the amount of rule violations.

2 Introduction

Rules have been prescribed to regulate social coexistence for as long as we can remember; and as old as the prescription of rules is, so too is the consideration to violate them. A very prominent example from Christianity is the Bible story about Eve`s rule violation in paradise. Eve decided to violate the rule and taste the apple from the forbidden tree. This story, which is part of the Christian notion of the genesis of humanity, demonstrates the significance of rules and rule violation for understanding human nature. Every day, every human being has to make frequent decisions about whether to comply with or violate rules. This applies to different rule types and different decision situations, from car-driving situations, which are regulated by the road traffic act, to situations which are determined by social norms, such as the behaviour in a family situation or when shopping, to decision situations at school or work, which are regulated by organisational rules and procedures.

The story of Eve, as well as the rule violations committed in everyday situations, raises the question of the determinants of rule-related behaviour. Why do people decide to violate rules? And how can rule violations be prevented? With regard to Eve, or every other person, who has to make rule-related decisions, the decision might be due to person-related factors, like age, gender, previous experience or personality, or it might depend on situational factors, like the rule characteristics, the probability of audits, or benefits and sanctions which are associated with rule violations. Like most psychological theories suggest, human behaviour is not exclusively determined by person-related or situational factors, but is a product of person-related factors, situational factors and interactions between these determinants. In this regard it can be assumed that rule-related behaviour is also determined by a conglomerate of these determinants.

The present investigation deals with the identification of rule violation determinants in general, but addresses in particular the violation of safety-related rule violations in High Reliability Organisations, since the violation of these rules is associated with especially severe consequences. Several industrial disasters have been caused at least partially by rule violations, such as the refinery explosion in Texas City in 2005, or the Deep Water Horizon oil spill in 2010, which illustrate vividly the need for more rule compliance to prevent the disastrous consequences which are associated with these accidents.

Gaining a better understanding of the determinants of safety-related rule violations is the basis for developing and implementing more effective and sustainable rule violation reduction measures. The present investigation should enhance a more holistic under-

standing of safety-related rule violations and their determinants. This should be achieved by summarizing different theoretical perspectives, supplying new empirical evidence and finally integrating both into a new adapted conception of the processes and factors which determine safety-related rule violations.

Although there is research from several areas regarding the determinants of rule violations, the respective findings are only noticed and applied within the research community in which the particular research was conducted. The theoretical part of the present investigation aims to close this gap by including the definition and distinction of different rule types; describing the incidence of rule violations in different industrial sectors; describing the theories and findings of the Human Factors research; exposing relevant concepts and theories in the area of Industrial and Organisational Psychology; and describing the relevant decision-making theories and their correlation with the decision-making process of rule violations. Finally, the different perspectives will be integrated into one holistic understanding of the processes and determinants of rule violations.

The new empirical evidence regarding the determinants of rule violations will be provided by presenting four studies, which were conducted within the scope of a project funded by the “Deutsche Forschungsgemeinschaft” (DFG; project ID: KL 2207/2-1). These studies aimed to discover the impact of several situational and person-related determinants of safety-related rule violations in a process control environment. The first study will address the impact of the framing of the production outcome and salary and the impact of the goods at stake on rule violations; the second study will focus on the impact of personality-related determinants of rule violations; the third study will concentrate on the impact of the accuracy of information about the audit probability as well as the impact of a just experienced audit on the amount of rule violations; and the fourth study will be concerned with the impact of audit timing on the amount of rule violations

In the conclusions part, the findings of all four studies will be summarised, the validity, practical relevance and usefulness of the results will be discussed, and future research questions and lessons learned will be described. Afterwards, the current results will be integrated into the theories on the determinants of safety-related rule violations which were described previously in the theoretical part and finally, the practical implications of the findings will be outlined.

3 Rule classification

The following section begins by defining and classifying different rule types. Since the present investigation is about the violation of (safety-) *rules*, it is necessary to describe the term *rule* and to distinguish it clearly from other, similar terms. In the following section the terms *law*, *social norms, rules and procedures* will be defined and described, and their implications for the present investigation will be outlined.

3.1.1 Law

According to The New Encyclopaedia Britannica, law is defined as "[...] profession concerned with the practices, and rules of conduct of a community that are recognized as binding by the community." (Gwinn, Norton, & Goetz, 1991, p. 200). Furthermore, according to the authors, the compliance with the legislation is enforced through a controlling authority.

The violation of *law* is only indirectly relevant to the research questions addressed in the present investigations. The common *law has* required organisations to provide safe workplaces for their employees for about 100 years (cf. for example Wickens, Lee, Liu, & Gordon Becker, 2004). In the 1960s, years most countries introduced a set of laws concerning the regulation of industrial safety; these regulations are usually summarised under the heading of the Occupational Safety and Health Act (OSHA). In Germany, the first laws regulating industrial safety even came into force back in 1869 (Kreck, 2001, p. 5).

If an accident occurs, organisations have to prove that they expended a "reasonable amount of care" to prevent accidents (Wickens et al., 2004). In order to prove this and to ensure safety, organisations are increasingly implementing safety-related rules (cf. Safety-related rules, 3.1.3), which are based on the OSHA of the respective country in which the organisations operate.

However, not only organisations are required to enhance safety; employees too have to meet certain obligations to contribute to safety at work (Friend & Kohn, 2007). For instance, according to Friend and Kohn (2007), they are required to check whether their work place meets the safety requirements. Moreover they are constrained to comply with all safety-related rules which are prescribed by the organisation.

3.1.2 Social Norms

Social norms are defined, according to Cialdini and Trost (1998, p. 152), as "rules or standards that are understood by members of a group, that guide and/or constrain so-

cial behaviour without the force of law." This definition emphasizes the behaviour-guiding function of norms and simultaneously draws a clear distinction between *social norms* and *law* based on their different enforcement mechanisms.

The definition by McAdams (1997) emphasises on the enforcement mechanisms of social norms. He defines social norms as "[…] informal social regularities that individuals feel obligated to follow because of an internalized sense of duty, because of a fear of external non-legal sanctions, or both." (McAdams, 1997, p. 340)

Biel and Thogersen (2007) stress the mechanisms of action of social norms. They assume that *social norms* regulate social life by guiding behaviour in the context in which the respective norm is activated. According to Biel and Thogersen, the activation of norms is an unconscious process which is triggered by certain stimuli. As a function of these stimuli, different types of norms are activated.

Kerr (1995) differentiates between *general interaction norms* and *benevolence norms*: Whereas *general interaction norms* refer to a person's beliefs regarding appropriate behaviour in certain situations, b*enevolence norms* refer to a person`s value concepts. Compliance with *general interaction norms* is enforced through external mechanisms (like rewards and punishments by other group members), whereas compliance with *benevolence norms* is only enforced by internal mechanisms (like feelings of guilt).

This means that the violation of safety-related rules comprises not only the violation of the respective rule, but also the violation of *(social) norms*. Both *general interaction norms* and *benevolence norms* are affected by the violation of safety-related rules. The affected *benevolence norm* is the generally accepted norm to comply with rules which are prescribed by the organisation/employer. The affected *benevolence norm* involves doing nothing that can endanger fellow human beings (if a safety-rule is violated, the person risks the consequence that persons might be injured or even killed).

The impact of norm activation on rule-related behaviour is also one of the main concerns of the following investigations. The first experimental study, described in the section about the impact of the goods at stake (cf. 6.1), takes a closer look at the impact of the activation of benevolence norms on the violation of safety-related rules.

3.1.3 Rules

The General Clauses Act (1960) defines a rule as a regulation which is enforced by the exercise of power. According to Lawton (1998), rules are used to exercise control. Rules as measures of behaviour control are associated with certain disadvantages, as time, effort and resources are necessary to enforce them (Lawton, 1998). The advantage

of rules is that quite complex tasks can be accomplished without a deeper understanding of the system, meaning that less skilled people can perform the respective tasks. According to Lawton (1998) rule-regulated tasks are less demanding, because a person merely needs to follow the rule rather than thinking about and deciding what to do. However this leads to tasks being perceived as more monotonous and boring; people may feel controlled and restricted, and moreover it may no longer be possible to manage new or exceptional situations (Lawton, 1998). Therefore, Lawton argues that rules should be only used to regulate routine activities.

Rule is very broad concept, which needs greater specification in order to obtain an appropriate understanding of what is meant in the respective context. The types of *rules* which are here relevant are *organisational rules* and *safety-related rules*, which will be described in the next sections.

Organisational rules

According to Zhou (1993, p. 2236) *organisational rules* are defined as “part of the formal structure that constitutes and defines stable patterns of relationships and activities." He described *organisational rules* further as “the storage of organizational memory" (Zhou, 1993, p. 1137) and considered the existence and increasing implementation of formal rules as a necessary feature of modern organisations.

Lehman and Ramanujam (2009) suggest a differentiation between internal and external organisational rules: Internal rules are internally developed and determined by the individual characteristics and policies of an organisation, while external rules are determined by external factors, such as the statutory provisions regarding, for example the safety in an organisation. Whereas external rules are usually the same across an industrial sector, internal rules differ between different organisations. Besides this differentiation, there are several more rule characteristics which Lehman and Ramanujam (2009) believe to influence the probability that a rule will be violated, such as the enforceability of a rule or the connectedness with other rules (cf. determinants of safety related rule violations, section 5.1.5).

Zhou (1993) also described also the motivation and background of the implementation of *organisational rules*, which are used to convey organisational knowledge to the organisational members and to make them as effective as possible in the shortest possible time. The rules should be a support measure for employees to establish a time-tested behaviour pattern, enabling them to achieve the targets of the organisation.

Achieving the maximum financial profit and guaranteeing safety are common but frequently conflicting goals of organisations (cf. section Safety-related rules above). The achievement of both of these goals is required, and several *organisational rules* describe in detail how the goals can be accomplished. Employees have to trade off safety-oriented against profit-oriented goals in order to decide which rules they will comply with and which they will violate. These considerations are essential elements in understanding the decision-making process concerning the violation of safety-related rules in organisations.

In the experiments which were conducted in the present investigation, this kind of conflict between different organisational goals and *organisational rules* was specifically induced in the participants (cf. Empirical evidence 6). Further aspects of organisational decision making will be described in the decision-making section (cf. Decision making in organisations 5.3.3).

Safety-related rules

Hale and Swuste (1998) considered a *safety-rule* as "[…] a defined state of a system or way of behaving in response to a predicted situation, established before the event and imposed upon those operating in the system, by themselves or others, as a way of improving safety or achieving a required level of safety" (Hale & Swuste, 1998, p. 164). This definition includes the technical as well as the behavioural aspect of safety and defines a rule as something which is determined and communicated before an action in order to acquire a certain level of safety. In this respect, Hale and Borys (2013b) found in their review that *safety-related rules* are an important tool for risk and safety management. Moreover, they found strong evidence for the assumption that the safety climate and safety culture is associated with rules and with the attitudes of employees towards these rules. They further state that *safety-related rules* are necessary to assign responsibilities and guide behaviour in working situations. Like *organisational rules*, the function of *safety-related rules* is also the provision of (safety-relevant) information to support the respective employee. The *safety-related rules* define which behaviour is still safe, and which behaviour is already dangerous and therefore forbidden by the rule. It can be said that the *safety-related rules* define the boundaries of safe behaviour (Hale & Borys, 2013b).

A differentiation can be made between different types of *safety-related rules*. In their review Hale and Boryc (2013a) termed the different types of *safety-related rules* (which were originally described by Hale & Swuste, 1998) as *performance goals*, *process rules*, and *action rules*. Hale and Swuste (1998) described the rules from the most gen-

eral to the most specified one. *Performance goals* are a type of rule which only specify which goals should be achieved and what sanctions will result if the goals are not met. They do not describe how the goals can be achieved. *Process rules,* according to Hale and Swuste describe how one comes to a decision about the necessary steps or how one reaches a solution to restore or maintain safety. *Process rules* contain only methods; no detailed steps of behaviour are specified. This specification of each step forms part of the *action rules, which* contain very detailed information which may be advantageous because everyone knows very precisely how to achieve safety, but is also disadvantageous because this rule type restricts freedom of choice more than any other (Hale & Swuste, 1998). The action rule is quite similar to the concept of procedures, which is described below (cf. Procedures 3.1.4). The rule types are not mutually exclusive but rather usually merge into each other. First, there is usually a *performance goal.* If the goal is quite complex, *process rules* and then *action rules* are needed to ultimately achieve the goal.

The *safety-related rule* which is used for the experimental studies of the present investigation (cf. Empirical evidence 6) is an *action rule*, which describes in detail which steps have to be taken to achieve system safety. The safety-related rules thus facilitate the clear detection of violations. This is necessary for valid data collection, which is the basis for new insights into the determinants of rule-related behaviour.

3.1.4 Procedures

On a very general level a *procedure* is defined according to Gove (1963), as a well-established course of action consisting of several steps that have to be taken in a certain order to accomplish a goal. In process control environments, which are addressed in the present investigations (cf. Empirical evidence 6), actions are regulated by so-called “Standard Operating Procedures” (SOPs). SOPs are predefined processes which are required either in routine situations or in non-routine, infrequent, but nevertheless normal situations (Kluge, 2014). In these situations, the SOPs are sufficient for task completion. If the situation is abnormal there are no SOPs which can be applied in the respective situation. Such abnormal situations have to be handled by knowledge-based rather than rule-based behaviour (Kluge, 2014).

Although procedures are, by their very definition, well established and usually applied in certain situations, the application of the *procedures* is not necessarily strictly prescribed. Some *procedures* are optional, while others may be recommended in certain situations, but there are also *procedures,* for example *safety procedures,* which are man-

datory or become a *rule* respectively. The safety-related rules which are investigated in the empirical section can be also described as prescribed safety procedures.
Decker (2005) describes the characteristics of *safety procedures* as resources of actions. He emphasizes that procedures entail a detailed course of action, but often do not include information about the circumstances in which the procedures should be applied. Therefore, the application of procedures is a cognitive activity which requires a certain skill level. Although *safety procedures* are prescribed to improve safety, sometimes these procedures even enhance the dangerousness of situations, because some (less skilled) people strictly comply with the procedure without questioning whether the procedure is suitable for the respective situation (Dekker, 2005). Accordingly, it cannot be assumed that safety is necessarily the result of compliance with the procedure; rather, it is the result of the insight into the determinants of the respective situation. To corroborate safety, it should be monitored and understood whether, when and why people comply with or violate procedures. Furthermore, the skills to recognise in which situations the procedures are suitable and in which they are not should be supported (Dekker, 2005).

3.1.5 Distinction between and common features of rule types

Although the previous sections did not include all conceivable rule types, the range which were presented in the current context make it clear that there are many rule types which differ according to various characteristics (for an overview of the definitions, cf. Table 1). The rule types can be differentiated based on their degree of obligation, their type and the extent of applied enforcement and sanctioning mechanisms. Moreover, they can be distinguished regarding their function and application context or regarding their degree of specification. The characteristic shared by all rule types is that they assign certain behaviour patterns to certain situations

This broad range of rule types shows that rules, and the compliance with or violation of rules, is a topic which is relevant in many different societal contexts and situations. Furthermore, it is clear that the different rule types are not independent, but are associated with each other. Although the present investigation addresses the topic of safety rules and the determinants of the compliance with or violation of these rules, other rule types and their definitions provide a valuable source of information in order to come closer to a holistic understanding of the characteristics of safety-related rules and their determinants.

Table 1. Rule types and their definitions

Term	Definition
Law	“[...] rules of conduct of a community that are recognized as binding by the community." (Gwinn et al., 1991, p. 200); enforced by a controlling authority
Social norms	“informal social regularities that individuals feel obligated to follow because of an internalized sense of duty, because of a fear of external non-legal sanctions, or both" (McAdams, 1997, p. 340)
Organisational rules	“part of the formal structure that constitutes and defines stable patterns of relationships and activities."; “the storage of organizational memory" (Zhou, 1993, p. 1137)
Safety rules	“[…] a defined state of a system or way of behaving in response to a predicted situation, established before the event and imposed upon those operating in the system, by themselves or others, as a way of improving safety or achieving a required level of safety" (Hale & Swuste, 1998, p. 164)
Procedure	Well-established course of action that consists of several steps, which have to be taken in a certain order to accomplish a goal (Gove, 1963).
Standard Operating Procedures (SOPs)	Predefined processes, which are required in process control environments in either routine, or normal but infrequent situations (Kluge, 2014).

4 Incidence and consequences of rule violations in organisations

Zeitlin (1994) assumed that a considerable amount of industrial accidents are attributable to the conscious decision to violate safety-related rules. Although, according to Mason (1997), the frequency of rule violations varies across different industries, he assumes that in certain industries, about 70% of all accidents are caused by the violation of rules. Mason supposes further that rule violations, and the accidents which are caused by them, account for enormous costs, such as damaged plants, compensation payments, lost production and poor quality of work. Since some of these impacts are not clearly associated with the accidents caused by the violation, he assumes that the management frequently does not consider the full cost implications of rule violations (Mason, 1997).

More recent evidence comes from Hobbs and Williamson (2002), Mascini (2005), Mendeloff and Gray (2005), Bell and Healy (2006) and Ko, Mendeloff and Gray (2010). Hobbs and Williamson (2002) found that rule violations account for about 18% of the variance of the reported safety-critical incidences in the aircraft maintenance sector. Bell and Healey (2006) also identified the violation of safety-related rules as factor, which contributes to major accidents in organisations and Mascini (2005) propose that man-made disasters are mostly due to the violation of rules. A positive correlation between rule compliance and safety is also found in the OSHA studies, which are concerned with the investigation of safety-critical incidences in manufacturing plants described by Ko, Mendeloff and Gray (2010) and Mendeloff and Gray (2005).

Considering that the frequencies of violations vary across different industries (Mason, 1997), the frequencies and costs of rule violations will be described separately for each industrial sector in the following section. Several investigations into the prevalence and costs of violations have been conducted in:

- the aviation (Helmreich, 2000; Hobbs & Williamson, 2002; Li & Baker, 1995; Rebok, Qiang, Baker, McCarthy, & Li, 2005) and aircraft sector (Cushing, 1994; Wenner & Drury, 2000),
- the surface transportation sector, such as railway (Evans, 2011; Free, 1994; Holmgren, 2005; Lawton, 1998), driving (Kontogiannis, Kossiavelou & Marmaras, 2002; Parker, West, Stradling, & Manstead, 1995; Parker, Reason, Manstead, & Stradling, 1995), or shipping (Chauvin, Lardjane, Morel, Clostermann, & Langard, 2013);

- and the healthcare sector (Alper et al., 2006; DeJoy, Searcy, Murphy, & Gershon, 2000; Dubbert, Dolce, Richter, Miller, & Chapman, 1990; Hersey & Martin, 1994; Horning & Smith, 1991; Nelsing, Nielsen, & Nielsen, 1997; Patterson, Rogers, Chapman, & Render, 2006).
- Furthermore, some investigations have been conducted in other industries, such as energy industry (Hudson & Verschuur, 1995; Mearns, Flin, Gordon, & Fleming, 2001; Reason, 1987; Smith, 2011, Verschuur, Hudson & Parker, 1996), mining (Laurence, 2005), or the manufacturing sector (Nyssen & Cote, 2010)

4.1.1 Aviation and Aircraft sector

Although the total amount of violations appears to be quite small, with 5.5 violations per million flight hours (Rebok et al., 2005), according to Rebok et al., their occurrence is a strong predictor of future crashes. The relatively small violation rate detected is due to the fact that Rebok et al.`s (2005) analysis is based on multiple data files compiled by the National Transportation Safety Board and the Federal Aviation Administration. These institutions are concerned with accident and incident investigation and have no possibility to acquire information about the rule-related behaviour of pilots which does not lead to incidents or accidents. It can be assumed that many safety-related rule violations are not detected and consequently not considered, because they do not spark an incident or accident.

Li and Baker (1995) also found a significant association between accident involvement and violation rates. They found that pilots who were involved in a crash were caught committing a violation in the first three years after their crash two to three times more often, than pilots of the control group who had not been involved in a crash. Accordingly, Li and Baker (1995) consider pilots who hold a violation record to be a “high-risk group” for future violations and crashes. Another investigation by Helmreich (2000), who used several data resources including the Line Operation Safety Audit (LOSA) data, revealed another interesting coherence: They found an association between violations and errors. A team that violated procedures was also 1.4 times more likely to commit errors.

Violations are associated not only with accidents during the flight but also with ground damages (Wenner & Drury, 2000) and quality incidents in the maintenance phase (Hobbs & Williamson, 2002). Wenner and Drury (2000) identified different hazard patterns accounting for the very cost-intensive ground damages, one of which describes problems with guidelines, a category in which violations can be also be subsumed: 8% of accidents

are caused by this hazard pattern. Hobbs and Williamson (2002) found a link between violations and the quality of maintenance, which affects the safety of an aircraft. They identified routine violations as the strongest predictor of incidents in the area of maintenance (Hobbs & Williamson, 2002).

4.1.2 Surface transportation sector (Railway, Driving, Shipping)

In the railway industry the analysis of accidents had led to the insight that violations are often relevant to the causation of accidents in shunting situations (Free, 1994; Lawton, 1998). Free (1994) collected data regarding the frequency of violations concerning different rules, and found that according to the shunters, a fixed portion of rules (15 %) were violated quite even though the riskiness of violating these rules was estimated to be quite high. Evans (2011) analysed the fatal train accidents in Europe between 1980 and 2009 and found that most serious level-crossing accidents are due to errors or violations by the road users. An investigation focusing on the examination of accidents in railway maintenance (Holmgren, 2005) found violations to be the second most frequent cause of accidents during maintenance execution.

Parker, Reason, Manstead and Stradling (1995) found that the tendency to violate a rule (questionnaire-based measure) is associated with accident involvement, while the tendency to commit an error is not related to the occurrence of accidents. Another investigation by Parker, West, Stradling and Manstead (1995) also demonstrated the association between violation and accident involvement; the authors even found that the tendency to disregard driving norms is associated with the severity of the accident. A more recent investigation by Kontogiannis et al. (2002) further corroborates the association between accidents and violations in the road traffic sector: The self-reported tendency to commit rule violations was found to be associated with accident liability and speeding convictions.

The analysis of the collision reports of 27 accidents which occurred between 1998 and 2012 in the shipping sector identified rule violations to be the cause of accidents in 3 % of cases (Chauvin et al., 2013).

4.1.3 Health care sector

In the healthcare sector, the violation of general precautions to prevent infections (DeJoy et al., 2000; Dubbert et al., 1990; Hersey & Martin, 1994; Horning & Smith, 1991; Nelsing et al., 1997) and the compliance with medication administration procedures (Alper et al., 2006; Patterson et al., 2006) have been investigated.

The evidence concerning the rate of rule violations of general precautions to prevent infections is quite inconsistent. Dubbert and colleagues (1990) investigated the hand-washing of nursing staff after critical procedures and found a violation rate of 30%, which could be reduced to about 8% through certain interventions. DeJoy et al. (2000) investigated not only hand-washing, but also the violation of other precaution rules. Their survey revealed similar findings concerning hand-washing, sharps disposal, use of gloves, waste disposal and handling of scalpels. These rules were violated in only 10% of cases. Other rules, such as needle recapping or eating and drinking in the work area, were found to be moderately violated (in 20-30% of cases). The use of eye shields or face masks are, for instance heavily violated (up to 50% of cases). The investigation by Nelsing et al. (1997) focused on the rule violation rate of doctors from different disciplines. The authors found that 65% of the physcians violated the basic principles of precautions (principles to avoid infections).

A study by Hersey and Martin (1994) included not only the patient care staff and the physicians but also the housekeeping staff in hospitals. Participants were asked to make estimates regarding the application of several precautions, such as wearing gloves when drawing blood, recapping used needles after giving injections, and using the disposal box. An average of 70% of the patient care staff violated these precautions occasionally, and 65% of the surveyed physicians occasionally violated the precautions. The housekeeping staff were asked to estimate their behaviour concerning the changing of gloves before going to another patient and hand-washing. 26% of them violated these precautions at least occasionally or even more frequently (all percentages were calculated on the basis of the data of Hersey & Martin, 1994). Overall it can be summarised that at least occasional violations of the precautions in place to prevent infections, seems to be quite commonplace in most hospitals.

Violations in hospitals concern not only general precautions, but also medical administration regulations. Alper et al. (2006) reported that nurses violated the protocol in medical administration in 8 – 30 % of routine situations. In emergency situations, even 32 % up to 53 % of nurses were found to violate the protocols. Due to the comparatively high percentage of nurses who violate protocols at least in emergency situations, the occurrence of medication errors was quite likely. In contrast to most other investigations, which are based on surveys and the voluntary disclosure of information, Patterson et al. (2006) acquired observational data. They observed the frequency of prescribed scanning of wristbands before giving the respective medication, and found that in acute care situations, the rule of scanning the wristband was violated in 53% of cases. In long-term care

situations, in which the patients are well known by the healthcare staff, the prescribed scanning rules were violated in 92% of cases.

It is possible to influence the awareness of and sensitivity to the topic of rule violations. Horning and Smith (1991) measured the frequency of violations before and after they introduced an educational program providing information about the topic of rule violation and encouraged the staff of the hospital to report observed violations using a newly implemented violation form. The frequency of reported violations increased from 15 (baseline measure before the program) to 197 reported violations per year (5 years after the implementation of the violation form).

4.1.4 Energy, mining and manufacturing sector

One very prominent example of the occurrence and extreme impact of rule violations is the nuclear disaster in Chernobyl in 1986. Reason (1987) analysed the sequence of events which led to the disastrous accident in the nuclear power plant. In accordance with Hollnagel and Sakuda (2010) who assume that 80-90% of industrial accidents in the nuclear power industry are due to human-related factors, Reason (1987) also found that the Chernobyl accident was caused by human behaviour, Reason even identified rule violation as the main cause: Overall, he found only two errors, but six violations which contributed to the disaster.

In the gas and offshore industry the occurrence of accidents like explosions, where many workers on the respective platform lose their lives, is a serious problem (cf. Mearns et al., 2001). Mearns et al. (2001) found that among other management failures, the violation of safety procedures contributed to these accidents. They also revealed that people who violated rules more often were more likely to be involved in near misses and accidents. A prominent example of a very disastrous accident in this sector, which was caused to some extent by the violation of several safety-related rules, is the Deepwater Horizon oil spill in 2005 in the Gulf of Mexico (Smith, 2011). The association between accidents and committed violations in the oil and gas sector is also emphasised by Verschuur et al. (1996) and Hudson and Verschuur (1995), who propose that many accidents within the Shell group were caused by safety-related rule violations.

The violation of rules also seems to be a great problem in the mining industry. According to Laurence (2005), more than 90 % of mineworkers expressed misgivings about safety rules and one third indicated not always complying with the prescribed rules. They also indicated that they are aware of the fact that other workers violate the rules and that the management is aware of these violations.

A study by Nyssen and Cote (2010) investigating the manufacturing of medication found that although violations occurred in only 3% of the total number of tasks, the tasks which were violated were done so in an average of 95% of cases.

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4.1.5 Conclusions regarding the incidence and possible consequences of rule violations in the different sectors

As the previous paragraphs demonstrated, there is a wide variance in the prevalence rates of rule violations and the amount of accidents which are caused by the violation of rules. The prevalence rates differ depending on the industrial sector or the method of measurement (questionnaire-based versus observation-based). Even in studies using the same method of measurement in the same industrial sectors, there are great differences regarding the ascertained amount of rule violations between different investigations. This is due to the large amount of rule types and situational and person-related factors, which promote or weaken people`s willingness to commit rule violations.

Although the prevalence rates of rule violations and estimates regarding the amount of accidents caused by rule violations differ between the investigations, an analysis of the literature nevertheless reveals that rule violations are a central problem in many industrial sectors. To address this problem it is necessary to develop a deep understanding of safety-related rule violations. Although investigations of rule violations have been carried out in different scientific communities and areas of practice, a holistic understanding of the concept of safety-related rule violations which integrates all of the information and knowledge gained from these studies is lacking. This holistic understanding can be achieved by considering different rule types (cf. Rule classification 3) and summarising the different theories and insights which have already been gained from different research perspectives (cf. Human Factors Perspective 5.1, Organisational and Industrial Psychology Perspective 5.2 and Decision-Making Perspective 5.3). Furthermore, it is deemed necessary to generate additional knowledge about the determinants of rule related behaviour by conducting further studies (cf. Empirical Evidence 6) and which integrate the insights into a knowledge base (cf. General discussion 7). This should generate an improved understanding of the processes determining rule-related behaviour and enable the development of more effective measures to reduce the amount of safety-related rule violations in organisations.

5 General Theory

In the following section, the concept of rule violation will be thematically integrated into the research areas “Human Factors”, “Industrial and Organisational Psychology” and “Decision Making”, and the relevant theories of each research area will be described in detail.

5.1 Human Factors Perspective

The topic of rule violations can be considered from different perspectives. The first and for the present investigation most relevant is the *Human Factors Perspective.* Human Factors research is concerned with the investigation of factors of the human-system interaction (Wickens et al., 2004). According to Wickens et al., the goals of *Human Factors* research are to enhance performance, user satisfaction and safety. *Human Factors* research investigates factors which influence these goal criteria and develops tools to support their achievement (Wickens et al., 2004). Although the violation of *safety-related rules* is quite common in the human system interaction of various industries and, moreover, is linked to the prevalence of accidents (cf. Incidence and consequences of violations in organisations, section 4), so far, this topic has received comparatively little attention from the *Human Factors* research community.

The description of the Human Factors perspective begins with the definition of *safety*. Then, the determinants of safety in organisations will be outlined and different measures of *safety management* in organisations, such as the implementation of *safety-related rules,* will be described. Following this, the different kinds of *rule-based behaviour,* which also include different types of rule violations, will be described, categorised and distinguished from each other. Finally, in the last paragraph different models, which are concerned with the determinants of rule violations will be described and discussed.

5.1.1 Safety

Safety is defined on a very general level as "a state or a place where people are not in danger or at risk.” (Walter, 2008). The Encyclopaedia Britannica differentiates between public and occupational safety, describing occupational safety as “concerned with risks encountered in areas where people work: offices, manufacturing plants, farms, construction sites, and commercial and retail facilities” (Gwinn et al., 1991). Although common *law* obligates organisations to provide *safe* workplaces for their employees, in many industrial sectors a certain level of accidents is unavoidable and publicly accepted (Wick-

ens et al., 2004). Although accidents cannot be prevented in all cases, most organisations in these sectors run certain risk and safety management programs in order to reduce the harms and losses in their organisation to a minimum (Reason, 2008). In particular, so-called *High Reliability Organisations* (Weick & Sutcliffe, 2003) have to undertake huge efforts in this regard. *High Reliability Organisations* are defined by Kluge, Sauer, Schüler and Burkolter (2009) as organisations which operate on an extremely high reliability level because technical malfunctions as well as action slips result in fatalities both for humankind and for environment. Due to the severity of accidents, the prevention of every single incident is especially important here.

5.1.2 Determinants of industrial safety

The analysis of major accidents supports the conclusion that most accidents are caused by a complex chain of technical malfunctions, individual misbehaviour and organisational failures (Bell & Healey, 2006). Consequently, for the development and implementation of effective safety management measures, different safety issues have to be addressed.

With regard to the *Human Factors Perspective,* the individual as well as the organisational failures are of interest. Hofmann, Jacobs and Landy (1995) differentiate in this regard between three levels of determinants: the *individual level*, the *micro-organisational level* and the *macro-organisational level*.

The *individual level* describes the “individual attributes that contribute to unsafe behaviour” (Hofmann et al., 1995, p. 132). These attributes include, for example, the attitude toward safety topics, the knowledge about the system in general as well as potentially hazardous behaviours of employees. The potentially hazardous behaviours are further divided by Hofmann et al. (1995) into two subtypes. The first subtype, routine short-cutting, describes a behaviour pattern in which certain steps of a procedure are generally skipped. This routine deviation already becomes an unofficial standard procedure. The second type refers to the violation of actually accepted rules, which are violated by only a few employees.

The *micro-organisational level* refers to an organisation’s approach to dealing with safety topics (Hofmann et al., 1995). According to Hofmann et al., this can consist of the connivance of hazardous situations as well as emphasising production goals over safety goals, but can also include targeted safety management efforts of an organisation. To enhance safety on this micro-organisational level, the management could make efforts to promote a positive attitude toward safety, change the work environment to reduce unsafe

behaviour, or introduce a regular and systematic analysis of safety-related problems which have occurred within the organisation (Hofmann et al., 1995).

The *macro-organisational level* (Hofmann et al., 1995) describes the influence of the organisational structure on industrial safety. According to Hofmann et al., the structure includes, for example, topics of the workforce organisation as well as the communication paths within organisations.

The *individual* as well as the *micro-organisational level* are especially relevant for the present investigation. The impact of certain aspects of both levels was systematically investigated. The individual level was mainly focused on the second section of the empirical evidence part (cf. 6.2), whereas the micro-organisational level of safety was considered in the other three investigations (cf. Empirical Evidence, 6.1, 6.3, 6.4). Nevertheless, the individual level variables were also considered in these investigations as covariates.

The next section will describe how these different levels can be addressed by safety management.

5.1.3 Safety management

All efforts of *safety management* are conducted to adhere to legal safety regulations (cf. *Law*: 3.1.1.). These regulations legally obligate organisations to provide a safe working environment for employees and to prevent the endangerment of the environment of the organisation. To achieve these goals, organisations implement *safety management* programs, which according to Wickens et al. (2004) should be performed following certain steps: 1) The hazards of the workplaces need to be analysed. 2) The hazards need to be identified and classified, and then 3) appropriate measures can be developed and implemented. Following implementation, 4) the effectiveness of the safety measures should be evaluated. The following section deals with the methods of risk analysis and the evaluation of safety program effectiveness, before presenting the different human factors-oriented *safety management* measures in the subsequent section.

According to Wickens et al. (2004), risk analysis includes the analysis of relevant documents, for example the analysis of previous incidents and accidents, and the acquisition of further data, for instance through interviews with the employees. Furthermore, it is recommended to collect data by making observations or conducting quantitative surveys (Wickens et al., 2004). The data serve on the one hand as a basis for choosing an adequate safety management measure, but on the other hand can be used for the pre-post comparison which should be conducted to evaluate the effectiveness of the measure

after the implementation. The effectiveness of the measures can, moreover, be determined by analysing objective data such as the amount of accidents or injuries (Wickens et al., 2004). In the following, the most common *safety management* measures are presented. To ensure a best possible effect of these measures, it is recommended to involve the executive management of the organisation in the different implementation processes of all these measures.

Safety promotion refers to measures which enhance a positive attitude toward safety issues and improve the motivation to engage in safe behaviour. This can be achieved by providing feedback on the frequency of safe behaviour or accident rates and by setting incentives for the achievement of certain safety goals (Wickens et al., 2004). The attitude toward safety can be further enhanced by carrying out certain activities which emphasise the importance of safety and possibly change negative attitudes toward this topic.

The *training* of employees as a safety measure includes a training which is especially focused on risk and safety topics. These training programs support a kind of collective mindfulness regarding safety issues (Reason, 2008). Deficiencies in safety performance, are according to Reason (1990), not only due to a lack of mindfulness to safety issues, but are also caused by a lack of competence. Therefore, the training of job-related issues which enhances the development of skills and expertise promotes industrial safety, as does risk or safety training.

The *prescription of safety-related rules* is one of the most common measures of safety management (cf. Dekker, 2005; Mol, 2003). Safety-related rules should be developed in close cooperation with the respective job holder (Reason, Parker, & Lawton, 1998). To prevent rule violations, it should be ensured that the rules are well defined and do not conflict with each other. Furthermore, the rules should be clearly prioritized according to their impact on safety (Battmann & Klumb, 1993). Besides a proper definition of the *safety-related rules,* it is highly recommended to regularly evaluate and if necessary revise *rules* (Wickens et al., 2004).

According to Wickens et al. (2004), the communication of the *safety-related rules* is also very important. The rules should be visible and generally accessible to all employees concerned. If there are many or quite complex rules it is recommended to conduct training sessions to introduce, refresh and test the retention of *safety-related rules* (Reason et al., 1998). Moreover, the organisation has to determine how the violation of *safety-related rules* should be audited and sanctioned (Wickens et al., 2004). Even if the rules are well defined and implemented, it will never be the case that all people comply with

rules. There will always be people who violate rules quite often or at least sometimes (Reason et al., 1998).

Audits are a necessary measure to reinforce rule compliance, but audits are very expensive (Power, 1997). To achieve the maximum impact with the minimum amount of audits, the timing of audits and the quality and extent of information which is revealed about the audit procedure should be carefully planned. To gain new insights into this topic with the aim of deriving recommendations for the optimal implementation of safety audits two studies were conducted. The respective studies will be described in the empirical evidence part: The effect of the accuracy of information about audit probabilities will be focused in the third section (cf. 6.3) and the effect of audit timing will be described in the fourth section (cf. 6.4).

5.1.4 Rule-based behaviour

In every situation that is regulated by *safety-related rules,* there are two behaviour patterns which can occur: Either the individual complies with the rule and acts in a safe manner, or the individual does not comply with the rule, or shows the so-called “unsafe act” (Reason, 1990). According to Reason, “unsafe acts” are defined as non-compliance with *safety-related rules* in a potentially risky situation. Although the observable *unsafe act* is always the same, the underlying causes of the unsafe act can be quite different.

Definition and categorisation of errors

If the unsafe act occurred unintentionally (*slips* and *lapses)* or due to false intention (mistakes), these behaviours are regarded as errors (cf. Figure 1, Reason, 1990). Reason (1990, cf. p. 9) defines the error term as a “[…] generic term to encompass all those occasions in which a planned sequence of mental or physical activities fails to achieve its intended outcome, and when these failures cannot be attributed to the intervention of some chance agency”. This can be either due to certain failures concerning the attention (slips), memory failures (lapses), or rule- or *knowledge-based mistakes* (cf. Figure 1). Reason (1990) describes *slips* and *lapses* as errors which occur due to failures during the retention or execution of actions. By contrast, he defines *mistakes* as attributable to failures in inferences concerning the selection of objectives or the choice of measures or actions to achieve the objectives.

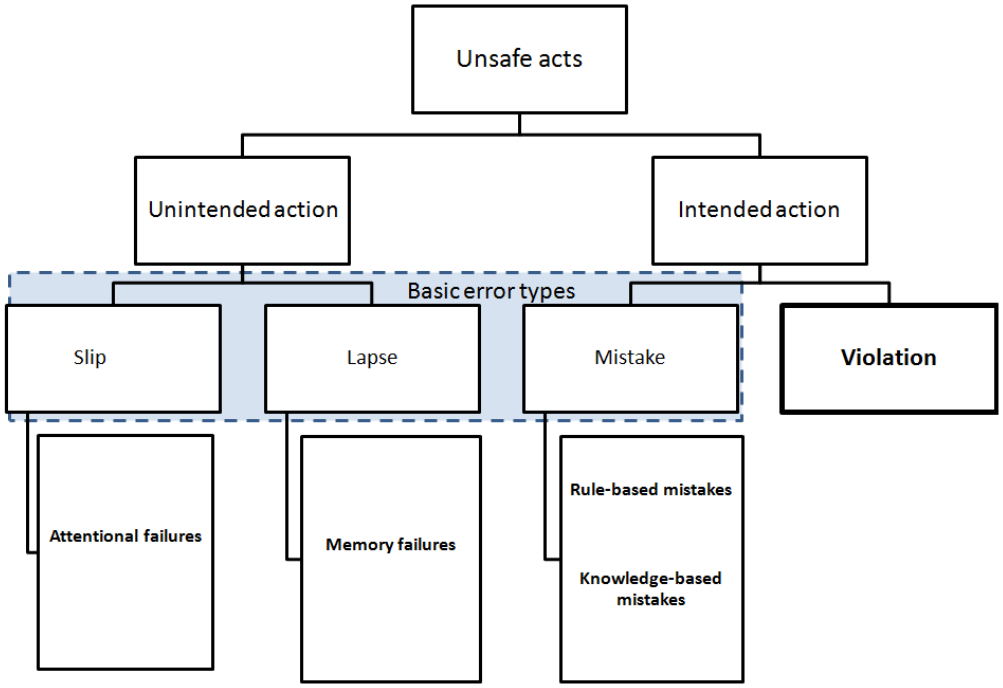

Figure 1. Depiction of different types of unsafe acts based on Reason (1990)

Reason (1990) also suggests allocating these error types to different cognitive stages of planned actions: the planning, retrieving and realisation of actions. *Mistakes* can occur during the planning phase, *lapses* during the retrieval phase, while slips occur during the realisation of the respective action sequences. Reason (1990) further suggests allocating the error types to different performance levels, which were originally described by Rasmussen (1982). Rasmussen distinguished between the *skill-based*, the *rule-based* and the *knowledge-based* levels of performance. Accordingly, in common situations, people take recourse to routine, mostly unconscious behaviour patterns. In these situations, people rely on their skills, and the performance on this level can therefore be considered as *skill-based*. Although the skill-based behaviour patterns are highly routine and often automated, during the retrieval and realisation of the routines, *slips* and *lapses* can occur. These failures can be categorized as *skill-based errors* (Reason, 1990).

In situations which are indeed familiar, but which are not the same every day, there are stored rules which help to determine the most appropriate behaviour for the respective situation (Rasmussen, 1982). *Errors* occur also on this *rule-based* performance level. According to Rasmussen, an example of a *rule-based error* is a wrong classification of situations and the subsequent application of wrong rules. These errors are classified by Reason (1990) as *rule-based mistakes*.

In highly uncommon situations, the properties of the situation must be carefully analysed and the priority of the different goals has to be considered before appropriate action sequences can be planed. This process depends strongly on the person`s knowledge (*knowledge-based performance level,* Rasmussen, 1982). Errors on this level are *knowledge-based* mistakes; they occur, for example, due to limited resources or a lack of knowledge (Reason, 1990).

Definition and categorisation of violations

The analysis of certain disasters, such as the Chernobyl nuclear power plant disaster, resulted in the insight that the error concept does not comprise all *unsafe acts* which lead to the respective disaster (Reason, 1990). There are *unsafe acts* which are not due to any kind of failure, but are the result of a deliberate decision to act in an unsafe manner. This kind of unsafe acts is labelled as *violation (cf.* Figure 1*)*. The *violation of safety-related rules* is defined by Lawton (1998, p. 78) as "[…] deliberate departures from rules that describe the safe or approved methods of performing a particular task or job."

Categorisation of violation

The concept of rule *violation* can be categorized further. If a rule is unintentionally violated, this behaviour is labelled as *unintentional* or *erroneous violation.* This type of violation mainly arises from a lack of understanding or from inexperience (cf. for example Lawton, 1998). Although some authors also subsume this behaviour under the construct of rule violations, according to the definition by Lawton which we assume here, this behaviour should be categorized as a *rule-based error* and not as a *violation*.

If a rule is deliberately violated, the *violation* can be committed due to different motivations. Reason (2008) differentiates between *malevolent violations/sabotage,* which were undertaken to damage the system, and n*on-malevolent violations,* which were not committed to harm an organisation. M*alevolent violations/sabotage* are related to the concept of *Counterproductive workplace behaviour* (cf. Counterproductive workplace behaviour 5.2.2), which is defined as behaviour that is contrary to the interests of the organisation (Sackett, 2002).

Although *malevolent violations* do also occur, most violations are not committed to harm an organisation (cf. for example Mason, 1997). The motivations for *non-malevolent violations* are quite different. According to Reason (2008), there are violations which were committed to demonstrate skills in handling difficult, risky situations (*optimizing violation*), or to arouse a thrilling experience (*thrill-seeking violation*). The *optimizing* or *thrill-seeking*

violations are defined by Reason as violations which are not due to functional aspects, but which optimise positive emotions during the rule violation. Examples are the violation of speed limits just for fun (*thrill-seeking violation*) or the violation of safety procedures to demonstrate a high skill level in presence of other people (*optimizing violation*). Reason (2008) states that these violation types are determined by demographic characteristics, such as gender or age (young people and men tend to perform this violation type more frequently than older people or woman).

Most non-malevolent violations are nevertheless not due to the thrill-seeking or optimizing motivation of people. Like errors, violations can also be categorized based on the different performance levels of Rasmussen (1982). According to Reason (2008), there are *skill-based*, *rule-based* and *knowledge-based violations* (cf. Table 2*)*. Besides this categorisation Reason (2008; 1990) also labels these different violation types according to their incidence. He describes *skill-based violations* also as *routine violations*; *rule-based violations* also as *situational* or *necessary violations;* and *knowledge-based violations* also as *exceptional violations* (cf. Table 2).

Skill-based (or routine) violations are highly habitual forms of corner cutting which occur very frequently and especially often if compliant behaviour is rarely rewarded, or violations are not often punished, respectively (Reason, 2008). Reason attributes *skill-based* or r*outine violations* to the general human tendency to choose the most comfortable, less effortful behaviour (Reason, 1990), and believes that they are also due to control illusions (Reason, 2008).

Illusions, or dangerous beliefs, are not only distinctive for routine rule violations; other violation types are also associated with certain illusions like the illusion of invulnerability, the feeling of being able to overcome every hazard, or the illusion of superiority, meaning on the one hand the conviction that one is especially skilled and on the other hand the belief that other people violate at least as frequently as oneself (Reason, 2008).

R*ule-based (situational or necessary) violations* are non routine behaviour patterns; each rule-based violation is deliberately elaborated and the rule is only violated if the benefits outweighed the costs (Reason, 2008). There are, according to Reason, certain factors which promote rule-based violations, for example the over-specification of situations by too many rules. If too many aspects of the situation are regulated, exceptional events can lead to situations in which the violation of a rule seems to be the only solution. The causes of these *necessary violations* are, besides over-specification, also deficient rules which do not fit the situation. Moreover, problems concerning the design of the workplace also lead to *necessary violations* (Reason, 2008).

Table 2. Types of non-malevolent violations (based on Reason, 2008; Reason, 1990)

Non-malevolent violations.		
"[…] deliberate but non-malevolent deviations from safety procedures, rules and regulations." (Reason, 2008, p. 49)		
categorisation according to performance level/ incidence		
Skill-based violation or routine violation	*Rule-based violations or situational/necessary violations*	*Knowledge-based violations or exceptional violations*
"These violations form part of a person`s repertoire of skilled or habitual actions" (Reason, 2008, p. 51); corner cutting (Reason, 2008); compliance rarely rewarded, violations rarely punished (Reason, 2008); "routine and optimizing violations are clearly linked to the attainment of personal goals […]" (Reason, 2008, p. 53)	"[…] are shaped by cost-benefit trade-offs, where the benefits are seen as outweighing the possible costs" (Reason, 2008, p. 54); "[…] violations can be provoked by regulatory and systemic over-specification of permitted actions." (Reason, 2008, p. 53); are more deliberate than skill-based violations (Reason, 2008) "[…] necessary violations have their origins in the deficiencies of the workplace and system. Initially, noncompliance is seen as essential in order to get the job done." (Reason, 2008, p. 54)	"[…]take place in novel atypical circumstances; For which there is unlikely to be any specific training or procedural guidance" (Reason, 2008, p. 54); ["…] involve the unexpected occurrence of rare but trained-for situation, or an unlikely combination of individual familiar circumstances" (Reason, 2008, p. 54-55); "[…] product of a wide variety of local conditions. " (Reason, 1990, p. 196)

Knowledge-based (or exceptional) violations occur in new or uncommon situations. The rule is violated because the compliant behaviour is not or insufficiently trained (Reason, 2008), meaning that people are unable to apply the prescribed behaviour. The

occurrence of *exceptional violations* is complex and depends on different situational influences (Reason, 1990).

The type of rule violations which is addressed by the present investigations is *non-malevolent skill-based routine violations*. This type of violation is the most common and is often also assumed to be the most harmless violation. However, the high frequency and the routinization of this behaviour pattern in fact make this violation type very hazardous. People become used to the risk which is associated with the rule violation and become increasingly convinced that the rule violation will not have any negative consequences. Therefore, people even often lack a sense of guilt when committing this type of rule violation. The high incidence and the lack problem awareness provide sound arguments for taking a closer look at this rule violation type and its determining factors.

5.1.5 Determinants of safety-related rule violations

The determinants of safety-related rule violations are very diverse. There are various models which deal with the description and explanation of (safety-related) rule violations. Although the models overlap in some respects, each model places their emphasis on different aspects. In the following, first, the *process-oriented* aspects of the models will be described, before different levels of rule violation determinants are then outlined. Several theories such as the theory about the *selectivity of rule violations* by Lehman and Ramanujam (2009) make assumptions about both the process and the level of determinants. Therefore, these theories will be part of both sections, but will be viewed in each section from different perspectives.

Process-oriented aspects of rule violation determination models

The theory about the *selectivity of rule violations* of Lehman and Ramanujam (2009), Lawton`s model of *factors promoting rule violations* (1998), as well as the theory of the *direct motivators and behaviour modifiers* of Mason (1997) provide information about the processes which determine the occurrence of rule violations. The *Integrated Model of Behavioural Prediction applied to Violations* (IMV, Kluge, 2010; Kluge, Badura, & Rietz, 2013) is also concerned with the process determinants of safety-related rule violations. Due to the decision-making focus of this theory the IMV will be described in the decision-making section (cf. paragraph 5.3.4).

Lehman and Ramanujam (2009) investigated rule violations in the organisational context and developed their theory about the *selectivity of rule violations*. In the theory, they assume that *rule characteristics, contextual conditions,* as well as interactions be-

tween these factors influence the *focus of attention* and the *risk perception*, which in turn determine the *likelihood that a certain rule will be violated* (cf. Figure 2).

Lehman and Ramanujam (2009) further assume in their theory that the decision to violate a rule is a decision which has to be made under risk. The aspects of risk taking and their impact on rule-related decisions will be addressed in the section focusing on decision making and risk taking (cf. paragraph 5.3.2).

The *rule characteristics* and *contextual conditions* which, according to Lehman and Ramanujam (2009), determine the focus of attention and perception of risk will be described in detail in the level theories section.

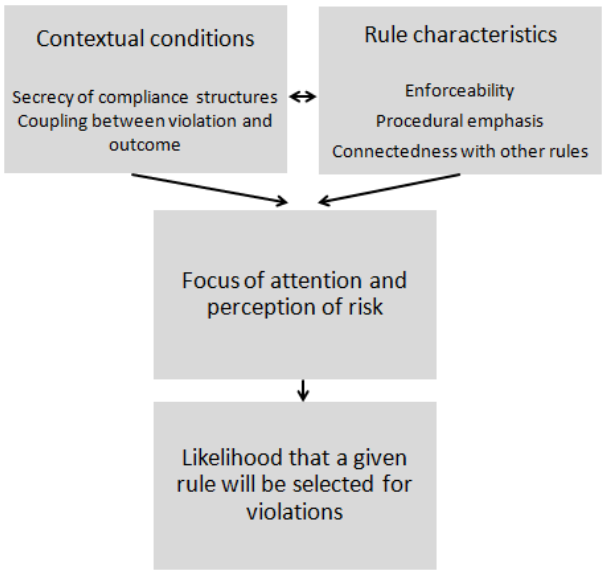

Figure 2. Selectivity in organisational rule violations, depiction based on a figure by Lehman and Ramanujam (2009)

Although, in her theory Lawton (1998) mainly describes certain f*actors promoting rule violations*, she also has a process-oriented focus, as she links the influencing factors with different violation types (cf. categorisation of rule violations 5.1.4). In her model, Lawton (1998) describes three violation routes in this regard:

(1) Violations which occur within the *knowledge route* are assumed to be due to a lack of knowledge about the rule. This lack of information is mostly attributable to organisational factors, meaning either defective rules, or poor training, monitoring or sanctioning mechanisms. The rule violation types which occur due to this *knowledge route* are mostly the unintentional or erroneous violations. Lawton (1998) describes this violation type as more dangerous than the intentional rule violations (like situational or routine violation), because people do not even know that they are violating

rules and it is therefore not possible for them to take at least some precautions during the rule violation. Since, based on our definition of rule violation (cf. definition and categorisation of rule violations 5.1.4), the unintentional violation of a rule is more an error rather than a violation, this route is not so relevant for an appropriate understanding of the rule violation process.

(2) The *situational route* describes the emergence of situational or exceptional violations. Rules are appropriate for most situations, but by their definition, rules lack flexibility. There might be new or exceptional situations in which a rule is not appropriate or even cannot be applied. Furthermore, there are many situational factors like staff shortage or high workload that promote so-called situational rule violations, which are committed getting the job done.

(3) The *attitudinal route* refers to rule violations which are committed because of a negative attitude toward the rule. This can be due to defective or obsolete rules, unfair sanctioning mechanisms, or the perception that the management is not committed to the respective rules. These factors affect the perception of the cost and benefits of rule violations, which in turn influences the decision for or against a rule violation. The *attitudinal route* can cause situational as well as routine violations.

Like Lawton (1998), who assumes that the perception of the costs and benefits of the violation influences the decision, Mason (1997) also describes the costs and benefits of an act as decisive. He described two levels of factors which determine rule-related decisions with different mechanisms of action, differentiating between direct costs and benefits of rule-violating behaviour (*direct motivators*) and indirect determinants (*behaviour modifiers*). *Direct motivators* for rule violations are, according to Mason (1997), that they usually make life easier, lead to financial gains and time savings, and can be a possibility to enhance self-esteem or demonstrate one`s skill level. Further *direct motivators* can be the perceived or real pressure to violate or comply with rules which is implicitly or explicitly exerted by colleagues or the management.

The *behaviour modifiers* exert no direct influence on the rule-related decisions, but indirectly increase or decrease the probability of a rule being violated (Mason, 1997). Mason provides the following examples of *behaviour modifiers*: deficits regarding the perception of safety risks, inadequate management practices, poor accountability, or ineffective disciplinary mechanisms or reward structures, respectively.

The assignment of the factors to the different levels *direct motivators* or *behaviour modifiers* is not always clear, because the levels are not mutually exclusive but rather overlap in some aspects (Mason, 1997). Moreover, Mason emphasised that the factors of

both influence levels and accordingly, the amount of rule violations are susceptible to managerial influences. The *direct motivators*, as well as the *behavioural modifiers,* describe the mechanisms of action of the determinants and not the source of influence, meaning that both the *motivators* and the *modifiers* can be found on all levels which will be described below in the level model section.

Mason`s (1997) assumptions regarding the impact of the *direct motivators* and *behaviour modifiers* are quite close to the assumptions of the rational decision-making theories (cf. Decision making under uncertainty, section 5.3.1). Mason assumes that the actual costs and benefits of a decision option *(direct motivators),* as well as the perception of the costs and benefits of the decision options *(behaviour modifiers)* influence which option is chosen.

Several other authors like Reason, Parker and Lawton (1998), Reason (2008) or Phipps et al. (2008) also assume that the decision to violate a rule is a decision which can be explained by the assumptions of rational decision-making theories. They propose that people will choose the option which is associated with a minimum level of cost and a maximum level of benefit. They assume that people will violate a rule if the perceived benefits exceed the potential costs of the violation (Reason, 2008). The probability of the costs and benefits is also considered in the rule-related decision. Whereas the benefits of rule violations are mostly quite small, but very immediate and likely, the costs by contrast, are mostly severe, but remote and unlikely (Reason, 2008).

The perceived benefits of rule violations described by Reason are almost congruent with the *direct motivators* of Mason (1997). Reason (2008) refers to the advantages regarding time and easiness, but also mentions the aspects of thrilling and macho demonstration which can be achieved by a rule violation. The perceived costs of rule violations are, according to Reason (2008), causing accidents, injuring of people, damaging property or losing the job. As these examples illustrated, the costs are indeed quite unlikely, but are also much more negative and serious than the benefits are positive.

Phipps et al. (2008) also explain rule violations by the endeavour of people to optimise the use of behavioural resources, and suppose that people violate rules when the existing rules are contrary to these efforts. In accordance with this assumption, Phipps et al. (2008) recommend the following measures to decrease rule violations: increasing the costs and decreasing the benefits of violations, and increasing the benefits and decreasing costs of rule compliance.

The impact of the processes of rational decision making will be also discussed from the decision-making perspective (cf. section on decision making under uncertainty 5.3.1).

Summing up the different aspects of the processes which determine rule violations, it can be stated that rule violations are determined by the attention focus and the risk perception, that different determinants lead to different rule violation types, and that the direct and indirect benefits and costs, respectively, are considered before rule violations are committed.

Level models

Hofmann, Jacobs and Landy (1995) already developed a level model for safety-related performance almost 20 years ago. Besides safety-related rule violations, the model also includes human error in general. They propose *individual, micro-organisational and macro-organisational impact factors* for safety performance-related indicators in High Reliability Organisations (HROs). Hofmann et al. (1995) assume that on the *individual level,* the attitude, e.g. the conviction that behaving safely is a sign of weakness, the behaviour, e.g. routinely cutting corners in procedures, and a lack of knowledge are factors which negatively affect safety performance.

On the *micro-organisational level* Hofmann et al. (1995) mention the following relevant impact factors: the safety-related self-regulation of the organisation, such as the organisational policy, which should promote the link between compliance and safety; and elements of the work environment and management activities, such as the emphasis that the most important thing is to get the job done no matter what, or the accurate formulation of job descriptions.

On the *macro-organisational level,* Hofmann et al. (1995) regard several characteristics of HROs as relevant determinants, for example the centralisation or decentralisation of certain decision-making processes, the vertical and horizontal communication procedures, or the redundancy of technology and management structures typical for HROs. If the centralized decision-making procedures are all agreed and decentralized decisions are also applied if the situation requires it, the information is continuously transmitted within and across different organisational levels, and the redundancy of technology-based and human-based decision-making procedures do not lead to a decrease in the personal responsibility for certain activities, this will contribute on the *macro-organisational level* to more safety in HROs (Hofmann et al., 1995). This level model of Hofmann et al. (1995) is already quite similar to the following level models, which do not consider safety-related

performance or the determinants of unsafe behaviour in general, but rather the determination of safety-related rule violation in particular.

The level models which are specially geared to the violation of safety-related rules include the *Macroergonomic Framework of safety violations* of Alper and Karsh (2009; cf. Figure 3), the *Behavioural Cause Model* of Verschuur et al. (1996), aspects of Lehman and Ramanujam`s (2009) theory about the s*electivity of rule violations* and further investigations and aspects of theories which make assumptions about the determinants of rule violations.

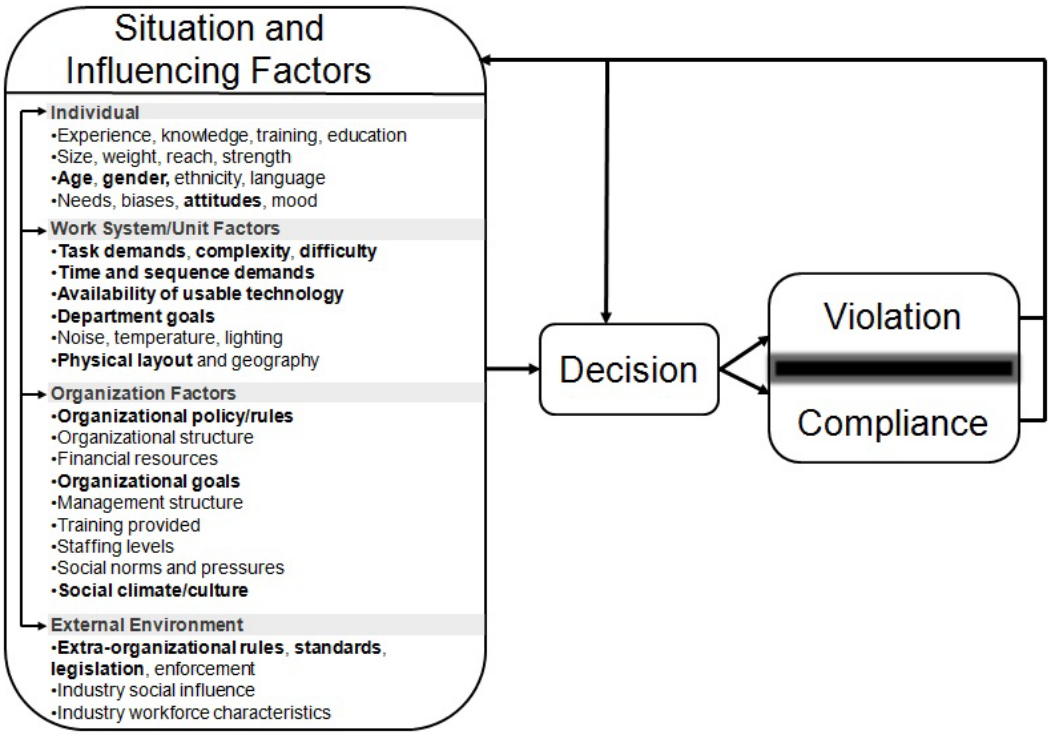

Figure 3. Alper and Karsh`s Macroergonomic framework of safety violations (depiction based on a figure by Alper and Karsh, 2009), bold variables are empirically validated)

Alper and Karsh (2009) conducted a systematic review of safety-related violations in industry and developed a *macroergonomic framework of safety violations* to summarise the influencing factors, which are or might be relevant for the decision to violate safety-related rules (cf. Figure 3). They considered 13 articles and found 57 variables to be significant predictors of safety-related rule violations. They categorize the predictors and describe four levels of influences: the i*ndividual level, the work system/situational level, the organisational level* and the *external environment level*. Each level includes variables which have already been experimentally validated (marked in bold in Figure 3) and variables which have not been investigated but are assumed to be relevant. The following

sections are based on the Macroergonomic framework of rule violations by Alper and Karsh (2009). All other determinants, which were described by various authors, are subordinated to the levels of Alper and Karsh (2009).

Individual level

On the *individual level* Alper and Karsh (2009) assume demographic variables, such as age, gender and ethnicity as well as a person`s *experience, knowledge, needs, biases*, or *attitudes* to be relevant.

Based on her investigation of rule violations in the area of railway shunting, Lawton (1998) proposes different levels of influencing factors, similar to Alper and Karsh (2009). One of the levels to which Lawton refers is the level of individual influences. The contents of Lawton`s (1998) individual differences level are largely the same as the *individual level* of Alper and Karsh`s Macroergonomic framework (2009). Besides the effect of *sex* and *age,* which were also mentioned by Alper and Karsh, Lawton mentions *sobriety, rigidity, pessimism and reserve* as associated with rule compliance*, whereas* she describes *aggression, excitability, impulsivity, optimism and* changeableness *as related* to rule violations.

Additionally, Reason (2008) described various individual factors as relevant for the determination of rule violations. As high-risk groups, he identified young men and people who were previously involved in an accident. Furthermore, Reason found (2008) that people who are less constrained by what others think, people who have a high opinion of their working skills, and people who are experienced and at the same time not error-prone are more likely to violate safety-related rules. Battmann and Klumb (1993) assume that experienced workers may think that they do not have to follow the procedures, because they are convinced that, in contrast to inexperienced workers, they have a “process feeling” which enables them to violate the procedures without any risk or with only very low risk. Furthermore, rule violations quickly become routine if they are rarely sanctioned or rarely lead to other negative consequences, while compliance with the rule is not associated with positive consequences (Reason, 1997). On the other hand, Molesworth, Tsang and Kehoe (2011) found that inexperienced pilots were more likely to engage in rule-violating behaviour and that simple rehearsal measures led to more rule compliance. Combining these results it can be assumed that a medium level of experience is most beneficial regarding the promotion of rule compliance.

A further influencing factor, which fits into the i*ndividual level* of Alper and Karsh`s (2009) framework is the *person`s beliefs*. According to Reason (2008), beliefs are quite relevant regarding the determination of rule violations. He investigated driving violations and found that rule violations are associated with several dangerous beliefs or illusions: the c*ontrol illusion*, the *illusion of invulnerability* and the *illusion of superiority*. People who have the *control illusion* feel powerful and overestimate their ability to control the situation; the *illusion of invulnerability* leads people to underestimate the probability of negative consequences of rule violations, and people with the *illusion of superiority* are convinced that they are more skilled than others. People with these illusions are more likely to violate rules than people without these illusionary beliefs. Beliefs are, moreover, an integral part of the Integrated Model of Behavioural Prediction applied to violations (Kluge, 2010; Kluge et al., 2013), which is described in paragraph 5.3.4.

On the *individual level*, a person's motivational background is also considered as relevant for the rule-related decision. If the violation satisfies personal goals, this is perceived as rewarding for the respective person, which will in turn reinforce the respective behaviour (Reason, 1997). According to Reason, the motivation for violations can be diverse. The motivation can be the effective use of resources (*routine violations, situational violations),* to manage the situation (*situational violation*), or to achieve a pleasant activation and emotional state (*thrill-seeking violation*). The motivation is determined through situational influences, but is also based on interpersonal differences. There are people who generally feel good violating rules, while others might even feel uncomfortable and guilty if they violate a rule even if the rule was not appropriate for the situation (Reason, 1997).

The *behavioural cause model* (described on the basis of Hudson, Verschuur, Parker, Lawton, & van der Graaf, 1998) proposes four major factors which determine the motivation to violate rules: (1) the *expectation*, (2) the *powerfulness,* (3) the *opportunity* and (4) the work *planning*. These four factors were found to explain 62 % of the variance in violating behaviour (Verschuur et al., 1996). In the following, the factors *expectation* and *powerfulness,* which belong to the *individual level,* will be described. The determinants *work planning* and *opportunity* will be described in the section regarding the *work system/situational level* and the *organisational level*. *Expectation* describes the conviction that rules have to be violated to get the job done. The higher the *expectation* that rule violations are necessary for accomplishing the task, the more likely the respective subject will be to violate the rule. *Powerfulness* describes the extent of the conviction that one has the abilities and the experience to accomplish the work task without strictly following

the procedure. This determinant is also positively associated with rule violations (Verschuur et. al., 1998).

Work system/situational level

According to Alper and Karsh (2009), the *work system level* includes several *work task characteristics, like task difficulty, time,* or *sequence demands*, the *availability of technology*, the *prescription of goals*, as well as *physical conditions* like the *noise level* and *lightning conditions* (cf. Figure 3).

Several factors of the *work system level* were also addressed by other authors investigating rule violations. For example, Lawton (1998) described that *time pressure* is conducive to the occurrence of rule violations. Moreover, Phipps et al. (2008) also describe *time pressure* and *design of equipment* as factors which influence both the occurrence of errors and the occurrence of rule violations.

An aspect which belongs to the *work system level* and which is of fairly central importance regarding the determination of rule violations is described by Battmann and Klumb (1993) as well as Reason, Lawton and Parker (1998). They assume that in the majority of the cases, rule violations are due to *conflicting goals* and *constraints*. According to Battmann and Klumb (1993), there are several constraints which are imposed on employees. These include external (for example organisational) and internal constraints, general constraints based on global rules, and local constraints which are only valid in certain areas. Since the different constraints often contradict each other (sometimes even the constraints on one level are contradictory, for example when different constraints of the organisation are in conflict), people have to decide which rule or constraint they want to comply with and which rule they have to violate.

According to Battman and Klumb (1993), the different rules/constraints and their outcomes are evaluated on different evaluation levels. For example, moral or material aspects are taken into account, and short-term and long-term outcomes are considered (cf. Decision making under uncertainty, paragraph 5.3.1). The different rules and constraints are ordered according to these criteria, and then the rule-related decisions are made in a hierarchical top-down process (Battmann & Klumb, 1993). A conflict which occurs very often in the organisational context is the conflict between performance- and safety-oriented goals (Reason et al., 1998). To make the decision situation in the experimental investigations (cf. Empirical Evidence paragraph 6) as realistic as possible, a conflict between safety and performance goals was simulated. First the participants were told that their compensation for participation would be based on their performance, and later

on they were also given certain safety instructions which were incompatible with their performance goals, meaning that they were forced to decide whether they wanted to achieve their safety goals or their performance goals (with the latter including a good remuneration).

The *behavioural cause model* (described on the basis of Hudson et al., 1998) also proposes works system/situational determinants. One of the factors proposed by the behavioural cause model is *work planning, which* describes the extent to which the respective work activity is scheduled and prepared. Inadequate planning and preparation enhance rule violations. Hudson et al. (1998) recommend supervision in order to coach people to improve their work planning skills.

Organisational level

According to Alper and Karsh (2009), influencing factors of the *organisational level* include the social climate, social norms and pressures as well as the *management structure* in an organisation. Additionally, the impact of *organisational policies*, the *financial state* and the *staffing level* of the organisation as well as the extent of *training* that is provided by the organisation are subsumed in the *organisational level* (Alper & Karsh, 2009).

Fogarty and McKeon (2006) investigated rule violations in the medical sector and found that a positive *organisational climate* was negatively correlated with rule violations in medication administration. The *organisational climate* was conceived by Fogarty and McKeon (2006) as positive if *supportive leadership* was practised, and the employees were *involved in decision making* and had the possibility to participate in professional *development measures*.

The determinant *opportunity* of the *behavioural cause model* (described on the basis of Hudson et al., 1998), is also subordinated to the organisational level. According to Hudson et al. (1998) the extent of perceived occasions to violate rules determines the amount of rule violations. The more *opportunities* for violations were perceived, the more likely people were to violate the rule. They suggest analysing the background of violations, investigating the violation potential of certain situations, and if necessary revising rules.

In her theory about factors promoting rule violation Lawton (1998), also describes certain organisational factors such as *staff shortages, supervisory pressure, equipment non-availability*, or *high workload*. All of these factors increase the pressure to violate rules in order to meet targets in the prescribed time period. Moreover, not only formally prescribed rules exist in an organisation; there are also rules which were developed and

enforced by the people who work in the organisation (Lawton, 1998). These *group norms* are used by the organisational members as a framework for actions within the respective organisation. Olson Grosshuesch, Schmidt, Gray and Wipfli (2009) provided evidence for the impact of *social norms* and *pressures*: They found that when role-models wore protective equipment, the number of people who did not wear the prescribed equipment decreased. A high frequency of rule violations can be due to *group norms* which conflict with the rules prescribed by the organisation. According to Lawton (1998), the organisation should corroborate norms which coincide with their rules, whereas conflicting *group norms* should be addressed by appropriate measures.

Although rules are considered on the *organisational level* in the Macroergonomic framework of Alper and Karsh (2009), the rule characteristics are not further specified and, moreover, do not assume a central position in their theory. The theory of the *selectivity of rule violations* (Lehman & Ramanujam, 2009) takes a closer look at the rule characteristics, the contextual conditions and the interaction between these factors.

Lehman and Ramanujam (2009) describe rules as constraints on people`s behaviour. The organisation prescribes the compliance with certain rules. Nevertheless, the organisation requires from its members not only this compliance with rules, but also the achievement of other organisational goals, such as the achievement of certain performance levels. Lehman and Ramanujam (2009) assume in this regard that people tend to violate rules if they are convinced that they are below the required aspiration level. This is congruent with the assumptions of the Prospect Theory by Kahnemann and Tversky (1979), which will be described in the section regarding decision making under uncertainty (cf. 5.3.1). Lehman and Ramanujam (2009) assume, moreover, that the decision to violate a rule depends on the consideration of the characteristics of that rule. As relevant rule characteristics, Lehman and Ramanujam (2009) considered the *enforceability of a rule*, the *procedural emphasis* and the *connectedness with other rules* (cf. Figure 2).

Lehman and Ramanujam (2009, p. 649) define the *enforceability* of a rule as “the extent to which regulatory agencies are able to monitor compliance with the rule and pursue justice for violations, as well as the extent to which such pursuit is likely to occur”. The *enforceability* of a rule is determined by the amount of audits and the magnitude of sanctions or fines which are prescribed if a rule violation is detected (Lehman & Ramanujam, 2009; Zhou, 1997). Also, the *supervision and punishment model,* which is based on the assumption that people are generally bad and lazy, assumes that rules are generally violated unless people are not forced into compliance by control and punishment measures (Hudson et al., 1998). The determinants control and punishment, which are pro-

posed in the *supervision and punishment model* explained 20 % of the behavioural variance regarding rule violations (Verschuur et al., 1996). The impact of audits, and in particular the impact of the accuracy of information about audit probabilities and the timing of audits on the occurrence of safety-related rule violations, is investigated in the studies described in the impact of audit probability section (cf. 6.3) and the section about the impact of audit timing (cf. 6.4).

The *procedural emphasis* is described by Lehman and Ramanujam (2009) as the extent to which the procedure and not the outcome is emphasised by the rule prescription. If the *procedural emphasis* is high, there is more ambiguity regarding the rule comprehension; therefore, people interpret the rules in such a way that they can legitimate the rule violations. If, by contrast, the procedural emphasis is low, there is no room for interpretation, therefore, rule violations are perceived as more risky and consequently these rules are violated less often.

The *connectedness* to other rules describes the extent to which a rule is linked to or interdependent with other rules and prescriptions (Lehman & Ramanujam, 2009). The authors assume that the higher the connectedness of a rule, the less likely it is that the rule will be violated. The connections between rules make the consequences of rule violations less controllable and the violation more risky, because other connected rules might be unintentionally affected by the violation.

The impact of rule characteristics on rule violations is also described by several other authors. Reason (1997; 2008) and Reason, Parker and Lawton (1998) assume that *clumsy, inappropriate* or *bad rules* and procedures increase the perceived benefits of rule violations, which in turn lead to more rule violations. According to Reason (1997) and Reason, Parker and Lawton (1998), the prescription of too many rules, which leads to so-called *procedural overspecification*, also increase the amount of (situational or necessary) rule violations. The *procedural overspecification* of situations, but also new exceptional situations which are not considered in the rule, can lead to a mismatch between the rule and the situation, making a rule violation necessary to get the job done (Reason, 1997; Reason, 1990; Reason & Hobbs, 2003). If these situations occur repeatedly, these originally situational or exceptionally committed violations can become routine violations (Reason, 1997).

Battmann and Klumb`s (1993) approach also considers the role of rule characteristics regarding the determination of rule violations. They assume that most violations can be explained by either *unclear* or *conflicting rules*, the *absence of standards to prioritise* between high- und low-level safety regulations, or finally, delayed or no feedback.

As these various outcomes of the influence of rule characteristics on the violation of rules shows, the content and formulation of rules has to be well conceived. Furthermore, the interplay between different rules and possible future situations should be regarded as far as possible. If a rule is violated very frequently and the goal is to reduce the amount of violation, one of the first priorities should be to review the rule characteristics.

The contextual conditions which are described by Lehman and Ramanujam (2009) are the *secrecy of compliance structures* and the *coupling between violations and outcomes*. The *secrecy of the compliance structures* refers to the extent to which organisations monitor and detect rule violations and how this is communicated to the organisational members. If the *structural secrecy* is high, the detection and control is concentrated in one organisational unit and only a small number of organisational members are informed about the monitoring, detection and regulation practices in the organisation (Lehman & Ramanujam, 2009). If the *secrecy of the compliance structures* is low, the monitoring activities are distributed to different units and the procedure is transparent for the organisational members. Lehman and Ramanujam (2009) found that a high secrecy of the compliance structures is associated with a high amount of rule violations.

The extent to which rule violations are monitored and detected varies according to the frequency with which audits are conducted and is also influenced by the amount of information which is revealed about the audit frequency. This aspect is addressed in the empirical part (cf. impact of audit probability, paragraph 6.3). The study described in this part focuses on the impact of the accuracy of information about audit probabilities on the occurrence of safety-related rule violations. On the basis of the theory of the *selectivity of rule violations* (Lehman & Ramanujam, 2009), it can be assumed that the higher the accuracy of information about audit probabilities, the less secret is the compliance structure, which in turn leads to a decrease in rule violations. If no information about the audit probabilities is supplied, this should result, by contrast, in a comparatively high amount of rule violations.

An example of possible interactions between *rule characteristics* and *contextual conditions*, which is mentioned by Lehman and Ramanujam (2009), is that the low *procedural emphasis* may facilitate the *enforceability of a rule*, because the low *procedural emphasis* makes the detection of rule violations easier. Conversely, rule characteristics can also influence contextual conditions, for example a high *interdependence of rules* leads to a low level of *compliance structure secrecy,* because the *interdependence of the rules* makes it difficult to concentrate the responsibility for rule compliance to only one unit.

A further determinant on *organisational level* is the o*rganisational culture*. The *organisational culture* is determined by organisational standards and objectives, which are implicitly or explicitly communicated to the organisational members (Lawton, 1998). As an example of influences of the *organisational culture,* Lawton refers to the quite common conflict between the performance- and safety-oriented goals of an organisation, which is also mentioned by Reason (1998) and Alper and Karsh (2009). In contrast to Lawton, Reason and Alper and Karsh assign the occurrence of goal conflicts to the *work system/situational level*.

According to Lawton (1998), three requirements have to be met by an organisation in order to support rule compliance. The first requirement refers to the rule quality: the rule should be accurate, comprehensible, user-friendly and should be updated and reviewed regularly. The second requirement is that people must be aware of the rule and the hazards which are risked if the rule is violated. This can be achieved by the proposition of regular training measures, which should be also used to introduce new rules and procedures. The last requirement which should be met by the organisation is the monitoring of rule-related behaviour and the fair and consistent sanctioning of rule violations in order to increase the costs of violating (Lawton, 1998). By implication, this means that bad rules, rules which are not known or rules which are not enforced by corresponding sanctioning mechanisms are factors which promote rule violations.

External environment level

The external environment level includes all exogenous influences on the organisation (Alper & Karsh, 2009). These influences can be legal regulations and governmental standards, as well as influences of the respective industrial sector (cf. Figure 3).

5.1.6 The Human Factors perspective – Conclusions

Human Factors research is associated with the continuous improvement of safety by focusing on the human contribution to safety in the man-machine-organisation interaction. The prevention of unsafe behaviour is in this regard one of the main research interests in this area. Whereas the topic of human error has been very central in the research community, the conscious decision to violate safety-related rules received comparatively little attention. Nevertheless, over the years, several Human Factors researchers have discovered the significance of this topic. They have identified different rule violation types and formulated models which describe different levels of factors determining rule violations. The previous section gave a summary of these research activities. To integrate the

various sources of information into one holistic understanding of the determinants and processes regarding safety-related rule violations, the *Process-Level Model of safety-related rule Violations* (PLMV) is developed by the author. The PLMV summarises on the one hand different levels of influencing factors, which are proposed by various authors and models, and on the other hand additionally considers the characteristics of the decision-making process and the determination of different rule violation types.

The PLMV (cf. Figure 4) is based on the findings of Alper and Karsh (2009) displayed in grey boxes, Lawton (1998) displayed in light blue elements (although this article is also considered by Alper and Karsh, it is nevertheless regarded secondly because different further aspects which have not yet been considered by Alper and Karsh are integrated), Parker Verschuur and Lawton (1996) displayed in light red, Reason, (1997; 2008), Reason, Parker and Lawton (1998), and Phipps et al. (2008) displayed in light orange, Lehman and Ramanujam (2009) in light ochre, Battmann and Klumb (1993) in yellow, and Mason (1997) displayed in light purple.

The levels proposed by the PLMV

The PLMV differentiates between three levels of influences on safety-related rule violations: the *individual level*, the *situational/organisational level* and the *external environment level*.

The *individual level* consists of the determinants by Alper and Karsh (cf. Figure 4), but is extended by the influential factors *expectation, powerfulness* (Verschuur et al., 1996)*, motivation* (Reason, 1997) and *beliefs/ illusions* (Reason, 2008).

The next level is the *situational/organisational level*. In contrast to Alper and Karsh (2009), who differentiate between four levels, the PLMV proposes only three levels. Since the assignment of certain determinants to either the work-system or the organisation level is difficult and does not make sense in many cases, these levels are summarized in the PLMV in one level. For example, the *time* or *task demands*, as well as the *department goals*, which are assigned by Alper and Karsh (2009) to the work-system/situational level are inextricably linked with the *organisational policy*, the o*rganisational culture* or the *social norms* in an organisation. This makes it difficult to assign, for example, *conflicting goals* to the *work-system/situational level* or the *organisational level*.

The *situational/organisational level* which is proposed by the PLMV consists of the determinants which are proposed by Alper and Karsh (2009) in the work-system/ situational and the organisational level. As further determinants, *work planning*, *opportunity*

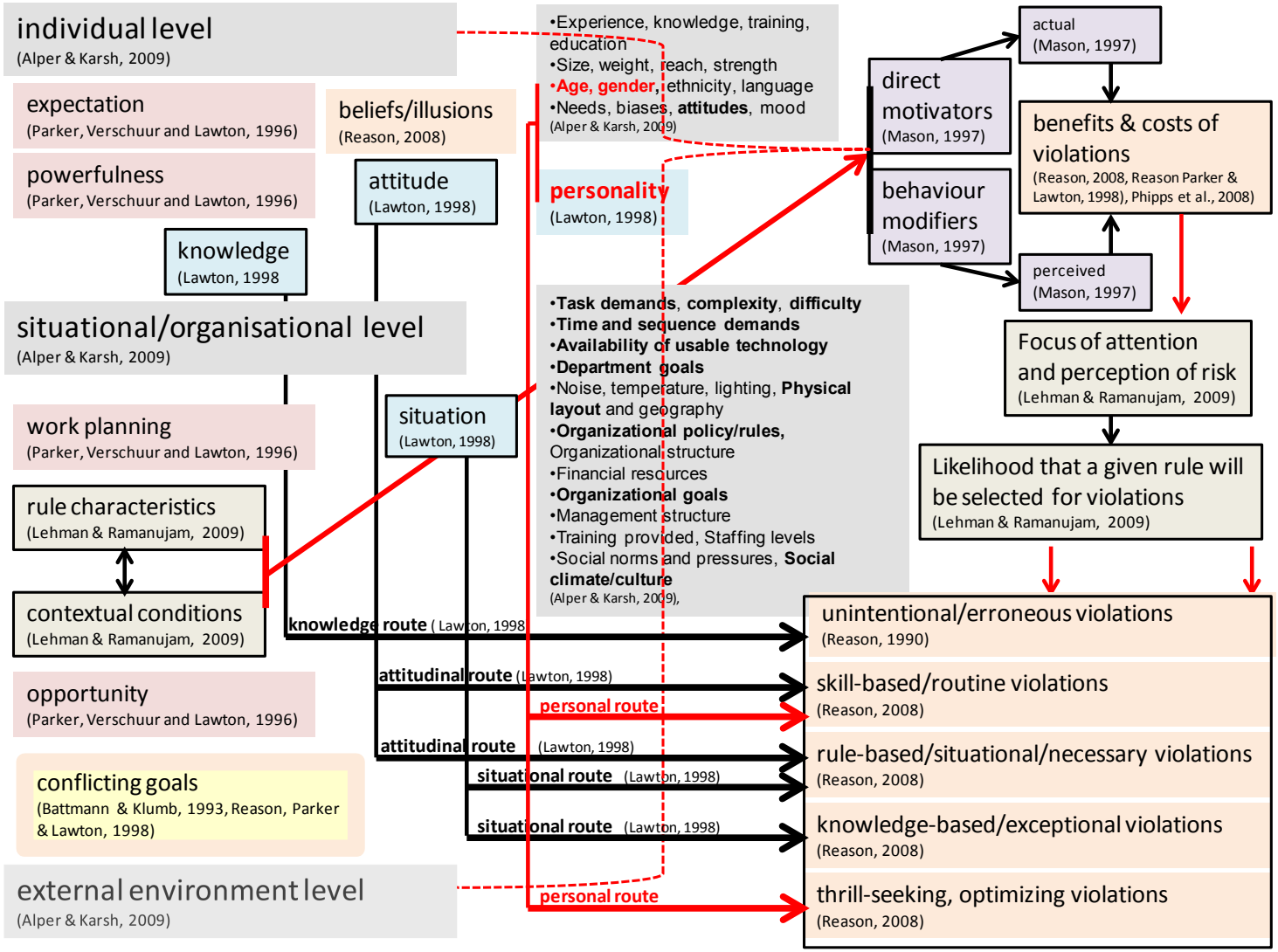

Figure 4. Process-Level Model of safety-related rule violations (PLMV)

(Verschuur et al., 1996), *rule characteristics*, *contextual conditions* (Lehman & Ramanujam, 2009) and *conflicting goals* (Battmann & Klumb, 1993; Reason et al., 1998) are regarded as relevant and were therefore added to this level.

The third level is the *external environment level*, which is also proposed by Alper and Karsh (2009). Although the external environment, such as the legislation or trends in the respective industrial sector, is relevant for the decision to violate a safety-related rule both as a direct and indirect influence, this level is usually not open to influence and is therefore regarded as a rather negligible source of influence. Therefore, this level is depicted in lighter font in the PLMV (cf. Figure 4).

The decision-making process proposed by the PLMV

The PLMV not only includes the definition of different influential levels, but also considers the processes which determine the occurrence of safety-related rule violations. All process aspects of the PLMV are marked by frames and arrows. The red elements are relations which are originally proposed by the PLMV.

The determinants *rule characteristics* and *contextual conditions,* which are assigned to the *situational/organisational level* are described by Lehman and Ramanujam (2009) as interdependent and interacting factors which influence the *likelihood that a rule will be selected for a violation* by influencing the *focus of attention and the perception of risk* (cf. Figure 4, light ochre elements). In the PLMV, it is assumed that the *rule characteristics* and the *contextual conditions* do not influence the *focus of attention and the perception of risk* directly. Rather, It is assumed that this influence is mediated by the *direct motivators* and *behavior modifiers* which are proposed by Mason (1997). The PLMV supposes further that not only the *rule characteristics* and the *contextual conditions,* but also the determinants of all levels, can be assigned to the category *direct motivators* or *behavior modifiers* (depicted by the large red bracket in the model). The differentiation between the *direct motivators* and the *behavior modifiers* is derived from the theory of Mason (1997), who assumes that every influential factor can be assigned to one of these categories. Whereas the *direct motivators* influence the *actual*, real *benefits* and *costs* of violations, the *behavior modifiers* influence the *perceived benefits* and *costs* (Mason, 1997). Both the *real and* the *perceived costs* and *benefits* are assumed to influence the amount of rule violations (proposed by Phipps et al., 2008; Reason et al., 1998; Reason, 2008) by determining the *focus of attention* and *perception* of *risk,* which in turn influence the *likelihood that a rule will be chosen for a violation.*

Although the observable behavioural response, the rule violation, is identical, the violations are caused by different sets of motivations. The categorisation of violations

depends on these different motivational backgrounds. The violation of rules can, for example, be unintentional and due to different error types (unintentional violation); they can be committed in order to harm an organisation (malevolent violation); they might be due to situational circumstances (situational violation); or they may be the result of a simple shortcut which was taken to make life easier (routine violation). In the PLMV, only the non-malevolent rule violations were considered, because it is assumed that these rule violation types are most relevant in the organisational context.

The connection between rule violations and rule violation types proposed by the PLMV

The different motivational backgrounds and violation types are closely connected to the determinants of rule violations. This becomes especially apparent in Lawton`s (1998) theory of *factors promoting rule violations*. In her theory, she describes different rule violation routes (cf. Figure 4, labelled arrows). Each route is characterised by different determinants, which lead to different rule violation types. For example, if people are not sufficiently informed about the rule, this will lead to unintentional/erroneous rule violations. If people have a negative attitude toward a rule, this can lead to skill-based/routine violations as well as rule-based/situational/necessary violations, and if there are situational aspects which lead to the rule violation, this violation can be assigned to the rule-based/situational/necessary violation or the knowledge-based/exceptional violation.

A further violation route is proposed in the PLMV. On the basis of the findings of Reason (2008), who describes that young males are more prone to violations, and in view of the assumption that certain personality traits are also associated with the violation of rules (cf. for example Lawton, 1998), the PLMV proposes the *personal route* (cf. Figure 4, red arrow). According to the *personal route* certain demographic variables such as age and gender as well as certain personality traits are associated with skill-based/routine violations as well as optimising and thrill-seeking violations. Both violation types are not triggered primarily by situational cues, but rather by habits and preferences which are assumed to be determined by demographic variables and personality traits.

Conclusions

The knowledge gained in the area of Human Factors research about the levels of determinants, the process and the types of rule violations is the first step in developing a holistic understanding of safety-related rule violations. The PLMV is a summary of the knowledge about rule violations gained in the area of Human Factors research and can be used as starting point for further investigations in this area. Furthermore, the PLMV

can be used as guideline for practitioners who want to reduce the level of rule violations in their organisation. In order to develop effective rule violation reduction or even better prevention measures, it is essential to understand the determinants and processes which lead to the rule violation in the specific situation. Moreover, the type of rule violation, which is committed in the respective situation, provides a valuable source of information which should be utilized. Prevention and reduction interventions can only be successful if they are specially geared to the causes of the respective rule violations.

Although the Human Factors research has made, and continues to make, major contributions to the understanding of safety-related rule violations, the view of the rule violation concept is rather restricted to evidence from their community. Rule violations are also investigated in other areas of research. To broaden and gain inspiration and new insights into the understanding of safety-related rule violations, the next paragraphs deal with the topic of rule violations from the perspectives of Industrial and Organisational Psychology and Decision Making.

5.2 Industrial and Organisational Psychology Perspective

Up to this point the topic of rule violations has been considered only from the *Human Factors perspective,* but the violation of rules is investigated in other areas as well, such as the field of industrial and organisational psychology. Industrial and organisational psychology is defined by Muchinsky (2006, p. 3) as "an area of scientific study and professional practice that addresses psychological concepts and principles in the work world". In this area, rule violations are investigated and discussed under the heading of *deviant behaviour*, *dysfunctional behaviour* or *misbehaviour* in organisations, as well as under the most commonly investigated *counterproductive workplace behaviour* (CWB). Whereas these terms are general and very broad concepts, there are further concepts which describe certain subtypes of these behaviour patterns (such as *organisational retaliation behaviour* or *mobbing)*. Although there is quite a lot research activity concerning the investigation of these phenomena, the different areas are not well interconnected (cf. Ones, 2002). The following sections should close the gap between the *Human Factors* and the *Organisational Psychology Perspective* by connecting the organisational concepts with the concept of safety-related rule violations, which is commonly used in the area of Human Factors research.

The following section begins by defining the general terms *deviant behaviour*, *dysfunctional behaviour* and *misbehaviour* in organisations. By comparing the different concepts with each other common features as well as inconsistencies among the terms will be described. As the next general term, the concept of *counterproductive workplace behaviour (CWB)* will be considered. Since this concept is the most popular and most investigated concept in the organisational psychology community, it will be described in greater detail. Moreover, its prevalence and measurement will be outlined, and finally, the determinants and relevance of the construct and the relation to rule violations will be discussed.

Besides the general terms, there are many other terms which are associated with the area of counterproductive workplace behaviour or rule violations in organisations. In the final section, the terms which describe different behaviour-oriented categories, such as theft or misuse of information, and certain subtypes of CWB, such as *organisational retaliation behaviour* or *workplace incivility,* will be defined. Finally, suggestions for the further classification of the behaviour-oriented categories will be described and discussed with regard to their relation to safety-related rule violations.

5.2.1 Deviant behaviour, dysfunctional behaviour /misbehaviour in organisations

Deviant behaviour, *employee deviance,* or *workplace deviance* are different terms for the same concept, which according to Robinson and Bennett (1995, p. 556) is defined "[…] as voluntary behaviour that violates significant organizational norms and in so doing threatens the well-being of an organization, its members, or both" The authors further describe the norms as "dominant administrative coalitions of organizations rather than the norms of work groups or subcultures" (Robinson & Bennett, 1995, p. 556).

Dysfunctional behaviour in organisations is defined by Griffin, O`Leary-Kelly and Collins (1998, p. 19) as "[…] motivated behaviour by an employee or group of employees that has negative consequences for an individual within the organization, a group of individuals within the organization, and/or the organization itself." In contrast to the definition of *dysfunctional behaviour in organisations* the definition of *workplace deviance* includes the violation of norms. All other aspects are the same in both definitions: both behaviour patterns are motivated and/or voluntary, meaning not unintentionally, and both are defined by their consequences, which are negative or threatening for individuals in an organisation or for the organisation as a whole.

Misbehaviour in organisations is, according to Vardi and Wiener (1996, p. 151), defined as "[…] any intentional action by members of organizations that violates core organizational and/or societal norms" Like the definition of *deviant* and *dysfunctional behaviour,* the definition of *misbehaviour in organisations* also includes the aspect of intentionality; like the definition of *deviant behaviour,* it also emphasises the aspect of norm violations. In contrast to the other constructs, *misbehaviour in organisations* is not defined by the negative consequences of the behaviour.

5.2.2 Counterproductive workplace behaviour (CWB)

The concept of CWB can be seen as a special concept insofar as it has received more scientific attention than the other concepts of deviant behaviour in organisations. Some authors (cf. for example Gruys & Sackett, 2003) even use the term CWB as generic term for all concepts which describe any form of deviant behaviour in the work context, meaning the more general terms which were already described above, as well as the subtypes which will be described below.

Sacket and DeVore (2001, p. 145) define CWB as "[…] any intentional behaviour on the part of an organization member viewed by the organization as contrary to its le-

gitimate interests." Marcus and Schuler (2004) refine this definition, describing three criteria which have to be met for behaviour to be categorized as CWB. They describe CWB as a *volitional act,* which has to be at least *potentially harmful* and has to be due to, but is *not* allowed to outweigh, other legitimate interests. The violation of safety-related rules meets all these criteria and can therefore be considered as a subtype of CWB.

The estimated incidence of CWB differs between studies and depends strongly on the type of occupation (blue vs. white collar worker) and the cultural background of the employees. Whereas some authors estimated that 33 - 75% of all employees sometimes engage in CWB (Harper, 1990), the investigation of white collar workers in Turkey revealed that about 13% of all employees engaged in CWB at some time (Bayram, Gursakal, & Bilgel, 2009), while another study showed that 44% of Chinese production workers showed CWB (Peng, 2012). As these quite high prevalence rates of CWB already suggest, the costs which are attributable to this behaviour are substantial (cf. for example Hogan & Hogan, 1989). Murphy (1993) even estimated that the annual organisational costs of CWB lie anywhere between 6 and 200 billion US dollars.

As the level of CWB and the associated costs are high, organisations are interested in reducing this behaviour (which also includes safety-related rule violations as a subtype of CWB).

To come closer to a holistic understanding of CWB (or safety-related rule violations, respectively), it is useful to understand the process which determines its occurrence. The *Paradigm for Counterproductive Behaviour* (Martinko, Gundlach, & Douglas, 2002, cf. Figure 5) offers a valuable framework in this regard. The paradigm draws a distinction between *Situational Variables* and *Individual Differences* which affect the *Cognitive Processing,* which in turn determines the CWB. Martinko et al. used the *Paradigm for Counterproductive Behaviour* as a framework to categorise the results of the investigated variables of all papers considered in their review. Based on this model, in the following, first the *Individual Differences* will be discussed under the heading *Person-related predictors of CWB*. The *Situational Variables* are described in the paragraph entitled *Situation-related predictors of CWB*. Since safety-related rule violations are considered as a subtype of CWB, the paradigm and the identified predictors might also be relevant for elucidating the processes which determine the compliance with safety-related rules.

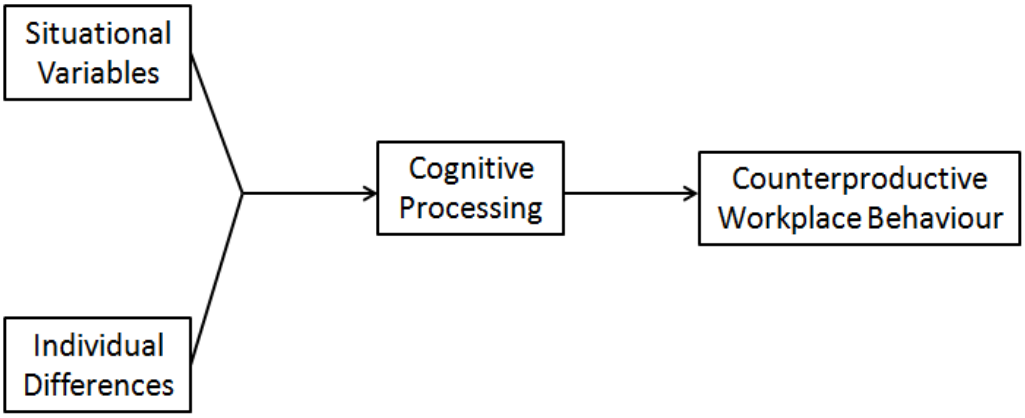

Figure 5. Simplified illustration of the "Paradigm for Counterproductive Behaviour" based on Martinko et al. (2002)

Person-related predictors of CWB

According to the review by Martinko et al. (2002), CWB is associated with sex (males engage more in CWB than females), locus of control (the external locus of control is associated with CWB), attribution style (the 'pessimistic' attribution style is positively related to CWB), core self-evaluations (self-esteem is negatively associated with CWB), negative affectivity (negative affectivity is positively related to CWB) and integrity (integrity is negatively related to CWB).

Integrity tests are explicitly developed to predict CWB, usually in the context of personnel selection. The test development is not based on theoretical considerations, but is criterion-oriented, meaning that the items are selected on the basis of their predictive validity instead of their theoretical background (Marcus, Ashton, & Lee, 2013). As a consequence, integrity tests have no theoretical foundation. They often consist of a mixture of measurements of different constructs like conscientiousness, reliability and honesty (Hakstian, Farrell, & Tweed, 2002). This procedure of criterion-oriented test development nevertheless guarantees a good quality of integrity as predictor of CWB (cf. for example Goldberg, Grenier, Guion, Sechrest, & Wing, 1991; Ones, Viswesvaran, & Schmidt, 1993), but the interpretation of the test results are difficult (Marcus et al., 2013). Other disadvantages are the obvious purpose of the test and the resulting susceptibility to manipulation. However, *integrity* is the most frequent construct used by organisations to predict CWB.

Although integrity tests are still the most common method of CWB prediction, researchers have also considered other personality traits, such as the Big Five (cf. for example Gonzalez-Mulé, DeGeest, & Mount, 2013; Hakstian et al., 2002). Hakstian et al.

(2002) found negative correlations of conscientiousness and agreeableness with CWB and a positive correlation between extraversion and CWB. Gonzales et al. (2013) considered not only the classic Big Five, but also the traits *morality* and *dutifulness,* which are theoretically located between agreeableness and conscientiousness. Gonzales et al. (2013) define *morality* as respect for authorities, following of rules and harmony preference, whereas *dutifulness* describes people`s tendency to behave well and to be thoughtful. Both *morality,* and *dutifulness* were identified as important predictors of CWB. The benefit of these CWB predictors compared to integrity tests lies in their inconspicuousness, which makes the manipulation of these personality tests at least less likely.

As a subtype of CWB, it can be assumed that safety-related rule violations are determined by person-related factors as well. Hence, there is a necessity to identify person-related predictors of safety-related rule violations. In the section about the impact of the goods at stake (cf. 6.1) risky decision making (measured by the GDT cf. Brand, Labudda, & Markowitsch, 2006) and conscientiousness (measured by the Mini-Markers of Saucier, 1994) were used as person-related predictors, but turned out not to be related to safety-related rule violations. The studies described in the impact of personality section (cf. 6.2) were conducted to identify other personality predictors of safety-related rule violations. In this regard, several concepts of undesired behaviour, like employee deviance, antisocial behaviour, lying behaviour, and imprudent and criminal behaviour were considered with regard to their associations with personality traits.

Situation-related predictors of CWB

The review by Martinko et al. (2002) revealed in addition to the person-related variables, several situational variables which influence CWB. Organisational constraints like inflexible organisational policies or rules, leadership style, wages, audits and punitive measures are only a few examples of the situational variables which were identified as influential concerning the determination of CWB (Martinko et al., 2002). Since safety-related rule violations are considered as a subtype of CWB it can be assumed that the violation of safety-related rules is determined by similar organisational factors.

The impact of certain situational variables on safety-related rule violations (and potentially also of CWB) will be addressed by the empirical investigations in sections 6.1, 6.3, and 6.4. In these investigations, the impact of the framing of the hourly wage as gain or loss was addressed. In the goods at stake study (cf. 6.1), it was additionally investigated how social norms influence safety-related rule violations. In the audit probability study (cf. 6.3), different accuracy levels of information about audit probabilities were in-

vestigated, whereas in the audit timing study (cf. 6.4), the impact of the timing of the audit was examined.

Since it is assumed that there are similar situational factors determining both safety-related rule violations and CWB, research into CWB should investigate whether the effects described in the empirical evidence part can be replicated for other CWB patterns besides safety-related rule violations.

5.2.3 Subtypes of undesired behaviour in organisations

The review of the literature on the construct of CWB, used here as a general term to undesired behaviour in organisations, resulted in a long list of behaviour patterns. Gruys and Sacket (2003) classify these patterns into eleven categories which range from theft and destruction of property, to misuse of information, time or resources, to unsafe behaviour, poor work quality, substance abuse and inappropriate verbal and physical actions.

In addition to these behavioural based categories, there are even more terms which are used to describe different subtypes of CWB, such as: *organisational retaliation behaviour, workplace aggression, mobbing, organisational delinquency, social undermining, workplace incivility* and *emotional abuse* (Nerdinger, 2008; O'Leary-Kelly, Duffy, & Griffin, 2000). Some of these terms are defined by their motivational background; for instance the *organisational retaliation behaviour* is defined by Skarlicki and Folger (1997, p. 435) as “[...] subset of such negative behaviors, those used to punish the organization and its representatives in response to perceived unfairness […]”. Other behaviour describes certain well-defined subtypes of CWB such as *mobbing* (cf. Zapf & Einarsen, 2005) or *emotional abuse* (cf. Keashley & Harvey, 2005).

Furthermore, there are terms which are used to describe a certain intensity of CWB, such as *workplace incivility,* which Pearson, Andersson and Porath (2005, p. 179) define as “[...] low intensity deviant (rude, discourteous) behavior with ambiguous intent to harm the target in violation of workplace norms for mutual respect". The term *organisational delinquency,* in contrast, describes more severe and criminal behaviour patterns such as theft, substance abuse, excessive absences, malingering, and equipment damage.

Hollinger and Clark (1982) propose a categorisation of CWB patterns into two broad categories: *property deviance* and *production deviance*. They suggest that all subtypes of CWB, from theft to inappropriate physical actions, can be assigned to one of these categories. *Property deviance* is described as “[...] instances where employees

acquire or damage the tangible property or assets of the work organization without authorization" (Hollinger & Clark, 1982, p. 333), whereas *production deviance* describes "[...] behaviors which violate the formally prescribed norms delineating the minimal quality and quantity of work to be accomplished" (Hollinger & Clark, 1982, p. 333-334). The violation of safety-related rules, as it is investigated in the present investigation, refers to behaviour which can be categorised as *production deviance*.

5.2.4 The Industrial and Organisational Psychology Perspective – Conclusions

As the previous sections have illustrated, in the area of organisational psychology, a large number of terms and concepts circulate regarding deviant, counterproductive or rule-violating behaviour in organisations. Although there are already some attempts to describe the interrelation between these concepts (cf. for example Nerdinger, 2008; O'Leary-Kelly et al., 2000), there remains a lack of conceptual clarity concerning the different terms and the transferability of the research results between these concepts. A valuable step in this direction is the comprehension of CWB as a general term for all deviant behaviour patterns in organisations (Gruys & Sackett, 2003; Martinko et al., 2002). This aggregation enables a systematic consideration of many empirical investigations into different but similar concepts in order to gain a consistent understanding of the determination of these counterproductive behaviour patterns, as was undertaken by Martinko et al. (2002). Although a great deal of work remains to be done in terms of summarising the different findings regarding counterproductive behaviour in the area of Organisational Psychology, the first step in this regard has already been taken.

The consolidation of the research results regarding rule violations from different disciplines like the Human Factors area, the Organisational Psychology area or the area of Decision Making is yet to be undertaken. As Ones (2002) noted, there is practically no exchange and communication between the different areas investigating CWB, or as a Human Factors researcher would call it, *safety-relevant rule violations*. The current investigation should close this gap by providing ideas about possible correlations between the concepts from the different areas. The results of industrial and organisational psychology research on different CWB behaviour patterns and personality traits are used to derive new predictors of *safety-related rule violations* (cf. Impact of Personality, section 6.2). Furthermore, this investigation should encourage the researcher from different areas to see the bigger picture and to also consider the findings from other research areas in which this type of behaviour is investigated. If the different perspectives are combined,

this should lead to a “truer” conception of this behaviour, and should prevent the research efforts investigating similar questions in different areas from being wasted.

5.3 Decision-Making Perspective

The *Human Factors Perspective* (cf. section 5.1) as well as the *Organisational Psychology Perspective* (cf. section 5.2) consider the topic of safety-related rule violations in a practical tangible context, in which either the consequences of the violations for (industrial) safety or the achievement of organisational goals are taken into account. This topic can also be seen in a more process-oriented context. The *Decision-Making Perspective* considers rule violations in relation to their process characteristics. The decision-making situation regarding the violation of rules is seen as decision making under uncertainty, therefore, first of all, the most relevant theories in this area, are described (cf. Decision making under uncertainty, section 5.3.1). The decision to violate a safety-related rule is, moreover, a risk-taking decision (cf. Decision making and risk taking, section 5.3.2), which is often committed in an organisational context (cf. Decision making in organisations, section 5.3.3). The final section is initially concerned with models which explain and predict the decision-making process and the emergence of certain behaviour tendencies on a general level. These models are ultimately integrated and applied to the decision-making process concerning the violation of safety-related rules (cf. Decision making regarding rule violations, 5.3.4*)*.

Finally, the different theories and their impact on the understanding of the decision-making process regarding safety-related rule violations are discussed (cf. The Decision-Making Perspective – Conclusions, section 5.3.5).

5.3.1 Decision making under uncertainty

Most decisions are made under uncertainty; important decisions which are well thought out, such as the decision to change job, as well as everyday decisions which are made very quickly, such as the decision to cross the road when the lights are red. All such decisions have to be made under uncertainty, and the decision maker has to take into account different options. It has to be considered which consequences are associated with each respective option, and it has to be estimated how desirable and how probable these different consequences are. Since these decisions are determined by expectations as well as evaluations, the decision-making theories are referred to as *expectancy (value) theories*.

The expectancy theories can be assigned to two different theoretical approaches. The normative or rational decision-making theories (cf. for example Keeney & Raiffa, 1976; March, 1994; Von Neumann & Morgenstern, 1972; Wilkinson & Klaes, 2008) assume that the decision-making process is determined by consequential and preference-

based procedures. It is assumed that the decision maker performs certain steps to come to a decision: first, all possible actions are considered, second the expectations regarding the consequences of the actions and the likelihood of the consequences are considered, and finally, a preference regarding the different actions, and the consequences associated with them, is developed (March, 1994).

The empirical investigation of the rational decision-making theories showed that some decisions could not be explained by the assumptions of these theories. The inconsistencies between theory and reality led to the development of new, more descriptively oriented theories such as Prospect Theory (Kahneman & Tversky, 1984). In the following, two rational decision-making theories are described. Following this, the descriptive decision making will be addressed by outlining of the most popular concept, the prospect theory, which also plays an important role in the empirical part of the present investigation (cf. Empirical Evidence, section 6).

Rational decision making

There are plenty of theories which describe decision making as a rational process. In the following, only the Expected Utility Theory (EUT, Von Neumann & Morgenstern, 1972) and the Expectancy Theory (Vroom, 1964) are described. The EUT was chosen because this theory represents the historical origin of the rational choice theories; all theories which followed refer to this theory and describe their theories in differentiation to the EUT. Whereas the EUT is a mathematically oriented theory, which was developed by a mathematician and an economist, the Expectancy Theory (Vroom, 1964) is more psychologically oriented. The Expectancy Theory was developed by the business psychologist V. H. Vroom and is one of the most popular motivation theories in psychology. Vroom`s theory bridges the gap between mathematical and psychological theory construction by combining a short simple mathematical formula consisting of terms which are not only mathematically defined but are also based on a precise psychological understanding of the involved processes and terms. In the following paragraph, first, the Expected Utility Theory (Von Neumann & Morgenstern, 1972) will be outlined, and subsequently, the Expectancy Theory of Vroom (1964) will be described.

The Expected Utility Theory (EUT). In 1947, Neumann and Morgenstern formulated the axioms of the Expected Utility Theory (described in Von Neumann & Morgenstern, 1972). They assume that the decision-making process is determined through the evaluation of the consequences of choices and their associated probabilities, which are

called expected utilities (defined here according to Wilkinson & Klaes, 2008). Neumann and Morgenstern (1972) assume that the expected utility is determined by the following axioms:

1. Completeness: describes the assumption that each consequence can be assigned to a preference level, which can be described by numerical values, these values can be ordered, so that the consequences (or utilities) can be sequenced according to their preference value, for example from the least preferred consequence to the most preferred consequence
2. Transitivity: if certain preference values (of consequences) are known, the relation between the remaining consequences can be concluded, if for example the consequence a) is evaluated as more preferable than consequence b), and consequence b) is less preferable than consequence c), than it can be concluded that consequence c) is more preferable than consequence a)
3. Continuity: if certain consequences are highly preferred, but are at the same time very unlikely, the value of this choice decreases, whereas the choice, of consequences which are not that preferred but are very likely increases in value
4. Independence: the preferability of choices (determined by the preference value and the possibility of the consequence) is not influenced by the combination with choices which refer to other decision situations

If the option with the greatest expected utility is determined according to these axioms, this option will be chosen and realised. Although the EUT is a very influential theory which had an enormous impact on subsequent theories, there is extensive empirical evidence contradicting the assumptions of the EUT (cf. for example Schmook, Bendrien, Frey, & Wänke, 2002).

The Expectancy Theory. The Expectancy Theory (Vroom, 1964) is a motivation theory which predicts the force/motivation to perform a certain act on the basis of psychological events which occur contemporaneously with the resulting behaviour. The motivation regarding the realisation of a certain act can be determined by a function of the strength of the *expectancy* and the *valence* and the consequences of the outcome. The term *valence* refers to an “affective orientation toward particular outcomes” (Vroom, 1964, p. 15) and is similar to the preference term used in other theories (for example in the EUT). The term valence as it is used in Vroom`s formula is not only defined by the affec-

tive orientation toward the outcome and the outcome consequences, but also takes into account the instrumentality with which the outcome leads to the respective consequences (Vroom, 1964). According to Vroom, the term *expectation* describes the degree to which a person believes that the achievement of the outcome is probable through the respective act.

Although the Expectancy Theory is assigned to the rational decision-making theories, the psychologically oriented definition of both the terms *valence* and the *expectation* implies that the processes are not completely due to rational deliberations. Rather, they are based on subjective estimations which are susceptible to several cognitive biases (Tversky & Kahneman, 1974). These effects cannot be explained by the rational decision-making theories, because they assume that the decision-making process is completely determined by rational cost-benefit calculations (cf. for example Keeney & Raiffa, 1976). These shortcomings are addressed by the descriptively oriented decision-making theories, and especially by the most prominent and successful of these theories, the Prospect Theory (Kahneman & Tversky, 1979), which is described in the next paragraph.

Descriptive decision making

As the rational decision-making theories are unable to predict and explain several decisions, Kahnemann and Tversky proposed (1979) the Prospect Theory, which is a descriptive decision-making theory that has been widely accepted and frequently investigated (Schmook et al., 2002). Kahnemann and Tversky (1979, p. 263) define a *prospect* as “a contract that yields outcome with probability". As in the rational decision-making theories, it is assumed that decision options or *prospects* are mainly evaluated on the basis of their outcome as well as their probability characteristics. But the Prospect Theory assumes, in contrast to these theories, that the evaluation of the prospects is not linear and includes several exceptions. In the following, first the conception of the decision-making process in the prospect theory will be described, before finally, the differences between the rational and descriptive decision-making theories are discussed.

The Prospect Theory. In the Prospect Theory of Kahnemann and Tversky (1979), it is assumed that there are two phases of decision making: the editing phase and the evaluation phase. The editing phase includes five steps: the information is (1) coded, (2) combined, (3) segregated, and some aspects of the prospect are furthermore (4) cancelled and (5) simplified. In contrast to the rational decision-making theories, the coding (1) is not determined by absolute conditions and values, it is based on comparisons between the outcomes and a certain reference point. This implies that people do not per-

ceive their state on an objective level, but evaluate the outcome in comparison to a previous situation or an expectation as gain or loss. This perception can be influenced by the description of the prospects.

The next step in the editing phase is the combination of information (2), which means that different probabilities that are associated with identical outcomes are combined into one general possibility (Kahneman & Tversky, 1979). In the segregation step (3), the prospects which consist of risky as well as risk-free components, are segregated. The components with sure outcomes are segregated from the components in which there is only a certain possibility that the outcomes can be achieved. In the cancellation step, (4) the components which are equal between the prospects are ignored, and only the components which differ between the prospects will be regarded. The simplification step (5) concerns the simple upward and downward adjusting of probabilities. After the information has been edited according to these steps, each prospect is considered in the evaluation phase.

According to Kahnemann and Tversky`s (1979) assumptions, the evaluation phase is determined by the attributes of certain value functions. The basis of these functions is the relation to a certain reference point, which is determined by expectations and situational influences like the prospect description. The outcomes of prospects are evaluated on the basis of deviations from this certain reference point. The value function is different for loss and gain perceptions: The value function of gain is concave, and less steep than the function of loss, which is convex (cf. Figure 6). Loss looms larger than

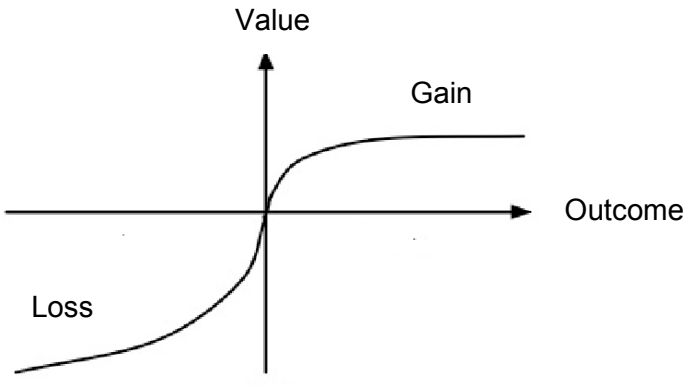

Figure 6. Hypothetical value function of Prospect Theory; depiction based on Kahnemann and Tversky (1979)

gain, meaning that if, for example, a certain amount of money is lost, the aggravation is higher than the pleasure if the same amount of money is gained. This can be transferred to the presentation of certain prospects: If a prospect with objectively the same value is displayed as loss, this should be perceived as comparatively more unpleasant and should be avoided more strongly than if the same prospect is merely presented as gain. Since people wish to avoid the loss situation, they are content to engage in more risky behaviour to have a chance of preventing this experience. However, if the same outcome is displayed as gain, people try to retain the situation by preferring more risk-averse decision options.

Comparison between rational and descriptive decision making

The descriptive decision-making theories, like the Prospect Theory (Kahneman & Tversky, 1979), capture the contradictions which arose during the empirical validation of the rational decision-making theories and consider and explain these effects.

The first example, in which the rational decision-making theories fall short, because the prospect with the highest expected utility is not chosen, concerns situations in which the choice has to be made between prospects where a positive outcome is possible but very unlikely. According to the Prospect Theory, in these situations, most people tend to choose the prospect which is associated with the larger gain, disregarding the exact probabilities of the prospects (Kahneman & Tversky, 1979).

In contrast to the rational decision-making theories, which assume that the pure value of outcomes is considered, Kahnemann and Tversky (1979) assumed in their Prospect Theory that people's decisions are not only influenced by the value of outcomes. As already described in the evaluation section, if outcomes are displayed as gains, people decide in a more risk-averse manner and choose the prospect which is associated with comparatively less outcome value, but with higher outcome probability. If the same outcome is described as possible loss, people tend to be more risk-seeking, choosing the prospect which is associated with maximal outcome values and accepting less high outcome probabilities.

Whereas the rationally oriented theories propose that every aspect will be appreciated equally, the Prospect Theory assume that decision makers try to minimize their cognitive workload during the decision-making process by focusing on the aspects of the prospects which distinguish between the decision alternatives and ignoring those aspects which the prospects have in common (Kahneman & Tversky, 1979).

The rational choice theories represent the historical origin and foundation of a proper understanding of the Prospect Theory, which is most relevant for the present investigation (cf. Empirical Evidence 6.1, 6.3, and 6.4). In these studies, it was investigated whether the framing of the production outcome and salary as gain or loss influences the decision to violate a safety-related rule. Participants were brought into a goal conflict between a good salary on the one hand and safety on the other hand, under the assumption that if the production goals and the salary are framed as loss, the participants would prefer the more risky choice of a rule violation in order to at least have a chance of avoiding the loss situation. If the production goal and the salary are, however, displayed as gain, people should tend to choose the safe option of rule compliance.

5.3.2 Decision making and risk taking

The violation of (safety-related) rules is associated with certain risks, which are considered during the decision-making process. In this regard, it seems to be worthwhile to outline the theoretical background regarding the decision making of risk taking. In the following, first, the term risk taking will be defined, and subsequently, the determinants of risk taking and risk acceptance, respectively, will be described.

According to Trimpop (1994, p. 9), risk taking is defined as “any consciously, or non consciously controlled behavior with a perceived uncertainty about its outcome, and/or about its possible benefits or costs for the physical, economic or psycho-social well-being of oneself or others." In contrast to the definition of rule violations (cf. Rule-based behaviour, section 5.1.4), the risk-taking decision is not by definition a conscious decision, but the decision has to be made under uncertainty and should have an impact on the well-being of oneself or other people.

There are several factors which determine the decision-making process regarding risk taking. There are neurocognitive processes, certain cognitive biases, and person-related, situational and social influences. Since the decision to violate a safety-related rule is a risk-taking decision, the following determinants of risk taking are also relevant regarding the determination of safety-related rule violations.

Neurocognitive processes of decision making under risk

Brand, Labudda and Markowitsch (2006) proposed a model which describes the neurocognitive processes that determine risk-taking decisions (cf. Figure 7). Brand et al. (2006) assume that the prefrontal cortex and the structures which are summarized under the term “frontostriatal loops” are relevant neurological structures that are involved in risk-

taking decisions. These structures are associated with executive functions that seem to be relevant in the decision-making process of risk taking. Brand et al. (2006) assume further that the neurotransmitters dopamine and serotonin modulate the risk-related decision-making processes on the neurochemical level.

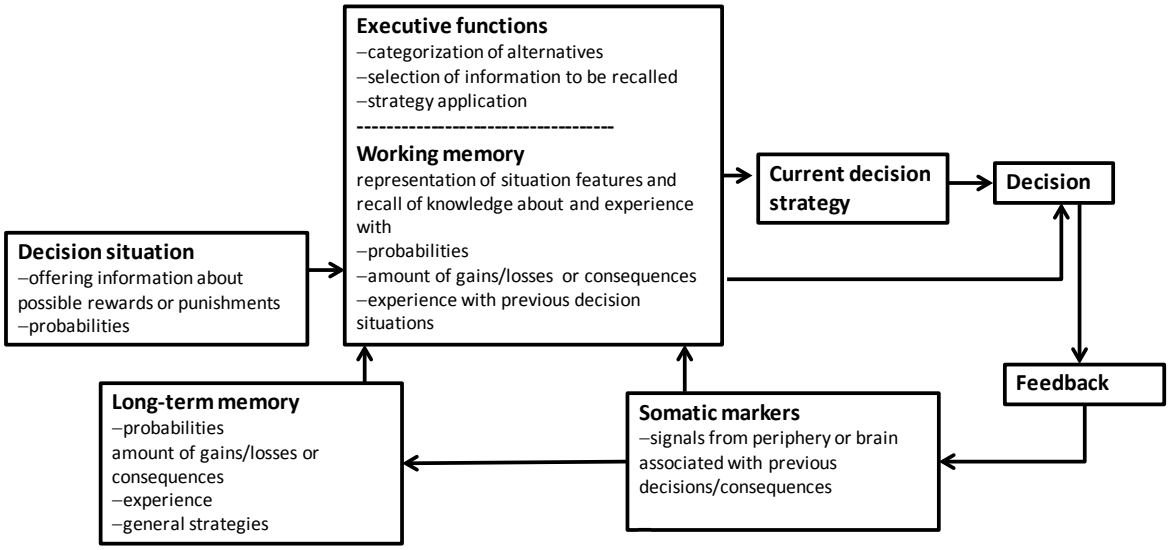

Figure 7. Brand`s model of decision making under risk, depiction based on Brand, et al., (2006)

Brand et al. (2006) propose the following neurocognitive processes in their model: first several aspects of the decision situation, like the outcome probabilities, or the amount and probability of rewards and punishments, are analysed in the working memory. This analysis is regulated by the categorisation and selection processes of the *executive function* (located in the prefrontal cortex and frontostriatal loop). Additionally, relevant information which is stored in l*ong-term memory* is retrieved. In *working memory,* this information is combined to generate an appropriate *decision strategy* for the current situation ("rational route"). The *decision strategy* determines the *decision*, which is in turn associated with either positive or negative *feedback* (like the gain or loss of certain resources). In the next step, the *feedback* leads to associations between emotional states and physiological signals (which thereby become *somatic markers)*. These *somatic markers* influence future decision-making processes on the "emotional route". On the emotional route, decisions are made without rational considerations only on the basis of certain physiological signals (somatic markers). These trigger emotional states, which in turn determine the choice of *decision strategies* and consequently the *decision.* Accord-

ing to Brand et al. (2006), overall there are three routes of decision making: The decision can be made on the basis of rational considerations, on the basis of emotional states (triggered by somatic markers) or by a mix of the two. Brand et al. (2006) assume that the integration of emotional and rational information will lead to superior decisions and performance compared to the processing on only one of the informational "routes".

Due to the fact that the decision to violate a safety-related rule is also a decision which has to be made under risk, it can be assumed that the processes described by Brand et al. (2006) can be transferred to this decision-making process, i.e. that the decision to violate a rule is controlled by similar neurological structures and neurochemical and psychological processes.

Cognitive biases and risk taking

In the following, certain biases of risk taking (Yates & Stone, 1992) will be described. First, on a general level, not all biases of risk taking will be described, but only those biases which are considered as relevant in the decision-making process of rule violations. Following this, the relationship with and application to rule-related decisions will be outlined.

Value bias: If a certain event and its outcome are strongly desired and the event does not occur particularly rarely, people tend to overestimate the likelihood of success and underestimate the risk of failure (Yates & Stone, 1992). Transferring the *value bias* to a rule-related decision would mean that the desire to achieve a certain benefit by violating a rule will lead to an overestimation of the likelihood that the rule-violating behaviour will succeed, or an underestimation of the risks associated with the violation, respectively.

The *personal role bias* refers to the overconfidence in one`s own abilities (Yates & Stone, 1992). According to Trimpop (1994), there is one personal role bias which is especially relevant with respect to the evaluation of risks: The belief that the risks of the situation can be controlled (illusion of control) leads to the underestimation of these risks. In particular, routine rule violations (cf. section 5.1.4), which are investigated in the empirical section (cf. section 6) occur due to the illusion that the risks associated with the violation can be controlled (Reason, 2008). This control illusion belittles the dangerousness of these violations and leads to a lack of guilty conscience and the normalisation of these rule violations.

Mood effects: People in a depressive mood overestimate the probability of failure in risk situations (Yates & Stone, 1992). In the decision-making process regarding rule violations, failure probabilities have to be considered as well; therefore, it can be assumed that the tendency to violate a rule is also influenced by a person`s mood. People

who are in a negative or depressive mood should be more likely to show rule-compliant behaviour (because the risk of failure is overestimated), whereas people who are in a good mood should decide comparatively more often to violate a rule.

Level effects: The wording of the task description or question can lead to different estimates of risks (Yates & Stone, 1992). The formulation of information about the risks which are associated with rule violations should influence how the risks are perceived and evaluated. This refers, for example, to the framing effect, which was already described in the scope of the Prospect Theory (Kahneman & Tversky, 1979, cf. section 5.3.1) and is investigated in the empirical studies described in the sections 6.1, 6.3, and 6.4.

The person-related determinants of risk taking

The individual differences regarding risk taking are also referred to as *risk propensity*, which is defined as "[...] the tendency of a decision maker either to take or to avoid risks" (Sitkin & Pablo, 1992, p. 12). A person`s *risk propensity* can be measured by assessing all risk-related decisions across different situations and times (Nicholson, Soane, Fenton-O'Creevy, & Willman, 2005). Nicholson et al. (2005) investigated *risk propensity* and found that there are people who are generally more risk-averse, while others are more risk-seeking. A third group turned out to differ in their *risk propensity* in different areas (cf. Motives of risk taking, section below).

What are the determinants of *risk propensity*? Several researchers, such as Trimpop (1994), assume that the *risk propensity* is determined by evolution. He argues that the skill to choose the optimal amount of risk is a very valuable advantage in the fight for the survival of the fittest. In order to acquire resources for oneself and one`s own descendants, it is necessary to run risks. People who are successful in this regard will survive longer, will have more descendants, and their genetic code will spread in the long term. However, if the risk is too high, the person will possibly die even before reproduction (Trimpop, 1994).The optimal risk level is not always the same, and also differs from person to person; the person`s own abilities and environmental influences have to be estimated (Buss, 1988). Trimpop (1994) assumes in his evolutionary approach that risk-taking behaviour is regulated on a physiological level: Choosing the optimal risk level is rewarded with a pleasant level of activation and positive emotional experiences, which are triggered by certain neurological processes. If risky situations are mastered, this again leads to positive emotions due to the pleasant arousal, the experience of control and the achievement of the objectives (Trimpop, 1994). Considering these different rein-

forcement mechanisms, the determination of risk taking can be described as controlled by physiological, as well as emotional and cognitive influences (Brand, et al. 2006, Trimpop, 1994).

A theory which also proposes that individual differences in *risk propensity* are due to physiological differences is the theory of *sensation seeking (Zuckerman, 1979)*. *Sensation seeking* is defined as the "need for varied, novel, and complex sensations and experiences and the willingness to take physical and social risks for the sake of such experiences" (Zuckerman, 1979, p. 10). Zuckerman assumes further that people differ regarding their sensation seeking because they have varying dispositional arousal levels. All people feel comfortable at a medium level of arousal. He assumes that depending on their dispositional arousal level, people prefer different extents of risks to achieve the pleasant medium level. People who have a low dispositional arousal level are sensation seekers, meaning that they are willing to run risks to achieve a medium level. People who have a high dispositional arousal level tend to avoid risks, because they have already achieved their preferred arousal level. Lauriola, Panno, Levin and Lejuez (2013) investigated the correlation between risk taking and sensation seeking and found in their meta-analysis a small to moderate association between sensation seeking and risk-taking behaviour.

Lauriola et al. (2013) also found a small correlation between impulsivity and the occurrence of risky behaviours. Besides *sensation seeking* and *impulsivity* sex is also associated with risk taking (Nicholson et al., 2005). In the questionnaire-based investigation by Nicholson et al. (2005), it was found that men reported more risk-taking behaviour. This effect of sex was also found in several investigations regarding rule violations, indicating that men violate rules significantly more often than woman (Reason, 2008). Nicholson et al. (2005) also investigated the correlation between self-reported risk taking and the Big Five, and found that high extraversion and openness were positively related to the tendency to run risks, and neuroticism, agreeableness and conscientiousness were negatively related to the tendency to run risks.

Summing up the person-related influences on risk taking, Trimpop (1994) concluded that person-related factors admittedly have a certain impact. He assumed that these factors explain 5-25% of the variance in risk-taking behaviour. Although the influence of person-related variables on risk taking is certainly not trivial, Trimpop proposes (1994) a stronger impact of situational influencing factors (cf. next paragraph).

Situational determinants of risk taking

Trimpop assumed (1994) that situational determinants are more influential regarding the determination of risk taking then person-related variables. The situational determinants of risk taking are omitted in this section because some factors, like the valence and the probability of the outcomes, are already sufficiently outlined in the section regarding Decision making under uncertainty (cf. 5.3.1). Other situational influencing factors which are relevant for the decision-making process of risk taking, as well as for the decision-making process regarding rule violations, will be described in the section on Decision making of rule violation (5.3.4).

Motives for risk taking

The section regarding the person-related determinants of risk taking already alluded to the topic of the motives for risk taking. There are, for example, people who need the stimulation for intrinsic pleasures (*sensation seekers*), while others only run risks in order to achieve extrinsic benefits, such as material profits (Trimpop, 1994). Nicholson et al. (2005) propose that due to the great diversity of risk-taking situations, the motives for risk taking are complex and vary intraindividually according to the respective situation. The goal classifications of Nicholson et al. (2005) which are described in the following are not mutually exclusive, meaning that depending on the situation, one person can have different motives for running risks.

Stimulation motive: People with this motive run risks because they are psychologically rewarding, giving them gratification and positive excitement. This motive is satisfied, for example, by dangerous sports or gaming. Not many people run risks due to the stimulation motive; the other motives are much more common (Nicholson et al., 2005).

Achievement of goals/Avoidance of loss motives: People with this motive run risks because they want to achieve goals, such as success, or popularity. Evidence showed that the personalities of people who run risks to achieve certain outcomes tend to feature a stronger manifestation of emotional coolness, toughness and insensitivity to rules and control (Nicholson et al., 2005).

The *avoidance of loss* appeals to the framing effect, which is described in the Prospect Theory of Kahnemann and Tversky (1979). According to the framing effect, people are willing to accept risks only to avoid the loss of certain properties. In both cases (achievement of goals and avoidance of loss), people would prefer to avoid running the risk. They bear the risk only to achieve their goals or prevent the emergence of the loss situation, respectively.

Risk adaptation motive: People of this motive group differ in their risk propensity depending on the situational background (Nicholson et al., 2005). The interaction of skills, interests and individual dispositions determine the risk propensity in the respective area. Several people run risks on a professional level, such as finance specialists who even receive specific training from their employer to raise the willingness to run risks (Nicholson et al., 2005).

Social determinants of risk taking

Society influences risk taking, for example by judging people according to certain stereotypes (Trimpop, 1994). People who risk their health or lives are evaluated favourably, e.g. pilots, racing car drivers or boxers, who are admired for their willingness to take risks. They are associated with the stereotype of "hero", whereas risk-avoidant persons are linked to the negative "coward" stereotype (Trimpop, 1994).

The influence of society on risk taking is also described by Slovic (2000) as *social amplification of risk*. He assumes that risk perception is a social experience which is determined by institutional structures, social-group behaviour and individual responses. According to Slovic (2000), there is no true or absolute risk value. The perception of risk is determined by social influences, the information system and the public opinion.

Slovic (2000) uses a metaphor for the social determination of risk; he describes the social influence as stereo receiver which intensifies, weakens and filters the risk-related information. In his Social Amplification Model, Slovic (2000) proposes key amplification steps. Besides the classical perception-oriented steps of filtering, decoding and processing of risk information, he describes that *social values* are attached to the information and that the risk information is validated by the interaction with certain peer groups. After the social validation, of information people formulate a behavioural intention to accept, ignore, tolerate or change risks (Slovic, 2000). Slovic`s Social Amplification Model illustrates that risk perception is a process which is socially influenced and closely connected to the determination of the intention and behaviour regarding risk taking.

The *social values*, which according to Slovic (2000) are attached to the risk-related information, are also referred to in the literature as *social norms*. Although nearly every situation is regulated by social norms, there are differences between the bindingness of norms. Kerr (1995) differentiates in this regard between *general interaction norms* and *benevolence norms. Benevolence norms* are only activated if important values, like the sanctity of human life, are threatened (Kerr, 1995). If these norms are triggered, they induce a stronger effect on the behaviour than the *general interaction norms*. The *general*

interaction norms are described by Kerr (1995) as beliefs regarding the appropriateness of behaviour in certain social situations. These norms are comparatively less binding. Whereas the *general interaction norms* affect the wellbeing of other people only indirectly, the *benevolence norms* refer directly to the preservation of the wellbeing of people (Kerr, 1995).

Social values and social norms are considered as relevant factors not only regarding the determination of risk taking but also with respect to the violation of rules. The Model of Behavioural Prediction applied to Violations (Kluge, 2010; Kluge et al., 2013), which is described in the section Decision making regarding rule violations (cf. 5.3.4) also includes the norms as one determinant of rule violations. The impact of the activation of different norm types on the violation of safety-related rules is furthermore investigated in the first empirical investigation (cf. Impact of the goods at stake, section 6.1).

5.3.3 Decision making in organisations

The decision to violate a safety-related rule can be made in the private as well as in the professional context. Although the prevention of safety-related rule violations is important in both contexts, especially in the professional or organisational context, rule violations are associated with more severe and extensive consequences. The empirical investigations (cf. 6 Empirical Evidence) refer to safety-related rule violations in a professional context. Although the studies had to be conducted in a laboratory setting, a simulation was used in order to come close to the real working conditions of people in the organisational context. In this regard, the decision making in organisations will be considered in the following section in order to get a holistic understanding of the decision-making process as it was investigated in the present context.

To understand the process of organisational decision making, it is necessary to consider theory about organisational structure and mechanisms of organisational control. Since rules are, according to Zhou (1997), one of the most relevant determinants of decision making and behaviour in organisations, organisational rules and their characteristics will be considered, before the different views of organisational decision making are subsequently addressed. It will then be discussed whether organisational decision making can be better described by rational choice or rule-following theories. Finally the paragraph about organisational decision making will be closed with a section about organisational conflicts.

Organisational structure and mechanisms of organisational control

The organisational structure is a quite fixed compilation of "formal authority and responsibility relationships and information sources and flows" (Huber, 2011, p. 132). According to Huber, the organisational structure determines the roles of the employees as well as the tasks and responsibilities of the supervisors, which in turn influence the employees' satisfaction and identification with the organisation. Since the organisational structure is quite tangible and therefore easy to visualise and communicate organisational change is quite frequently induced through the communication of new organisational structures (Huber, 2011).

Organisational structures can be described by several attributes and dimensions. Huber (2011) suggests describing organisational structures by their degree of *specialisation, formalisation* and *centralisation*. Regarding the *specialisation,* he further distinguishes between two dimensions, the *vertical* and the *horizontal specialisation*. Whereas the *vertical specialisation* is defined by Huber (2011, p.133) as "the number and distinctiveness of hierarchical levels", he describes the *horizontal specialisation* as "the functional scope and distinctiveness of horizontally located positions or units" (Huber, 2011, p. 133). The degree of *specialisation* is a decisive factor regarding the complexity of the organisational integration mechanisms, such as the organisational communication and coordination structures and routines.

This leads to the next dimension, the *formalisation* of policies, routines or job descriptions. The f*ormalisation* can be described by the degree of rigidity (or flexibility, respectively), the extend of (in-)formality and whether the *formalisation* mainly emerges due to mechanical or organic mechanisms (Huber, 2011).

The degree of *centralisation* of organisational structures can also be further distinguished. *Vertical decentralisation* is described by the degree to which the "authority is concentrated at the top of an organization"(Huber, 2011, p. 133). If the authority is also located in the lower and middle management the degree of *vertical centralisation* is low. *Horizontal centralisation* describes, according to Huber (2011), the distribution of authority on one hierarchical level. If only one function possesses all authority, the organisational structure can be described as highly horizontally centralised.

As the previous section demonstrated, the organisational structure is closely connected to organisational authority and the execution of organisational control. Hatch and Cunliffe (2013) describe in this regard three theories that address different mechanisms of control which occur on different hierarchical levels in the organisational context.

The most basic theory, which described organisational control mechanisms on a societal or upper management level, is the theory of market, bureaucracies and clans of Ouchi (1979). According to this theory, the control is exerted to achieve cooperation and minimise transaction costs. The market exerts its control by the law of supply and demand, and the organisational processes are adjusted to keep pace with the offer of competitors. By this means, the market controls the organisational processes and performance (Ouchi, 1979). When there is no competition, organisations are controlled by bureaucracy or by clans. The bureaucracy exerts control by the prescription of rules and procedures (Ouchi, 1979). The adherence to the rules is controlled by close monitoring of the supervisor. The clan exerts its influence through social norms, expectations and cultural values. Only symbolic control is exerted. According to Ouchi (1979), organisations are not regulated by one of these mechanisms; they are determined by a conglomerate of market, bureaucracy and clan influences to differing extents. Since market regulation works only if the individual has to face the market, almost all large organisations are somehow regulated by bureaucracy or clan mechanisms.

The agency theory, as described by Hatch and Cunliffe (2013), considers the control mechanisms which are engaged on the executive level of organisations. The agency theory describes how it can be ensured that agents, such as managers, meet the goals which are prescribed by the shareholder/owner of the organisation. This is achieved by exerting control through (1) contracts between the shareholder and the manager, (2) the provision of information which allows the manager to meet the prescribed goals, and (3) presenting the prospect of rewards when goals are met (Hatch & Cunliffe, 2013).

The last theory, the cybernetic theory (cf. Hatch & Cunliffe, 2013), focuses mainly on the organisational control which is exerted to ensure goal accomplishment on the individual level. This is achieved by the following control processes: organisational goals are set, work targets and standards are then derived and prescribed, and finally, performance is monitored to detect and correct deviances (Hatch & Cunliffe, 2013).

For the scope of the present investigation of the determinants of safety-related rule violations, especially the control mechanisms proposed by the market, bureaucracy and clan theory as well as the mechanisms assumed by the cybernetic theory are relevant. In our empirical investigations, we simulate organisational control mechanisms by prescribing performance as well as safety goals (control mechanism proposed by cybernetic theory and the bureaucracy). Furthermore, one of the main objectives of the investigations were to explore the impact of audit timing and accuracy of information about the probability of audits, which are implemented to exert organisational control to ensure

compliance with the prescribed rules (the controlling/auditing of organisational members is a further control mechanism proposed by cybernetic theory and the bureaucracy). The impact of clan-based control mechanisms is focused on in one of the investigations, in which the impact of social norms on rule violations is addressed (cf. Impact of goods at stake section 6.1).

Whereas Huber (2011) concentrates in his description of organisational structures on the distribution of authority, and Hatch and Cunliffe (2013) concentrate on theories about different levels of organisational control, Simon (1976) makes certain assumptions about the determinants of authority acceptance. Simon distinguishes in this regard between five determinants:

(1) *Social sanctions* refer to societal compliance expectations in several social situations; if the expectations are not met, the person will be disapproved of the other members of the society; social sanctions are the most influential and therefore the most important sanction type (the impact of social norms, enforced by social sanctions, was investigated in the scope of the current work and will be described in the section about the impact of the goods at stake, cf. 6.1)

(2) *Formal sanctions* depend on the correlation between the work in the organisation and the financial security or status (for the example of rule violations, formal sanctions are bonus payments which are associated with compliance, or fines which have to be paid in the case of a rule violation)

(3) *Inter-individual differences:* There are indications person-related differences exist regarding the receptiveness to the influence of authority (person-related predictors of rule violations were focused on in the investigations described in the section about the impact of personality, cf. 6.2)

(4) *Identification with the organisation and the organisational purpose* is determined by the belief in the organisation, the organisational processes and the skills and abilities of the superior

(5) *Convenience:* If a person does not have to make a decision, this is much more convenient than if a person has to come to, and be responsible for, his/her own decisions

Since safety rules are prescribed by organisational units, or members who use authorities and organisational control mechanisms to enforce rule compliance, these factors were considered in order to reach a better understanding of rule-related decisions in the organisational context, as is focused on in the present investigation.

Besides the aforementioned dimensions of *specialisation, formalisation* and *centralisation,* Huber (2011) refers to three additional characteristics with which the structure of organisations can be described. He assumes that the characteristics of the *employee*, the *organisational culture* and the *organisational routines* are relevant organisational design features. He assumes further that these features determine the performance of the organisation.

Regarding the *employee*, the required number, skill type and skill level of the employees has to be determined. Then, the respective employees have to be recruited and retained to generate the respective performance level which the organisation is aiming to achieve.

The *organisational culture* consists of “values and norms that guide communication and behaviours in the organisation” (Huber, 2011, p. 140). A culture would be described as strong when the norms and values are intense and widely held. The organisational culture can be further characterised by its seniority, integrity, openness to change, uniformity, the degree of competitiveness versus cooperativeness, or risk proneness. The congruence between the aimed for and the real attributes and the strength of the culture contributes to the performance of an organisation. If strong cultures are resistant to change, this can also be dysfunctional in fast-changing environments, but usually strong cultures are beneficial (Huber, 2011).

Organisational routines are described by Huber (2011, p. 141) as “organizational processes not part of the technological core“ but “congruent with achievement of the organization`s focal goals.” According to Huber (2011), *organisational routines* refer, for example, to organisational processes in the following areas: employee recruitment, training or compensation, budgeting and financial control and, especially relevant for the present investigation, *organisational routines* also regulate safety and security activities.

Although the definitions of *organisational routines* and *organisational rules* (cf. section 3.1.3.) differ in certain aspects, they also have several aspects in common. Both describe a defined process/pattern which is applied in the organisational context. Whereas *organisational routines* are defined as processes, which are engaged to achieve organisational goals, but do not refer to the core business activities (Huber, 2011), the term *organisational rule* is not as specific. *Organisational rules* are simply defined as formal structures that describe stable relationships and activities (Zhou, 1993). The term *organisational rule* is broader and can be further specified and distinguished according to certain dimensions, cf. next section.

Organisational rules

The *organisational rule* was already defined and described in the previous section and initially and in more detail in the section on rule classification (cf. *Organisational rules* 3.1.3). In the following, some further aspects which are especially relevant regarding the decision making in organisations should be addressed. First, the difference between implicit and explicit rules will be described, before the factors which determine the effectiveness of rules are outlined. Finally, different functions of rules in organisations are discussed.

Explicit versus implicit organisational rules. Zhou *(1997)* differentiates between explicit and implicit rules in organisations. He defines explicit rules as ”formal procedures, policies and regulations“, whereas he describes implicit rules as “norms conventions and standards“ (Zhou, 1997, p. 285). It can be said that explicit rules are consciously communicated by the organisations, whereas implicit rules are expectations which are not explicitly conveyed, because it is assumed that these rules are generally known. The implicit rules are close to the term norm, which was described in the section on social norms (cf. 3.1.2).

A similar distinction was made by Huber (2011), who characterises organisational structures according to their degree of formality. It can be assumed that the informal organisational structures described by Huber are similar to the implicit rules of Zhou and the explicit rules described by Zhou, are much the same as the formal rules to which Huber refers.

This distinction is relevant insofar as the explicit/formal and implicit/informal rules do not have to be congruent. For example, there can be an explicit safety-related rule which prescribes a certain safe behaviour pattern. The implicit rule or social norm in the respective organisational unit can be the violation of this explicit rule (for example in order to achieve a certain performance level). Actually, people have to violate one of the rules; they can only choose which one they violate. The contradiction between different rule types is mostly due to goal conflicts, which will also be addressed in the last section (cf. section *Goal conflict*). To prevent the violation of explicit/formal (for example safety-related) rules, the implicit/informal rules and norms in the organisation should be considered as well. It should be analysed whether there are any conflicts between explicit and implicit rules. If contradictions are detected, it should be further analysed whether they are due to objectives which are set by the organisation. If goal conflicts are identified as a cause of the rule violations, this problem can be addressed through certain interventions.

One possibility is the representation/description (framing) of the performance goals. The impact of this intervention on the amount of safety-related rule violations is addressed in empirical investigations in sections 6.1, 6.3 and 6.4.

The effectiveness of rules. The effectiveness of rules depends on the available measures to enforce compliant people and detect and sanction the people who violate rules (Lehman & Ramanujam, 2009; Zhou, 1997). Zhou describes organisational decision making as a repeated situation in which people learn through their experiences. If the rule violations are sanctioned regardless of whether the people have to pay a fine or lose their social reputation, the probability of further violations will decrease (Zhou, 1997). Rule violations can only be sanctioned if they are detected, for example by an audit. Since audits are very expensive (Power, 1997) the placement of audits should be well thought out in order to achieve a high compliance rate with a minimum of audits. In this regard, the impact of information about audit probabilities (cf. section 6.3) and the audit timing (cf. section 6.4) were systematically investigated in the scope of the empirical evidence part.

Functions of organisational rules. Organisational rules serve different functions: They are implemented to manage conflicts and uncertainty and to support the retention of the organisational learning process (Zhou, 1997).

According to Zhou (1997), organisational rules can prevent the emergence of intrapersonal conflicts: If the organisation prescribes certain behaviour, the organisational members are forced to comply with this rule. This is especially relevant if there are norms from the organisational framework which are contradictory to the organisational rules; then, the rules can be a kind of protection for the organisational member. The person does not have to explain why s/he is doing something which is not congruent with the norm, because there is an organisational rule which prescribes it.

Deciding which behaviour is most appropriate in the respective situation requires often a high level of competence: The prescription of rules facilitates this decision process by reducing the uncertainty in the situation (Zhou, 1997). In this regard, the compliance with rules is mostly not due to the insight that the rule is the most effective and appropriate behaviour in the situation; rather, it is due to people`s tendency to avoid uncertainty (Zhou, 1997).

As described by Zhou (1997), organisational rules are usually developed on the basis of organisational routines and knowledge about certain technologies, the process and operation in an organisation. In this regard, the development and prescription of rules

is one of the most popular measures of knowledge management and learning in organisations (Zhou, 1997).

Organisational decision making- The points of view

The discussion regarding decision making in organisations usually focuses too much on the role of the organisation. The role of the individual decision makers and the impact of the societal and legal background are mostly disregarded. The following paragraph focuses on these aspects.

The role of the decision maker – The micro point of view. The individual background of the decision maker, such as social identity, expectations and the habits, has a determining influence on the decisions which are made in the organisational context (Zhou, 1997). These factors determine the underlying preferences which in turn determine organisational decision making. Zhou (1997, p. 264) described this effect as follows: “Decision making starts long before individuals begin the decision-making process." The sense of morality or the social norms that prescribe which behaviour is appropriate determine the decisions which are made in different contexts, such as in the organisational context. The impact of the activation of social norms is addressed in the first empirical study (cf. 6.1)

People`s norms and values are not unchangeable (Zhou, 1997). On the contrary, it has been shown that professional training and practice not only influences the skills and competences of a person, but can also change the professional norms, ethics and rules of conduct in the respective situation (Zhou, 1997).

The identification with a social group that is similar regarding the dimensions of power, status and prestige is also very influential concerning the determination of decision making. The affiliation to a social group promotes the influence of stereotypes on people`s attitudes, beliefs, values, affective reactions and behavioural norms (Zhou, 1997). According to Zhou, the decision-making process can be seen as the product of a social categorisation process.

The legal background – The macro point of view. Organisational rules are usually derived from legal systems, governmental regulations and cultural rules (Zhou, 1997). This foundation increases the appropriateness and legitimisation of organisational rules. Furthermore, organisations are penalised if they deviate from these institutionalised rules, and rewarded if they act in compliance with them (Zhou, 1997). As a consequence, most

organisational rules are formulated in accordance with cultural rules and legal regulations.

Summing up it can be said that governmental regulations, cultural rules and norms influence organisational decision making on two different levels. On the one hand, the norms and legal regulations influence the decision maker on the individual level, because the norms and regulations determine the formation of individual preferences (cf. section role of the decision maker and the micro point of view). On the other hand, the cultural norms and legal background influence organisational decision making on the macro level, because organisations use the norms and legal regulations as the basis for the formulation of organisational rules. Thus, the respective cultural norms and legal background should be taken into account in order to gain a comprehensive understanding of the (rule-related) decision-making process in the respective organisational context.

Rational choice versus rule following

Regarding the description and explanation of decision making in organisations according to Zhou (1997), there are two competing theoretical approaches: the rational choice approach and the rule-following approach.

The rational choice approach assumes that decision making in organisations is based on the anticipation and evaluation of future consequences (Von Neumann & Morgenstern, 1972; Zhou, 1997). For a more detailed description of the rational choice theories, cf. Decision making under uncertainty (section 5.3.1).

The rule-following approach assumes that organisational decision making can be best described by rule following theories, because most decisions made in organisations are made on the basis of certain rules. Zhou (1997) assumes that the decision to follow a rule is based on routines and requires the analysis of the context and history of a situation. According to March (1994), people who decide to follow a rule undergo the following process:

(1) they analyze the situation
(2) afterwards they analyze their own identity and ask themselves who they are,
(3) finally they combine their previous insights by thinking about the question of what a person like them should do in this organisation in this situation.

Whereas the rational choice theories assume that the decision making is determined by the optimisation effort of people, the theories which describe rule-following behaviour assume that people do not try to decide for the most optimal behaviour, but for the most appropriate behaviour (Zhou, 1997).

To integrate the rational choice and the rule-following approach, the following concepts should be considered. Simon (1965) distinguishes between programmed and non-programmed decisions in organisations. He describes programmed decisions as decisions which are made in repetitive and routine situations. Due to the high frequency of occurrence of these situations, there are routines and procedures which prescribe exactly what and when certain steps have to be taken. Non-programmed decisions have to be made, according to Simon (1965), in novel and exceptional situations. Due to the fact that these situations occur so rarely or are even occuring for the first time, there are no available procedures or methods which describe how the situation can be handled. Simon (1965) proposes further that these concepts are not distinct. He assumes that there is a continuum, with each decision lying anywhere between the poles of highly programmed decision and highly non-programmed decision.

Whereas Zhou (1997) described rule compliance and rational decision making as two competing approaches to explain decision making in organisations, the assumptions of Simon (1965) suggest that depending on the situational context, different decision-making strategies are applied. The programmed decisions described by Simon are similar to the rule-following behaviour concept mentioned by Zhou (1997). The non-programmed decisions are assumed to be in accordance with the rational decision-making approach described by Zhou. It can be assumed that depending on the situation, either predominantly the propositions of rule-following theories (or programmed decisions), or the propositions of the rational decision-making theories (non-programmed decisions), or a mixture of the two determine the decision making in organisations.

Organisational conflict

According to Hatch and Cunliffe (2013, p. 252), *organisational conflicts* are "an inevitable aspect of organizing". They define organisational conflict as "the struggle between two or more individuals or groups in an organisation" (2013, p. 252).

Hatch and Cunliffe (2013) describe a medium level of organisational conflicts as optimal, since too few and too many conflicts are assumed to decrease organisational performance. According to Hatch and Cunliffe (2013) too few conflicts are an indicator of a lack of motivation and concentration, and too many conflicts are an indicator of distraction, uncooperativeness and politicisation. They view a medium level of organisational conflicts as an indicator of cohesiveness, productivity and willingness for cooperation.

The assumption that a medium level of conflicts is optimal implies that depending on the conflict level of the respective organisation, it can be worthwhile to reduce or even

stimulate the occurrence of conflicts in organisations. But before such interventions can be implemented, it is necessary to analyse the status of conflicts in the respective organisation.

According to Hatch and Cunliffe (2013), indicators of goal conflicts are open hostility, distrust and disrespect, as well as information distortion, avoidance of interaction and lack of cooperation. When these indicators have been ascertained, in a next step, the causes of conflicts should be determined. Hatch and Cunliffe (2013) differentiate between nine local conditions which may trigger organisational conflicts, such as interpersonal differences, status congruity, communication obstacles, goal incompatibility and reward and performance criteria.

Reward and performance criteria and goal incompatibility are especially relevant with respect to the violation of safety-related rules which are investigated within the scope of the present investigation (cf. paragraph 6). The impact of reward and performance criteria was investigated by varying the framing of the production outcomes/salary as gain or loss. Furthermore, in all investigations, a conflict between performance and safety was triggered by the prescription of mutually incompatible safety and performance goals. These goal conflicts are due to the fact that different hierarchical levels or organisational units communicate different, often contradictory organisational demands and goals to their organisational members, which is very common in most organisations.

In safety-critical organisations, there is always a tension between the centralised guidance which prescribes certain (safety-related) rules and the daily practice (Dekker, 2005). According to Dekker (2005), this tension is mostly due to the fact that compliance with (safety-related) rules and getting a job done in the demanded time and with the demanded quality are often mutually exclusive. The organisational members have to achieve different goals: On the one hand they should act safely, but on the other hand the systems were not created to be safe, but to achieve certain economic gains by maximising the capacity utilisation (Dekker, 2005).

The purposive idea in the management of commercial organisations is the simultaneous optimisation of costs, schedule and reliability key figures (McCurdy, 2001), or in other words the maximising output and minimising input at the same time (Simon, 1976). This philosophy can also be briefly described as “faster, better and cheaper” (McCurdy, 2001). The achievement of these goals should be possible through the use of innovative technology and the employment of new management tools. Actually, it is a misconception that all three goal criteria can be optimised simultaneously; at least one of these goals is disregarded in order to achieve the other goals (Dekker, 2005). Nevertheless, the organi-

sations expect their members to achieve all goals. Certainly, the conflicting goals are not communicated per se, but the organisational members are given different directives from different management levels, departments and people (Dekker, 2005). Furthermore, some goals are not explicitly communicated but are conveyed by subtle messages and pressure, which is exerted subliminally, for example by the management or the customers (Dekker, 2005).

Independently of the explicitness with which the goals are communicated, people usually feel a certain obligation to achieve the goals somehow. This leads to different phenomenon, which will be described in the next paragraphs.

Fine-tuning. The organisational members try to overcome the goal conflict, for example, by "fine-tuning" their performance (Starbuck & Milliken, 1988). Based on previous experiences people try to fulfil their tasks in a faster, better or cheaper manner by doing particular things differently than how it was done before or how it is prescribed by the organisation (Dekker, 2005). People fine-tune their activities in order to get the job done. They draw on the knowledge of experienced colleagues, who know how to complete the task better, cheaper, or faster as it is required from the management without provoking safety-related consequences (Dekker, 2005). If this works, according to Decker (2005) it sets off a very dangerous process: The deviation becomes routinized and the lack of failure is seen as validation that the fine-tuning is not dangerous at all. In fact, fine-tuning is often quite dangerous; with the frequency of fine-tuning, the probability of safety-critical incidences increases. One prominent example of the dangerousness of fine-tuning is the Challenger disaster in 1986. The analysis of the disaster revealed that "fine-tuning makes failures very likely" (Starbuck & Milliken, 1988, p. 335)

The fact that fine-tuning of prescribed procedures towards a faster and more remunerative operation, as was even ascertained in one of our previous investigations (von der Heyde, Brandhorst, & Kluge, 2013), makes it quite likely that such activities are fairly common behaviour patterns in organisations with multiple objectives.

Blue feeling is a term which has its origins in the aircraft sector and describes "the willingness and ability [...] to actually deliver on all three goals simultaneously (safety, punctuality, and value for money)" (Dekker, 2005, p. 146). It is called *blue* feeling, since blue was the dominant colour of one of the airlines in which the blue feeling was investigated. There is no association here with the term *feeling blue*, which describes a feeling of depression or sadness in everyday parlance.

The description of this phenomenon proves that people in organisations try to achieve all goals simultaneously. The achievement of goals which are actually irreconcilable is even a source of professional self-esteem: People with the *blue feeling* do not feel uncomfortable about the conflicting goals; they feel more confident, because they are able to attain the unattainable (Dekker, 2005). People, who do not have the blue feeling are even perceived negatively by their colleagues and superiors (Dekker, 2005). According to Dekker, it is assumed that they are not motivated or willing enough to achieve the different goal criteria.

The fact that most rule violations are due to goal conflicts and the attempt to overcome these conflicts leads to the insight that the violation of rules and the *fine-tuning* of behaviour is not generally negative and the compliance with rules is not generally positive (Brandhorst, von der Heyde, & Kluge, in prep.; Dekker, 2005). It depends on the organisation and the priorities of the organisation how it evaluates rule violating behaviour. In fact, rule violations and fine-tuning can even be a competitive advantage for the organisation, because the employees are creative and competent regarding the fulfilment of their work task, which can lead to savings in terms of expenses or time. Furthermore, it can be argued that rule violations which are committed because of goal conflicts are not real rule violations, because they are committed to comply with other rules and goals which are prescribed by the organisation (Dekker, 2005).

5.3.4 Decision making regarding rule violations

The previous sections looked at the decision-making process regarding rule violations from different angles. The theories regarding the decision making under uncertainty, decision making regarding risk taking, as well as the organisational decision making depict essential aspects and processes regarding the violation of rules. The following sections are concerned with a theory which was originally developed to describe the determinants of planned behaviour in various situations (Theory of Planned Behaviour, Ajzen, 1991). This theory was extended in different steps in order to predict behaviour (Integrative Model, Fishbein, 2000; Integrative Model of Behavioral Prediction, Fishbein, Hennessy, Yzer, & Douglas, 2003) and was finally applied by Kluge (2010) and Kluge, Badura and Rietz (2013) to the violation of safety-related rules.

Theory of Planned Behaviour

Predicting and explaining human behaviour is a challenging task, which can be addressed by different theoretical approaches. The Theory of Planned Behavior (TPB, cf.

Figure 8, Ajzen, 1991) is based on the Theory of Reasoned Action (Ajzen & Fisbein, 1980; Fishbein & Ajzen, 1975), which was developed because attitude alone is not a good predictor of human behaviour. The Theory of Reasoned Action and the TPB are almost congruent. The difference between these theories is one more determinant, the *perceived behavioural control*, which is only included in the TPB. In order to avoid unnecessary repetitions and overlapping, only the TPB is described in the following.

The TPB concentrates on the explanation and prediction of volitionally controlled *behaviour* and focuses in this regard on self-regulation processes, which are considered as key determinants of the behavioural intention, which in turn determines whether or not the behaviour is performed (Ajzen, 1991).

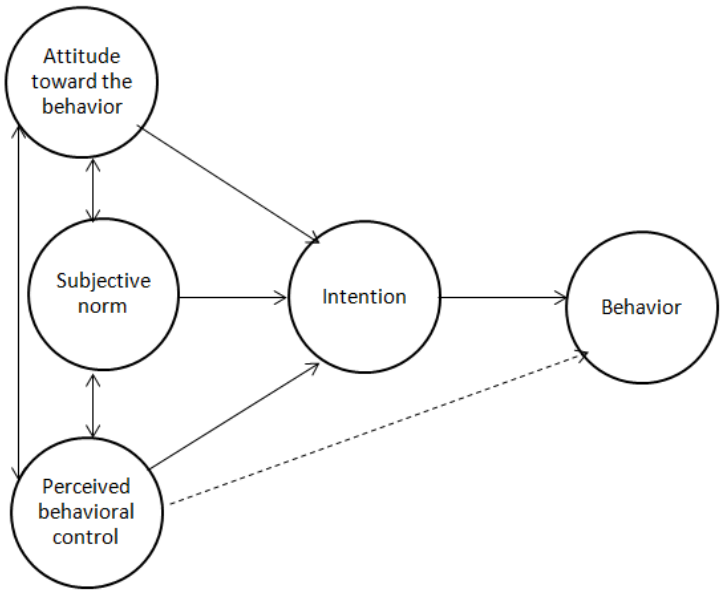

Figure 8. Theory of Planned Behaviour (figure based on a an illustration by Ajzen, 1991)

Besides *behaviour*, one of the essential factors in the TPB is *intention*, which can be understood as motivation to perform a certain *behaviour*. The stronger the *intention, or* the motivation, respectively, the more effort is exerted to perform the *behaviour*, which makes its occurrence more likely (Ajzen, 1991). The self-control processes, which according to Ajzen (1991), determine the *intention* are the *attitude toward the behaviour*, the *subjective norm* and the *behavioural control*. The *attitude toward behaviour* "refers to the degree to which a person has a favorable or unfavorable evaluation or appraisal of the behavior in question" (Ajzen, 1991, p. 188). The *subjective norm* is a social factor which refers to "the perceived social pressure to perform or not to perform the behavior" (Ajzen, 1991, p. 188). The last determinant, the *perceived behavioural control,* describes the

"perceived ease or difficulty of performing the behavior" (Ajzen, 1991, p. 188). According to Ajzen is the *perceived behavioural control* influenced by past experience as well as anticipated difficulties or obstacles which may occur.

According to the TPB (Ajzen, 1991), all determinants are positively related to the intention, meaning that the more favourable the *attitude* and *subjective norm toward the behaviour* and the greater the perceived behavioural control, the stronger the intention will be, which in turn makes it more likely that the intention will be realised. The *perceived behavioural control* has a special role in the TPB. This determinant influences the *behaviour* not only by affecting the *intention*: In conjunction with the *intention,* the *perceived behavioural control* directly determines the *behaviour* (illustrated by the broken line in Figure 8).

Ajzen (1991) further assumes that the relative importance of the determinants is not always the same, but varies across different situations. There may even be situations in which only one of the factors is relevant regarding the determination of the intention. Moreover, Ajzen (1991) believes that the strength of the intention is determined by several external, non-motivational influences, such as the availability of resources or the skill level. These factors are already considered in the p*erceived behavioural control* determinant and are therefore not specifically regarded as further determinants in the model.

As the TPB should not only predict but also explain human behaviour, it makes certain assumptions about the antecedents of *attitudes, subjective norms* and perceived *behavioural control*. Ajzen (1991) assumes that behaviour is a function of the beliefs which are salient in the respective situation. He differentiates between three belief types: *behavioural beliefs,* which are associated with the *attitude toward the behaviour*; *normative beliefs* (assigned to the *subjective norms*); and finally *control beliefs*, which correspond to the *perceived behavioural control*.

*Behavioural belief*s correlate behaviour with outcomes. The *behavioural beliefs* (and the *attitudes toward the behaviour)* are positive if the behaviour is usually associated with positive consequences, whereas the *behavioural beliefs* (and *attitudes toward the behaviour*) are negative if the respective behaviour is usually connected with negative outcomes.

According to Ajzen (1991), *normative beliefs* are concerned with the assessment of the attitude of important reference persons or reference groups. It is estimated whether the reference person or group supports or opposes the respective behaviour. The more important a person is, and the more persons are assumed to share the attitude, the stronger is the normative belief and the subjective norms and their impact on the inten-

tion. Moral obligations are not covered by *normative beliefs* and *subjective norms*, but are assumed to influence the intention as a further determinant (Ajzen, 1991).

A person`s *control beliefs* are influenced by his/her own experiences of success regarding the respective behaviour and/or second-hand information from other people who have experiences with the behaviour, or who are informed about other factors which increase or decrease the probability of success of the behaviour in question (Ajzen, 1991). The resources which enhance success as well as (possible) obstacles are considered in the control beliefs, or the p*erceived behavioural control*, respectively, which is determined by the control beliefs.

The usefulness of the TPB for predicting people`s the intentions and behaviours in several contexts has been determined by several studies (cf. for example Armitage & Conner, 2001). Nevertheless, there are certain determinants of behaviour which are not considered and certain questions which remain unacknowledged in the TPB. The TPB makes no assumptions about the determinants of the beliefs, and also does not consider factors which may influence the correlation between the intention and the behaviour. These aspects are addressed by the Integrative Model of Behavioral Prediction, which is based on the TPB but expands this theory by several further aspects (Fishbein, 2000; Fishbein et al., 2003). The Integrative Model (of Behavioral Prediction) will be described in the next paragraph.

Integrative Model (of Behavioral Prediction)

The Integrative Model of Behavioral Prediction (IM, cf. Figure 9, Fishbein, 2000; Fishbein et al., 2003) is based on several previous models (such as the TPB of Ajzen, 1991; or the Behavioural Belief Model of Rosenstock, 1974). These models were integrated into a new model in order to achieve a better understanding of the determinants of behaviour, to enable a more precise prediction of behaviour and more effective behaviour change, for example in the health-care sector regarding the prevention of HIV infections (Fishbein, 2000).

Most elements of the IM are the same as in the TPB (cf. Figure 8, Ajzen, 1991). Like the TPB, the IM (cf. Figure 9) includes *behavioural, normative* and *control* or *efficacy beliefs*, which determine the *attitude*, *norms* and *self-efficacy* (the same as *perceived behavioural control* in the TPB). These factors influence the intention, which is central regarding the determination of behaviour. According to the IM, behaviour is defined by four elements: the *action*, which describes the activity of the behaviour, the *target,* which describes what should be achieved by the behaviour, the *context* in which the behaviour

occur, and the *time period* in which the behaviour takes place or is expected to take place (Fishbein, 2000; Fishbein et al., 2003).

As in the TPB, the strength of the intention is quite crucial for the realisation of the respective behaviour pattern in the IM, but in contrast to the TPB, it is further assumed in the IM that the skills and abilities which are necessary to perform the behaviour, as well as environmental constraints concerning the behaviour, determine whether or not the intended behaviour actually occurs (Fishbein et al., 2003, cf. Figure 9). The probability that a certain behaviour will be performed is highest if the intention is strong, the person is qualified to perform the behaviour, and there are no or only few environmental constraints to prevent the respective behaviour. These two additional determinants of behaviour offer an explanation for why so many strong intentions are not realised.

In addition to skills and abilities and environmental constraints, which influence behaviour as new factors in addition to intention, the IM also includes several so-called external or distal variables (cf. Figure 9). These external variables are, for example, demographic variables, such as sex or age, personality traits or past behaviour. These variables are assumed to influence the intention only indirectly by affecting the different underlying beliefs and values (Fishbein et al., 2003). The integration of these factors on the one hand explains how these factors influence people's intentions and behaviour, and on the other hand highlights the emergence of beliefs more clearly.

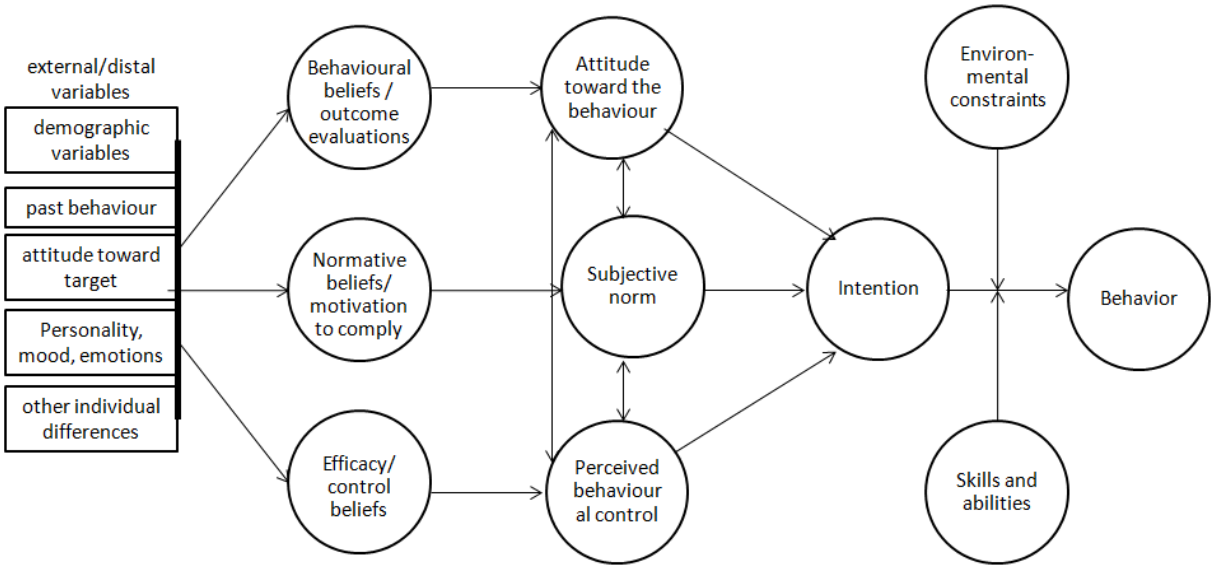

Figure 9. Integrative Model (figure based on the illustrations of Fishbein, 2000; Fishbein et al., 2003).

Overall, it can be stated that the IM constitutes a very valuable further development of the theories which aim to explain, predict, and in a final step change human behaviour. The questions which were left unresolved by the TPB were answered by the IM. In the following paragraph the IM is applied to the context of rule violations.

Integrated Model of Behavioural Prediction applied to violation

Kluge (2010) and Kluge et al. (2013) identified the Integrated Model of Behavioural Prediction (IM) of Fishbein et al. (2003) as a model which includes all levels of influence that are relevant for describing the determinants of safety-related rule violations. She used the elements of the IM to summarise the determinants of safety-related rule violations proposed by different investigators (cf. Figure 10).

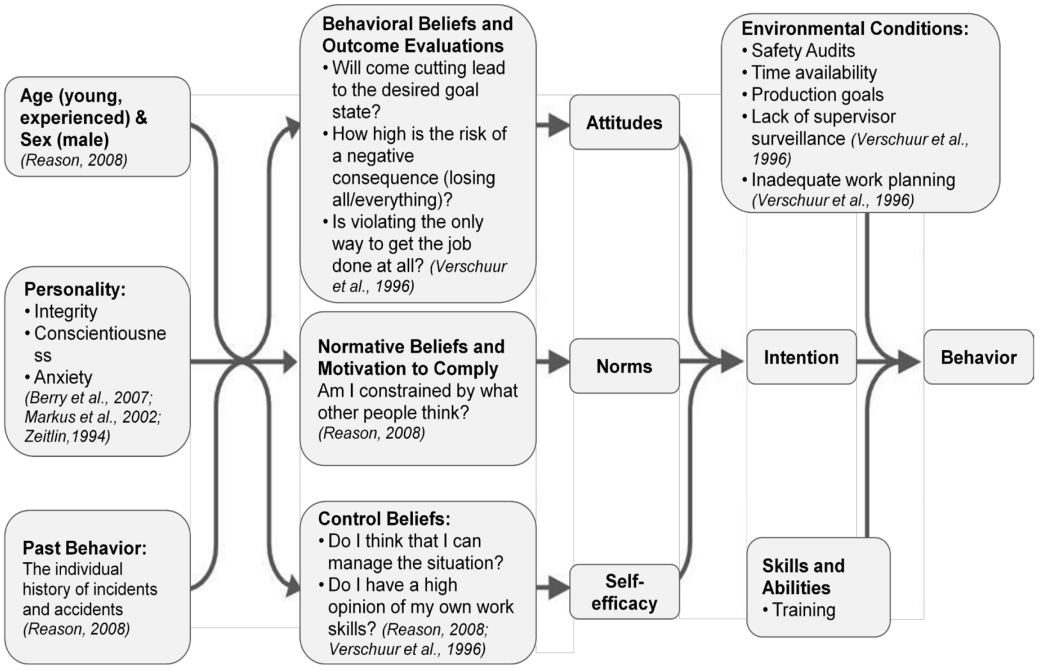

Figure 10. Integrated Model of Behavioural Prediction applied to Violations (Kluge, 2010; Kluge et al., 2013)

The demographic variables which are, according to Kluge (2010), relevant in the context of safety-related rule violations include people`s *age* and *sex*. Young people and men are especially prone to rule violations (Reason, 2008). Regarding the *personality,* Kluge (2010) considers conscientiousness (based on the findings of Berry, Ones, & Sackett, 2007), integrity (based on the findings of Marcus, Schuler, Quell, & Hümpfner, 2002) and anxiety (based on the findings of Zeitlin, 1994) as relevant determinants. The *past behaviour* determinant is described by Kluge (2010) as history of previous accidents

and incidents: Here, Kluge refers to the results of Reason (2008), who found a positive association between the amount of safety-critical events like accidents and the amount of committed rule violations.

Besides the person-related variables, Kluge (2010) describes several beliefs which influence the decision to violate a safety-related rule. The *behavioural beliefs* are, according to Kluge, the assumptions regarding the instrumentality of the rule violation, the beliefs regarding the risk of negative consequences associated with a violation, and assumptions about the necessity of the respective violation (beliefs deduced on the basis of the findings of Verschuur et al., 1996). Regarding the *normative beliefs*, Kluge (2010) refers to Reason (2008), who assumes that the willingness to violate rules is influenced by people's concerns about what others may think of them. According to Reason, people for whom it is important what others think should tend to comply with rules to avoid negative evaluations of others. On the basis of Reason (2008) and Verschuur et al. (1996), Kluge (2010) proposes, moreover, an impact of *control beliefs* on rule-related behaviour. *Control beliefs* are described by Kluge (2010) as beliefs regarding the manageability of the current situation. This assessment is influenced by the beliefs regarding one's own skills and abilities and the perception of external influences which also determine the controllability of a situation.

On the basis of the assumptions of the IM (of Fishbein et al., 2003), Kluge (2010) proposes that the impact of *behavioural beliefs* on *intention* is mediated by *attitudes*; the impact of *normative beliefs* is mediated by *norms;* and the *control beliefs* influence the *intention* through their impact on *self-efficacy*. Whether the resulting *intention* to comply with or to violate a rule will be realised is influenced, according to the IM, by the *environmental constraints* and the *skills and abilities* of a person. Based on the findings of Verschuur et al. (1996), Kluge (2010) describes safety audits, time availability, production goals, supervisor surveillance and inadequate work planning as *environmental constraints* which are relevant with regard to the determination of rule-related behaviour. Additionally, the impact of the *skills and abilities* on behaviour, proposed by the IM, are considered by Kluge as relevant determinants of rule-violating behaviour. The *skills and abilities* are, according to Kluge (2010), a factor which can be influenced by the extent of training which is supplied by the respective organisation.

The *environmental constraints* production goal and safety audits and their impact on rule-related behaviour are focused on in the empirical part of the present investigation. The impact of the framing of production goals will be described in sections 6.1, 6.3, 6.4, the impact of safety audits will be outlined in sections 6.3, 6.4. In the section about the

impact of the goods at stake (cf. 6.1), the impact of *norms* and norm activation on safety-related rule violations is additionally addressed. In all empirical investigations, several person-related determinants, as well as knowledge and performance indicators and their correlation with rule violations, were considered. Hence, the empirical part of the present investigation offers substantial evidence regarding the validity of the IMV. In the General discussion (cf. section 7), all findings regarding the IMV will be integrated in the model.

5.3.5 The Decision-Making Perspective - Conclusions

The decision-making perspective revealed valuable insights into the processes which determine rule-related decisions. The decision to violate a rule is on the one hand determined through simple cost-benefit considerations and the appraisal of expected probabilities, but on the other hand is also influenced by irrational biases, which are due to the characteristics of people`s cognitive processing capacities. Furthermore, people`s demographic characteristics, personality traits, experience, beliefs, attitudes, norms, self-efficacy and skills and abilities as well as certain environmental constraints determine their behavioural intentions and behaviour.

Each determinant comprises information for the effective intervention against future rule violations. An intervention which is based on the insight that rule violations are determined through cost-benefit considerations can be the implementation of control mechanisms like safety audits and the use of subsequent enforcement and punitive mechanisms, respectively, which ensure that the violation of rules is associated with high costs and that compliance is rewarded through certain benefits. This is only one example of rule violation reduction interventions, which are assumed to be highly effective because they are based on a profound and holistic understanding of the decision-making process of safety-related rule violations.

Although the Human Factors perspective already comprises the definition of different influencing levels and factors, the decision-making perspective makes a further proposition about the coherence between the influencing factors, and about moderations and mediations, and is therefore a very valuable supplement to the determinants which were already described in the previous perspectives.

In particular, the IMV was used for the derivation of the hypotheses which were investigated in the Empirical evidence part (cf. section 6). The framing of the production outcome, which was investigated in the studies described in sections 6.1, 6.3 and 6.4, addresses the effects proposed by the Prospect Theory and the environmental constraints which were described by the IMV. The goods at stake study (described in section

6.1) refers to the impact of norms, which is a component of the TPB, IM and IMV. The personality variables which are considered in the IMV are especially focused on in the second paper (cf. section 6.2). The impact of the accuracy of information about audit probabilities (cf. section 6.3) is considered in the IMV and can be assigned to the environmental constraints, which presumably influence a person`s outcome and control beliefs, but additionally affect furthermore also the cost-benefit considerations which are proposed by the rational decision-making theories. The bomb crater effect (cf. section 6.3), which describes the tendency to violate a rule just after an audit has occurred, as well as the impact of audit timing (cf. section 6.4) can be explained by the aspect of experience or past behaviour which is proposed by the IMV.

5.4 Integrating the perspectives

To come closer to a holistic understanding of safety-related rule violations, the previous sections looked at this concept from different angles.

The Human Factors perspective focused on rule violations as one type of unsafe behaviour in organisations. Safety-related rule violations were defined and distinguished from similar concepts; furthermore, different rule violation types were identified and described. The different theories and models about rule violations were summarised and represented according to their contribution to a better understanding of the process and the different determinants of safety-related rule violations.

The Industrial and Organisational Psychology perspective includes the definition of different types of deviant behaviour in the organisational context. Here, different general as well as specific, concrete terms were described and their correlations with the concept of safety-related rule violations were outlined. Furthermore, due to the research focus of the community of industrial and organisational psychology, this perspective focused especially on personality traits and their correlation with deviant behaviour in organisations.

The Decision-Making perspective concentrated on the process which determines the decision to violate a safety-related rule. Here, different decision-making theories were identified as relevant: theories in the area of decision making under uncertainty, theories about decision making in risk-taking situations and theories and assumptions about decision making in organisations.

The different perspectives reflect the different research communities and their respective research focuses regarding the topic of safety-related rule violations. Interestingly, each community places an emphasis on different aspects. Whereas in the area of

Human Factors, process-oriented aspects as well as person-related and situational determinants are considered, the industrial and organisational psychology perspective focuses especially on person-related determinants, and the decision-making perspective concentrates mainly on the process-related aspects in their research. The consideration of the findings and theories gained in the different research communities and the integration of the different perspectives enables a more holistic understanding of safety-related rule violations (cf. Figure 11).

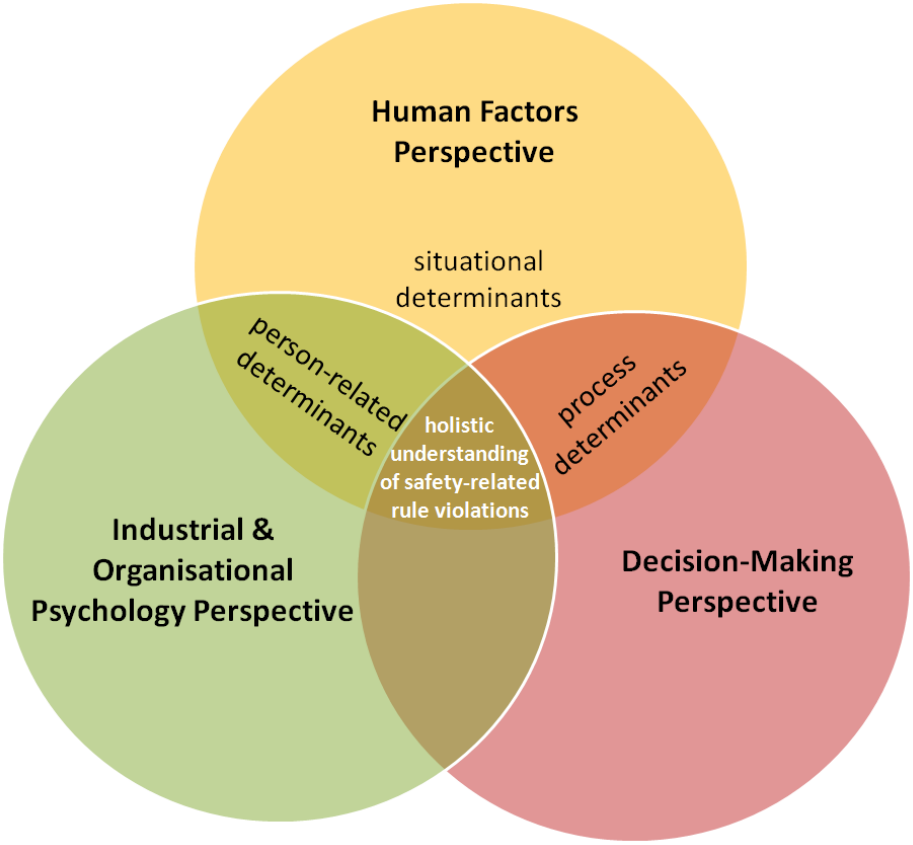

Figure 11. Integration of the perspectives on safety-related rule violations

Moreover, the transfer of insights between the different perspectives provides a valuable source for developing new research questions. The studies described in the present investigation are good examples of this (cf. Empirical Evidence 6). The Industrial and Organisational Psychology perspective and the Decision-Making perspective were used to derive research questions and hypotheses for the investigation of safety-related rule violations in the Human Factors context.

The investigations described in the section about the impact of personality (cf. 6.2) are based on the consideration of personality traits, which correlate with deviant behav-

iour in the area of organisational and industrial psychology. It was investigated whether these traits a context typical for Human Factors research. Some of the hypotheses which were investigated in the studies on the impact of goods at stake (6.1), audit probability (6.3) and audit timing (6.4) were derived from different decision-making theories (Prospect theory, cf. section 5.3.1 and Integrated Model of Behavioural Prediction, cf. section 5.3.4).

6 Empirical Evidence

6.1 The impact of goods at stake – Social norms and their impact on safety-related rule violations: It doesn't matter if people are harmed

6.1.1 Abstract

It is assumed that violations of safety-related rules contribute to unsafe acts and trigger safety-critical events in organisations. In contrast to a "human error", rule violations are assumed to be intentional, based on explicit decision-making processes. In a production context, and based on the assumptions of the Integrated Model of Behaviour Prediction, the impact of different *goods at stake* (injured residents versus damaged plant) and the effect of *framing* the production outcome (gain versus loss) on safety-related rule violations were investigated in two studies. In the pre-study, the scenarios which were developed to induce different *goods at stake* were evaluated. In the main study, the effect of the *framing* and the *goods at stake* were investigated experimentally. In contrast to previous studies, no *framing* effect was found in the present investigation. Moreover, the *goods at stake* had no significant impact on rule violations. Post-hoc analyses showed that person-related variables, such as *skills* and *knowledge*, were significantly related to the decision for a violation. The correlations between violations and performance and knowledge parameters suggest that more emphasis should be placed on the education and training of staff in order to prevent rule violations in organisations.

6.1.2 Introduction - Explaining safety-related rule violations

To achieve safety in organisations, it is important to consider both the technical and the human side. The emergence both of technical malfunctions and of human errors should be prevented. Since erroneous acts are not the only human contribution to safety-critical events, violations should also be addressed (cf. for example Reason, 1990). Violations are assumed to be a serious problem in many organisations (Fogarty & McKeon, 2006; Helmreich, 2000; Hobbs & Williamson, 2002; Lawton, 1998; Reason, 2008). They are defined as deliberate, but non-malevolent deviations from safety rules and regulations (Reason, 2008) and are likely to lead to erroneous actions and "unsafe acts" (Reason & Hobbs, 2003).

Although violations do not necessarily lead to undesired outcomes (Alper & Karsh, 2009; Besnard & Hollnagel, 2014), it has been assumed that up to 70% of all accidents in safety-critical organisations are due to violations of regulations (Mason, 1997, p. 289). In order to enhance safety, an understanding of the processes which constitute the decision-making process of rule-violating behaviour is required. Safety issues need to be considered from both a system-oriented and an individual-oriented perspective (cf. for example Wiig & Lindøe, 2009). The Integrated Model of Behavioural Prediction (Fishbein et al., 2003), applied to Violations (IMV, Kluge, 2010: Kluge et al., 2013, cf. Figure 12), integrates both perspectives and is therefore used as a theoretical framework for the current investigation (Figure 12). The IMV considers person-related (like *age*, *personality* or *past behaviour*) as well as organisational variables (*environmental conditions*) with regard to the emergence of rule violations. These variables affect a person's behavioural, *normative* and *control beliefs*, which influence the person's *attitudes*, *norms* and *self-efficacy*, which in turn influence *intentions* and rule-related *behaviour*. In the present studies, the impact of the *normative beliefs* and (social) *norms*, their responsiveness to environmental conditions, and the coherence with the framing of the production outcome as loss or gain are investigated.

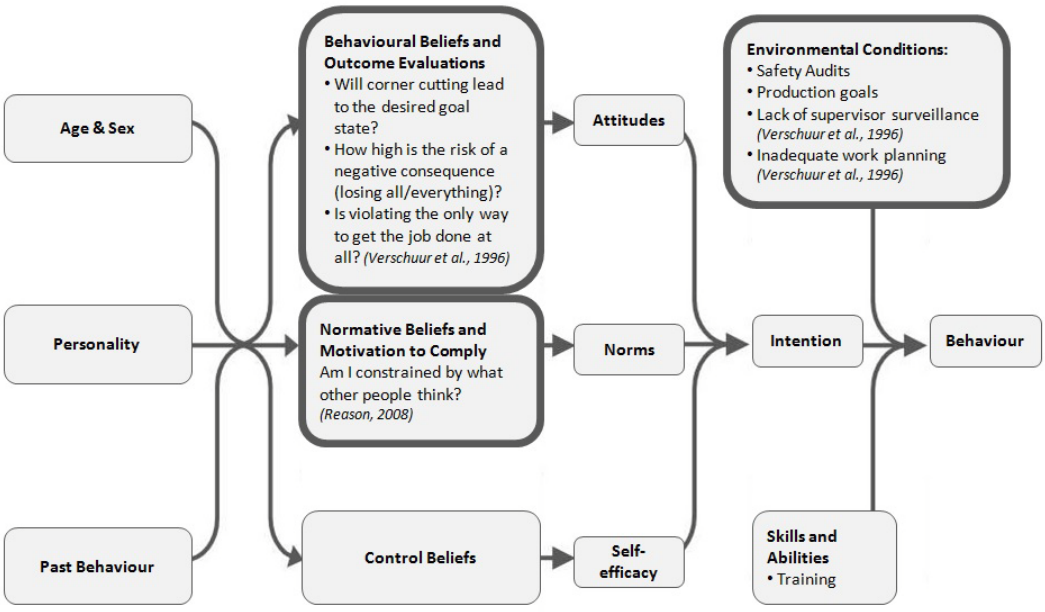

Figure 12. Adapted Integrated Model of Behavioural Prediction (Reason, 2008; Verschuur et al., 1996) applied to violations (IMV, Kluge, 2010; Kluge et al., 2013).

6.1.3 Theoretical background

The decision-making process is based on a comparison of the benefits and costs of the compliant behaviour with the benefits and costs that will accompany the violation behaviour (Battmann & Klumb, 1993; Zeitlin, 1994). It is assumed that people calculate some kind of implicit trade-off in order to determine the most purposive alternative. The amount of resources which can be gained in relation to the resources which must be invested and/or risks which are associated with the respective alternative are balanced against one another.

Referring to the IMV (Kluge, 2010; Kluge et al., 2013), it can be assumed that people's beliefs have a determining influence on the appraisal of the potential benefits and costs. The probability that people will violate is especially high in situations in which the violation is associated with high benefit, low costs and low perceived negative consequences (Polet, Vanderhaegen & Wieringa, 2002).

The impact of outcome beliefs – Framing of the salary earned

In addition to the evaluation of the benefit ratio, Lehman and Ramajunam (2009) found evidence of an increased tendency to violate a rule if one will not meet one's own target value and expect a potential loss without rule violation. In this case, risks are accepted as a "necessary evil" to achieve the production goals after all (cf. Sanne, 2008). In this regard, Kahneman and Tversky (1984) showed that presenting an identical situation while altering points of reference (for example a production goal) leads to a differing perception of the results. For example, the payment of 20 € can be seen as "gain" if the reference point is to get nothing (0 €), but if the reference point is to get 25 €, a salary of 20 € would be seen as a "loss" of 5 €. Although the ultimate salary is the same, it is assumed that the potential loss is perceived as more aversive. Therefore, people try to avoid the "loss" by maximising their production outcome, for example by violating a rule.

Kluge, Badura, Urbas and Burkolter (2010), as well as Kluge et al. (2013) have already shown that the *framing* of the salary as "gain" or "loss" influences the decision-making process concerning rule violations. If the production outcomes and the salary are framed as "loss", more people tend to violate the safety-relevant rule. If the production outcome is framed as "gain", people complied significantly more with rules. The first hypothesis concerns the replication of this previously shown *framing* effect:

Hypothesis 1: The framing of the salary influences whether people violate a safety-related rule. If the salary is framed as “loss”, people will violate the rule more often than if the salary is framed as “gain”.

In addition to the investigation of the "pure" *framing* effect, the present studies aimed at investigating variables which moderate the *framing* effect on rule violations. For example, Schmook, Bendrien, Frey and Wänke (2002), as well as Kühberger, Schulte-Mecklenbeck and Perner (1999), found evidence that the *goods at stake* acted as a possible moderator of the effect of *framing*.

Goods at stake

The costs and benefits of a risk-related decision are considered not only with respect to personal consequences but also with respect to other stakeholders such as the organisation, local inhabitants and the environment which are affected by the individual decision. The *goods at stake* concern the possible consequences for others that may accompany a decision. According to Polet et al. (2002) the perception of risk is determined by the probability of the undesired situation and the consequences of the undesired situation**.** In the case of deciding to commit a rule violation, it is argued that people trade off the *goods at stake* in relation to the severity of the consequences that might be associated with rule violation. The violation of safety-related rules, for example in an industrial plant, might result in the destruction of property, the injury of people or even the endangerment of human life. The risk value of a decision can be reduced by either a reduced risk probability or by decrease the severity of the consequences (Polet et al., 2002). Since human life is perceived as more valuable than material property (Fagley & Miller, 1997), it is assumed that safety-related rule violations are less likely if the *goods at stake* concern the well-being of people.

The perception of the value of certain things is assumed to be determined through the *normative beliefs* and (social) *norms*, which represent some of the major determinants of rule violations (cf. IMV, Kluge, 2010; Kluge et al., 2013). Social norms are defined as norms that guide social behaviour without the force of laws such as rules or standards (Cialdini & Trost, 1998). The activation of social norms is triggered by certain stimuli. As a function of these stimuli, different types of norms are activated. In this respect, Kerr (1995) differentiates between *general interaction norms* and *benevolence norms*. *General interaction norms* refer to a person’s beliefs regarding appropriate behaviour in certain situations. Such norms affect the welfare of a group member only indirectly, in contrast to *benevolence norms*, which directly affect the welfare of others. *Benevolence norms* are

activated when important values are threatened, for example the sanctity of human life. By contrast, the endangerment of material property only activates *general interaction norms*. The activation of *benevolence norms* leads to a stronger inhibition of norm-diverging behaviour than the activation of *general interaction norms.* Therefore, it can be assumed that people are less likely to violate *benevolence norms* than *general interaction norms*.

Fagley and Miller (1997) found evidence of an aversion to the violation of *benevolence norms*. Individuals appear to try to prevent the endangerment of human well-being by all available means. Based on the study by Fagley and Miller (1997), it can be assumed that if a violation would risk endangering human life, people have a higher tendency to comply with the rule (and the *benevolence norms*). By contrast, if only material property might be affected through the violation, the tendency towards compliance should be lower. In summary, the *goods at stake* influence whether people comply with or violate a safety rule.

Hypothesis 2: If a safety-related rule violation might result in the endangerment of human life, people comply with the safety rule more often than if the violation might result in the destruction of property.

The interaction of framing and goods at stake

If the *goods at stake* address human well-being, there should be no difference depending on whether the production outcome is framed as gain or loss; individuals should show compliant behaviour because they want to avoid the endangerment of people by all available means (Fagley & Miller, 1997).

Regardless of whether the production outcome is framed as gain or loss, people should tend to comply with the safety-related rule. It can be assumed that the impact of social norms (which imply compliance to ensure safety) exceed the desire to achieve certain production outcomes to maximise one's own salary. If only material property might be affected through the rule violation, the framing effect should occur. In this case, it is expected that if the outcome is framed as loss, people tend to violate the rule, whereas if the outcome is framed as gain, they tend to comply with the rules.

Hypothesis 3: There is an interaction between framing and the *goods at stake* concerning the decision to comply with or violate a safety-related rule.

Hypothesis 3.1: If the goods at stake trigger benevolence norms, individuals comply with the safety-related rule regardless of the framing.

Hypothesis 3.2: If the goods at stake concern material property, the effect of the framing of the production outcome should occur (cf. hypothesis 1).

In order to test the hypotheses, a pre-study and a main study were conducted, which are described below.

6.1.4 Pre-study

Prior to the main study, a web-based pre-study was conducted in order to test the scenarios regarding their potential to activate social norms addressing different *goods at stake*. In this regard, the participants were asked to rate the outlined scenarios on various dimensions.

Method

Sample. 99 participants (52 females) aged between 16 and 75 years (M = 30.17, SD = 10.94) completed the online study. Participants were recruited via email. About one half of the sample consisted of employees from different organisations, while the other half comprised engineering students from the University of Duisburg-Essen.

Procedure. The participants had to fill in an online questionnaire, which consisted of 28 pages with different content and input options. First of all, subjects were informed about the purposes of the study and told that they could discontinue participation at any time (in terms of informed consent). Subsequently, they were introduced to the scenario and were required to answer several questions about the respective scenario. Finally, they were asked to provide information regarding demographic characteristics.

Introduction of the organisational scenario. Participants were asked to imagine that they are in the role of a production supervisor running a waste-water treatment plant. As a production supervisor, they should start up the plant to separate a water-solvent mixture into their components. They should further imagine that their salary depends on their production performance. In their position as a production supervisor, they have the choice between two procedures to start up the plant.

Subsequently, in the next part of the investigation, two start-up procedures were introduced: an 11-step and an 8-step procedure. The 11-step procedure was described as safe; if this procedure was applied, no deflagration would occur. This procedure was additionally labelled as time-consuming due to the number of steps that have to be im-

plemented. The time required for the start-up process leads to a late separation of waste water, and therefore the production target and the maximum salary cannot be achieved.

The 8-step procedure bears a 20% risk of a deflagration and consists of fewer steps; this takes less time and leads to an increased salary compared to the 11-step procedure.

The Independent Variable: Introduction of the "goods at stake". After the introduction of the scenario, participants were instructed to read one of the newspaper articles (see Figure 13), continuing to imagine themselves in the role of supervisor. Based on the design and content of a scenario already used in previous studies (cf. Kluge et al., 2010), three different scenarios were developed. The scenarios were designed to trigger different social norms (see Table 3).

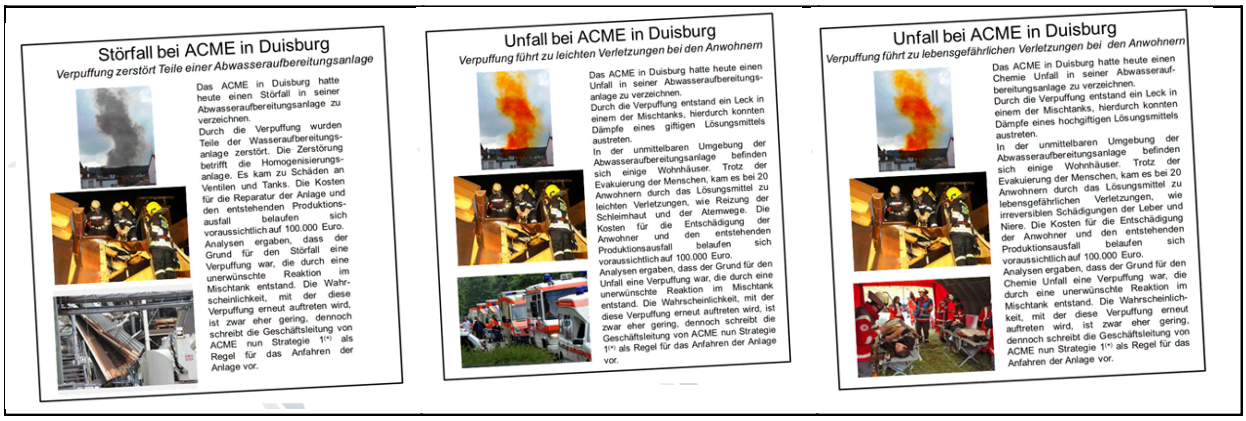

Figure 13. Layout of scenarios damaged plant (left), slightly injured residents (middle) and seriously injured residents (right) in German language

The scenarios differed in terms of the consequences of the deflagration which were described (*goods at stake)*. In scenario 1, the consequence of the deflagration was a damaged plant, whereas in scenarios 2 and 3, residents were injured. Scenarios 2 and 3 differed in the severity of injury: In the second scenario, the residents were slightly injured, while in the third scenario, they were seriously injured (cf. Table 3). The different consequences of each scenario were illustrated through photographs (cf. Figure 13). The photographs were intended to make the impact of the respective scenario more "visible".

Table 3. Comparison of the newspaper article content.

Manipulation	Scenario I: Damaged plant	Scenario II: Slightly injured residents	Scenario III: Seriously injured residents
Part 1	Today, the ACME in Duisburg had an **incident** in its wastewater treatment plant.	Today, the ACME in Duisburg had an **accident** in its wastewater treatment plant.	Today, the ACME in Duisburg had a **chemical accident** in its wastewater treatment plant.
Part II	Due to a deflagration, parts of the water treatment **plant** were **destroyed.** Destruction concerns the homogenisation plant. **Damages to valves and tanks occurred**.	Due to a deflagration in one of the mixing tanks, **toxic solvent escape occurred**. In the immediate vicinity of the wastewater treatment are some houses. Despite the evacuation of residents, **20 residents were slightly injured, e.g. irritation of the mucous membranes and respiratory problems.**	Due to a deflagration in one of the mixing tanks, **highly toxic solvent escape occurred**. In the immediate vicinity of the wastewater treatment are some houses. Despite the evacuation of residents, **20 residents were seriously injured,** e.g. **irreversible liver damage.**
Part III	Costs for **repairing the plant** and resulting loss of production are expected to amount to 100,000 €.	Costs for **indemnity** and resulting loss of production are expected to amount to 100,000 €.	Costs for **indemnity** and resulting loss of production are expected to amount to 100,000 €.
Photo at the bottom *	of a damaged plant	of many ambulances entering the location of the accident	of injured residents lying on stretchers

Note: The columns marked in grey were chosen to induce the goods at stake in the main study.
* The only photograph which differed between the scenarios

Dependent Variables: realism, credibility, dramaturgy, emotionality, and reprehensibility. The participants were asked to evaluate the newspaper articles on a seven-point Likert scale according to cases of realism ("I think the event described is realistic"), credibility ("… is credible"), dramaturgy ("… is dramatic") and emotionality ("… is emotionally touching"). Additionally, the participants had to rate the moral reprehensibility of running

the risk of a deflagration. Finally, participants were asked to choose a procedure (either the 11-step procedure, which is safe but comes with less benefit, or the 8-step procedure, which is unsafe but comes with a higher personal benefit).

Results

For data analysis, descriptive statistics, one-way ANOVAs and a Chi^2 test were calculated. The results show significant main effects for the rating of the scenario regarding the dimensions of being emotionally touched, dramaturgy, realism, credibility, and moral reprehensibility (cf. Table 4 for means and test statistics). Post-hoc analysis (using Tukey HSD) revealed that the damaged plant scenario was perceived as less emotionally touching than the scenario with slightly injured residents (p<.05) and the scenario with seriously injured residents (p<.01). The scenario with seriously injured residents were also perceived as more dramatic than the damaged plant scenario (p<.05). Additionally, the participants judged taking the risk that residents will be slightly (p<.05) and seriously (p<.01) injured as more morally reprehensible than taking the risk of plant damage.

Table 4. M and SD of scenario evaluation scales.

Scales	Damaged plant	Slightly injured residents	Seriously injured residents	Sig.
	M (SD)	*M (SD)*	*M (SD)*	
Being emotionally touched*	3.18 (1.29)	4.24 (1.71)	4.85 (1,54)	$F_{(2,96)}$ = 10.10, p = .00, η_p^2= .17
Drama*	4.48 (1.46)	4.85 (1.70)	5.45 (1,39)	$F_{(2,96)}$ = 3.41, p = .04, η_p^2= .07
Realism*	5.03 (1.38)	5.67 (1.22)	4.73 (1.72)	$F_{(2,96)}$ = 3.59, p = .03, η_p^2= .07
Credibility *	5.06 (1.22)	5.64 (1.29)	4.67 (1.61)	$F_{(2,96)}$ = 3.08, p = .02, , η_p^2= .06
Reprehensibility*	4.33 (1.95)	5.42 (1.3)	5.48 (1.4)	$F_{(2,96)}$ = 5.60, p = .01, η_p^2= .10
Percentage of intended violations	18.2%	6.1%,	6.1%;	$\chi^2_{(2,99)}$ = 3.56, p=.17, η_p= .19

Note: *Scale from 1 to 7.

The scenario with the seriously injured residents were perceived as significantly less realistic than the scenario with the damaged plant (p<.05); the scenario with the slightly injured residents was also rated as more realistic than the scenario with seriously injured residents, although the difference does not reach significance (p=.08). Regarding the credibility rating, the scenario with the seriously injured residents was perceived as significantly less credible than the scenario with the slightly injured residents.

On a descriptive level, the participants in the damaged plant condition seemed to be more often willing to violate a rule (18.2% vs. 6.1% in the scenarios with injured residents). According to the calculated Chi^2 test, this difference was not statistically significant (see Table 4).

Conclusions for the selection of scenarios

The two scenarios in which people were injured were evaluated as equally dramatic and emotionally touching and were therefore assumed to trigger *benevolence norms* equally well. As the scenario with the slightly injured residents was rated as more realistic and credible than the scenario with seriously injured residents, this scenario and the damaged plant scenario were chosen for use in the main study to operationalize the *goods at stake*.

The results of the pre-study also lead to the assumption that if there is a possibility that people might be injured, subjects are less likely to intend to violate a safety-related rule. The following main study should answer the question of whether subjects actually act on this intention.

6.1.5 Main Study

For the main study, a simulation of the scenario described in the pre-study was used. The simulation (*WaTrSim*, Burkolter, Kluge, German, & Grauel, 2009) offers the advantages of an experimental setting such as the possibility to vary certain conditions like the framing of the production outcomes and the goods at stake conditions. Nevertheless, the experimental situation is close to a real working context because the simulation of an industrial plant is used.

Method

A 2 x 2-factorial experimental design with the factors *framing* (loss vs. gain) and *goods at stake* (destruction of material property vs. slightly injured residents) was imple-

mented. The experiment was approved by the Ethics Committee at the Department of Psychology of the University of Duisburg-Essen.

136 students (52 female) aged between 19 and 37 years (*M* = 22.99, *SD* = 2.99) from the Engineering Department of the University of Duisburg-Essen participated in the experiment, which was conducted between July 2011 and May 2012. Participants were randomly assigned to the *framing* conditions and the *goods at stake* conditions. Participants were recruited by flyers and advertising in lectures of the university. The cover story of the investigation was that training for operating the simulation should be evaluated. It was announced that in about three hours, *up to* 25 EUR could be earned in the experiment.

Participants were invited in groups of up to eight people per experimental session. First of all, participants were informed about the purposes of the study and told that they could discontinue participation at any time (in terms of informed consent). One session included the measurement of person-related variables, the introduction and training phase, the criterion measurement and finally the debriefing (see Figure 14).

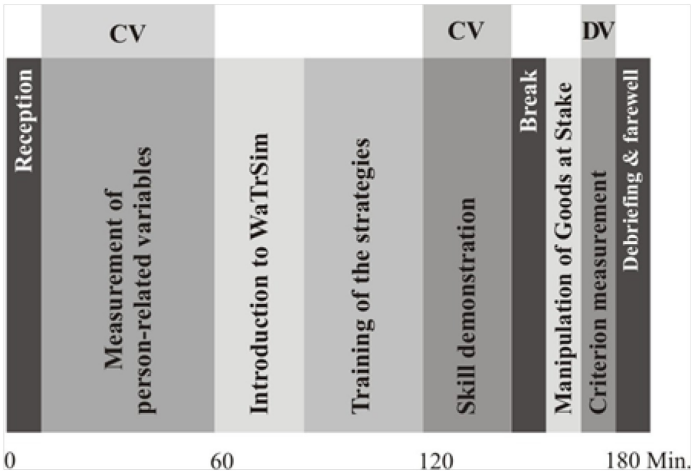

Figure 14. The experimental procedure, CV= Control Variables, DV= Dependent Variables.

A seven-item test of prior technical knowledge, general mental abilitiy (Wonderlic, 2002), a test on risky decision making (Game of Dice Task GDT, Brand et al., 2006), and a short test for assessing conscientiousness (Saucier, 1994) were applied to assess person-related variables identified as relevant in the IMV (see Figure 12). It was assumed

that people might differ concerning their responsiveness to the *goods at stake* conditions depending on their empathy. Therefore, empathy was measured using the empathy scale of Paulus (2007). A sample item is: “Often, I am very emotional about things which I actually only observed.”).

The participants’ task. The participants were introduced to the Waste Water Treatment Simulation (*WaTrSim*, Burkolter et al., 2009). *WaTrSim* is a computer-based simulation of a plant for purifying industrial waste water.

The training. The training began with basic information about the simulation, then, participants were introduced to the user interface, the sub-processes, and the objectives of minimisation of the off-spec (waste product) and maximisation of the production output. Participants were also informed that their individual performance would be assessed in relation to a given production goal which has to be achieved. Both groups were trained in the application of the mandatory 11-step and 8-step procedure (see procedure characteristics of the pre-study).

Posttest. After the training, all participants took a posttest which measured the declarative knowledge about the simulation and the performance in applying the two procedures.

The production goal framing. Participants in both framing conditions received feedback on their production outcomes and salary while they were working with *WaTrSim*. In the *gain framing* condition, the participants trained and worked with a *WaTrSim* version in which the salary is displayed as a gain: Participants could see the amount of money they had earned (for example 20 EUR). The participants in the *loss framing* condition trained and worked with a *WaTrSim* version in which the salary to be earned is displayed as a loss: Participants see the amount of money they have earned in relation to the maximum salary of 25 EUR (for example, if they earned 20 EUR, the display reads -5 EUR).

It is important to note that frames are manipulated by changing the salience of reference points, meaning that participants perceive formally identical outcomes either as gains or as losses. In the *loss framing*, the reference point (production target) is the production which is achievable using the 8-step procedure, whereas in the *gain framing*, the reference point is the production which is achievable by using the mandatory 11-step

procedure. Therefore, the expected outcomes are identical in the two conditions: The 11-step-procedure leads in both framing conditions to about 20 EUR, while the 8-step-procedure leads in both framing conditions to up to 25 EUR. If a deflagration occurs, participants in both groups receive 10 EUR.

The goods at stake conditions. After the training phase, the posttest and a short break, participants returned to their computers and were told that they are now the responsible shift supervisor. Subsequently, they received a personal note which included a message from the company's safety department that there is a strict order to adhere to the 11-step procedure due to deflagration in one of the company's plants.

To provide some background information on this message from the safety department, the experimenter presented one of the newspaper articles (cf. Figure 13), in which it was described that the deflagration caused damage to the plant (scenario I) or led to slightly injured residents (scenario II, cf. pre-study).

The criterion measurement and debriefing. After receiving the personal message, participants were reminded of the objectives to be achieved as the shift supervisor and that their financial compensation for the participation would depend on their performance in this final trial. Subsequently, it was accentuated that each participant is responsible, in the role of shift supervisor, for the production and that it is his/her decision which procedure to choose. To ensure that the participants felt unobserved, the experimenter was called away by a colleague and left the room for one minute. It was measured how many participants complied with (started up the plant by using the 11-step procedure) or violated the safety-related rule (by using the 8-step procedure). After this final trial, participants were debriefed and all of them received 25 EUR.

Results

Three participants who were unable to perform the 11-step procedure after the training were excluded from the ANCOVA analysis to examine the hypothesis. Furthermore, the data from seven participants were excluded because these participants started WaTrSim without permission several times and were therefore more experienced in starting up the plant than the other participants. In total, 126 data sets were used for the ANCOVA.

For the statistical analysis, the variable violation (violation = 1, compliance = 0) was used as a continuous variable, because in this case it represents a quantitative at-

tribute (Tabachnick, Fidell, & Osterlind, 2001).

ANOVAs and Chi^2 tests were calculated to determine whether the groups differed significantly regarding different person-related variables, which might influence the decision-making process concerning rule violations (cf. Table 5).

Table 5. Descriptive Statistics of the control variables, M (SD).

	Gain		Loss		Sig
	Damaged plant *n* = 31	Injured residents *n* = 32	Damaged plant *n* = 31	Injured residents *n* = 32	.
Sex	9 female 22 male	15 female 17 male	13 female 18 male	14 female 18 male	$X^2_{(3,126)}$= 2.40, p = .49, η_p=.01
Age	22.97 (2.55)	22.94 (2.98)	23.81 (3.32)	21.94 (2.09)	$F_{(3,122)}$ = 2.40 p = .07, η_p^2= .06
General Mental Abilities (max. 50 pts)	28.94 (7.43)	26.50 (5.10)	26.94(5.47)	26.59 (4.25)	$F_{(3,122)}$ = 1.27 p = .29, η_p^2= .03
Conscientiousness scale (1-9)	6.59 (1.00)	6.47 (1.14)	6.56 (1.03)	6.56 (1.09)	$F_{(3,122)}$ = 0.85 p = .97, η_p^2< .01
Empathy scale (1-5)	3.45 (.53)	3.49 (.51)	3.39 (.56)	3.47 (.41)	$F_{(3,122)}$ = 0.21 p = .89, η_p^2= .01
Risky decision making (-18 – 18) +	9.10 (10.68)	10.07 (8.94)	13.71 (5.84)	9.56 (11.02)	$F_{(3,120)}$ = 1.57 p = .20, η_p^2= .04
Prior knowledge (max. 7 pts)	5.81 (1.01)	5.91 (1.12)	5.65 (.98)	5.59 (1.13)	$F_{(3,122)}$ =.58 p = .63, η_p^2= .01
Performance practical test (11-step procedure, hourly wage in €)	20.35 (1.09)	19.89 (1.17)	20.97 (2.67)	20.82 (1.94)	$F_{(3,122)}$ = 2.26 p = .09, η_p^2= .05
Performance practical test (8-step procedure, hourly wage in €)	22.45 (.90)	22.24 (1.08)	23.27 (1.93)	23.32 (.77)	$F_{(3,122)}$ = 6.26 p = .001, η_p^2= .13
Posttest knowledge (max. 28 pts)	21.55 (3.51)	22.41 (4.10)	21.29 (3.91)	21.22 (3.61)	$F_{(3,122)}$ = .66 p = .58, η_p^2= .02
Violations	12 violations 19 compliance	8 violations 24 compliance	11 violations 20 compliance	6 violations 26 compliance	$F_{(3,122)}$ = .130 p = .28, η_p^2= .03

Pairwise comparisons showed a significant difference only with regard to the performance of the 8-step procedure (cf. Table 5, line 10). Therefore, an ANCOVA with the performance of the 8-step procedure as covariate was calculated to test the hypotheses. Preliminary checks revealed that the assumption of homogeneity of variances was violated. Therefore, in the following analysis, an alpha level of $\alpha < .01$ is assumed to determine the significance of the results (cf. for example Pallant, 2001).

A two-way between groups ANCOVA was conducted to test the hypotheses regarding the impact of the framing and the goods at stake on rule violations.

Hypothesis 1, which proposes an impact of the *framing* on rule violations, was not supported by the data. The main effect for the *framing* ($F_{(1,\ 121)}$=0.60, p=.44, η_p^2= .01) does not reach significance (cf. Table 6 for means). Thus, previous effects of the *framing* found, for example, by Kluge et al. (2013) could not be replicated. Hypothesis 2, which suggests that the *goods at stake* have an impact on people's tendency to violate safety-related rules, also could not be verified. The main effect regarding the *goods at stake* did not reach significance ($F_{(1,121)}$=3.39, p=.07, η_p^2= .03, cf. Table 6 for means).

Finally, hypothesis 3, which suggests an interaction between the *framing* and the *goods stake*, has to be rejected. There was no significant interaction effect between the *framing* and the *goods at stake* ($F_{(1,\ 121)}$=0.05, p=.83, η_p^2< .01).

Table 6. Descriptive statistics concerning safety-related rule violations M (SD)

Goods at stake	Framing	*M*	*SD*	*N*
Damaged plant	Gain	.35	.49	31
	Loss	.23	.43	31
	Total	.29	.46	62
Injured residents	Gain	.22	.42	32
	Loss	.16	.37	32
	Total	.19	.39	64
Damaged plant & injured residents	Gain	.29	.46	63
	Loss	.19	.40	63
	Total	.24	.43	126

Note: Coding of behaviour: 0=compliance, 1=rule violation.

Post-hoc analysis of person-related variables and their impact on safety-related rule violations. To investigate the relationships between the various person-related variables with rule-related behaviour, point-biserial correlations were calculated (cf. Table 7). The participants who were excluded because they were unable to perform the 11-step procedure were included in the correlation calculation in order to describe the whole spectrum of the ability and performance levels present in the data set.

This analysis showed medium-sized positive and highly significant ($p < .01$) correlations between general mental ability and the prior knowledge, the performance during operating with the more complex 11-step procedure, and the posttest knowledge (cf. Table 7).

Table 7. Correlations between control variables and violations (N=126)

	M	D	1	2	3	4	5	6	7	8	9
Age (1)	23.05	3.05									
General mental abilities (2)	27.12	5.72	-.16								
Conscientiousness (3)	6.57	1.09	-.08	-.02							
Empathy (4)	3.45	0.50	.04	-.02	-.07						
Risky decision making (5) +	10.54	9.41	-.01	.15	-.06	.14					
Prior knowledge (6)	5.70	1.09	-.08	.34**	-.09	-.01	.02				
Performance *11-step procedure* (7)	20.33	2.20	-.20*	.31**	-.01	-.12	-.04	.28**			
Performance *8-step procedure* (8)	22.71	1.68	-.27**	.21*	.04	.04	.07	.15	.57**		
Posttest knowledge (9)	21.40	4.08	-.14	.42**	-.04	-.12	.08	.43**	.45**	.38**	
Violation (10)	37 violations 89 compliance		.08	-.08	.16	-.09	-.02	-.06	-.20*	-.07	-.22*

Note: Coding of behaviour: 0=compliance, 1=rule violation. The value of the practical test for both strategies 1 and 2 is a mean of the two-time execution of both strategies. + A high score means that the participant is risk-averse. *pt* = practical test; * $p < .05$, ** $p < .01$

Significant small-sized negative correlations ($p < .05$) were found between the rule-related behaviour and the performance in the complex 11-step procedure and the posttest knowledge. This means that the better the performance of the 11-step procedure, and the better the results of the posttest, the less likely participants were to commit a rule violation.

The general mental ability correlates with theoretical (posttest) knowledge during training and procedural knowledge (performance of the procedures) of the required task indicating that general mental ability is the best premise to acquire theoretical and procedural knowledge. The amount of knowledge and acquired skill in performing the 11-step procedure led, in turn, to a higher tendency to comply with rules.

6.1.6 Discussion

Results indicate that the *goods at stake* as well as the *framing* of the production outcome do not affect the decision-making process concerning rule-related behaviour. This means that violations occur to an equal degree under all experimental conditions.

The absence of the framing effect was unexpected because this effect was demonstrated in the same experimental context in several previous studies (Kluge et al., 2013; Kluge et al., 2010). A plausible explanation for the absence of the *framing* effect is that the effect might be sensitive to situational factors, like the implementation of the *goods at stake* manipulation in the experimental environment, or other situational influences which differed between the investigations. It can be assumed that additional factors moderate the occurrence of the *framing* effect in the decision-making situations investigated here. Further studies should investigate the stability of the *framing* effect. If it turns out that the *framing* effect is susceptible to situational influences, as appears to have been the case in the present investigation, these influences should be identified, characterised and further investigated with regard to their moderating role.

Concerning the *goods at stake*, the statistical analysis suggested that the *goods at stake* had no significant influence on the decision-making process regarding rule violations. However, it should be taken into account that the difference was marginally significant (p=.07), suggesting that the effect of the *goods at stake* might be detected with a larger sample. Therefore, further investigations should be conducted to determine whether or not the *goods at stake* are a relevant influencing factor regarding rule violations.

If the assumption that the *goods at stake* exert no effect on the occurrence of rule violations is maintained, this might be explained by different considerations. The participants were in a realistic goal conflict between the safety of the plant and the achievement

of their production goals. Participants wanted to achieve both the performance and the safety goals, but they were probably aware that the scenario, and the described possible consequences of the rule violation with which the *goods at stake* were induced, were fictional. The lower production outcome, by contrast, was not fictional, and a failure to reach performance goals directly affected their compensation for the investigation. The fictional nature of the *goods at stake* scenarios might therefore be one explanation why the participants decided to try to achieve their performance goals at the expense of the consideration of the *goods at stake*.

A further explanation for the findings is that in contrast to the investigation by Fagley and Miller (1997), who found an effect of the *goods at stake*, the main study was an experimental investigation in which the participants had to implement whatever decision they made. In Fagley and Miller`s investigation and in our pre-study, only the *intention* to violate a rule was investigated, whereas the main study captured the frequency of rule violations (*behaviour)*. As predicted, for example, by the Integrated Model of Behaviour Prediction applied to violation (Kluge, 2010; Kluge et al., 2013, cf. Figure 12), there is a relation between the intention and the behaviour, but *environmental factors* and the factor of *skill and training* also influence this relationship. Thus, it can be assumed that most participants presumably intended to comply with the rule in the condition in which residents could be injured, but this intention was not realised because several other factors interfered with it. These findings are consistent with those of McKeon, Fogarty and Hegney (2006), who found that the level of knowledge is negatively associated with the level or rule violations. In this regard, the data analysis revealed several person-related factors which significantly correlated with rule violations. The participants who performed the 11-step procedure well or who had substantial knowledge regarding the simulation violated the mandatory procedure significantly less. According to these findings, it can be assumed that a high level of skill and knowledge prevents rule violations. By contrast, deficits regarding the fulfillment of the work task lead to a higher tendency to violate a rule. The rule violations might be used by the participants to compensate for certain deficits in operating the plant.

The impact of knowledge on rule violations is corroborated by the findings of Grote, Weichbrodt, Gunter, Zala Mezoe and Kunzle (2009) who showed that rule-related decisions with negative consequences are often due to lacking knowledge about the task and the situation. Besnard and Greadthead (2003) even discovered that the accuracy of the representation of the reality, or task knowledge, is correlated with the positive consequence of the violation. The more accurate the representation the more likely the viola-

tions lead to positive consequences. In sum, a comprehensive knowledge and proficient skill level are likely to prevent rule violations and if they are committed they are less likely to lead to negative consequences.

In addition to the person-related factors, according to the IMV, there are also *environmental factors*, such as the achievement of the performance goals (Kluge, 2010; Kluge et al., 2013, cf. Figure 12), which influence whether people`s intention to comply with a rule is realised. Like in the experimental setting of the main investigation, the achievement of performance goals is also associated with certain bonus payments in many organisations. The current findings indicate that it is very important for participants to meet performance goals to achieve a good remuneration. The prevention of the endangerment of human life seems to only take second place. This finding is consistent with the results of a study by Falk and Szech (2013), in which participants had to decide either to save the life of a mouse but receive no money, or to get 10 € but have to accept that a mouse will be killed. They found that 40 % of the participants decided to accept that a mouse will be killed in order to get the remuneration; if they had to decide about the life of the mouse in a market situation, the rate of those who agreed to kill the mouse for financial remuneration even increased up to 80%. These results impressively demonstrate that the majority of the people are willing to diverge from social norms and act in a morally reprehensible way in order to achieve even a relatively small amount of money.

The non-occurrence of the effect of the *goods at stake* might also be attributable to the different characteristics of the performance and the safety goals. As mentioned above, the participants were in a conflict between the achievement of the performance and the safety goals. It seems possible that the *goods at stake* were not relevant for the decision due to the different levels of abstraction of the performance and the safety goals. While the achievement of the production goals directly affected the salary of the participants in every case, the consequences of disregarding the safety goals *(goods at stake)* were more elusive and abstract. It can be assumed that the high level of abstraction of the *goods at stake* led the participants feel less emotionally affected by the described consequences. Furthermore, Perse (1990) showed in her investigation that the emotional involvement with (television) news depends on the motivational setting of the viewer. While being confronted with the newspaper articles in the current study, the motivation of the participants was to achieve a high production outcome. Although the participants may have perceived the information that residents were injured to be quite dramatic, due to their motivational background and the distal consequences of the *goods at stake* condi-

tions, they did not really become emotionally involved. Therefore, the *goods at stake* did not affect the decision concerning the rule violation.

The issue regarding the emotional involvement in the experimental setting may raise the question why an experimental setting was used for the present investigation. At first the investigation, how it is designed here, is inconvertible in an organisational setting, because all details of the investigations have to be permitted and corroborated by the industrial council and by the managers of the respective organisation. The random assignment to different experimental conditions as well as the collection of personal data are some of the very problematic requirements which can only be met be experimental, "laboratory settings", but not by real organisational or "field" investigations (Stone-Romero, 2011). The laboratory setting, or as Stone-Romero says "special purpose setting" is in that respect associated with a high level of internal validity which enable the reliable conception of causal relations. Stone-Romero (2011) argues in this regard that a high internal validity justify the generalisation of the findings to other non-laboratory like for example organisational settings.

Considering the practical implications of the investigation, the assumption that rule violations can be prevented if it is described that the consequences may affect human well being, is not supported by the present findings. The evidence suggests that rather than appealing to *social norms,* it is more effective to offer *regular training measures for the operators* to reduce the amount of rule violations. A high proficiency level and substantial knowledge about the work task seem to provide the best prevention against rule violations. It should be further investigated whether the effect of performance and knowledge on rule violations can be found in other contexts as well. If it transpires that this effect is stable across different contexts and investigations, this will provide the very valuable insight that personnel development which improves the performance of a certain task or the knowledge about it is one tool that can be used to achieve more compliance, and thus more safety in organisations.

The present investigations led to several very valuable insights into the determination of safety-related rule violations. The factors knowledge and task performance are identified as significant predictors of safety-related rule violations. The *framing* effect does not seem to be as stable as appeared to be the case in previous investigations, and the *goods at stake* do not seem to influence safety-rule related behaviour at all. Nevertheless, several research questions remain. Besides the investigated factors, there are further environmental conditions which are assumed to determine safety-rule related behaviour as well. To investigate these factors, the *WaTrSim* basic version has been extended

into a new version called *WaTrSim-Annual*. *WaTrSim-Annual* simulates a whole production year in which the participants have to decide not only once, but a total of 48 times whether they want to comply with the rule. This extension of the simulation allows the investigation of the decision-making process concerning safety-related rule violations over the course of time. This is even closer to the decision-making situation in the real working environment in an organisation, because operators usually have to decide regularly whether to violate a certain rule. Considering the IMV (cf. Figure 12), safety audits are assumed to be influential in this repeated, more long-term-oriented decision-making process. Therefore, the impact of safety audits and the impact of different accuracy levels of the information about the possibility of safety audits will be investigated in subsequent studies.

6.2 The impact of personality – Counterproductive Work Behaviour in a simulated production context: An exploratory study with personality traits as predictors of safety-related rule violations

6.2.1 Abstract

Counterproductive workplace behaviour (CWB) is investigated in Organisational Psychology as well as in the area of Human Factors. So far, each of these disciplines has mostly disregarded findings by the other. The present studies integrate findings gained from the two disciplines to investigate the qualities of personality traits that predict safety-related rule violations in a production context. A pilot study was conducted to test a set of personality traits in terms of their predictive qualities regarding the intention to violate a rule. Three traits (integrity subscale: *cautiousness, self-interest, injustice sensitivity*) emerged as predictors and were applied in a business simulation of a production environment (main study). *Cautiousness* turned out to be significantly correlated with safety-related rule violations in the production context. Hence, *cautiousness* should be measured in personnel selection in order to enhance safety and reduce the costs of CWB in organisations.

6.2.2 Introduction - The relationship between Counterproductive Workplace Behaviour (CWB) and Human Factors research on safety-related rule violations

Enhancing the productivity and wellbeing of people in organisations is the major goal of work and organisational psychologists. Traditionally, organisational psychologists have focused on the investigation of beneficial behaviour, such as motivation or job satisfaction, while less attention has been paid to negative, counterproductive behaviour patterns (Griffin et al., 1998). According to Sacket (2002), CWB is defined as intentional behaviour on the part of an organisational member, which is contrary to the interests of the organisation. Examples of CWB include theft, misuse of information or unsafe behaviour (enumeration of Gruys & Sackett, 2003). There are many terms which describe behaviour that is similar to or the same as CWB (cf. *employee deviance*, see below). In line with some authors who suggest using CWB as generic term (cf. for example Gruys & Sackett, 2003), in the following, CWB is used as generic term for all concepts which describe deviant behaviour in the work context.

6.2.3 Theoretical background

The fact that CWB is assumed to cost organisations billions of dollars every year (Murphy, 1993; Ones, 2002) demonstrates that CWB is not an unlikely practice in many organisations. In the past years, CWB has become an important topic in the area of Organisational Psychology as well as in Human Factors research.

The Human Factors Perspective

Human Factors research is concerned with the investigation of the human-system interaction and its effects on performance, user satisfaction and safety (Wickens et al., 2004). In the area of Human Factors, CWB is mainly considered under the heading of safety-related rule violations and their impact on safety. The *violation of safety-related rules* is defined as "[…] deliberate departures from rules that describe the safe or approved methods of performing a particular task or job" (Lawton, 1998, p. 78).

Reason (2008) further differentiates between *malevolent violations*, which are undertaken to damage the system, and n*on-malevolent violations*, which are not committed to harm an organisation. Malevolent violations occur due to different motivations: Some are committed to compensate for deficiencies in the workplace (Reason, 2008), while others are due to the general human tendency to choose the most comfortable, less effortful behaviour (Reason, 1990). According to Reason (2008), some violations are committed to demonstrate skills in handling difficult risky situations or arouse a thrilling experience.

The Organisational Psychology Perspective

Like rule violations, CWB is affected by different factors. Possible variables that might influence CWB include the safety climate in an organisation (Ehrhart & Raver, 2014), and a lack of vocational fit (Iliescu, Ispas, Sulea, & Ilie, 2015). CWB in general has been measured by several instruments (see below) which use peer rating (co-workers or supervisors) as well as self-rating. Since self-reports were shown to be more valid than external assessments, the self-rating method of measurement is recommended (Berry, Carpenter, & Barratt, 2012).

In the area of Organisational Psychology, CWB is investigated under different headings and terms. CWB includes a variety of different behaviour patterns, which are described with different terms and at different levels of abstraction. The following list is not exhaustive; on the contrary, only the terms which are relevant in the context of the investigation at hand are described and defined.

There are terms that are used more or less synonymously with CWB, like *employee deviance* (Bennett & Robinson, 2000), and terms that describe behaviour which can be categorized as CWB if it occurs in the organisational context but which are not restricted to this area, like *antisocial behaviour* (Giacalone & Greenberg, 1997), *lying behaviour* (Williams, 2002), or *imprudent* and *criminal behaviour* (Arneklev, Grasmick, Tittle, & Bursik Jr, 1993; Arneklev, Elis, & Medlicott, 2006).

Employee deviance refers to "[...] voluntary behaviour that violates significant organizational norms and in doing so threatens the well-being of an organization, its members, or both" (Bennett & Robinson, 2000, p. 556). Examples of such behaviour include theft, disciplinary problems, substance abuse, property damage or organizational rule-breaking (Salgado, 2002). All of these examples refer to rule-violating behaviour; however, the latter example plays an important role in the context of safety-related rule violations in organisations.

Antisocial behaviour can be defined as any behaviour that impairs or aims to impair an organization or its members (Giacalone & Greenberg, 1997). According to the authors, examples of *antisocial behaviour* in organizations are fraud, interpersonal violence, lying or violations of confidentiality.

Lying behaviour can be understood as "[...] an assertion, the content of which the speaker believes to be false, which is made with the intention to deceive the hearer with regard to that content" (Williams, 2002, p. 96). As such, lying behaviour involves the act of knowingly giving out wrong information with the intention of misleading another person; behaviour that can harm an organisation or even endanger work safety.

Imprudent behaviours can be conceived of as irresponsible acts such as smoking, alcohol consumption and gambling (Arneklev et al., 1993). Similar to *criminal behaviours*, imprudent behaviours also "[...] require little planning, provide immediate gratification, and offer a great deal of excitement" (Baron, 2003, p. 404). According to Arneklev et al. (2006), the difference between the two types of behaviour is that imprudent behaviour is not illegal while criminal behaviour always is.

Integrating the Organisational Psychology and Human Factors Perspective

The wide range of terms makes it hard to integrate and compare empirical findings. Most researchers have a specialised understanding and have developed their own theories regarding their conception of CWB; hence, the research results pertaining to similar constructs are often not considered (Ones, 2002). In particular, the research in the different areas of Organisational Psychology and Human Factors have mostly disregarded findings and developments in the respective other area.

When considering these terms and definitions, the link between CWB and *safety-related rule violations* becomes apparent. CWB involves the violation of certain rules or norms, but *rule violations* are often, but not necessarily, CWB. Rule violations are associated with the risk of undesired outcomes, but most violations do not result in harm for the organisation (Alper & Karsh, 2009; Besnard & Hollnagel, 2014). If the rule violation is committed in order to handle a new situation, or to achieve other, more important, organisational goals, the violation can even be advantageous for the organisation (Besnard & Hollnagel, 2014; Hale & Swuste, 1998). Taken together, the constructs of CWB and rule violations seem to be closely connected. The connection between these constructs suggests that there are similar processes which determine these behaviours.

Preliminary findings regarding safety-related rule violations

The present investigation assumes a Human Factors-oriented perspective and therefore focuses on the violation of safety-related rules. As such, the *Macroergonomic Framework of Rule-Violations* by Alper and Karsh (2009) was used as a starting point for the investigations. Alper and Karsh (2009) described different levels of factors which influence the decision to violate a safety-related rule. They differentiate between individual factors, such as experience, knowledge, or age; factors which are associated with the work system, such as the task complexity, time demands or department goals; organisational factors, such as organisational policy or social norms; and finally, external, environmental factors, such as the legislation, or influences of the industry.

Our research concentrated on the investigation of factors which refer to the work system level or the organisational level (cf. for example Kluge et al., 2013; von der Heyde et al., 2013; von der Heyde, Presting, Kluge, & Badura, 2012). Nevertheless, some individual factors, like sex, age, conscientiousness or risky decision making were measured as control variables, because there are already some findings showing that these factors are valid predictors of rule violations (cf. for example Berry et al., 2007; Hale & Swuste, 1998). Surprisingly, none of the measured predictors, like conscientiousness or risky decision making, proved to be significant predictors of the violation of safety-related rules in our investigations (cf. von der Heyde et al., 2012). Therefore, the present study aims to identify personality traits that potentially predict rule-violating behaviour which have not yet been investigated in this context.

While the investigation of these correlations is comparatively less common in the area of Human Factors research, in the area of Organisational Psychology and personnel selection, the prediction of CWB on the basis of certain variables, like integrity or certain

other personality traits, is quite common (Ones et al., 1993; Peng, 2012; Salgado, 2002; Woolley & Hakstian, 1993).

The empirical findings concerning the correlation between CWB and personality traits should be used to gain new ideas for personality traits that might predict *safety-related rule violations* in organisations.

Personality traits for predicting safety-related rule violations in the production context

The review of the literature regarding the association between personality traits and various CWB behaviour patterns revealed eight concepts to be promising for the prediction of rule-violating behaviour.

Self-control describes the tendency to avoid acts whose negative long-term consequences outweigh current advantages (Marcus, 2004). The general theory of crime proposes that engagement in criminal behaviour is caused by low self-control (Gottfredson, 1990). These findings are supported by research demonstrating that various criminal and imprudent behaviours can be attributed to low self-control (e.g. Grasmick, Tittle, Bursik, & Arneklev, 1993). A more recent investigation in a student sample even found that self-control is associated with the violation of rules (Muraven, Pogarsky, & Shmueli, 2006). Therefore, *self-control* was included as one possible predictor.

Integrity is understood as an individual's conformity regarding values, norms and actions (Marcus, 2006). Marcus (2006) developed a practice-oriented method of *integrity* measurement to predict counterproductive behaviour in organisations. *Integrity* was included in this study because it is a well-established construct for predicting counterproductive work behaviour (Marcus et al., 2013). Five sub-constructs of integrity (Marcus, 2006) were assessed in the current study:

a. *Low distribution* assesses the strength with which the violation of norms and rules is distributed in daily work settings.

b. *Non-rationalization* describes the tendency to search for causes that justify unreasonable behaviour.

c. People with high levels of *reliability* are supposed to work in a structured manner, to keep their word and to control their impulses.

d. *Cautiousness* describes a person's preference for safe and predictable actions as opposed to risky and exciting situations.

e. *Conflict avoidance* refers to a person's tendency to avoid conflicts and to pursue a peaceful way of problem solving.

The *belief in a just world* is a concept that was originally introduced by Lerner (1980), who defined it as the belief that we are living in a world where individuals always get what they deserve. Hafer (2000) found that a strong *belief in a just world* was associated with a decreased use of unjust means to achieve long-term goals. The violation of rules can, to some extent, be regarded as use of unjust means; hence, it is assumed that rule-violating behaviour can be associated with a low *belief in a just world*.

The *sensitivity towards injustice* is, according to Schmitt, Maes and Schmal (1997), a construct which needs to be assessed from three perspectives: the victim perspective (others are advantaged while oneself is disadvantaged), the observer perspective (observing someone else being treated unfairly from a neutral position), and the perpetrator perspective (Schmitt et al., 1997). The latter perspective is mostly interesting in terms of an individual's tendency to feel guilty about unjustified benefits (Schmitt et al., 1997). Violations may be conducted to acquire (unjustified) benefits; hence, the perpetrator`s perspective is also included in the present investigation. Research investigating the effects of this trait suggests that *sensitivity towards injustice* from the perpetrator's perspective is positively related to prosocial behaviour and negatively related to antisocial behaviour (Gollwitzer, Schmitt, Schalke, Maes, & Baer, 2005).

Self-interest can be described as an action that is "undertaken for the sole purpose of achieving a personal benefit or benefits", such as tangible (e.g. monetary) or intangible (e.g. group status) benefits (Cropanzano, Goldman, & Folger, 2005, p. 285). Self-interest was included in the current investigation because it was found to be associated with lying behaviour (Grover & Hui, 1994).

Self-responsibility is focused on decision-making processes concerning planning and action regarding an individual's behaviour. An individual acts *self-responsibly* if important objectives and the achievement of objectives are thoroughly thought through before action is taken (Bierhoff et al., 2005). This personality trait was chosen because prior research found that the amount of performed safety observations can be associated with feelings of personal or *self-responsibility* (DePasquale, 1999).

Regulatory focus at work refers to the regulatory focus theory (Higgins, 1998), which differentiates between promotion-oriented individuals, who aim to

achieve desirable outcomes, and prevention-oriented individuals, who aim to avoid undesirable outcomes. Depending on the type of *regulatory focus* (promotion vs. prevention), individuals tend to apply different approaches which lead to the desired outcomes. The *regulatory focus* also leads to the occurrence of different error types. Higgins et al. (2001) found that Individuals who are promotion-oriented were less likely to make an "error of omission" (refers to an action in which something has been left out). Furthermore, an "error of commission" (refers to an action which should not have been taken) was less likely for individuals with a prevention orientation. Wallace, Johnson and Frazier (2009) applied the *regulatory focus* theory to work settings and found this theory to be a valid and reliable measure for predicting work outcomes such as productivity or safety performance. More specifically, Wallace et al. (2009) found that a promotion focus was positively related to productivity performance but negatively related to safety performance, suggesting that individuals with a promotion focus tend to work quickly rather than accurately and safely. Conversely, individuals with a prevention focus showed a positive relationship with safety performance (Wallace et al., 2009). It can be assumed that the regulatory focus is also associated with rule violations because the compliance with rules is an integral part of safety performance.

To investigate whether these personality traits are suitable for the prediction of *safety-related rule violations* in the production context (as a subtype of CWB), two studies were conducted. In the pilot study, merely the *intention* to violate a rule was investigated, whereas in the main study, concrete *behaviour* was looked at.

6.2.4 Pilot study

A web-based pilot study was conducted in order to preselect the personality traits which show the most promise regarding the prediction of safety-related rule violations in the production context (main study). The underlying assumption is that the personality traits which significantly predict rule-violating behaviour in daily life scenarios are also applicable for the prediction of safety-related rule violations in the production context. The pilot study included eight personality traits and their relations to the intention to violate a rule in daily life settings. Personality traits were measured using existing scales. The intention to violate rules in daily life settings was measured applying a self-constructed ten-item instrument, the purpose of which was to mirror the underlying principles of the busi-

ness simulation production scenario of goal conflicts (used in the main study and which takes 5 hours to complete) in ten small-scaled scenarios.

Method

Overall, 91 participants were recruited (65 female), most of whom (86.8%) were students while the rest were employees or freelancers. The participants were aged between 18 and 50 years (*M = 24.43; SD = 6.92*). The study was a questionnaire-based online study which took about 45 minutes to complete. Students were compensated with course credits; the remaining participants did not receive any compensation.

The online study was conducted between September and November 2012. It was approved by the local Ethics Committee. Subjects were informed about the purposes of the study and told that they could discontinue at any time (in terms of informed consent). The participants were recruited on the campus of the University Duisburg-Essen through flyers and posters, and posts in online forums as well as in online social communities (German student forums such as uni-protokolle.de and forums and social communities of students from different universities).

Predictor variables. As outlined in the theoretical background, seven personality traits were selected to be tested as predictors of rule-violating behaviour: *self-control, integrity, belief in a just world, sensitivity towards injustice, self-interest, self-responsibility* and *regulatory focus at work.* Apart from the constructs *self-control* and *regulatory focus at work*, all scales used in the study were designed in German. Exemplary items were translated for the purpose of this paper only.

The operationalisation of the predictor variables including the scale description, authors and exemplary items are displayed in Table 8. Most of the applied scales were shortened; items that fit well into the study's context were selected (an overview of items used can be found in the Appendix 11.2). All α-values provided in Table 8 refer to the reliability measures of the present pilot study.

Criterion: Rule-violating behaviour in daily life situations. Ten items measuring the tendency for rule violations in daily life situations (see Table 9) were developed by the authors (for the German Items, see Appendix 11.2.8). The rule violation instrument was developed as a short and efficient way to measure rule violations in the pilot study. Since the business simulation used in the main study is very time-consuming (taking 5 hours per person), the rule violation instrument was developed to enable a comparatively quick pretest of a large number of personality traits. The purpose was not to develop and validate the rule violation instrument as a new measurement method but rather to use it as a

substitute for the comprehensive simulation. This enabled the pilot study to be conducted online with the aim of selecting the best predictors of rule-violating behaviour from a number of already validated instruments.

Table 8. Operationalisation of the predictor variables

Personality trait	Authors	Scale description	Exemplary items	All items
Self-control	Seipel (1999) (derived from Grasmick et al., 1993)	15 out of 21 items (α = .67); 5-point Likert scale (disagree/agree)	"I never allow myself to lose control."	Appendix 11.2.1
Integrity	Marcus (2006) – Inventory of Work-Related Attitudes and Self-Assessment	5 (35 items) out of 9 (115 items) subscales • Low distribution (α = .67) • Non-Rationalization (α = .54) • Reliability (α = .64) • Cautiousness (α = .76) • Conflict avoidance (α = .77) 5-point Likert scale (disagree/agree)	• Low distribution ("Everyone cheats on their tax returns") • Non-Rationalization ("To be successful in one's professional life, one mustn't be too particular about rules and guidelines") • Reliability ("I work on tasks quickly rather than thoroughly") • Cautiousness ("I am sensible rather than adventurous) • Conflict avoidance ("I try to avoid conflict if possible")	Appendix 11.2.2
Belief in a just world	Schmitt et al. (1997)	Subscale "ultimate justice"; 6 items (α = .89); 5-point Likert scale (disagree/agree)	"Anyone who does wrong will be called to account for it one day."	Appendix 11.2.3
Sensitivity towards injustice	Schmitt et al. (1997)	Subscale "perpetrator perspective"; 9 items (α = .90); 5-point Likert scale (disagree/agree)	"It bothers me if I get something that someone else deserves"	Appendix 11.2.4
Self-interest	Mohiyeddini & Montada (2004)	8 items (α = .80); 6-point Likert scale (disagree/agree)	"I think it is more important to follow my own interests than the interests of others"	Appendix 11.2.5
Self-responsibility*	Bierhoff et al. (2005)	6 out of 20 items (α = .39); 6-point Likert scale (disagree/agree)	"I think everyone can contribute to improving their daily life."	Appendix 11.2.6
Regulatory focus at work	Solga (in prep.) (derived from Wallace et al., 2009)	6 items (1,3,5,7,9,11) subscale prev. focus (α = .87); 5 items (2,4,6,8,10) subscale prom. focus (α =.70); 5-point Likert scale (never/always)	"I concentrate on completing work tasks correctly" (prev. Focus)	Appendix 11.2.7

* Scale was excluded from analysis due to poor reliability levels

The items of the *rule violation instrument* explore an individual's intention to violate a rule, guideline or social norm in daily life settings. The instrument consists of ten items in which dilemma situations are described. The dilemma situations address different areas of daily life concerns that are assumed to be commonly experienced by individuals across Europe. As such, the dilemma situations include heterogeneous behaviour concerning sports activities, public and road transport, (illegal) internet activities and general social behaviour. Each situation comprises self-interested goals which are in conflict with different types of rules (e.g. social norm or law) in order to correspond to the behaviour investigated in the main study, as explained below. The rule violation instrument was developed to measure a person's tendency to violate or comply with rules when s/he is exposed to conflicting goals which either suggest complying with or violating a rule or social norm. Since these goal conflicts appear in different contexts, the items represent the various goal conflicts in various situations. Nevertheless, in order to mirror the simulation context which is used in the main study, the items of the rule violation instrument are congruent regarding the underlying conflict between the individual goal and the rule or norm.

The content validity of the rule violation instrument was designed to be high, since the propensity to commit rule violations in situations with conflicting goals is measured across different situational contexts and with reference to different rules and norms. Furthermore, the items were rated by a group of ten experts with respect to their closeness to reality and the extent of the dilemma which is experienced regarding each item. Only the items with a high interrater agreement in the expert rating were included in the rule violation instrument. Since the rule violation instrument was designed as a method to measure the criterion of rule violations more efficiently in a pretest, and was not conceived as a new instrument, neither the convergent nor the divergent validity was determined in the present investigation.

For each situation, the individual has to rate the degree to which s/he would violate the rule on a four-point Likert scale (disagree/agree). Through the use of a four-point scale, the participants are forced to indicate at least a tendency for one decision option (compliance/violation). The full list of items including means, standard deviations, item difficulties and discriminatory powers is presented below (Table 9).

Table 9. Means, Standard Deviations, item difficulties and discriminatory powers for items of the rule violation instrument, N=90

	Item	*M*	SD	p_m	r_{it}
1	I would rather risk being caught speeding than be late for an important appointment.	2.23	.97	.56	-.17
2	Although I have a blood alcohol level of 0.8 per cent (blatantly above the legal limit), I give my injured friend a lift to the hospital.	2.14	1.03	.54	.12
3	Although an opposing player lies injured on the ground due to my foul, I continue the match to make the final score for my team.	2.12	.97	.53	.33
4	I would cross the street when the lights are red in order to catch the bus, even though a family with small children is standing next to me.	3.13	.11	.78	.23
5	I would rather risk missing the last train than get on it without a valid ticket.	2.79	.11	.70	.23
6	I would rather risk failing an important exam than cheat using illegal means.	2.26	1.1	.56	.25
7	Although I notice that I've damaged another car while backing out of a parking space, I drive on (hit and run) so that my insurance doesn't go up.	1.98	1.01	.49	.37
8	Although I suspect the Smart phone (list price 600€) being offered to me by an acquaintance for 200€ is stolen, I buy it	2.23	1.13	.56	.37
9	Since my favourite film is out of stock in the shops, I download it illegally off the internet	2.74	1.22	.69	.37
10	Although I do not feel well, I offer my bus/train seat to a frail person.	1.72	.82	.43	.12

Notes. p_m = item difficulty; r_{it} = discriminatory power; items written in a lighter font are not included in the score calculation

The item difficulties are satisfactory; they are in the middle range and vary between .43 (Item 1) and .78 (Item 4). The discriminatory power of the items is not satisfactory; most items vary between .23 and .37. The items with a lower discriminatory power than .23 (items 1, 2 and 10) were excluded from the score calculation (excluded items are marked in a lighter font in Table 2).

As the rule violation instrument covers a heterogeneous construct, the calculation of Cronbach's Alpha as an indicator of reliability was not assumed to be applicable. The

calculation of retest reliability seems to be more appropriate, but requires two measurement times. Due to the fact that the rule violation instrument was designed not as a new measurement method but merely as a time- and cost-efficient alternative method to measure the criterion in the pretest, we suggest considering the discriminatory power values of the items as indicator for the reliability of the rule violation instrument (cf. Table 9).

Results

Pearson correlations were calculated to analyse the relationships between the items of the rule violation instrument and the personality traits (cf. Table 10).

Table 10. Means, Standard Deviations and Pearson Correlations for the Criterion and the Predictor Variables, N=91

Item	Self-control (Range 1-5)	Injustice sensitivity (Range 1-5)	Self-interest (Range 1-6)	Regulatory focus at work prom. Focus (Range 1-5)	Regulatory focus at work prev. Focus (Range 1-5)	Self-responsibility (Range 1-6)	Belief in a just world (Range 1-6)	+Low distribution (Range 1-5)	+Non-rationalization (Range 1-5)	+Reliability (Range 1-5)	+Cautiousness (Range 1-5)	+Conflict avoidance (Range 1-5)
1	-.01	-.10	.19	.21	.17	.04	.13	.24	.16	.11	.33	.09
2	-.09	.11	.04	.00	-.13	-.27**	-.01	.09	.03	-.17	-.09	-.11
3	-.05	-.36**	.39**	.21*	.11	-.12	-.07	-.04	-.31**	-.13	-.27*	-.16
4	.14	-.26*	.11	.32**	.14	.03	-.17	.07	-.04	-.04	-.44**	-.15
5	-.02	-.12	.12	-.04	.01	.03	-.16	.11	-.09	-.13	-.32**	-.13
6	-.06	-.11	.05	-.17	-.02	.03	-.07	-.26*	-.19	-.11	-.16	-.12
7	-.04	-.39**	.48**	-.10	-.09	-.13	.10	-.02	-.17	-.31*	-.22	.05
8	-.17	-.28**	.18	-.02	-.22*	-.13	-.11	-.02	-.16	-.17	-.21	-.06
9	-.19	-.15	.16	-.14	-.18	-.15	-.14	.03	-.09	-.19	-.16	-.12
10	.14	-.07	.26*	.21	.31**	.04	-.07	.21*	-.01	-.06	.08	.05

Rule-violation in-strument (13)	-.11	-.42**	.37**	.10	-.07	-.12	-.16	-.03	-.27*	-.28**	-.45**	-.18

Note. + indicates a subscale of the Integrity Inventory, ** p < .01, * p < .05

The means, standard deviations and correlations are displayed in Table 10. Significant medium-sized negative correlations were found between the *rule violation* instrument and the scales assessing *sensitivity towards injustice*, *non-rationalization*, *reliability* and *cautiousness* (see Table 10). These correlations suggest that higher scores on the respective scales assessing the personality traits are accompanied by a lower intention to violate a rule in a daily life setting. A significant medium-sized positive correlation was found between several items and the total score of the *rule violation* instrument and *self-interest*.

Regression

A backward regression was conducted to assess which combination of predictor variables (personality constructs) is best able to predict the dependent variable (intention to violate a rule in daily life settings). All predictors which significantly correlated with the r*ule violation instrument* were entered into the model. The weak predictors were removed until only useful predictor variables remained in the model (see Table 11). Therefore, not all of the tested predictors ended up in the model.

Table 11. Regression Analysis with Rule-Violating Behaviour (Rule Violation instrument) as Criterion

Predictor	*B*	*SE*	*ß*	*T*	*p*
Cautiousness (Range 1-5)	-.33	.07	-.41	-4.93	.00
Injustice sensitivity (Range 1-5)	-.14	.06	-.24	-2.50	.02
Self-interest (Range 1-6)	.15	.06	.22	2.25	.03
Non-rationalization (Range 1-5)	-.17	.09	-.17	-1.99	.05
R^2		.42			

The results of the backward regression indicated that four predictors explained 42% of the variance ($F_{(4,85)} = 15.17, p < .01$). Significant predictors of rule violations are *cautiousness* (ß= *-.41, p < .01*), *sensitivity towards injustice (ß = -.24, p < .05*) and *self-interest* (*ß = .22, p <.05*). The Beta coefficient of *non-rationalization* was not significant (*ß = -.17, p =.05*). The results indicate that low levels of *cautiousness* as well as *sensitivity towards injustice* (perpetrators perspective) are indicators of a high intention to violate a rule in daily life settings, whereas low levels of *self-interest* are associated with a low intention to violate a rule in daily life settings.

Discussion

The pilot study suggests that *cautiousness, sensitivity towards injustice,* as well as *self-interest* are personality predictors of the violation of rules in daily life settings. These results must be interpreted with caution because the criterion validity of the rule violation instrument could not be determined, as no external criterion for the violation of safety-related rules was measured. Due to the fact that this was a pilot study aiming to reveal which personality traits show the most promise regarding the prediction of rule-violating behaviour, the effort was minimized, but further studies should be conducted to determine the validity of the rule violation instrument.

The pilot study revealed *cautiousness, injustice sensitivity* and *self-interest* as valid predictors of the intention to violate a rule in daily life situations. The main study aims to investigate whether these personality traits are also suitable for the prediction of actual behaviour in a production work setting.

6.2.5 Main study

The investigation of rule violations in a real work setting is challenging because violations are associated with serious risks and endangerments. Therefore, a business simulation was used to investigate this research question. The business simulation *WaTrSim-Annual* (von der Heyde et al., 2013) represents the work situation of an operator in a chemical plant.

The participants assumed the role of an operator who has the task of starting up the *WaTrSim* plant each week (48 weeks in total) for one simulated production year. The participants were told that they would be paid for their participation and that their salary would be dependent on their performance level when operating the plant. As operators, they had to decide for every simulated week whether to comply with the rule and start up the plant according to the compulsory and safe 11-step procedure (productive behaviour), which is, however, not as profitable, or to violate the rule, applying a more profitable but

unsafe 8-step start-up (work-around) procedure (CWB). Overall, the participants were confronted 48 times with the goal conflict (or dilemma), with a good remuneration on the one hand and safety on the other hand.

The behaviour in this dilemma situation is assumed to be determined by several factors. On the basis of the pilot study results, it can be assumed that *cautiousness, injustice sensitivity* and *self-interest* are valid personality predictor variables not only for the intention to violate a rule in a daily life dilemma situation, but also for the actual behaviour concerning safety-related rule violations in a production environment.

Hypotheses:

1) Low rates of safety-related rule violations can be associated with high scores on the *cautiousness* scale.
2) Low rates of safety-related rule violations can be associated with high scores on the s*ensitivity towards injustice* scale.
3) Low rates of safety-related rule violations can be associated with low scores on the *self-interest* scale.

Method

Overall, 152 students (38 female) of the Faculty of Engineering of the University of Duisburg-Essen were recruited to participate in the study. The sample was aged between 18 and 33 years (M = 21.32; SD = 2.39). The study took about five hours to complete, including the training of operators. To generate a goal conflict between safety and good remuneration, the participants were told that they will be paid based on their performance in operating the plant. Due to ethical considerations, every participant was compensated with 50 Euros each. The study was conducted between November 2012 and July 2013. It was approved by the local Ethics Committee. The participants were recruited on the campus through flyers, posters, face-to-face contact in lectures and by posts in online forums and in social networks (forums and social communities of students of the city in which the study takes place and of cities in the immediately surrounding areas).

Procedure. First, participants were informed about the purposes of the study and told that they could discontinue at any time (in terms of informed consent). Then, they were introduced to the business simulation *WaTrSim.* They learned and were trained on how to operate the chemical plant by applying the two start-up procedures. After the training, the participants had to start up the plant and make their own decisions regarding which procedure to use. After they had completed the year in the business simulation, the

predictors *cautiousness, injustice sensitivity* and *self-interest* were measured. At the end of the study, the participants were debriefed and paid.

The Criterion Variable. After the first quarter of the simulated year, the 8-step procedure was declared as forbidden, because this procedure bears the risk of a deflagration (for further details see Kluge et al., 2013). To underline the severity of the consequence, participants were informed that the compliance with the mandatory procedure would be audited (cf. von der Heyde et al., 2013). If a participant violated the mandatory procedure and this was uncovered by an audit, s/he would have to pay a fine, which was to receive no weekly salary for the respective production week. From this point, the participants were in a goal conflict: They had to decide whether they would comply with the rule by using the safe but less profitable 11-step procedure or whether they would violate the rule by using the profitable but unsafe 8-step procedure (CWB). This decision had to be made a total of 36 times (criterion: 0-36 rule violations).

Results

Due to missing values in the data set or the inability to perform the two start-up procedures (measured by the performance in applying the procedures during the training), eight participants were excluded from further analysis. Thus, 144 participants were included in the analysis. Regarding the means and standard deviations, it becomes clear that the participants decided to violate the safety-related rule on average 13 out of 36 trials when starting up the plant (see Table 5).

Testing the hypotheses. It was hypothesized that low rates of safety-related rule violations (CWB) can be associated with high scores on the *cautiousness* scale (H1), high scores on the s*ensitivity towards injustice* scale (H2) and low scores on the *self-interest* scale (H3).

Hypotheses 2 and 3 have to be rejected, as there were no significant correlations of sensitivity towards injustice and self-interest with the amount of rule violations (see Table 12). A significant negative correlation was found between *cautiousness* and violations ($rs = -.21, p. < .05$), supporting hypothesis 1, which predicts that high levels of *cautiousness* are associated with low rates of safety-related rule violations.

Table 12. Means, Standard Deviations and Pearson Correlations, N = 144

	M	*SD*	1	2	3
Cautiousness (1)	2.43	.72	-	-	-
Injustice sensitivity (2)	3.53	1.01	-.09	-	-
Self-interest (3)	2.60	.96	.05	-.41**	-
Number of violations (4)	13.33	10.54	-.21*	-.04	.13

Note. **p < .01, *p < .05

6.2.6 Discussion

The present investigation aimed at forging bridges between the research into CWB in the areas of Organisational Psychology and Human Factors research. Predictors of CWB which are particularly suitable for the identification of applicants who are prone to safety-related rule violations were identified. The integrity subscale *cautiousness* is seen as a promising personality trait for predicting rule violating behaviour in daily life situations, as well as the violation of safety-related rules in the production context.

Although it is very effective and time-saving to measure only one predictor, the prediction of behaviour is more reliable if different predictor variables are used. Unfortunately, of the three investigated traits, only one trait (*cautiousness*) was found to be associated with rule violations in the production context. Further investigations should identify more predictors to ensure a reliable identification of applicants who are not prone to safety-related rule violations. Besides variables investigated in the main study, the pilot study showed further personality traits which correlated significantly with rule violations in daily life settings. *Reliability* and *non-rationalization*, which are subscales of integrity, correlated significantly with the criterion, but were not chosen for the main investigation because they explained the same variance as the chosen variables. Nevertheless, these traits may be more suitable for the prediction of safety-related rule violations in the production context. Furthermore, only five out of nine subscales of the integrity questionnaire (Marcus, 2006) were applied in the pilot study. However, the remaining four subscales (behavioural intentions, calmness/self-esteem, reliability/forethought and restraint) may also have the power to predict safety-related rule violations in the production context. This should be investigated in subsequent studies.

The initial assumption that there are similar processes and influencing factors which determine rule violations in the different contexts has to be reconsidered. The fact that only one of three investigated personality traits seems to be suitable for the prediction of rule violations both in daily life settings and in the production context suggests that rule-related decisions are influenced by the context in which the decision has to be made. It appears to make a difference whether the decision making concerning the violation of rules has to be made in the private or in the professional sector.

Limitations

Although a business simulation was used, the investigation was experimental in nature, meaning that it may be subject to a comparatively lower power in terms of generalising the findings to an organisational context on a 1:1 basis. In this regard, it may be asked whether the behaviour in organisational settings is comparable with the behaviour of the participants in the study at hand. Violating a rule in a simulation environment might differ from violating a rule in a true organisational setting because participants are aware that the consequence associated with their rule-violating behaviour (deflagration) is only a fictitious one.

The deficit regarding the external validity is one limitation of the main study. Nevertheless, the lacking external validity can be assumed to be compensated by the high internal validity associated with this type of experimental investigation (Stone-Romero, 2011). Besides the fact that relations can best be identified in experimental settings (Stone-Romero, 2011), it is very difficult to investigate rule violations in organisational settings. The issue of rule violations is a sensitive one, and the management and industrial council have to allow the collection of person-related data, including the measurement of certain personality traits as well as the person-related recording of rule violations. As a result, the investigation of rule violations in organisations, as it is proposed in the study at hand, is virtually impossible from both an ethical and an internal validity perspective.

However, the experimental setting is not necessarily disadvantageous: Stone-Romero (2011) pointed out that the findings gained in experimental settings are highly valuable because the internal validity is high and the relations found in the experimental setting can be generalised to field settings (such as the organisational setting).

A further limitation concerns the sample, which consisted only of students with the respective educational background and age range. Although the participants were engineering students (the same education as the people who work in such plants), the external validity of the results has to be verified. In this regard, an (ideally longitudinal) field

study is needed to prove whether the identified personality trait is, in fact, a good predictor of safety-related rule violations in the organisational context.

The participants in both studies were recruited not only personally (main study), but also via online forums and social communities (pilot study, main study) in which the study was announced. It might be argued that due to the investigation method of the pilot study and the recruitment procedures of both studies, the samples are not representative and that certain traits and experiences might be overrepresented. As there is evidence that online and paper-and-pencil data collection can generally be seen as equivalent (Weigold, Weigold, & Russell, 2013), and as predominantly student forums and communities were used for recruitment, it can be assumed that there are no fundamental differences between the participants recruited online and those recruited face-to-face. Hence, the authors assume that the samples are representative for the considered student population.

Conclusions

The present study considered deviant behaviour from various angles. The Organisational Psychology perspective and the Human Factors perspective were combined in order to gain new insights. The associations between CWB and personality traits were used to generate ideas for personality predictors of the violation of rules and norms in daily life settings as well as in the organisational context. In summary, it can be stated that the assumption that both CWB and rule violations are determined by the same factors was partially confirmed. *Injustice sensitivity*, *self-interest* and *cautiousness* are associated with CWB as well as the intention to violate a rule in daily life settings. With regard to rule-violating behaviour in the production context, *cautiousness* remained as a common predictor.

The outcomes show that interconnecting the findings from the different areas of Organisational Psychology and Human Factors offers a valuable resource to generate new ideas for the investigation of deviant behaviour in the respective other area. Future investigations should use this option more intensively in order to gain a better interdisciplinary understanding of the research topic of CWB and rule violations, respectively.

If further investigations replicate the findings of an association between *cautiousness* and safety-related rule violations, *cautiousness* should be used in the selection and development process of employees in general to prevent CWB. However, it should be used in particular for employees who work in high-risk settings, such as the production context, to prevent safety-related rule violations. Previous safety management regarding the “Human Factor” has been concerned with the prevention of unsafe acts mostly in

terms of industrial engineering and ergonomics. The measures of personnel selection are not yet used consistently. In the future, the measures of personnel selection should not only be used to improve performance, but should also be applied to enhance safety. As Kamp and Krause (1997) suggested, the identification of employees who are especially prone to rule violations should be an integral part of safety management measures in every organisation.

6.3 The impact of audit probability – The impact of the accuracy of information about audit probabilities on safety-related rule violations and the bomb crater effect

6.3.1 Abstract

The present investigation was conducted in order to gain insights into the determinants of safety-related rule violations. Thus, the aims were to replicate the framing of the production outcome investigated in previous studies; to ascertain the impact of the accuracy of information about audit probabilities; and to determine whether the amount of violations increases just after an audit has been experienced. The research questions were experimentally investigated using a 2x3 design with the factors framing (gain, loss) and accuracy of information about audit probabilities (no, vague or precise information). The participants (n = 148) were required to put themselves in the role of a control room operator of a waste water treatment plant. They had to choose whether to start up the plant using the prescribed safe but non-profitable procedure or to apply the profitable but unsafe and therefore forbidden start-up procedure. Participants violated the rule significantly more frequently when the production outcome was loss-framed. Furthermore, it was shown that precise information about audit probabilities led to significantly more rule violations than vague or no information. The data analysis additionally revealed that participants tend to violate a safety-related rule significantly more often if they have just experienced a safety audit (bomb crater effect). To prevent rule violations, it should be avoided that people (1) think that they are not reaching their objectives (as suggested by a loss-framed depiction of the production outcomes), and (2) receive precise information about audit probabilities. Furthermore, it is recommendable to occasionally conduct two consecutive audits.

6.3.2 Introduction

Organisational accidents are rare but disastrous events occurring in environments which involve complex modern technologies such as in the chemical industry, the aviation sector or the railway sector (Reason, 1997). Such accidents can have fatal consequences not only for the staff and the assets of the organisation, but also for the surrounding population who are not actually involved (Reason, 1997). The nuclear power plant disaster in Tschernobyl in 1986 and the explosion of the BP Refinery in Texas City in 2005 are two of the most notable catastrophes among the vast number of organisational accidents

which have occurred since the beginning of industrialisation. Most accidents are not monocausal, the accident analysis often revealing that technical malfunctions as well as unsafe behaviour led to their occurrence (Reason, 1997).

One of the most popular countermeasures to reduce unsafe behaviour in organisations is the establishment of safety-related rules (Dekker, 2005). Hale and Swuste (1998, p. 164) define safety rules as a prescribed behaviour response or system state which is required to occur in a certain situation. Safety rules are established and communicated to the system operator in order to improve safety. In many organisations, the adherence to rules is controlled by safety audits and inspections. In the present study, we address the communication of information about audits and the impact of experiencing a safety audit on behaviour. How are audits perceived and reacted to, and do they support rule compliance in the assumed direction?

Variables affecting rule violations

Since there is always a tension between rules and local practice (Dekker, 2005), the existence of safety-related rules is no guarantee that an employee will comply with them. Mason (1997) assumed that up to 70% of industrial accidents are attributable to the violation of rules. The violation of safety-related rules is defined as "[…] deliberate departures from rules that describe a safe or approved method to performing a particular task or job" (Lawton, 1998, p. 78). The motivational backgrounds from which a rule violation is committed can be rather diverse. Some rule violations are due to the motivation to damage the system (malevolent rule violations, Reason, 2008; allied to the concept of counterproductive behaviour in organisations, cf. for example Sackett, 2002), while others are not committed to harm the organisation (non-malevolent rule violations, Reason, 2008). Safety-related rule violations, as they are investigated in the present study, are assumed to be non-malevolent rule violations which arise due to conflicts between performance and safety goals.

Recent examples of severe accidents which have been officially declared to be due at least in part to the violation of safety-related rules are the Deep Water Horizon disaster in 2010 and the explosion of the Indian submarine Sindhurakshak in 2013 (Shaukat, 2013; Smith, 2011). In addition to the immense financial and environmental consequences of these disasters, both accidents claimed several lives. How can such accidents be prevented?

A theoretical model that comprehensively integrates several variables which affect safety-related rule violations is the Integrated Model of Behavioural Prediction applied to

Violations (IMV, Kluge,2010; Kluge et al., 2013), which is based on the work of Fishbein, Hennessy, Yzer and Douglas (2003).

The IMV describes the decision-making process of rule violations as influenced by individual as well as organisational factors. On the individual level, age, sex, as well as personality traits and past behaviour are considered as relevant for the determination of rule-related behaviour (Kluge et al., 2013). These variables exert their influence by affecting the behavioural, normative and control beliefs, which in turn influence a person's attitude, norms and self-efficacy.

Previous investigations by our research group focused on the environmental conditions, such as the framing of the production outcomes (cf. 6.1; cf. Kluge et al., 2013), the impact of different goods at stake on the activation of norms (cf. 6.1; von der Heyde et al., 2012), and the identification of personality traits which predict rule violations (von der Heyde, Miebach, & Kluge, accepted). Regarding the framing of the production outcomes, the results were mixed. Kluge et al. (2013) found a medium to strong effect of the framing of production outcomes on safety-related rule violations, whereas von der Heyde and Kluge (cf. 6.1) were unable to replicate these findings; in the latter investigation, the framing did not influence the rule-related decision. Surprisingly, the activation of social norms in terms of the goods at stake had no effect on the decision to violate safety-related rules. Whether the rule violation could damage the plant or was associated with the risk of injuring residents had no effect on the amount of rule violations which were committed (cf. 6.1).

The present investigation was designed to investigate the stability of the framing effect, the impact of the accuracy of information about audit probabilities, as well as the effect of a recent audit on the occurrence of safety-related rule violations.

The impact of the framing of the production outcome

The decision making concerning the violation of safety-related rules can be categorized as decision making under uncertainty. One very popular theory in this area is the Prospect Theory by Kahnemann and Tversky (1979), which proposes that people do not evaluate a situation on the basis of the consideration of total outcome values. On the contrary, their evaluation is based on a certain reference point, which is determined by expectations and situational influences. Kahnemann and Tversky (1979) assume that depending on the reference point, the same outcome can be perceived as a gain or loss. They assume further that the value function, which is the foundation of the outcome evaluation, differs for loss and gain perceptions. Loss looms larger than gain, meaning that

losing a certain amount (for example of money) is perceived to be more negative than gaining the same amount is perceived to be positive. This leads to different risk-related decisions: According to the Prospect Theory, the loss is perceived to be so negative that people will try to avoid the unpleasant situation by running relatively high risks. If the outcome is perceived as a gain, people will be more risk-averse. These assumptions of the Prospect Theory can be applied to the decision-making process regarding safety-related rules: If people are put into a loss situation, they should run the risk of rule violation significantly more often than if they find themselves in a gain situation. The loss and gain perception is manipulated by altering reference points regarding the financial remuneration (salary) for participation, which depends on the participants' performance. According to the Prospect Theory (Kahneman & Tversky, 1979), it can be assumed that the people violate safety-related rules significantly more often in the loss-framing condition than in the gain-framing condition. Our research group has already investigated this effect on safety-related rule violations, and so far, the results have not been entirely consistent. Whereas Kluge, Badura and Rietz (2013) found the proposed framing effect in three studies, von der Heyde and Kluge (cf. section 6.1) were unable to replicate the framing effect in a slightly modified experimental setting. Nevertheless, based on the assumptions of the Prospect Theory (Kahneman & Tversky, 1979) and on the evidence of Kluge et al. (2013), it can be assumed that there is a general effect of framing on rule violations, leading to the following hypothesis:

Hypothesis 1: If the salary is framed as a loss, people will violate significantly more often than if the salary is framed as a gain.

The impact of safety audits

One of the most obvious methods to reduce the frequency of safety-related rule violations is the implementation of safety audits (Dekker, 2005; Mol, 2003). According to Mol (2003), safety audits include, for example, the regular inspection of documents, the analysis of workplace design characteristics and emergency and hazard inspection plans. The compliance with rules is checked in so-called *process audits*, which involve the analysis of work practices: The employee's behaviour is compared to the standards or rules which regulate the behaviour in the respective situation (Mol, 2003).

During the decision-making process regarding rule violations, people weigh up the benefits and risks of the decision options (Battmann & Klumb, 1993; Zeitlin, 1994). In order to predict the rule-related decision, Lehman and Ramanujam (2009) developed a framework regarding the selectivity of rule violations in organisations. One of the contex-

tual conditions which they describe as influential regarding the determination of violations is the extent to which organisations monitor and detect rule violations and enforce rules, and the communication of this information to the organisational members. The extent of monitoring and detection of rule violations varies according to the frequency with which audits are conducted, and is also influenced by the amount of information which is revealed about the audit frequency (accuracy of information about audit probability). The enforceability of a rule is determined by the amount of audits and the magnitude of sanctions or fines which are prescribed if a rule violation is detected (Lehman & Ramanujam, 2009; Zhou, 1997).

Considering the framework of Lehman and Ramanujam (2009), it can be concluded that organisations should conduct audits to achieve a reduction in rule violations. Although most organisations use this measure, the analysis of several disasters revealed that many of these accidents are at least partly due to defective audit mechanisms of safety management (Hopkins, 2000). Since safety audits are associated with high costs (Power, 1997), it is important to carefully plan the implementation and timing of audits, as well as the type and extent of information provided about audit probabilities.

The impact of several audit characteristics and information about audits on people's rule compliance has been already investigated in the area of personal financial decision making (Kirchler, Muehlbacher, Kastlunger, & Wahl, 2007; Mittone, 2006; Spicer & Thomas, 1982). The authors found that participants try to maximize their outcome by weighing the possible gain which is associated with rule violations against the possible loss if the evasion is detected and punished. The evaluation of the risks is determined by the audit probability and the fine (Andreoni, Erard, & Feinstein, 1998; Kirchler et al., 2007). The more likely an audit and the higher the fine which would be incurred in the case of a detected rule violation, the less likely it is that people will decide to violate the rule (von der Heyde et al., 2013)

The impact of the accuracy of information about audit probabilities

Spicer and Thomas (1982) also considered the impact of the accuracy of information about the audit probability on rule violation or compliance. They varied the accuracy of information about audit probability: Depending on the experimental condition, the participants were provided with *precise* information about audit the probability (e.g. "an audit will occur on 1 in 20 occasions"), with moderately accurate information (e.g. "the audit probability is low"), or with no information about the audit probability. Only the precise information had an impact on the amount of rule violations insofar as participants

who received information with this level of accuracy committed significantly fewer rule violations than participants in the other two conditions. Mittone (2006) corroborated these findings: Comparing vague with precise information about audit probability, he found that people who received only vague information about the audit probability violated a rule significantly more frequently than people who were given precise information. It is assumed that this finding, which seems to represent a stable effect in the context of violations in the area of financial decision making, can be transferred to the decision-making process regarding the violation of safety-related rules in the production context.

Hypothesis 2: People who receive precise information about audit probabilities violate a safety-related rule significantly less often than people who receive vague or no information about audit probabilities.

The impact of an experienced audit - The bomb crater effect

The officially conveyed information about the audit probability is not the only informational source which people are assumed to consider when assessing the likelihood of further audits. The occurrence and the direct experience of previous audits are also assumed to be used as a reference. Several studies (Guala & Mittone, 2005; Kastlunger, Kirchler, Mittone, & Pitters, 2009; Kirchler et al., 2007; Mittone, 2006) found the "*bomb crater effect*", which is said to arise when assessing the future audit possibility during the time interval when an audit has just occurred: Participants assume that the probability that another audit will follow directly after the previous experience is very small, and they therefore decide more often to violate a rule or law during this time than during other time intervals. The term *bomb crater effect* is derived from an effect which was observed during the First World War. During bombardments, the soldiers tried to take shelter in bomb craters because they assumed that a bomb would be very unlikely to hit the same place twice in a short time period (Mittone, 2006).

According to Kastlunger et al. (2009), there are two approaches to explain the *bomb crater effect*: The effect can be due to a misperception of probability, which is also known as *gambler's fallacy* (Tversky & Kahneman, 1971), or may result from the motivation to compensate for fines for violations which were detected in the audit which has just taken place. According to the *gambler's fallacy*, people erroneously assume that every random sequence has to reflect the true proportion in the population. If, for example, a coin is flipped and heads has occurred five times in a row, people assume that the probability that tails will occur next time is higher than if the proportion was balanced. In actual fact, the probability is the same each time the coin is flipped, independent of what hap-

pened before. If this bias is transferred to the assessment of an audit probability, then people will erroneously assume that an audit is less likely if an audit has just occurred, leading to the occurrence of the *bomb crater effect*. In turn, it is assumed that the bomb crater effect can be transferred to the violation of safety-related rules. Based on this assumption, the following hypothesis is derived:

Hypothesis 3: The amount of safety-related rule violations is significantly higher directly after an audit than in the other considered time periods.

6.3.3 Method

In the present study, a 2x3-factorial design was implemented with the factors framing (gain and loss) and accuracy of information about audit probability (none, vague and precise). 152 engineering students (114 male) from the University of Duisburg-Essen participated in the investigation in winter semester 2012/2013 and were tested in groups of 4 to 14 persons. The participants' mean age was 21.32 years (*SD*=2.39). They were recruited by announcements in student panels, on notice boards and in lectures as well as by flyers distributed across the university campus. All participants were told the cover story that the study is about skill acquisition and retention in process control industries and human behaviour in system operations. The experiment was approved by the local Ethics Committee at the Department of Psychology of the University of Duisburg-Essen.

Applied simulation

The violation of safety-related rules is a sensitive topic, which is associated, moreover, with certain safety hazards. The assignment to the experimental conditions as well as the collection of person-related data has to be permitted by the industrial council and the managers of the respective organisation. This makes an investigation in an organisational context virtually impossible. In order to create an investigation context with the best possible internal and external validity, the experimenter decided to use a simulation.

A simulation combines the advantages of an experimental or special-purpose setting, which is associated with a high internal validity (Stone-Romero, 2011), with the best possible external validity, which is achieved through the simulation of a working situation with high face validity. Furthermore, well-established research on rule-related behaviour has already been conducted using simulated environments (Thibaut, Friedland, & Walker, 1974).

The computer-based simulation (*WaTrSim*, Burkolter et al., 2009) used in the present study is based on the simulation of waste water treatment plant. In the *WaTrSim* simulation, the participants assume the role of a control room operator, who is responsible for starting up and controlling one of the 20 plants of the company (WaterTec-Rhein-Ruhr). As operators, participants segregate industrial waste water, composed of solvent and water. The operator's highest-priority task is to maximize their production outcome.

For the present investigation, the *WaTrSim* was extended to a new advanced version called *WaTrSim-Annual* (von der Heyde et al., 2013, cf. Figure 15). *WaTrSim-Annual* simulates a production year with a total of 48 production stages, divided into four quarters with 12 stages, each of which represents one week within the production year. Every week (duration 180 seconds), the participant has to conduct a start-up procedure for running the plant. Depending on their performance, the participants can earn a maximum salary of 1€ in each week. Together with a general payment of 2€ for the training period, they were therefore able to earn up to 50€ for 5 hours of participation.

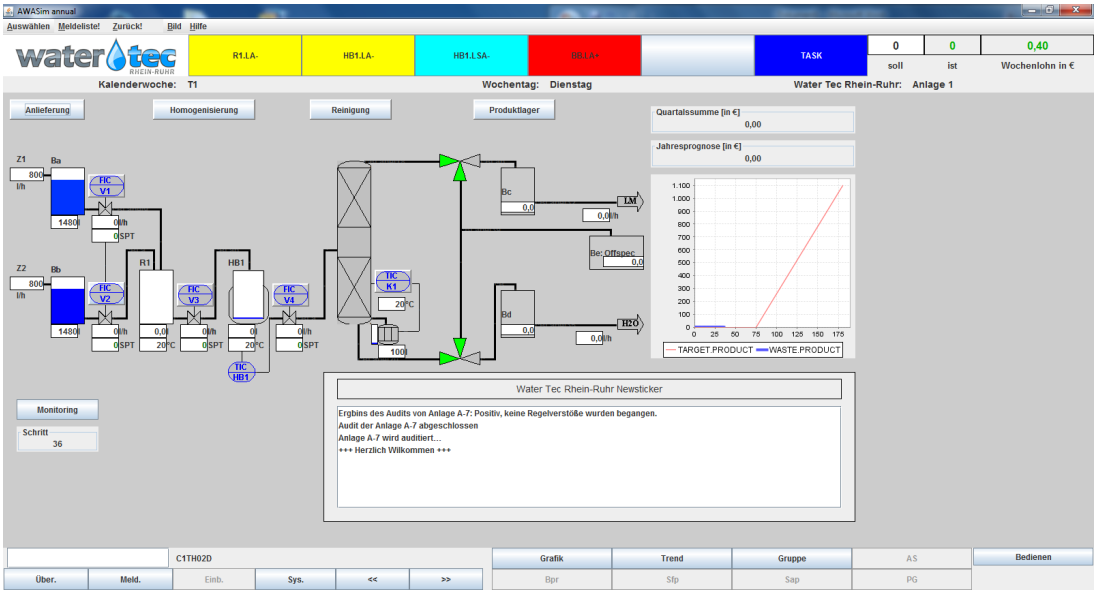

Figure 15. User interface of *WaTrSim-Annual*, the control room operator's view of the adjustable components of the plant, the performance display, and a news-ticker panel

Since starting up the plant 48 times in a row and repeating the same steps again and again was assumed to be a monotonous activity, an additional task, which changed weekly, was implemented in the simulation environment. This additional task was optional and not related to performance indicators. Furthermore, the additional tasks were only available after the plant had been started up in order to prevent distraction from the main

task. The additional tasks included, for example, voting to choose the next team event or entering the current amount of liquid into the different storage tanks.

Operationalisation of safety-related violation (dependent variable, DV)

There are two procedures which can be used to start up the plant. The procedures differ regarding safety and duration, and regarding the output and salary, which can be achieved by the procedure, respectively. The longer it takes to start up the plant, the less production outcome and salary can be achieved.

First, the participants were familiarized with the 8-step procedure (8 SP), which is a comparatively short and simple start-up procedure with which the plant can be started up very fast (within 56 seconds). Using this procedure, a weekly salary of up to 1.00 € can be achieved. The disadvantage of the 8 SP is that it can cause a critical system state, which involves the risk of a deflagration.

During the experiment, which encompassed a total of 48 simulated weeks, a deflagration occurs in one of the plants of the company after the 12th week. Subsequently, the 8 SP was declared as forbidden and the participants were made aware of the 11-step procedure (11 SP), which was henceforth the mandatory procedure. Within the 11 SP, the former 8 SP is extended by 3 additional steps at the beginning of the procedure to prevent a critical system state. These additional steps take more time to start up the plant (approximately 73 seconds); therefore, the 11 SP is less remunerative, as only up to 0.80 € can be earned.

The dependent variable, the safety-related rule violations, was measured by the procedures which were applied by the participants in the last three quarters. The *WaTrSim-Annual* software detects the occurrence of critical system states which are caused by the 8 SP. If the participants conducted the forbidden 8 SP in the last three quarters, this was registered as a rule violation; if the participants conducted the mandatory 11 SP, this was registered as compliance (range of rule violations: 0-36).

The independent variables

The following paragraphs address the implementation of the independent variables framing of salary and production outcome and accuracy of communicated audit probability. Additionally, the procedure for calculating the effect of a currently experienced audit on the participants' estimation of the audit probability for the next week will be described (bomb crater effect, cf. Hypothesis 3).

Framing. The framing was manipulated by varying the reference point of the display of the production target and salary in the most recent production week (see Figure 16). The salary depended on the production outcome which was achieved by the participants. In the gain-framing condition, the salary was displayed in relation to the reference point of earning nothing (0 €), meaning that if participants reached a weekly salary of 0.80 €, this was displayed as 0.80 € in green digits (see Figure 16, left). In the loss-framing condition, the reference point was the maximum possible weekly salary of 1€. In line with the previous example, the salary of 0.80 € was displayed as - 0.20 € in red digits (see Figure 16, right).

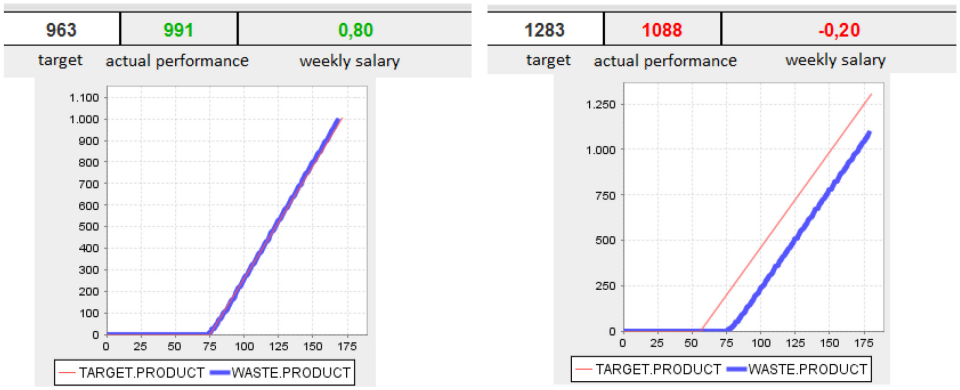

Figure 16. Framing of weekly salary and production target by conducting the 11 SP; left: gain-framed presentation; right: loss-framed presentation (this Figure is a summarized representation of framed parts of the user interface which were originally located differently)

The communication of the current and target production outcome was also framed. The required production outcome was communicated by a numerical reference point (see Figure 16, “target”), as well as by a diagram (see Figure 16, thin line).

In the gain framing, the reference point (i.e. amount) which should be achieved was 1100 litres. This production outcome can be achieved by applying the 11 SP. In the loss-framed display of the production outcome, the participants had to achieve 1300 litres. This production outcome could only be achieved by conducting the forbidden 8 SP. The reference point (i.e. production target) and the current production outcome which was achieved by the participants were communicated in real time by digits (see Figure 2, “actual performance”) as well as by a diagram (see Figure 16, bold line) to enable a permanent target-performance comparison.

The salary in the current quarter (see Figure 17, “quarterly total [in €]”) and the extrapolated salary for the entire production year (Figure 17, “annual forecast [in €]”) were,

depending on the experimental condition, also displayed on the user interface as gain-framed, Figure 17, left) and loss-framed, Figure 17, right). The salary in the current quarter represents the actual salary within the quarter just gone, meaning that the salary in the previous quarter was added and displayed. As already mentioned, in the gain-framing condition, the reference point was 0 € (i.e. if 4.80 € was earned, 0 + 4.80= 4.80 € was displayed, cf. Figure 17, left). In the loss-framing condition, the reference point was the maximum possible salary of 12 € (i.e. if 4.80 € was earned, - 12 + 4.80 = - 7.20 € was displayed, cf. Figure 17, right). The framed extrapolated salary for the entire production year was calculated by adding the salary earned so far to the expected salary in the coming weeks by determining an average performance (which had previously been calculated as 0.80 € per week). In the gain-framing condition, the reference value was 0 € (i.e. an extrapolated annual salary of 34 € was displayed as 0 + 34 € =34 €) and in the loss-framing condition, the reference point was 48 € (i.e. an extrapolated annual salary of 34 € was displayed as – 48 + 34= - 14 €).

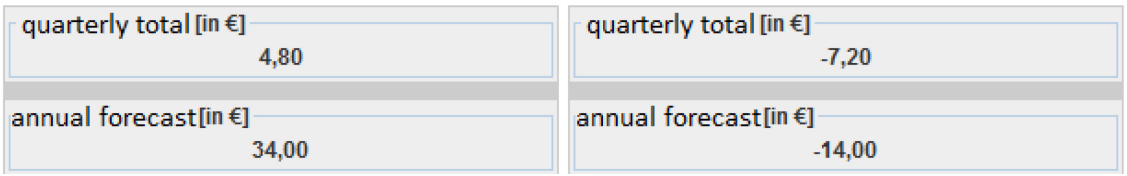

Figure 17. Framing of the salary in the current quarter (see “quarterly total [in €]”, and framing of the extrapolated salary for the entire production year (see “annual forecast [in €]”); gain-framing (left) and loss-framing (right)

At the end of each quarter, a temporary display appears with a quarterly report (cf. Figure 18, “quarterly figures”). This contains four values: the salary of the previous quarter (cf. Figure 18, “earnings in most recent quarter”); the accumulated salary which has been earned so far (cf. Figure 18, “salary to date”), the mean weekly salary (cf. Figure 18, “mean per week”); and the extrapolated salary for the entire production year (cf. Figure 18, “annual extrapolation”), which was also shown within the user interface Figure 17, “annual forecast [in €]”) .

To ensure that the framing exerted its full effect, the participants were additionally requested to transfer the values of the quarterly report to a paper-and-pencil-based production protocol.

Accuracy of communicated audit probability. After the 11 SP was declared as mandatory, the participants were informed that they would be regularly audited for the

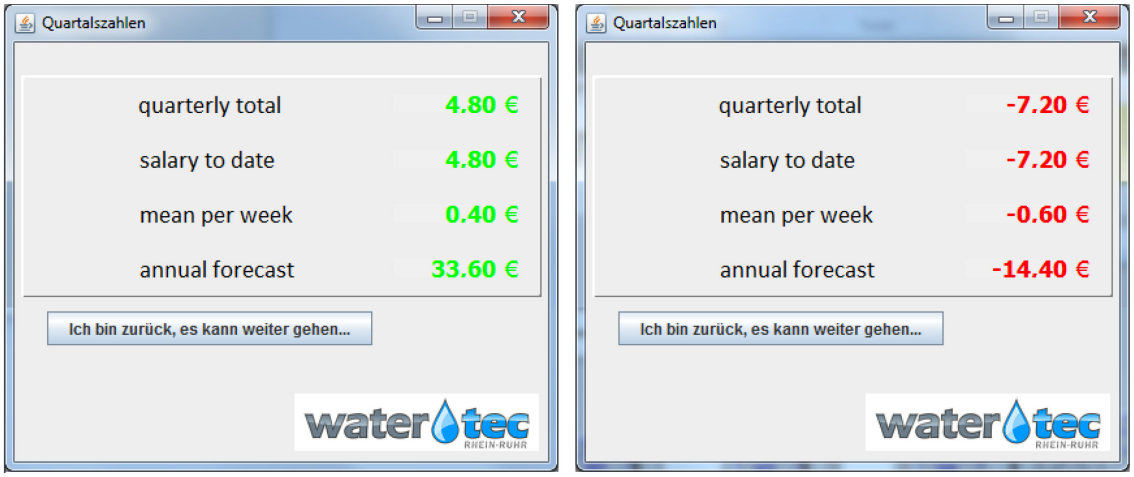

Figure 18. Framing of the quarterly report displayed at the end of each quarter; gain framing (left) and loss framing (right)

remaining three quarters. They were also informed that if a violation was detected, they would lose their salary for the respective week.

The audit frequency varied in the three remaining quarters. In the second quarter, there would be an audit in 1 of the 20 plants of the company each week (1 in 20 probability for the participants); in the third quarter, 5 of the 20 plants would be audited each week (5 in 20 probability for the participants); and in the final quarter, 3 of the 20 plants would be audited each week (3 in 20 probability for the participants). To ensure comparability between the experimental groups, the audits were not conducted at random in accordance with the respective probability; rather, the actual frequency of audits was predefined and therefore semi-random. To determine in which week the audits should be conducted, the plants to be audited were previously determined by a random selection of the plant numbers (for example: for the 1 in 20 probability, one of the plants were randomly selected, for the 3 in 20 probability, three plants were randomly selected and for the 5 in 20 probability, five plants were selected). Every time the plant number one was selected, the participants would be audited in the respective week. This random selection procedure resulted in audits for week 20 (second quarter, audit probability 1 in 20), 25, 29, 34 (third quarter, audit probability 5 in 20) 37, 43 and 46 (fourth quarter, audit probability 3 in 20). The number and temporal position of the audits in the production year were the same for all participants.

At the beginning of each quarter, the participants received information about the audit probability. The extent of information was varied according to the experimental factor *accuracy of information about audit probability*. The participants were randomly as-

signed to one of the three experimental conditions: no information about the audit probability *(n=50)*, vague information about the audit probability *(n=49)* or precise information about the audit probability *(n=49)*. The information provided to the respective experimental group in the given quarter is listed in Table 13. To ensure that participants were aware of this experimental manipulation, the respective announcement regarding the audit probability was made twice; first by the experimenter prior to the beginning of each quarter, and second via information in a pop-up window within the simulation. Furthermore, they were also informed about the audit probability by the news ticker which was implemented in the user interface (cf. Figure 15, large text box in the lower half of the interface). In the news ticker, the participants were given information about the current audit activities in the company according to the accuracy level of their experimental group (cf. Table 13). Therefore, in the no information condition it was merely displayed that audits were being conducted. In the vague information condition, participants were informed that a small (or large or medium) number of plants were being audited. The precise information condition included the specific plant numbers which were being audited (for example "currently, plant 5 is being audited").

Table 13. Announced audit probabilities for the respective experimental group and quarter in each week.

	No information	Vague information	Precise information
2nd quarter	**Various** plants are being audited	A **small number** of plants are being audited.	**1 in 20** plants are being audited
3rd quarter	**Various** plants are being audited	A **large number** of plants are being audited.	**5 in 20** plants are being audited.
4th quarter	**Various** plants are being audited	A **medium number** of plants are being audited.	**3 in 20** plants are being audited.

Audit Feedback. Each time the participants were audited, they received feedback concerning the outcome of the audit. This feedback occurred after 90 seconds within the particular week in which an audit was being conducted (as a reminder: the 11 SP takes approx. 73 seconds and the 8 SP approx. 56 seconds). This delay ensured that the participants were not alerted by others who had been faster in conducting the chosen start-

up procedure and could therefore be audited earlier. The feedback was implemented by a pop-up window notification (Table 14) containing positive (rule compliance detected) or negative (rule violation detected, no salary for the respective week) feedback.

Table 14. Displayed notification of positive and negative audit feedback

positive	negative
Your plant has just been inspected by the audit team. They found that you **complied with** the company directives and used the prescribed procedure to start up the plant. You have therefore **avoided** the risk of operations being interrupted by an undesired reaction. **You therefore do not have to expect a fine.** We would ask you to continue comply with the company directives in the future; otherwise, you will face a sanction of 1.00 €.	Your plant has just been inspected by the audit team. They found that you did **not** comply with the company directives and used the forbidden procedure to start up the plant. You have therefore **run** the risk of operations being interrupted by an undesired reaction. **According to the company directives, this will be sanctioned with a fine of 1.00 €.** We therefore ask you to comply with the company directives in the future; otherwise, you will face a sanction of 1.00 €.

The effect of an experienced audit (bomb crater effect)

To investigate the *bomb crater effect*, two specific values were calculated; first, the mean amount of violations committed in the subsequent week (and subsequent trial) after an audit had been executed (mean violation amount after audit); and second, the mean violation amount in the remaining weeks of the quarters 2-4 (base mean violation amount) excluding only the first quarter (because the 8 SP was allowed in this quarter) and the weeks after an audit had been executed. This exclusion is important for calculating a value that describes a mean tendency to commit a rule violation during the weeks that are not related to an audit. Based on the coding of compliance (0) and violation (1), the mean violation amount is the sum of all rule violations committed in the respective weeks, divided by the number of considered cases (here: N=148 for each considered week). As a consequence, the mean violation amount after an audit, as well as the base mean violation amount, ranges between 0 and 1 and can also be interpreted as the probability of a rule violation in the respective week.

Control Variables

The ascertained control variables comprised a set of demographic information such as sex and age, the level of experience in handling simulated environments as they are used in gaming environments (gaming frequency; Item: "Do you play computer games?", 6-point Likert scale), the general mental ability (Wonderlic, 2002), prior knowledge regarding simulation-related contents, performance, and the theoretical knowledge regarding the different start-up procedures (8 SP and 11 SP). Furthermore, the salary earned and several personality variables were controlled for. The presence in terms of the simulation environment was ascertained by the 11-item presence scale of Frank and Kluge (2014); cautiousness was measured by a 7-item subscale of Marcus´ integrity scale (2006), self-interest was measured by an 8-item scale by Mohiyeddini and Montanda (2004); and sensitivity towards injustice was measured by a 9-item subscale of the questionnaire of Schmitt, et al (1997).

General procedure

First of all, participants were welcomed, informed about the purposes of the study and, in terms of informed consent, told that they can discontinue participation at any time (see Table 15). Demographic information was then obtained. Afterwards, they were introduced to the simulation and learned how to start up the plant using the 8 SP. After the training, they had to demonstrate their practical skills (performance practical test 8 SP, see Table 15) by starting up the plant without any job aids. The knowledge about the simulation was tested by a posttest (posttest 8 SP, see Table 15). Subsequently, the first quarter began.

After the first quarter, the participants received a note written by the company's safety department. It had come to the department's knowledge that a deflagration had occurred in another plant of the company and that this deflagration was due to the 8 SP. To prevent future accidents, it was announced that a new start-up procedure would be introduced. This new 11-step start-up procedure was declared as mandatory.

To enable the participants to start up the plant using the new, mandatory procedure, the participants completed an additional training session. Afterwards, they had to demonstrate their practical skills regarding the 11-step procedure (performance practical test 11 SP), and their knowledge about this start-up procedure were tested by a short posttest (posttest 11 SP, see Table 15). Before the participants continued the production year, they were informed that it would be randomly audited whether they complied with the safety-related rule.

Table 15. General procedure (CV=control variable; DV=dependent variable)

Reception	Time		
Measurement of prior knowledge and general mental ability	*30*		**CV**
Introduction and training WaTrSim & 8 SP	*55*		
Performance and knowledge test regarding the 8 SP	*15*		**CV**
System operation quarter 1 (weeks 1-12)	***25***		**DV**
Break	*5*		
Deflagration	*5*		
Introduction & training of 11 SP	*25*		
Performance and knowledge test regarding the 11 SP	*15*		**CV**
Announced audits with no, vague or precise information	*5*		
System operation quarters 2 – 4 (weeks 13-48)	***75***		**DV**
Measurement of person-related variables	*20*		**CV**
Debriefing & farewell	*5*	=	***∑ ca. 285 min.***

After the participants had completed the production year, further person-related variables were measured in an online questionnaire. Subsequently, the participants were debriefed and paid. On average, they earned a salary of 39.52 € (*SD*=1.77). Due to ethical considerations, all participants received 50 €, independently of their performance.

6.3.4 Results

To ensure that the violation or compliance was a deliberate choice between the procedures, it needed to be checked whether the participants were able to conduct both procedures equally well. Therefore, an exclusion criterion was defined, according to which both procedures had to be executed correctly at least twice, either during the performance test after the training or during the production year. Based on this criterion, four of the original sample of 152 participants had to be excluded; thus, 148 participants remained for further analysis.

Manipulation check - The impact of the manipulated audit probabilities

A one-way repeated measures ANOVA was conducted to compare the amount of rule violations depending on the various audit frequencies in quarter 2 (1 in 20 audit probability, M=5.74, SD=4.47), quarter 3 (5 in 20 audit probability, M=3.95, SD=3.77) and quarter 4 (3 in 20 audit probability, M=5.17; SD=4.16). There was a significant effect of the changing audit probability ($F_{(2,96)}$=15.63, p<.01, η_p^2=.25), with a medium effect size.

The control group, which received no information about the audit probabilities, was tested separately. In this group, the amount of committed rule violations did not differ significantly ($F_{(2,48)}$<0.01, p=.99, η_p^2<.01) between the second (M=3.46, SD=4.27), third (M=3.46; SD=4.10) and fourth quarter (M=3.40; SD=3.85).

Control of confounding variables

To ensure that differences in the amount of rule violations were due to the experimental variation, the experimental groups were checked regarding significant differences in the control variables. The pairwise comparisons of the ascertained variables revealed that there were no significant differences between the experimental groups (cf. Table 16).

Testing the hypotheses

Due to the fact that there were no covariates identified in the previous analysis, an ANOVA was conducted to test Hypotheses 1 and 2. For Hypothesis 1, which refers to the effect of the framing on the amount of safety-related rule violations, the results show that an average of about 11 rule violations (of 36 possible violations) were committed in the gain condition (M=11.28, SD=10.39). In contrast, in the loss condition, an average of about 16 rule violations were committed (M=15.44, SD=10.34, cf. Figure 19). The main effect of the framing is statistically significant ($F_{(1,147)}$=6.67, p=.01, η_p^2=.05), albeit with a small effect size. These results support Hypothesis 1, which assumes that people violate safety-related rules significantly more often if the salary is loss-framed than if the salary is gain-framed.

Table 16. Descriptive statistics of the control variables, (M (SD)).

	Gain framing			Loss framing			
control variable (range)	None n = 25	Vague n = 26	Precise n = 25	None n = 25	Vague n = 23	Precise n = 24	Sig.*
Gender	10 female 15 male	8 female 18 male	2 female 23 male	4 female 21 male	8 female 15 male	6 female 18 male	$\chi 2$ = 9.37, p = .10 (for N = 148)
Age	21.88 (2.92)	21.77 (3.27)	20.76 (1.76)	21.84 (2.36)	21.00 (1.60)	20.79 (1.86)	$F_{(5,142)}$ = 1.28 p = .28, η_p= .04
Gaming frequency (1-6)	2.76 (1.33)	2.92 (1.49)	2.64 (1.44)	2.80 (1.80)	2.35 (1.50)	2.50 (1.53)	$F_{(5,142)}$= 0.47 p = .80; η_p= .02
Semester	3.48 (3.40)	2.92 (3.13)	2.38 (1.79)	3.91 (4.06)	3.45 (2.39)	2.17 (1.52)	$F_{(5,141)}$= 1.34 p = .25; η_p= .05
General Mental Ability (0-50)	29.16 (7.34)	28.54 (6.60)	27.08 (5.41)	30.48 (6.14)	27.78 (7.03)	29.21 (6.01)	$F_{(5,142)}$ = 0.85 p = .52, η_p= .03
Pretest knowledge (max. 7 pts)	5.32 (1.22)	5.54 (1.14)	5.60 (1.00)	5.44 (0.92)	5.65 (1.03)	5.46 (1.14	$F_{(5,142)}$=.30 p = .91, η_p= .01
Performance (8-SP, average output)	1111,74 (93,43)	1173,81 (90,26)	1121,83 (208,18)	1120,73 (79,01)	1120, 20 (155,38)	1160,14 (172,54)	$F_{(5,146)}$ = .80 p = .55 η_p = .028
Performance (11-SP, average output)	1197,68 (154,66)	1210,35 (117,39)	1162,20 (176,66)	1192,62 (129,33)	1161,11 (218,93)	1212,35 (130,73)	$F_{(5,150)}$= .40 p = .85, η_p= .01
Posttest knowledge 8 SP (0-27)	19.88 (4.02)	19.96 (3.24)	19.68 (3.34)	19.64 (3.55)	20.61 (4.58)	20.33 (3.81)	$F_{(5,142)}$= 0.25 p = .94; η_p= .01
Posttest knowledge 11 SP (0-3)	2.85 (0.46)	2.80 (0.41)	2.87 (0.34)	2.92 (0.27)	2.72 (0.61)	2.64 (0.75)	$F_{(5,142)}$= 1.07 p = .38; η_p= .04
Salary €	39.54 (1.04)	40.10 (1.04)	39.15 (1.77)	40.07 (1.24)	39.00 (1.90)	39.20 (2.69)	$F_{(5,142)}$= 1.84 p = .10; η_p= .06
Presence (1-6)	3.57 (0.92)	3.29 (0.92)	3.13 (3.13)	3.34 (0.93)	3.67 (0.98)	3.08 (0.76)	$F_{(5,140)}$= 1.70 p = .14; η_p= .06
Integrity: Cautiousness (1-5)	2.51 (0.82)	2.56 (0.76)	2.29 (0.61)	2.31 (0.70)	2.31 (0.70)	2.46 (0.73)	$F_{(5,135)}$ = 0.53 p = .75, η_p= .02
Sensitivity towards injustice (1-6)	3.48 (1.23)	3.38 (1.06)	3.38 (0.93)	3.42 (0.90)	3.88 (1.04)	3.66 (0.86)	$F_{(5,135)}$ = 0.86 p = .51, η_p= .03
Self-interest (1-6)	2.75 (1.13)	2.62 (0.98)	2.91 (0.90)	2.50 (0.70)	2.44 (0.94)	2.41 (1.08)	$F_{(5,135)}$ = 0.90 p = .49, η_p= .03

*The degrees of freedom differ in the various analyses due to missing values.

Hypothesis 2 refers to the influence of the accuracy of information about audit probabilities on the tendency to violate safety-related rules. It predicts that people who receive precise information violate rules significantly less often than people who receive no or only vague information about audit probabilities.

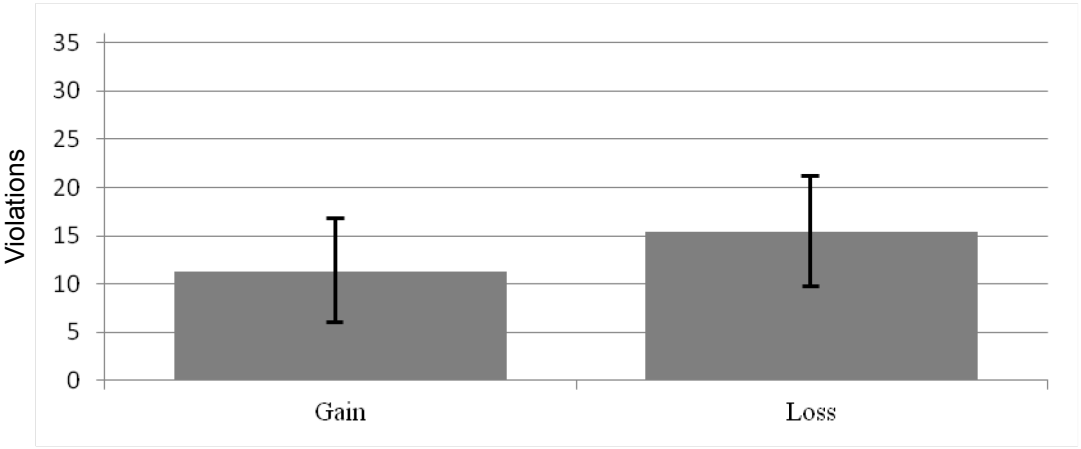

Figure 19. Means of safety-related rule violations (quarter 2-4; range 1-36) in the gain (*n*=76) and loss (*n*=72) condition

The comparison between the means in the different experimental conditions shows that there are differences between the conditions, but not in the hypothesized direction. In the no information condition, about 10 rule violations occurred on average (*M*=10.32, *SD*=10.12; *n*=50); in the condition in which the participants received vague information about audit probabilities, about 12 rule violations were committed (*M*=11.89, *SD*=9.72; *n*=49). The highest number of rule violations occurred in the precise information condition, in which an average of about 18 violations occurred (*M*=17.87, *SD*=10.41; *n*=49, cf. Figure 20).

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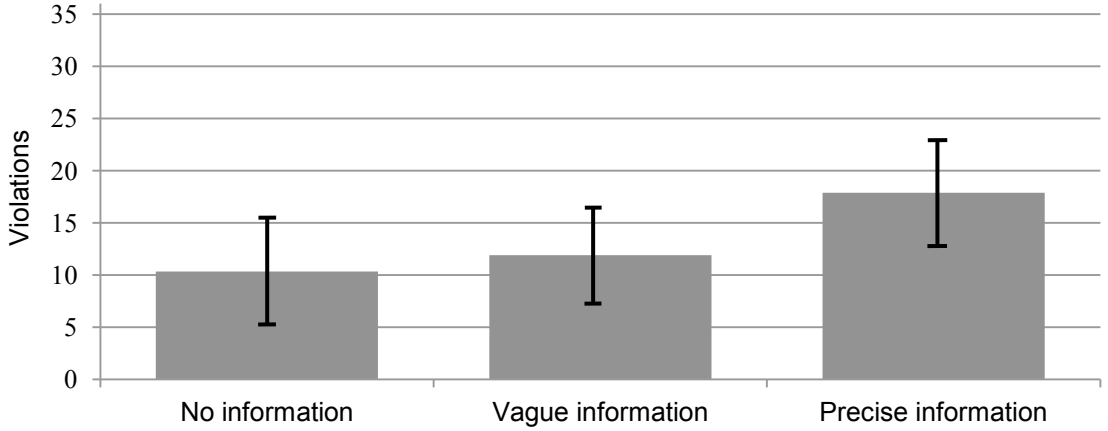

Figure 20. Means of rule violations in each condition (quarters 2-4; range 0-36)

The main effect regarding the effect of the accuracy of information about audit probability on the violation of safety-related rules is statistically significant ($F_{(2,147)}$=8.18, p<.01, η_p^2=.10). To test Hypothesis 2, the simple contrast type is chosen. The difference between the no information and precise information group is significant ($t_{(147)}$=-7.55,

p<.01), as is the difference between vague information and precise information ($t_{(147)}$=-5.97, p<.01). The hypothesis predicted a lower rather than a higher amount of rule violations in the case of precise information; therefore, Hypothesis 2 has to be rejected

According to the *bomb crater effect,* (Hypothesis 3), it is assumed that in the week after an audit has occurred the amount of rule violations will increase. In Figure 21, the amount of rule violations in each week is shown. The weeks in which an audit took place are circled. While during the second quarter (weeks 13 to 24) the first implemented audit led to a decrease in safety-related rule violations, in quarters three and four the amount of rule violations increased after the audits (except the violation amount after the final audit). To test Hypothesis 3, a one-tailed t-test was conducted. The t-test compares the mean violation amount with the amount of rule violations in the week after an audit. The mean violation amount (including all weeks except the weeks after the audits) is 0.36 (*SD*=0.30; 53 in total). In the week after an audit, the mean violation amount raised to 0.40 (*SD*=0.34, 61 in total). The difference between the mean violation amount and the mean violation amount in the week after an audit is statistically significant, with $t_{(147)}$=-1.71, *p*<.05. Hence, Hypothesis 3 is supported.

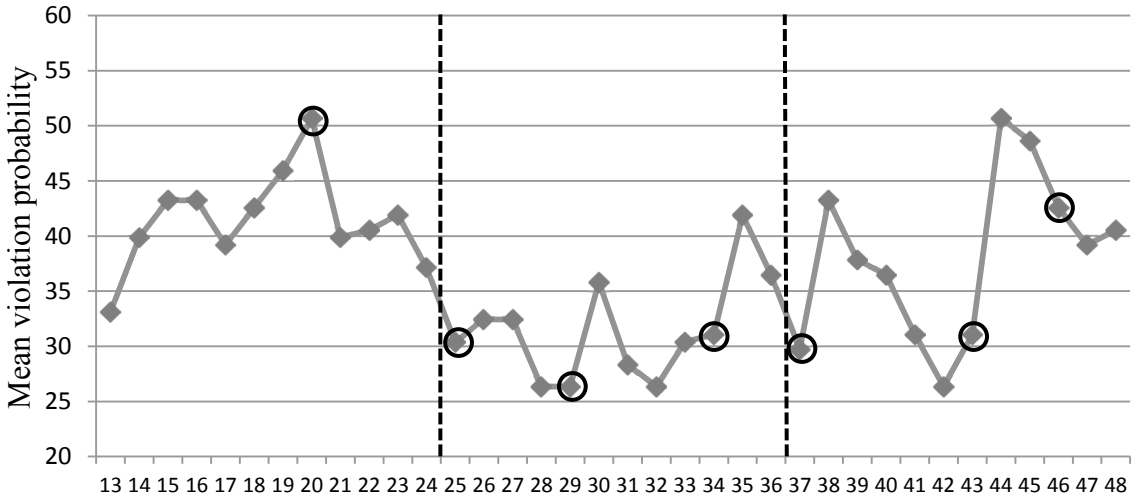

Figure 21. Progression of committed violations per week expressed with marked times of audits.

The differences between the mean violation amounts in the weeks in which an audit was being conducted and the mean in the weeks after the audit had been conducted were investigated in more detail. Table 17 shows the repeated measures ANOVA for these comparisons. For the first audit, there is a significant decline in committed viola-

tions. After the second audit as well as after the final audit, no significant change can be observed. The audits in weeks 29, 34, 37 and 43 are followed by a significant raise in the tendency to violate the rule (cf. Table 17).

Table 17. Probability of rule violations before and after an audit (N=148) compared by a repeated measures ANOVA.

Audited weeks		*M*	*SD*	$F_{(1,147)}$	*p*
20	Week of audit	.51	.50	6.02	.02*
	Week after audit	.40	.49		
25	Week of audit	.30	.42	0.22	.64
	Week after audit	.32	.47		
29	Week of audit	.26	.44	5.96	.02*
	Week after audit	.36	.48		
34	Week of audit	.31	.46	6.02	.02*
	Week after audit	.42	.50		
37	Week of audit	.30	.56	9.62	<.01**
	Week after audit	.43	.50		
43	Week of audit	.31	.46	18.43	<.01**
	Week after audit	.51	.50		
46	Week of audit	.43	.50	0.86	.36
	Week after audit	.39	.49		

Note. *M*=mean, *SD*=standard deviation, *p*=significance, *p<.05, **p<.01

Post-hoc analysis

A set of person-related variables were correlated post-hoc with the amount of safety-related rule violations. It was found that the sex (coded: 1=female, 2=male) is positively associated with the amount of committed rule violations (r=.20, p=.01), insofar as male participants violated the rule significantly more often than female participants. A significant negative correlation was also found between rule violations and cautiousness (r=-.21, p=.01). Moreover, the mean production outcome by applying the 11 SP is negatively associated with the amount of committed rule violations (r=-.30, p<.01). In other words, the higher the cautiousness and the better the performance regarding the 11 SP, the fewer rule violations were committed.

Other person-related variables such as age, general mental ability, sensitivity towards injustice, or self-interest, were not associated with the amount of rule violation.

6.3.5 Discussion

The present study was conducted to develop a deeper understanding of the processes and conditions of safety-related rule violations. Besides the framing effect, which was already focused upon in previous studies by our research group, in particular the impact of audits and the accuracy of information about audit probabilities on the occurrence of safety-related rule violations over the course of time were investigated.

The preliminary findings regarding the framing of the production outcome are inconsistent: Whereas Kluge et al. (2013) found that people more frequently violated safety-related rules in the loss-framed condition (von der Heyde and Kluge, cf. 6.1) were unable to replicate these findings, and did not find an effect of framing on safety-related rule violations. On the contrary, the present investigation found a significant framing effect and corroborates the results of Kluge et al. (2013). Although the framing effect seemed to be prone to certain situational influences which may account for the findings of von der Heyde and Kluge (cf. 6.1), on the basis of the current findings it can be assumed that the effect of framing is nevertheless a quite robust effect. This effect has been found both in an investigation of single-case decisions regarding rule violations (Kluge et al., 2013), and in an investigation of recurring rule-related decisions which have to be made repeatedly over a long time period as in the present study.

Regarding the audit placement and the communication of audit probabilities, the manipulation check regarding the accuracy of information about audit probability already revealed interesting results. Of relevance regarding the determination of safety-related rule violations is not the real frequency of audits, but rather the information about audit probability. The participants who received no information about the audit probability did not change their-rule related behaviour pattern during the different quarters. Although the audit frequency changed in the quarters (one audit in the second quarter and three audits each in the third and fourth quarters), it can be assumed that the audit frequency was too low to be discovered by pure observation, meaning that it was not considered in the rule-related decision.

In the experimental conditions in which the participants received precise or vague information about the audit probability, the mean audit amount differed significantly between the second (1 in 20) and third (5 in 20) quarters, and between the third and fourth quarters (3 in 20), even though in the latter case only the information about the audit frequency differed, and not the actual frequency. This shows that it is not the real frequencies that are decisive, but rather the information about the audit probabilities.

However, the fact that the occurrence of safety-related rule violations did not differ significantly between the second and fourth quarters indicates that people only adapt their behaviour due to major changes in the audit probability. They only became more cautious and committed significantly fewer rule violations if it was announced that the probability was high (i.e. 5 in 20 plants would be audited). If the announced audit probability was medium (3 in 20) or low (1 in 20), this did not seem to be decisive regarding the determination of the rule-related behaviour.

The current investigation revealed further that the accuracy of information about audit probability is decisive regarding the determination of rule-related behaviour, but not in the hypothesised direction. In contrast to the studies in the area of fiscal evasion, in which the level of accuracy of information about audit probability was negatively associated with rule violations (in terms of evasion, see Mittone, 2006; Spicer & Thomas, 1982), the current study suggests a positive correlation between the accuracy of information about audit probability and the amount of rule violations. The precise information about audit probabilities led to a higher amount of rule violations than if no or vague information about audit probabilities was supplied. These results can be explained by considerations of Heiner (1983), who assumed that a high level of uncertainty will lead to more compliance with rules, because the rules are the only available information regarding the appropriateness of behaviour. A recently published study, in which the impact of information about audits was investigated in the area of fiscal evasion, also proposed this uncertainty affect e.g. regarding tax evasion (Tan & Yim, 2014). Tan and Yim (2014) assume that most people will choose a worse but sure outcome over a better but risky outcome in order to avoid uncertainty.

Therefore, in the present case it can be assumed that the participants in the no information condition chose to comply and accept a lower salary in order to avoid the uncertainty which was associated with the rule violation. However, if the participants received precise information about the audit probability, they presumably believed that they could control the risk and therefore decided more often to violate the rule. Furthermore, it can be assumed that the information about the audit probability was perceived as a hidden request to adapt the behaviour according to the varying audit probabilities. The participants may have asked themselves why the organisation was communicating the audit probabilities, and as they were also constrained to achieve the production goals, assumed that they were also expected to adapt their rule-related behaviour to the varying audit probabilities.

The *bomb crater effect*, which had already been found in previous studies to be very robust (cf. Guala & Mittone, 2005; Kastlunger et al., 2009; Kirchler et al., 2007; Mittone, 2006), was also found in the present investigation. The mean amount of rule violations in the week after an audit was significantly higher than the mean amount of rule violations in the other weeks. The analysis of the *bomb crater effect* on a more detailed level, taking into account each week after an audit had occurred, revealed, moreover, that the post-audit increase in rule violations was significant in all weeks, with three exceptions: The bomb crater effect did not occur after the first two weeks after an audit and after the final audit. In the first week after an audit, the mean amount of rule violations even decreased significantly. This is congruent with the findings of other authors (Kastlunger et al., 2009; Mittone, 2006), which also revealed that the compliance increased after the first audit. This can be explained by a kind of deterrence effect, which already declines after the second audit and even becomes a reversed effect after the third audit. The absence of the *bomb crater effect* after the final audit may be due to the motivation to maintain the outcome level that has already been achieved. A loss of remuneration in the final trials can hardly be compensated, meaning that people may be more risk-averse, or only continue with their previously practiced rule violation strategy instead of reacting to current events like audits.

Limitations

Although the experimental design offers certain advantages, such as a high internal validity and the enablement of the systematic investigation of sensitive topics like the violation of safety-related rules, this research method is also associated with certain disadvantages. The external validity of experimental investigations is not as high as in field studies. The samples used in experimental investigations as well as the artificial nature of experimental settings raises questions regarding the transferability of assessed results. These problems were addressed by using only engineering students for the investigation; although the participants are not currently working in organisations, they represent the new generation of employees who will work in the positions of interest in the future. Furthermore, a simulation was used to generate an experimental situation which is as realistic and close to the working situation in organisations as possible. Nevertheless, it has to be admitted that the simulation is an artificial environment which may have led to the over- or underestimation of the specific extent of safety-related rule violations. The effects ascertained in the current investigation are assumed to be valid, but the total frequencies

of committed rule violations need to be interpreted with caution and should be verified by field investigations in the respective contexts.

The simulation of a whole production year, in which the plant has to be started 48 times in total, enables the investigation of routinized rule-related decisions, which is a big step towards a more realistic representation of the working situation. On the other hand, however, the same start-up procedure has to be fulfilled again and again, which is quite a tiring and boring activity. To make the simulation richer in variety, an additional (not performance-related) task was implemented in the simulation. This task changed every week and could be accomplished voluntarily after the plant had been started up. Although this additional task was not mandatory, it was completed quite frequently, with the participants deciding to accomplish it in about 19 out of the 48 weeks (*M*=19.37, *SD*=12.93 Min=7; Max =48). Thus, it can be assumed that the goal to diversify the activity by this additional task is presumably accomplished in the majority of the cases.

The pretest of the present investigation (von der Heyde et al., 2013) showed that there are quite diverse effects when not only the common rule violation is considered, but also the fine tuning of the mandatory procedure. In the pretest by von der Heyde et al. (2013), the increase in the fine led to a decrease in common rule violations, but an increase in fine-tuning activities. The effect of the framing and the accuracy of information about the audit probabilities on the fine-tuning of the mandatory 11 SP were not considered in the present investigation. Future investigations should consider the effect of these aspects on this more subtle type of rule violation.

Outlook and practical implications

The present investigation provides very valuable insights into the underlying mechanisms of repeated rule-related decisions. It was shown that people feel a strong need to avoid falling short of expectations. If it is made salient that they cannot meet their goals if they comply with the safety-related rule, they violate these rules more frequently than if this shortcoming is not made salient. If the same amount is earned, but it is not emphasised that they will fall short of expectations, the participants complied with the rule more frequently. If an organisation wishes to promote rule compliance, it is recommendable to display the performance output and the salary as a gain in any case, and not to emphasise the information that employees have not met the desired value.

If audits are not conducted very frequently and on the basis of an easily understood principle, the present investigation suggests that the real frequency of audits is not decisive regarding the decision to violate the respective rule. More important is the infor-

mation about the audit probability. If no or vague information about the audit probability is supplied, people consistently tend to comply with the rules more, because they have no points of reference to determine an advantageous or less risky moment to violate the safety-related rule. Although they have their own experience as an informational resource, the total frequency of rule violations is too minor to detect variations which can be used as an indication of the audit probability and thus be of use for adapting the rule-related behaviour.

If people receive precise information about audit probabilities they adapt their rule-related behaviour and are generally more willing to violate rules. However, people do not react to small changes in the communicated audit probability. Whether the audit probability is 1 in 20/ low or 3 in 20/medium is irrelevant; they only adapt their rule-related behaviour if there are big changes in the probabilities (for example if the audit probability changes from 1 in 20/low to 5 in 20/high). The recommendation which can be deduced from these results is that to enhance compliance with safety rules, no or only vague information about audit probabilities should be supplied. If people have no points of reference on which they can base their decisions, they are generally more risk-avoidant and are more likely to comply with rules. Furthermore, the *bomb crater* effect which was shown in the present investigation suggests that it may be effective to conduct two audits in a row in order to make clear that the fact that an audit has just occurred does not make it more unlikely that another one will immediately follow.

Although the rule-related decisions in the areas of fiscal evasion and industrial production have certain common features, such as the *bomb crater effect*, the present investigation shows that there are quite large differences between the different contexts regarding rule-related decision making. Thus, although the outcomes of investigations of rule violations in other research areas can provide inspiring starting points for the further development of knowledge about the regulation of rule-related decision-making processes, the results and insights gained in one context need to be replicated in other areas of interest. For example, it should be investigated whether the results of the present investigation are valid with respect to decision making regarding the violation of safety-related rules in areas such as the medical or aviation sector. Therefore, the present investigation highlights the immense need for research investigating the determinants of rule violations in different contexts.

6.4 The impact of audit timing – The impact of safety audit timing and framing of the production outcomes on safety-related rule violations in a simulated production environment

6.4.1 Abstract

In an experimental study, participants (n=79) assumed the role of control room operator of a simulated plant. For a total of 36 times, they had to decide whether to violate a safety-related rule to maximize their own salary, or to comply with it at the cost of a lower income. The experimental variation was the *timing of audits* in the simulated production year ("early" = audits accomplished within weeks 13-30 versus "late" = audits accomplished within weeks 31-48) and framing of production outcomes and salary (gain versus loss). Results show that early-audited participants committed significantly fewer rule violations in the early period than those who had not yet been audited. Later on, the early-audited participants began to violate the rule, whereas the late-audited participants continued violating even though they had now been audited. Participants who experienced a loss-framed production outcome committed significantly more violations than participants in the gain-framed condition. When safety rules are prescribed, audits should be accomplished immediately. The late implementation of audits leads to persisting rule-violating behaviour. Furthermore, audits should be accomplished at regular time periods. To reduce the amount of safety-related rule violations, the production outcomes should be displayed as gain.

6.4.2 Introduction - The need for safety audits

A causal analysis of the BP refinery explosion in Texas city in 2005, the Deepwater Horizon accident in 2011 and the sinking of the Indian submarine INS Sindhurakshak in 2013 revealed that these disasters were at least partially due to the violation of safety-related rules (Khan & Amyotte, 2007; Shaukat, 2013; Smith, 2011). The association between rule violations and safety is additionally corroborated by several investigations (cf. for example Hobbs & Williamson, 2002; or Phipps et al., 2008) which identified the violation of safety rules as one of the main causes of industrial accidents in several industrial sectors. Thus, the implementation of safety audits to reduce rule violations is a very common measure of safety management (cf. for example Griffiths, 1985; or Hale & Borys, 2013b). Since safety audits are time-consuming and expensive (Power, 1997), the im-

plementation of audits should be planned in an evidence-based manner to achieve a maximum impact with a minimum amount of audits. The aim of the present study is to address issues of optimal timing of safety audits; furthermore, the effect of framing the production outcome and salary as gain or loss on the amount of safety-related rule violations will be outlined.

6.4.3 Theoretical Background - Individual and organisational factors affecting the adherence to safety-related rules

Accidents are not monocausal; they are mostly due to an unfortunate series of events. As described in Reason`s (1990) "Swiss Cheese" model, organisational accidents are due to an interplay between situational characteristics (latent failures) and unsafe acts like errors or rule violations (active failures). Since there is already a great deal of research about human error, the current study addresses the topic of rule violations. Lawton defines safety-related rule violations as "[…] deliberate departures from rules that describe the safe or approved methods of performing a particular task or job" (Lawton, 1998, p. 78).

The factors which determine the decision-making process regarding rule violations are described by the Integrated Model of Behavioural Prediction applied to Violations (IMV) which was proposed by Kluge (2010) and Kluge, Badura and Rietz (2013) based on findings by Verschuur, Hudson and Parker (1996). According to the IMV, *person-related determinants* like age, sex, personality traits and past experience are assumed to influence the decision-making process regarding rule violations by determining the *behavioural, normative* and *control beliefs* of the decision-maker. In turn, these beliefs are assumed to influence the *attitude, norms* and *self-efficacy*, which determine the decision-maker's *intention*. Whether the *intention* is realised in *behaviour* is assumed to be influenced by the *environmental conditions*, like the occurrence of safety audits or the framing of certain production goals, and by the *skills* and *abilities* of the decision-maker (cf. Figure 22).

Previous investigations by our research group have already demonstrated the impact of the framing of the production goals as gain or loss (Kluge et al., 2013; von der Heyde, Brandhorst, & Kluge, submitted). Furthermore, the impact of personality traits (von der Heyde et al., accepted), the impact of the accuracy of information about audit probability and the impact of previously experienced safety audits (von der Heyde et al., submitted), and of skills and abilities (von der Heyde et al., 2012) on rule violations were investigated. The new aspect in the present study concerns the investigation of the *envi-*

ronmental constraints, especially the audit timing, which can be easily influenced by the organisation. The timing of audits is varied and the impact of early or late audit implementation on the total amount of safety-related rule violations is addressed. Following one previous investigation (von der Heyde & Kluge, cf. 6.1) in which no framing effect was found, the current study aims to attain more empirical evidence regarding the effect of framing on the amount of rule violations. Moreover, from a methodological perspective, the rule-related behaviour is not operationalised as a single decision, but is embedded in a total 36 decisions in a (simulated) production year.

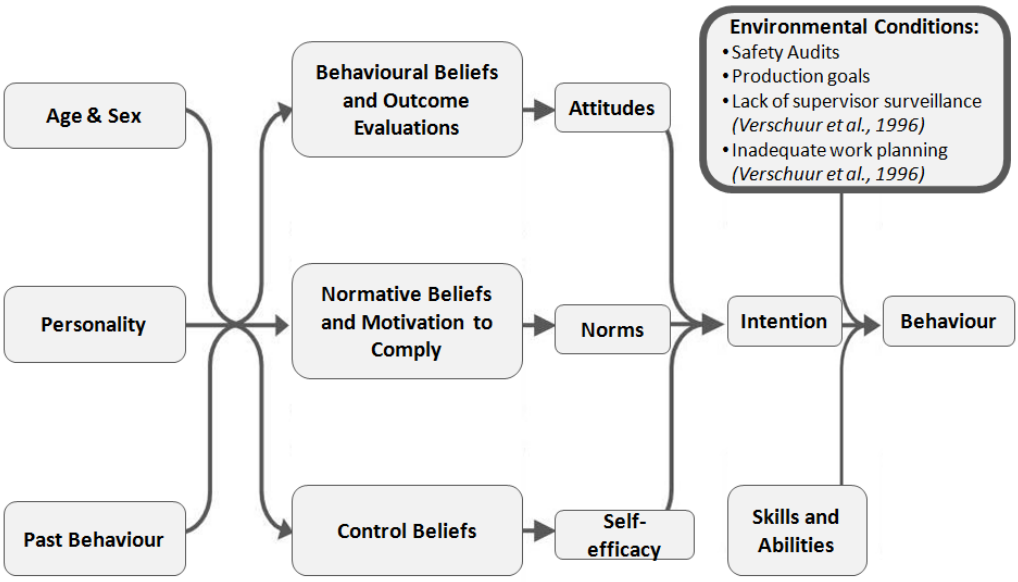

Figure 22. Adapted Integrated Model of Behavioural Prediction (Reason 2008; Verschuur, Hudson, and Parker 1996) applied to violations (IMV, Kluge, 2010; Kluge, et al., 2013).

Audit timing

Organisations are not only concerned with improving safety; they also have to optimise their effectiveness. Since compliance with safety rules is often more effortful and time-consuming and less lucrative than violation, employees are often in a conflict between performance- and safety-oriented goals. Battmann and Klumb (1993) and Reason, Parker and Lawton (1998) also assume that safety-related rule violations are often committed due to goal conflicts. Since the achievement of performance goals by committing a rule violation is often associated with short-acting benefits, the reinforcement of safety-related rules by safety audits and fines is a necessary and often used measure to increase the costs and decrease the benefits of rule violations (cf. for example Hale &

Borys, 2013b; or Lehman & Ramanujam, 2009). As safety audits are quite costly and burdensome (Power, 1997), an attempt should be made to achieve the maximum rule compliance with the minimum level of safety audits. One starting point for optimization is the timing of audits.

A concept which provides information regarding the perfect timing of audits is the availability heuristic, which is proposed by Tversky and Kahneman (1974). This describes people's tendency to overestimate the probability of incidences which they easily remember or for which examples easily come to mind. With respect to the impact of audit timing, it can be assumed that safety audits that are implemented comparatively early on lead to significantly fewer rule violations, as people will easily remember their last audit experience and will overestimate the probability of future audits.

The impact of audit experience on the amount of rule violations committed afterwards has already been investigated in the context of tax evasion (Mittone, 2006; Spicer & Hero, 1985). In the investigation by Spicer and Hero (1985), participants had the possibility to violate a rule in a total of 10 rounds. The amount of rule violations in the final round was negatively associated with the amount of audits experienced in the rounds before. Mittone (2006) did not vary the total amount of audits, but rather the timing. Participants had to pass through 60 periods in which they had to decide whether to violate or comply with a rule. All participants were audited six times: One group was audited predominantly in the first 30 periods, and the other predominantly in the last 30 periods. The group that was audited late violated the rule significantly more frequently in both periods than the group that was audited early. On the basis of the availability heuristic (Tversky & Kahneman, 1974) and the findings of Spicer and Hero (1985) and Mittone (2006), the following hypothesis is proposed:

Hypothesis 1: Participants who are audited early in a production year violate a safety-related rule significantly less often than people who are audited late in a production year.

Framing of the production outcomes

Kahneman and Tversky (1979) assume in the Prospect Theory that decision making is not determined by the absolute value of outcomes, but is influenced by people's subjective evaluations. If a person becomes convinced that he/she will not reach the expectations or the goal which was proposed (loss framing), this is perceived as so aversive that the person will run high risks (for example committing a rule violation) in order to ultimately meet the goal. If the same performance level is achieved but the performance is

displayed as gain (compared to the reference point of achieving/earning nothing), the person will experience it as less negative. He/she will then be comparatively satisfied with the performance and salary level already achieved and will therefore tend to be less willing to undergo the risk associated with a rule violation.

The framing effect has already been investigated quite frequently by our research group, but with inconsistent results. In two studies, the framing of the production outcome and salary led to significant differences in the amount of rule violations, with small effect sizes (Kluge et al., 2013; von der Heyde et al., submitted). However, in another investigation (von der Heyde & Kluge, 6.1), the framing effect was not significant. The present investigation should provide further empirical evidence regarding the stability of the framing effect. Hence, in accordance with the Prospect Theory and most of our previous findings, the following hypothesis is derived:

Hypothesis 2: If the salary is framed as loss, people will violate the safety-related rule significantly more often than if the salary is framed as gain.

6.4.4 Method

A 2x2-factorial experimental design was conducted with the factors audit timing (early and late auditing) and framing (gain and loss). Between November and December 2013, 81 engineering students (43 male) from the University of Duisburg-Essen with a mean age of 20.80 years (*SD*=2.51) participated in the study. As a large sample size was estimated to be necessary for the analysis, engineering students rather than real working operators were recruited. From the perspective of experimental control, it would have been extremely challenging to find 80 real working operators who were almost identical regarding their occupation and industrial sector, age, educational background and vocational training, experience and job tenure in the area of Duisburg-Essen.

Participants were recruited through flyers at the university campus, announcements in lectures, and online forums of engineering courses. Participants were tested in groups of 4 to 8 persons. As a cover story, they were told that the study was about skill acquisition and retention in process control industries. The experiment was approved by the Ethics Committee of the Department of Computer Science and Cognitive Science of the University Duisburg-Essen.

Applied simulation of the production environment

To investigate the topic of safety-related rule violations, a computer-based simulation of a waste water treatment plant *WaTrSim-Annual* (von der Heyde et al., 2013, cf. Figure 23) was used. Since it is practically impossible to investigate safety-related rule violations in a real organisational setting due to ethical and legal considerations, the simulation was used to establish an experimental setting which is as close as possible to the conditions in an organisation. The investigation in a laboratory setting is furthermore associated with high internal validity, which according to Stone and Romero (2011) justifies the generalization of the outcomes even in non-laboratory settings. There is a long tradition of using simulations to investigate rule-related behaviour. The main advantage is that the experimenter does not need to wait for the event (e.g. a rule application) to begin, and nor does he/she have to rely on reports obtained long after the event took place (Weick, 1965). The freedom regarding when to begin experimental events stands in stark contrast to the situation commonly faced in field research (Weick, 1965). Moreover, simulations entail the advantage of being able to control sources of variation, because uncontrolled variables remain potential alternative explanations (Marx & Hillix, 1963). Weick (1965) states that in this sense, laboratory observation is superior to naturalistic observation (p. 198).

In *WaTrSim-Annual*, participants assume the role of a control room operator, who is responsible for starting up and controlling one of a total of 20 plants of the company (WaterTec-Rhein-Ruhr). The task of the operator is to maximise the production of segregate industrial waste water, which is composed of solvent and water. The adjustable components of the interface with which the participants interact are highlighted in Figure 23a.

In *WatrSim-Annual*, the plant has to be started 48 times over one simulated production year (48 weeks), divided into 12-week quarters (a week lasts for 120 seconds). Depending on their performance (produced purified water), the participants could earn up to 1 € per week (48 € in 48 weeks). For the training period, all participants received 2 €, meaning that they could earn up to 50 € for 4.5 hours of participation.

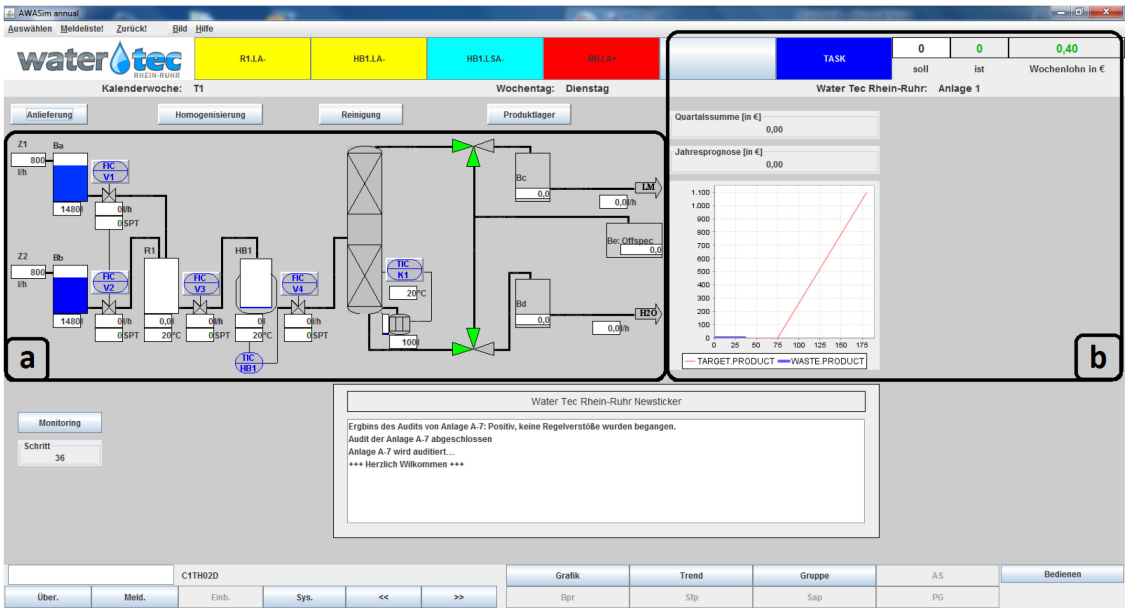

Figure 23. For the purpose of visualization: partly highlighted user interface of *WaTrSim-Annual*, the control room operator's view of the adjustable components of the plant (a) and the performance display (b).

Operationalisation of the violation (dependent variable, DV)

To start up the plant, two procedures were available and trained. The 8-step procedure (8-SP) enables a fast start-up of the plant and therefore a high production outcome and salary of up to 1 € per week. However, it is associated with certain safety risks: It can cause a critical system state which can in turn cause a deflagration.

The 11-step procedure (11-SP) consists of three additional steps added at the beginning of the procedure. These additional steps prevent the critical system state and deflagration, which can be caused by the 8-SP. As the 11-SP takes more time to start up the plant, less production outcome can be achieved, and consequently a lower salary of up to 0.80 € per week can be earned by this procedure.

Due to safety issues, the 8-SP is forbidden after the first quarter and the 11-SP is declared as mandatory (cf. General procedure for more details). This intervention provokes a conflict between safety-oriented goals (which can be achieved by the 11-SP) and performance and profit-related goals (which can be achieved by the 8-SP).

The forbidden 8-SP causes a critical system state, which is detected by the *WaTrSim-Annual* software. If such a critical state occurs, this is registered as rule violation. The dependent variable is the number of committed violations during the last three quarters (range 0-36).

The independent variable audit timing

To test the hypothesis regarding the impact of the audit timing on the amount of safety-related rule violations, the participants were randomly assigned to two experimental conditions. After the 11-SP was declared as mandatory, the following 3 quarters (weeks 13 to 48) were divided into halves. Participants in the early-auditing condition (early auditing, EA) were audited in the first half (weeks 13-30), and those in the late-auditing condition (LA) were audited in the second half (weeks 31-48). The temporal distance between the audits were the same in both conditions. Similar to the study by Mittone (2006), participants in the EA group were audited in weeks 13, 15, 22 and 26, while participants in the LA group were audited in weeks 31, 33, 40 and 44. Before the participants began the operation in the first half, they were made aware that audits would be conducted to check compliance with the regulation prescribing the 11-SP as mandatory. They did not receive any additional information about the audit timing or the audit frequency.

Audit Feedback. To ensure that the participants did not alert each other (for example by showing a surprised reaction to an audit), the audits were executed after all participants had finally started up the plant. As a signal that they had been audited, the participants received notification about the result of the audit (positive = rule compliance detected, negative = rule violation detected) via a pop-up window (Table 18).

Table 18. Displayed notification of positive and negative audit feedback

audit feedback	
positive	negative
Your plant has just been inspected by the audit team. They found that you **complied with** the company directives and used the prescribed procedure to start up the plant. You have therefore **avoided** the risk of operations being interrupted by an undesired reaction. **You therefore do not have to expect a fine.** We would ask you to continue to comply with the company directives in the future; otherwise, you will face a sanction of 1.00 €.	Your plant has just been inspected by the audit team. They found that you did **not** comply with the company directives and used the forbidden procedure to start up the plant. You have therefore **run** the risk of operations being interrupted by an undesired reaction. **According to the company directives, this will be sanctioned with a fine of 1.00 €.** We therefore ask you to comply with the company directives in the future; otherwise, you will face a sanction of 1.00 €.

The independent variable framing

The framing was realised by manipulating the presentation of the achieved production outcome (performance) and the earned salary. The performance displays affected by the framing are highlighted in Figure 23b. The salary as well as production outcome were displayed with altering points of reference (cf. Figure 24; e.g. “weekly salary in €”). In the gain-framed condition, the graphical and numerical production target (Figure 24, graphical: thin line; numerical: “target”) was 485 litres of purified waste water (associated with a salary of 0.80 €). This target, and the salary, respectively, could be achieved by conducting the safe 11-SP. In contrast, in the loss-framed condition, the production target was 687 litres (associated with a salary of 1.00 €). This target could only be met by conducting the forbidden 8-SP. The currently achieved production output (Figure 24, graphical: bold line; numerical: “actual performance”) was communicated in real time, enabling participants to continuously observe whether or not the production target would be met.

The reference point of the salary was also framed. The same salary was displayed differently depending on the framing condition. In the gain framing, the point of reference was 0.00 €, meaning that if the participant had achieved, for example, 0.80 €, this was displayed as 0.80 € in green digits. In the loss framing, the reference point was 1.00 €, meaning that if the participant had achieved a salary of 0.80 €, this was displayed as -0.20 € in red digits (cf. Figure 24).

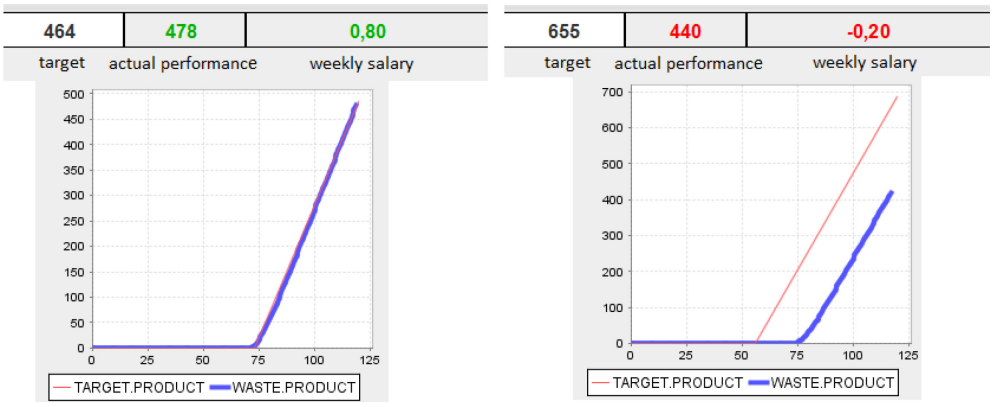

Figure 24. Framing of weekly salary and production target by conducting the 11 SP; left gain-framed illustration; right loss-framed illustration.

To corroborate the framing, two more salary-related permanent displays were framed and integrated in the user interface (cf. Figure 25): the salary so far of the current quarter (cf. “quarterly total”) and the extrapolated salary for the entire year (cf. “annual

forecast"). The salary so far of the current quarter is the sum of the already earned salaries in the respective quarter. In the gain framing, the reference point for the current quarter was 0.00 €. In the loss framing, the reference point for the current quarter was 12.00 €.

The extrapolated salary for the entire year was calculated by adding the salary already earned to an expected salary for the upcoming weeks by assuming the achievement of an average performance (expected salary for average performance 0.80 € per week). The reference point in the gain-framed condition was 0.00 €; in the loss-framed condition it referred to the maximum possible salary of 48.00 €.

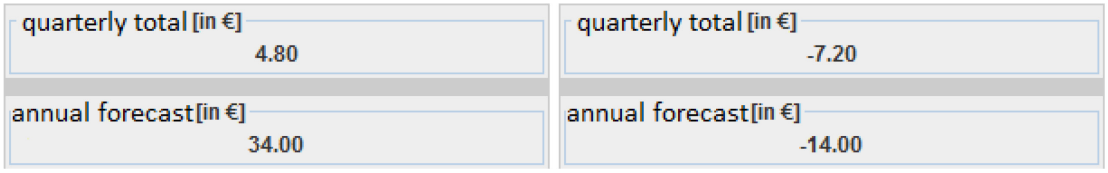

Figure 25. Framing of the salary in the current quarter (see "quarterly total [in €]", and framing of the extrapolated salary for the entire production year (see "annual forecast [in €]"); gain framing (left) and loss framing (right).

At the end of each quarter, some framed main values were also listed in a quarterly report (Figure 26, "quarterly figures"). In the first line, the salary of the previous quarter was listed (cf. Figure 26, "quarterly total"). The accumulated salary earned so far was listed in the second line (cf. Figure 26, "salary to date").

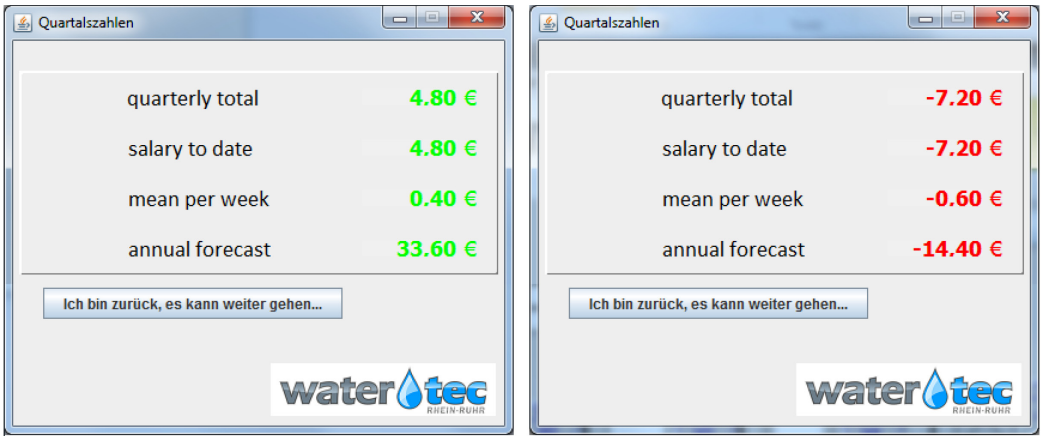

Figure 26. Framing of the quarterly figures displayed at the end of the quarters; gain framing (left) and loss framing (right), figure terms translated; other textual elements are displayed in the original German.

In the third line, the mean salary for all performed weeks was presented (cf. Figure 26, “mean per week”) and at the end of the quarterly report, the extrapolated salary for the entire year (cf. Figure 26, “annual forecast”) was listed. Concomitantly with the production year, the participants were asked to fill in these values in an accompanying paper-and-pencil production protocol. This set of arrangements was important to ensure that the participants were aware of and exposed to the framed communication of the production outcome.

Person-related control variables

Cronbach (1957) proposed that a science of behaviour cannot be built on studies of variance of treatments or among individual differences alone. Organism and treatment are an inseparable pair and research should not dismiss one or the other as error variance (Cronbach, 1957, p. 683). Therefore, as control variables, a set of demographic information such as sex, age, duration of study (number of semesters completed), prior experience of interacting with simulated environments as examined by the participants’ gaming frequency (Item: "Do you play computer games?", 6-point Likert scale), general mental ability (Wonderlic, 2002), prior knowledge regarding water-related chemical processes (pre-test), general technical comprehension (Hesse & Schrader, 2000) and the performance and the theoretical knowledge regarding the different start-up procedures (8 SP and 11 SP) were measured. The participant’s *presence* in the simulation environment was measured by the presence scale of Frank and Kluge (2014) with 11 items, e.g. “The simulation world triggered my emotions (e.g. anger, sadness, satisfaction).”

Based on the findings of von der Heyde, Miebach and Kluge (accepted), the following constructs were selected as personality-based control variables: *Cautiousness,* which is a sub-construct of the integrity construct, was measured by 7 items (e.g. “I am reasonable rather than adventure seeking”) of Marcus` integrity scale (2006); *self-interest* was measured using an 8-item scale (e.g. “I think it is more important to follow my own interests than the interests of others”) by Mohiyeddini and Montada (2004). The regulatory focus at work was measured using a German version (translated by Solga, in prep.) of the Regulatory Focus at Work scale of Wallace, Johnson and Frazier (2009). This scale consists of 6 items for the prevention focus (“I focus on doing my duty at work”) and 6 items for the promotion focus (“I focus on accomplishing a lot of work”).

General procedure

Participants were welcomed, informed about the purposes of the study and told that they could discontinue participation at any time (in terms of informed consent). Then, prior knowledge regarding water-related chemical processes (pre-test), general technical comprehension, general mental ability, as well as several demographic variables such as sex, age and educational background were measured (cf. Table 19).

Table 19. General procedure (CV=control variable; DV=dependent variable)

Reception	Time	
Measurement of prior knowledge and general mental ability, sociodemographic data	*30*	**CV**
Introduction and training *WaTrSim* & 8 SP	*55*	
Performance and knowledge test regarding the 8 SP	*15*	**CV**
System operation quarter 1 (weeks 1-12)	***25***	**DV**
Break	*5*	
Deflagration and management directive	*5*	
Introduction & training of 11 SP	*25*	
Performance and knowledge test regarding the 11 SP	*15*	**CV**
Announcement of audits	*5*	
System operation quarters 2 – 4 (weeks 13-48)	***75***	**DV**
Measurement of personality traits cautiousness, self-interest, regulatory focus at work	*20*	**CV**
Debriefing & farewell	*5*	= ∑ ***ca. 285 min.***

Subsequently, participants were introduced to *WaTrSim-Annual* and trained to start up the plant using the 8-SP. Following the training, they had to start up the plant without any job aids to demonstrate their practical skills. Their theoretical knowledge about the simulation and the 8-SP was tested by a post-test including multiple-choice questions and graphics with blanks to fill in. After this, the first quarter began.

After the first quarter, all participants received a note from the (simulated) company`s safety department. The note informed the participants that a deflagration had occurred in one of the company's plants. It was further stated that as the deflagration was

due to the 8-SP, for the remaining three quarters, a new procedure, the 11-SP, would be mandatory. This safe procedure includes 11 steps, takes more time for start-up, and is therefore less lucrative than the previously trained and used 8-SP. To enable the participants to conduct the mandatory 11-SP, they received additional training concerning this procedure. After the training period, the practical skills and the theoretical knowledge regarding the 11-SP were tested by a second practical and theoretical test. Before the second quarter started, the participants were made aware that audits would be executed randomly to check rule compliance. Furthermore, they were told that a detected rule violation would have the consequence of a total loss of the current week's earnings (maximum 1€ per week).

After the participants completed the remaining three quarters, cautiousness, self-interest and regulatory focus at work were measured. Finally, the participants were debriefed and paid. On average, they earned a salary of 39.90 € (*SD*=1.66). Due to ethical considerations, all participants received 50 €, independently of their performance. The whole procedure is illustrated based on a time-line in Table 19.

6.4.5 Results

To ensure that the participants' decision for the 8-SP or 11-SP was based on a deliberate choice, an exclusion criterion was defined: Every participant had to perform each procedure correctly at least twice, either during the training or during the production phase. Otherwise, the participant would be excluded from the data analysis. Based on this criterion, two participants were excluded. The further analyses were therefore based on 79 participants (41 male) with a mean age of 20.70 years (*SD*=2.50).

Control of confounding variables

The descriptive statistics of the measured control variables, as well as the pairwise comparisons of the experimental groups are displayed in Table 20. No significant differences between the different experimental groups were found, meaning that none of the control variables had to be considered as covariate in the further analysis.

Table 20. Descriptive statistics of the control variables, frequency/mean (SD)

control variables (range)	condition Gain/ early auditing (n=20)	Gain/ late auditing (n=20)	Loss /early auditing (n=20)	Loss / late auditing (n=19)	Sig.
sex	8f 12m	8f 12m	9f 11m	13f 6m	X^2 p=.23
age	19.75 (1.41)	21.05 (2.50)	20.65 (2.83)	21.47 (2.87)	$F_{(3,78)}$=1.74; p=.17
semester	1.30 (0.98)	2.60 (2.30)	2.15 (2.74)	2.42 (2.73)	$F_{(3,78)}$=1.25; p=.30
gaming frequency (1-6)	3.00 (1.72)	3.10 (1.71)	3.25 (1.68)	2.42 (1.54)	$F_{(3,78)}$=0.92; p=.44
pre-test (0-7)	5.15 (1.31)	5.20 (1.24)	4.85 (1.50)	4.68 (1.38)	$F_{(3,78)}$=0.64; p=.59
technical comprehension (0-6)	3.50 (1.85)	3.45 (1.82)	3.60 (1.46)	3.16 (1.46)	$F_{(3,78)}$=0.25; p=.86
General mental ability (0-50)	25.75 (8.47)	31.50 (8.33)	28.30 (5.18)	27.21 (4.28)	$F_{(3,78)}$=2.53; p=.06
post-test 8 SP (0-24)	17.60 (5.18)	16.45 (3.27)	18.35 (4.18)	17.50 (3.48)	$F_{(3,78)}$=0.73; p=.54
performance 8-SP	628.94 (44.41)	628.82 (40.97)	628.63 (60,17)	627.26 (50.81)	$F_{(3,78)}$<0.01; p=.99
post-test 11 SP (0-3)	2.85 (0.67)	2.85 (0.37)	2.95 (0.22)	3.00 (0.00)	$F_{(3,78)}$=0.65; p=.57
performance 11-SP	346.20 (63.93)	349.99 (53.47)	346.28 (56.74)	310.46 (70.75)	$F_{(3,78)}$=1.77; p=.16
presence (1-6)	3.68 (0.84)	3.36 (0.80)	3.57 (0.81)	3.37 (1.00)	$F_{(3,78)}$=0.70; p=.56
cautiousness (1-5)	2.33 (0.60)	2.39 (0.65)	2.33 (0.50)	2.23 (0.60)	$F_{(3,78)}$=0.22; p=.88
RFW-prevention (1-5)	4.13 (0.51)	4.10 (0.45)	4.10 (0.48)	4.00 (0.52)	$F_{(3,78)}$=0.34; p=.80
RFW-promotion (1-5)	4.00 (0.60)	3.94 (0.59)	4.00 (0.64)	3.93 (0.51)	$F_{(3,78)}$=0.10; p=.96
self-interest (1-6)	2.55 (0.71)	3.04 (0.97)	2.72 (0.96)	2.38 (0.92)	$F_{(3,78)}$=2.15; p=.10

Notes: SP=step procedure; f=female; m=male; RFW=regulatory focus at work

Testing hypothesis 1

A two-way between groups ANOVA was conducted to test the hypotheses regarding the impact of the audit timing on rule violations (Figure 27).

Hypothesis 1, which predicts a higher tendency to violate safety-related rules if the audits are placed late in the production year, was not supported by the data. Although there was a difference in the amount of committed violations between the means of the EA condition (M=7.68, SD=8.47) and LA condition (M=10.67, SD=9.77) in the expected direction (Figure 27), this difference did not reach significance ($F_{(1,78)}$=2.55 p=.12 η^2_p=.03). Therefore, Hypothesis 1 has to be rejected.

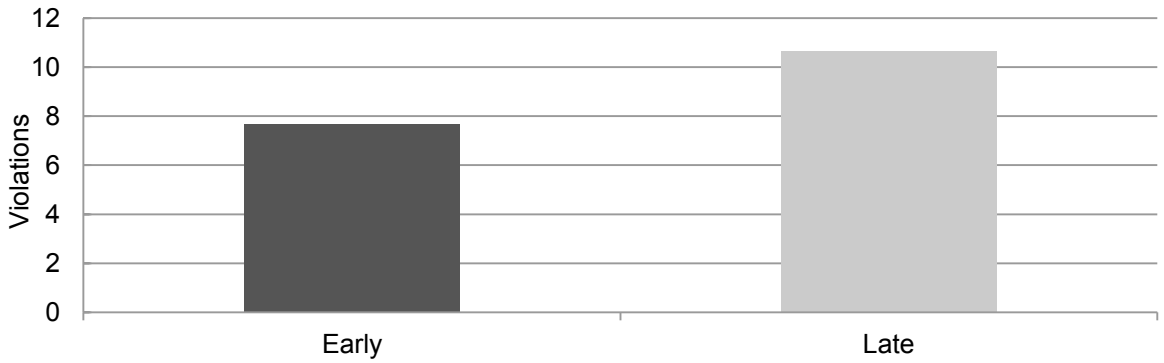

Figure 27. Mean amount of violations committed by the early-audit and the late-audit group

Explorative analysis regarding the impact of audit timing on the rule violations in the first and second half of the production year

To get a deeper understanding of the data, further explorative analysis were calculated. In this regard at first a repeated measures ANOVA was conducted to test the effect of the audit timing on rule violations committed in the first halve of the year after the 11-SP was declared as mandatory after the first quarter (meaning weeks 13-30) and second half of the year (meaning weeks 31-48). There was no main effect of the audit timing ($F_{(1,77)}$=2.96, p=.09, η^2_p =.04), but a significant interaction of audit timing and the repeated measures factor *half of the year* was found ($F_{(1,77)}$=11.49, p<.01, η^2_p =.13). The significant interaction indicates that the audit timing caused a significant difference in the amount of rule violations only in one half of the year.

To determine the half in which the audit timing had an impact, a further ANOVA was conducted. Regarding the first half of the year, the ANOVA showed a significant

main effect of audit timing on the amount of committed rule violations ($F_{(1,78)}$=10.41, p<.01, η^2_p =.12). In the first half, more than twice as many rule violations were committed by the LA group (M=5.79, SD=5.64) compared to the EA group (M=2.43, SD=3.39, cf. Figure 28).

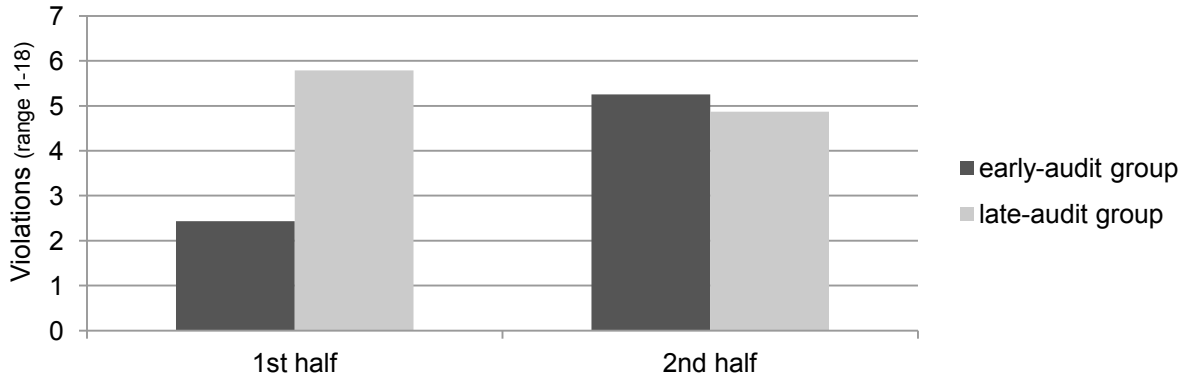

Figure 28. Mean amount of violations committed by the early-audit and late-audit group in the first half (weeks 12-30) and second half of the year (weeks 31-48).

To compare the amount of rule violations committed in the first half with the amount committed in the second half within the EA group and the LA group, further repeated measures ANOVAs were conducted. At first a ANOVA was conducted to test the EA group regarding significant differences in the two halves of the year. The results show a significant main effect of the half of the year ($F_{(1, 39)}$=11.45, p<.01, η^2_p=.23). The amount of rule violations in the EA condition rose significantly from the first half (M=2.43, SD=3.39) to the second half of the (M=5.25, SD=6.19).

A further ANOVA was conducted to test the LA group regarding significant differences in the two halves of the year. There was no significant main effect of the half of the year detected ($F_{(1, 38)}$=1.69, p=.21, η^2_p=04). The amount of rule violations within the LA condition did not change significantly between the first (M=5.79, SD=5.64) and the second half (M=4.87, SD=5.11).

Testing hypothesis 2

Hypothesis 2, which proposes an impact of the *framing* on rule violations, was supported by the data. The data analysis revealed a significant small main effect of framing ($F_{(1,78)}$=9.70, p<0.01, η^2_p=.11). The comparison of the mean amount of rule violations in the gain-framed and loss-framed conditions showed that the amount of violations was

nearly twice as high in the loss-framed (*M*=12.18, *SD*=9.04) compared to the gain-framed condition (*M*=6.20, *SD*=8.46; cf. Figure 29).

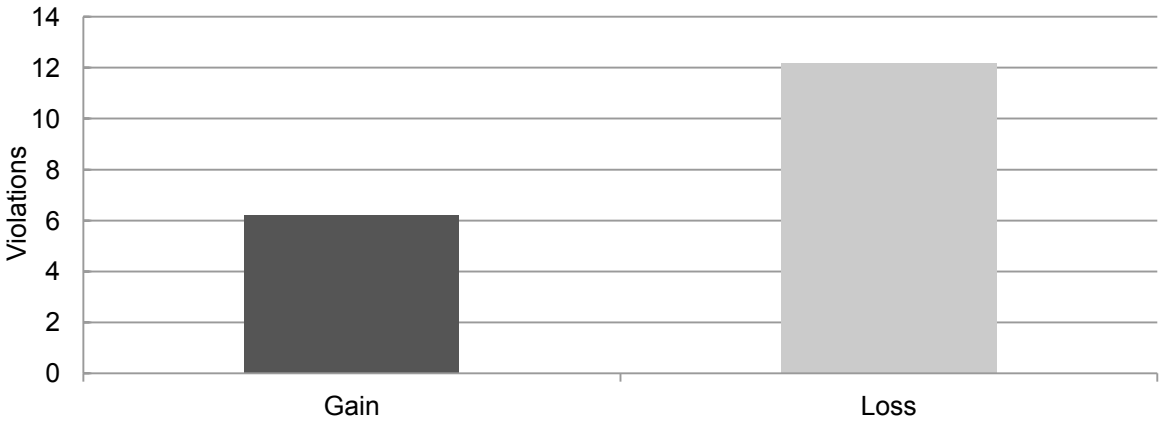

Figure 29. Mean amount of violations committed by the gain-framed and loss-framed group (range 1-36)

Post hoc analysis regarding the impact of person-related variables

All measured personality variables were tested regarding their coherence with rule violations. Of all considered personality variables, only the prevention focus (subscale of regulatory focus at work questionnaire) was negatively correlated with the amount of violations (*r*=-.27, *p*=.02). This means that people with high scores on the scale measuring the prevention focus committed rule violations less often than persons with low scores on this scale. A significant correlation was also found between rule violations and the performance regarding the 11-SP (r=-.83; p<.001), indicating that the participants who performed well with the 11-SP violated the rule less often.

6.4.6 Discussion

The purpose of the study was to explore the impact of early or late audit timing and framing on the total amount of rule violations. The hypothesis that an early audit experience will lead to more rule compliance overall within the whole production year was not supported by the current findings. However, a closer look at the rule violation frequencies computed separately for each half of the production year revealed even more interesting results.

The audit timing led to significant differences with respect to the amount of rule violations in the first half of the year. The participants who were audited early violated the

rule significantly less often in the first half of the year than the participants who were audited late (small effect size). This finding is in line with the availability heuristic (Kahneman & Tversky, 1979). Due to the high availability of audits in the early-audited group, the probability of future audits was overestimated. This made the early-audited participants more risk-avoidant and led to a higher level of rule compliance in the first half of the production year. In contrast to Hypothesis 1, which proposed that this effect would persist throughout the whole production year, the amount of rule violations increased in the second half and reached the same level of violations committed by the late-audited group in the entire year. This evidence suggests that audits are a highly transient measure of safety management. Based on the current findings, it is assumed that audits only exert an influence if they are conducted quite regularly. When participants are given the impression that audits will no longer be conducted, the willingness to comply with rules decreases immediately. This is not consistent with previous investigations (Mittone, 2006; Spicer & Hero, 1985), which found that frequency and early auditing reduce the amount of rule violations in a sustained manner.

The finding that participants who were audited comparatively late persisted with rule-violating behaviour even once the audits had started is consistent with the first hypothesis. The lack of audit experience at the beginning of the production year led presumably to a persisting underestimation of the audit probability, which in turn led to constantly more decisions favouring the rule violation option over the compliance option, regardless of whether or not an audit had recently taken place. Due to their previous experience with rule violations and the related higher production output, they might have become convinced that rule violations were sufficiently remunerative to make the risk associated with the rule violation worthwhile. Furthermore, the late occurrence of audits in this condition might have led to the perception that audits are a temporary, exceptional phenomenon, which is usually followed by a period in which no audits are conducted, as was their experience in the first half of the production year.

Regarding the impact of the framing of the production outcome, the current study is in line with the findings of previous investigations (Kluge et al., 2013; von der Heyde et al., submitted), which also revealed a small effect of framing on rule violations. When people are evaluating their importance, the reference point is relevant rather than the total values of achieved production outcome/earned salary. If people become convinced that they will not reach their production goals, or assume that they will earn less compared to a certain value (loss framing), this is perceived as so negative and aversive that they will decide more frequently to violate safety-related rules to meet the production

goals and avoid the loss of remuneration. The findings of the current investigation underline that the framing of the production outcome and the salary is a small but robust effect, which is valid across varying conditions.

Limitations

The violation of safety-related rules is very a sensitive investigation context. The potentially very severe consequences of violations, such as injury or death of people, make the systematic variation of organisational determinants in an organisational context impossible due to ethical and legal considerations. Nevertheless, the experimental variation of certain variables is needed to determine clear cause-and-effect relations. These relations in turn enable practical implications to be derived for rule-violation reduction interventions to enhance safety. Hence, a laboratory setting was chosen for the present investigation.

Stone-Romero (2011), Thibaut et al. (1974), and Weick (1965) suggest that results gained in a laboratory setting with high internal validity can be transferred to external conditions. To improve the external validity further, the simulation of a chemical plant was used as the experimental environment. Furthermore, only engineering students were included in the investigation. Presumably, these students will work in such a context in the future, and are also quite similar to real-life operators regarding several characteristics.

Although the external validity was enhanced by both the sample and the simulation, the findings should be interpreted within these limitations. The rule-related behaviour of people in organisations is influenced by a complex interaction of impact factors, which cannot entirely be simulated in an experimental context. The current investigation focused on several person-related and situational determinants, but organisational influences like safety climate or organisational commitment could not be considered due to the experimental nature of the study.

Practical implications

The findings regarding the timing of audits suggest the following practical implications: (1) Audits should be conducted from the beginning, just after a new rule has been prescribed, and (2) audits should be conducted continuously and should not be stopped after a certain time period.

Each organisation should make a cost-benefit analysis to determine either the amount of rule violations which they can tolerate, or deduce the expense which they are willing to sacrifice for audits. With this information and knowledge about the optimal timing

of audits, as supplied by the present investigation, the timing of audits can be optimised to achieve the best possible compliance rate with the available means.

Organisations that wish to reduce the amount of safety-related rule violations should also consider the configuration of their goal and feedback system. To improve safety, the present study suggests that performance feedback should be displayed as gain. This could be accomplished by choosing appropriate reference points (goals) that can be achieved, or preferably even exceeded. This would lead to more rule compliance overall, but is potentially also associated with performance losses. In this respect, the organisation has to assign priorities: Employees cannot improve performance, safety and costs at the same time (cf. McCurdy, 2001).

7 General Discussion

The general discussion is concerned with the findings gained in the four studies which are described in the empirical evidence part (cf. section 6) and will address four scopes. First, the internal validity, the external validity, as well as the practical relevance and usefulness of the findings will be discussed in the limitations section (cf. section 7.1.). Then, the empirical findings will be discussed in terms of the investigated situational and person-related determinants (cf. section 7.2). Subsequently, in the third section, the empirical findings will be integrated into the different theoretical perspectives described in the general theory part (cf. section 7.3), and finally, in the fourth section the empirical evidence will be used to derive field guidelines for practitioners who wish to implement evidence-based safety-management measures to reduce safety-related rule violations in their own organisation (cf. section 7.4).

7.1 Limitations

The limitations of the empirical findings will be discussed according to the threats to internal validity described, for example, by Cook and Campbell (1979). Furthermore the practical relevance and usefulness dimensions suggested by Thomas and Tymon (1982) will be addressed, and finally, the degree of external validity will be evaluated.

7.1.1 Internal validity

Cook and Campbell (1979) describe several threats to internal validity. Four of the threats are relevant for experimental investigations, with only one measuring date: the *effect of testing*, the *instrumentation effect*, the *statistic regression effect* and the effect of *selection.*

The effect of *testing* describes, according to Cook and Campbell (1979), the impact of the act of measurement on the object of investigation. For example, the object of investigation might be influenced by the characteristics of the experimental environment, or the presence of the experimenter. In the goods at stake investigation, in which the criterion was measured only once, the influence of the experimenter on the rule-related decision was minimized by the following procedure: The experimenter left the laboratory under a pretext in order to make the participants feel more unobserved during their rule-related decision. Although the experimenter did not leave the laboratory in the other studies, the experimenter concentrated during the simulated production year on other activities (like reading or working on the computer) and did not watch the participants` behav-

iour. The presence of the experimenter was nevertheless necessary to ensure concentration and silence during the investigation. The quite high amount of rule violations in all conducted investigations (the participants decided to violate in about 30% of cases) suggests that the participants did not feel constrained to comply with the rule because they felt observed and feared the moral condemnation of the experimenter.

The effect of *testing* is also assumed to be potentially relevant with respect to the measurement of certain personality traits. It is conceivable that the measurement of certain variables has an impact on the subsequent (rule-related) behaviour. It is likely that the consideration of certain personality-related items influences the cognition or emotion in the rule-related decision subsequently. For example, items about integrity might make integrity-related values more cognitively available, which might lead to more rule compliance than if the participants had not been confronted with the items. Due to this consideration, the decision was made to measure the personality traits which were considered in studies 2-4 at the end of the investigation.

In fact, it cannot be entirely ruled out that the effect of *testing* influenced the findings of the present investigation somehow. However, the effect of *testing* was considered during the scheduling of the experiments in order to minimize the impact.

The *instrumentation effect* refers to the reliability of the used instruments (cf. for example Cook & Campbell, 1979). The reliability of the applied scales was established by the choice of appropriate, meaning highly reliable, valid and objective scales. To test for the reliability of the applied scales, the Cronbach`s alpha indicators were calculated and reported in the methods section of each study. All in all, the reliability indices were satisfactory to good; otherwise, the scales were not considered further. Therefore, it can be assumed that the reliability of the applied instruments is adequate and the likelihood of the threat of *instrumentation* is minimized for the empirical evidence reported in the scope of the present investigation

The *statistic regression* effect refers to the fact that an extreme score in a certain criterion is usually followed by a lower score, because there is a regression to mean values (Cook & Campbell, 1979). This effect can lead to a misinterpretation of the findings of studies with multiple measurement times, as some effects are not due to the variation of the independent variable after the first baseline measurement, but are only caused by the regression toward the mean. This could only be relevant in the two studies which investigated the impact of audit probability and audit timing (cf. sections 6.3, 6.4), as in these studies, the criterion was measured multiple times. Since none of these investigations had a pretest-treatment-posttest design, this misinterpretation cannot have occurred.

The *statistic regression* effect can not only lead to misinterpretations; in addition, large-sized effects which are ascertained in only one study in which the criterion is measured only once are often overestimated. It is very likely that extreme effects will be followed by much less extreme values, which would put the huge effect size into perspective and enable a more realistic estimate of the impact. This is especially relevant for the interpretation of the findings of the impact of goods at stake investigation. In this study, the criterion was based on only one measurement, as the participants were only once in the situation where they had to decide whether they wanted to violate or comply with the safety-related rule. It can be proposed that if the participants had been given more times to decide, they may have decided differently in the second or third trial. Therefore, it quite likely that effects might have been overestimated, underestimated or overlooked. The fact that no effect of goods at stake or framing was found might be due to coincidence rather than a lack of existence of the proposed effect. Since the framing effect was found by Kluge et al. (2013) as well as by the impact of audit probability and impact of audit timing investigation (cf. sections 6.3 and 6.4), it can be assumed that there is an effect of framing, which was simply not detected in the goods at stake study. The investigations in which *WatTrSim-Annual* was used (audit probability and audit timing study), the criterion measurement was not based on one decision, but on 36 rule-related decisions per participant. This makes the findings of these investigations more robust and less susceptible to extreme values. With one limitation (the goods at stake study), the statistical regression should not diminish the significance of the findings.

Selection effects refer according to Cook and Campbell (1979) to systematic distortions which are due to the non-randomized formation of experimental groups. Since the assignment of participants to experimental groups was randomized, it can be assumed that the present findings are not affected by the threat of *selection* effects.

In summary, it can be assumed that the internal validity of the studies presented in the scope of the present investigation is rather appropriate due to the benefits of experimental control (such as consistent experimental conditions in the laboratory, or the measurement and control of several potentially confounding variables). The high internal validity enables the reliable deduction of cause-and-effect relations. Since the aim of the present investigations was to provide empirical evidence regarding the effect of the different determinants on rule-related behaviour, a high internal validity is especially important.

Stone-Romero (2011), who discusses the importance of internal and external validity of empirical investigations in general, even evaluates the achievement of internal

validity as sufficient (independent of the external validity) for the deduction of valid conclusions from experimentally gained findings to other people, situations and times. Nevertheless, the external validity of investigations should be considered and optimized by every investigator. The external validity of the studies will be discussed in the next section.

7.1.2 External validity

Campbell and Cook (1979, p. 39) define external validity as “approximate validity with which conclusions are drawn about the generalizability of a causal relationship to and across populations of persons, settings and times.”

High external validity can be achieved by conducting investigations in the field instead of the experimental environment. If the impact of certain variables is found despite the complexity of the interaction of real-life influences, the generalization to similar contexts is more legitimate than if certain findings are gained in the controlled experimental context. On the other hand, the deduction of cause-and-effect relations of findings gained in a field context is difficult, because there are plenty of interfering factors which might be responsible for the findings instead of the actually investigated object.

The violation of safety-related rules is a very sensitive topic. Field investigations of this phenomenon, which include not only surveys but the systematic variation of independent variables, are practically impossible. The variation of variables, which will presumably lead to systematic differences in the amount of safety-related rule violations, and which in turn might result in the avoidable endangerment of human well-being, is morally reprehensible. Furthermore, industrial councils have reservations regarding the investigation of such topics, as they fear that employees who violate the rules can be identified and will have to bear sanctions for the rule violations. Besides these difficulties, the present investigations are concerned with the identification of rule violation determinants, meaning that clear causal relations between the investigated determinant and the amount of rule violations should be measured. Due to the sensitive nature of the topic of rule violations, and as the discovery of causal relations in field investigations is very difficult, the current research question could not be investigated in the field, but had to be conducted in an experimental context.

To increase the external validity a simulation was used for the investigation. In the simulation, the participants had to assume the role of a control room operator in a waste water treatment plant. They were introduced to their tasks, the characteristics of the plant and the goals of the organisation. Afterwards, the participants had to control the plant. In

the audit probability and the audit timing studies, even the daily work routine was simulated by an advanced simulation version in which the participants had to operate the plant for one simulated production year. In this regard, it can be concluded that the participants were in situation which is quite similar to the working situation in organisations regarding different characteristics.

In order to enhance the external validity of the findings further, only engineering students, who will presumably work in similar or the same context in the future, and presumably have similar characteristics to people who are currently working in comparable positions, were allowed to participate in the investigations. Only the survey which was conducted in the scope of the personality investigations as part of the pilot study was not restricted to this selected circle of participants.

Although the external validity of the present investigations is limited due to the experimental character of the study design, it can be assumed that the simulation and the participant selection maximized the degree of external validity which can be achieved by an experimental investigation. Even though the external validity of the investigations is nevertheless estimated as being medium to low, this level of external validity in combination with the high internal validity (cf. section 7.1.1) is sufficient for discovering valid cause-and-effect relations which are assumed to apply in other, for example organisational, contexts (Stone-Romero, 2011).

7.1.3 Practical relevance and usefulness

Thomas and Tymon (1982) consider the practical relevance and usefulness of research findings and suggest five dimensions with which the degree of the practical relevance of empirical evidence can be described: the *descriptive relevance*, the *goal relevance*, the *operational validity*, the *non-obviousness* and the *timeliness.*

Thomas and Tymon (1982, p. 346) define *descriptive relevance* as “accuracy of research findings in capturing phenomena encountered by the practitioner in his or her organizational setting.” The descriptive relevance describes the degree to which the research topic is relevant for practitioners, and is therefore connected to the external valence term which was also addressed above (cf. section 7.1.2). The descriptive relevance is determined by the significance of the research topic for the practitioner and the congruence between the experimental and the application context.

The research topic of the present investigation is deduced from the broad empirical evidence regarding the incidence and consequences of safety-related rule violations in different industrial sectors (cf. section 4). This shows that the occurrence of safety-

related rule violations is a big problem in many organisations across different branches and is not a phenomenon which is merely interesting for a narrow research community. It can be assumed that the current findings will attract wide interest from every practitioner who is responsible for the optimization of the human factors-related safety key figures.

The second aspect of the descriptive relevance refers to the congruence between the investigation and the application context. Although the investigations were conducted not in an organisational, but in an experimental setting, the congruence between the investigation and the application context is also assumed to be high. Due to the use of the simulation of a chemical plant *WaTrSim-(Annual),* which was developed by specialists in process control engineering from the Dresden University of Technology, the interface and the process characteristics of the simulation are assumed to be highly ecologically valid (for the validation of WaTrSim cf. Burkolter et al., 2009). In other words, it can be assumed that the characteristics of the decision situation in the experiment are quite congruent with the characteristics of the decision situation of people working in comparable positions in the process control of real chemical plants.

As the significance of the research topic for the practitioner and the congruence between the experimental and the application context are assumed to be high, the current results can be seen as high in *descriptive relevance*.

Goal relevance is defined by Thomas and Tymon (1982, p. 347) as “correspondence of outcome (or dependent) variables in a theory to the things the practitioner wishes to influence”. Thomas and Tymon (1982) propose that the *goal relevance* of many investigations is low, as only humanity indicators are considered as goal criteria, but while efficiency or performance output figures are neglected. The studies conducted in the scope of the present investigation considered performance-related indicators in several respects.

The decision situation of organisational members was simulated by creating a goal conflict between safety-related and performance-related goals. The participants were required to comply with the safety-related rule, but were also constrained to maximise their production outcome and their salary. In this regard, the participants had to decide whether they wanted to comply with the safety-related rule, which is associated with safe production, but also lowers their performance output and salary, or to violate the safety-related rule to achieve a better production outcome and salary. The communication of conflicting goals is quite common in most organisations. Organisations want to be faster, better, cheaper (McCurdy, 2001), but simultaneously require the accomplishment of safety goals. The organisations and the practitioners charged with the improvement of

safety or performance indicators have to appreciate that the goal criteria cannot be maximized simultaneously, but rather have to be prioritised. The current findings regarding the determinants of rule violations can be either interpreted as guidance for enhancing rule compliance and safety at the expense of performance, as it is suggested by the author, or they can be used to optimise performance indicators at the expense of safety. In this regard, the current findings provide a wide range of insights which can be used for the accomplishment of different objectives.

The impact of the perceived performance and the perceived goal accomplishment was further investigated in the current studies as one determinant of rule-related behaviour. The impact of the framing of the production outcomes and the achieved salary as gain or loss on the amount of rule violations, which was associated with better production outcome and a higher salary, was investigated by three of the four studies (cf. sections 6.1, 6.3, 6.4).

In sum, performance as well as safety goals were prescribed in the simulation to achieve a more realistic investigation situation which is congruent with the decision situation in organisational contexts. Furthermore, the impact of performance feedback on rule-related behaviour was investigated as independent variable, meaning that the *goal relevance* of the current findings is assumed to be high.

Operational validity is defined by Thomas and Tymon (1982, p. 348) as the "ability of the practitioner to implement action implications of a theory by manipulating its causal (or independent) variables". All investigated determinants, such as the framing, the personality factors or the timing of safety audits, can used as starting points to derive concrete recommendations for action. The findings regarding the framing can be considered during the design and implementation of performance feedback systems and during the definition of performance goals (cf. 7.4.2); the findings regarding the impact of certain personality traits on rule-violations can be used during the personnel selection and the allocation of responsibilities (cf. 7.4.1); the findings regarding the accuracy of information about audit probabilities can be used to improve the communication regarding audits; and the findings regarding the timing of audits and the bomb crater effect can be used to advance the time scheduling of audits. Hence, the *operational validity* of the current findings is assumed to be high.

Nonobviousness is defined by Thomas and Tymon (1982, p. 348) as "the degree to which a theory meets or exceeds the complexity of common sense theory already used by a practitioner". As the hypotheses which were validated in the studies of the present investigation are all based on psychological theories and previous investigations, and are

not proposed on the basis of common sense assumptions, a high nonobviousness of the current findings can be assumed.

Timeliness is defined by Thomas and Tymon (1982, p. 349) as the degree to which a theory is "available to practitioners in time to use it to deal with problems." The current studies were conducted between May 2011 and December 2013. Parts of the investigations have already been published in conference papers (von der Heyde et al., 2013; von der Heyde et al., 2012). The investigation described in 6.1 will only be published in the present investigation. The studies described in the sections 6.2 and 6.3 are already published by the Journal of Ergonomics and Safety Science. The study described in 6.4 is at this time in preparation for submission. Although it can be assumed that the publication in journals will achieve more attention, all findings are at least available in this dissertation. As the investigated phenomena are assumed to be stable, the findings are and will remain relevant if they are published with delay of up to 3 or 4 years.

As conference papers have already been published, and due to the comparatively quick publication in the scope of this dissertation, the planned publication in journals (which is admittedly more delayed due to the time requirements of the review process), and the assumed stability of the impact factors, it can be assumed that overall, the timeliness criterion is met.

Since all criteria of the practical relevance dimensions described by Thomas and Tymon (1982) are met, the practical relevance of the findings presented in the scope of the present investigation is assumed to be high. To enhance the practical relevance further, the findings will be summarized with regard to the respective determinant (cf. section summary of the empirical findings 7.2), and finally the implication for practitioners will be outlined in a special section (cf. 7.4).

7.2 Discussion of the empirical evidence according to the investigated determinants

In the following paragraphs the findings of the empirical evidence part will be summarized and discussed according to the investigated influencing factor.

7.2.1 Framing

The framing of the production outcome and salary was investigated in the goods at stake, the audit probability and the audit timing study. Whereas in the goods at stake investigation (cf. 6.1) no framing effect occurred, in the audit probability (6.3) and audit timing study (6.4) the framing effect was demonstrated. The participants whose produc-

tion outcome and salary was loss-framed violated the rule significantly more often than those in the gain-framing condition.

It can be argued that the inconsistency between these findings was triggered by the differences between the applied *WaTrSim* simulations. Whereas the goods at stake study used a basic version of *WatrSim,* in which each participant had to decide only once whether to violate the rule, in the audit probability and audit timing investigation, in which the framing effect was found, a whole production year was simulated by the extended version *WatrSim-Annual.* Within this simulation, each participant had to decide 36 times whether to comply with or violate the safety-related rule. However, a previous investigation which also only applied the basic version of *WatrSim* (Kluge et al., 2013) did find an effect of framing on rule violations.

As only one investigation found no effect, while the two other studies reported in the scope of the present investigation as well as the other study of our research group (Kluge et al., 2013) did find an effect of framing, it can be assumed that the framing of the production outcome and salary has quite a robust influence on the amount of rule violations. When people get the impression that they are behind their production goal or will lose money (loss framing), they are more prone to safety-related rule violations than if they believe that they will meet their goals (gain framing).

7.2.2 Goods at stake

The results of the investigation of the impact of the goods at stake (cf. section 6.1), if a rule is violated, indicated no effect of this influencing factor. It seems to have no influence on the decision to comply with or violate a safety-related rule whether the goods at stake are material property or people's well-being. What might be the reason for this finding?

There are two different explanatory approaches: Either the goods at stake simply do not affect the rule-related decision, or the effect was simply not detected, possibly due to the experimental nature of the investigation context. Since this was the first investigation to address the impact of the goods at stake on safety-related rule violations and due to the fact that the findings were gained in an experimental study, the current findings should be interpreted with caution. They should be seen as an indicator, but not as proof, that the goods at stake are generally irrelevant for rule-related decisions.

7.2.3 Personality traits as predictors

In all investigations reported in the empirical evidence section, personality traits were considered as control variables. In the first investigation, in which the impact of the goods at stake was investigated (cf. 6.1), conscientiousness, empathy and risky decision making, or more precisely risk-taking propensity, were measured. None of these personality traits correlated significantly with the rule-related behaviour.

The pilot study, reported in the impact of personality section (cf. 6.2), tested a host of personality traits regarding their ability to predict the intention to violate a rule (self-control; belief in a just world; sensitivity toward injustice; self-interest; self-responsibility; regulatory focus at work and the integrity subscales: low distribution, non-rationalization, reliability, cautiousness and conflict avoidance). Only the integrity subscales cautiousness, non-rationalization, reliability, as well as self-interest and injustice sensitivity emerged as significant predictors of the intention to violate a safety-related rule.

In the assessment reported in the main study of the impact of personality section (cf. 6.2), as well as in the study reported in the impact of audit probability section (cf. 6.3), cautiousness, self-interest and injustice sensitivity were measured as personality predictors of safety-related rule violations in the process control environment. Only the integrity subscale cautiousness was significantly correlated with the amount of committed rule violations. The lower the cautiousness, the more often people decided to violate the safety-related rule.

In the study reported in the impact of audit timing section (cf. 6.4), cautiousness and regulatory focus at work were measured. The data analysis revealed a significant negative correlation between prevention focus at work and the amount of committed rule violations. The more people were prevention-oriented (focus on the achievement of safety and compliance and avoidance of failure) the less often they violated the rule. In contrast to the previous investigation, cautiousness was not related to the amount of rule violations.

Ultimately, the personality traits cautiousness (although the findings were partially inconsistent) and prevention focus at work turned out to be most promising predictors of safety-related rule violations in organisations. Nevertheless, more evidence is needed to determine whether or not these personality traits are actually valid predictors of safety-related rule violations.

7.2.4 Other person-related predictors

In all studies presented in the scope of the present investigation, sex and age were measured. Furthermore, in all the studies excerpt the pilot study described in the impact of personality section (cf. 6.2), general mental ability, prior knowledge about chemical processes in general, task-related knowledge after the training (post test) and the performance regarding the two procedures were measured as control variables. The posttest knowledge is an indicator of the knowledge about the simulation and task, and the performance measures are indicators of the skills and abilities which are necessary to operate the plant using the different procedures. In the final investigation, which investigated the impact of audit timing (cf. 6.4), technical apprehension was additionally measured.

As the variance in terms of age was only small in the investigated student samples, it can be assumed that if there is an effect of age, it is barely detectable using the samples which were assessed and described within the scope of the present investigations.

Sex was only significantly associated with the decision to violate a rule in one investigation (impact of audit probability, cf. section 6.3). In this investigation, males violated the rule significantly more often than females, which is consistent with the literature (cf. for example Alper & Karsh, 2009; Reason, 2008). The fact that the correlation was only small, and furthermore only found in one investigation, suggests that sex is only a weak (if at all) influencing factor with respect to the violation of safety-related rules.

Prior knowledge, general mental ability, and technical comprehension were not correlated with the safety-related rule violations in any of the investigations. Hence, according to the current findings, the basic cognitive abilities and prior knowledge seem to have no direct influence on safety-related rule violations.

On the contrary, the knowledge about the task and the simulation and the operating skills, which was measured by performance indicators regarding the 8-step procedure and 11-step procedure, was quite influential with respect to the determination of safety-related rule violations. The skills of operating the plant with the more complex 11-step procedure were negatively correlated with the amount of committed rule violations in all three experimental studies of the present investigation. Poor performance in operating the plant with the 11-step procedure was associated with a high amount of safety-related rule violations. In one investigation, the goods at stake study (cf. 6.1), there was also a negative correlation between the knowledge about the simulation (posttest knowledge) and the decision to violate the safety-related rule. In this investigation, a high amount of

knowledge about the simulation was associated with a low level of rule violations. These findings suggest that in particular, a good skill level, which can be achieved by regular training measures, reduces the amount of safety-related rule violations. Since the correlation between violations and knowledge about the task and the simulation was only found in one investigation, knowledge seems to be a less important and not always relevant determinant of rule violations.

7.2.5 Implementation of audits and communication of audit probability

The impact of audits and the effect of different implementation and communication mechanisms were investigated in the audit probability and audit timing study (cf. sections 6.3, 6.4.). Below, first, the impact of audit frequency, audit timing and audit experience will be outlined, followed by a description of the impact of audit communication.

When organisations consider the implementation of audits, they want to achieve a maximum effect with a minimum amount of audits. Therefore, they consider what amount of audits they should place within defined time span (determine the audit probability), and at what point in time they should implement audits (audit timing).

In the study investigating the impact of audit probability, the amount of audits was varied in certain time periods in a within-subject design. All participants were audited in one simulated quarter at 1 of 12 possible times, and in two quarters at 3 of 12 possible times. When the participants received no information about the variation of the audit frequency, the frequency had no impact on the amount of rule violations committed in the different periods. This indicates that audited participants either did not detect relatively small differences in the amount of conducted audits, or they considered this information as irrelevant with respect to their rule-related decision. Probably, they would have detected larger differences if, for example, the audits had been accomplished 6 in 12 times or 1 in 12 times, but the differences in the frequencies which were investigated here had no impact. This suggests that a quite small amount of rule violations is sufficient. Whether an audit is conducted 1 in 12 times or 3 in 12 times makes no difference; if the amount of rule violations should be reduced the audit frequency must be increased more intensely.

The investigation regarding the audit timing (cf. section 6.4) revealed that it is effective to conduct audits immediately after the rule has been prescribed. If audits are experienced early on, people comply with the rule in this early time period more frequently than if their first audit is comparatively late. Based on the findings of the present investigation, the late implementation of audits is very ineffective. In the beginning participants violated because they had not been audited, but even once the audits had started later

on, they did not change their behaviour: They violated equally frequently even though audits had now taken place.

Nevertheless, the early start of auditing is not sufficient; audits have to be conducted regularly, as if the audits stopped after a certain time period, participants quickly began to violate the rule. Hence, due to the transient effect of audits, audits can be indeed reduced if necessary, but it is recommended to not stop them entirely.

Regarding the scheduling of audits, the bomb crater effect, which was proved by the impact of audit probability study (cf. section 6.3), should also be considered. People tend to violate the rule especially often when they have just been audited, as they assume that audits will not be subsequently carried out. It would be effective to occasionally perform two audits in succession to demonstrate that audits are equally probable every time, even when an audit has just occurred.

To maximize rule compliance with a minimum amount of audits, not only the timing, but also the communication with respect to audits and their probabilities should be considered. As mentioned above, the frequencies of audits need to differ quite substantially if they are to reduce the amount of rule violations. If not only the audit probability is changed, but additionally information about audit probability is supplied, more rule compliance can be achieved with no or only minor changes in the audit frequencies.

As the impact of audit probability study demonstrated (cf. section 6.3), the changes in audit frequency only had an effect on the amount of committed rule violations when the participants received either precise (e.g. they were made aware of the frequencies, i.e. there will be an audit in 1 in 20 cases) or vague information (e.g. the audit probability is low) about audit probability. Since the total amount of audits was the same in the quarter in which a medium, or 3 in 20, probability was announced and the quarter in which a high, or 5 in 20, probability was announced, but the participants nevertheless violated significantly more often in the medium/3 in 20 probability condition, it can be assumed that not the real frequencies, but only the information about audit probability is relevant for the rule-related decision. The communication of high audit probabilities can be used to reduce safety-related rule violations. Nevertheless, the real and the communicated rule frequencies/probabilities should not differ too much because it can be assumed that people will detect the deception.

Not only the information about audit probabilities is decisive, but also the accuracy of information about audit probabilities which is provided. It was demonstrated that a high degree of accuracy leads to a comparatively high amount of rule violations. It is assumed that the highly accurate information makes people feel able to make better estimates re-

garding the probability of audits, and they then perceive the risk as more controllable and therefore less threatening. The participants who received precise information violated the rule significantly more often than those who received no or vague information. The amount of rule violations did not differ significantly between participants who received no information and those who received vague information. It can be summarized that it is advisable to provide information about audit probabilities, but the information should be only vague to achieve maximum rule compliance.

7.3 Integration of empirical findings into the theoretical background

In the following section, the empirical findings which were gained in the scope of the present investigations will be integrated into the theoretical background described in the general theory part. The models which are considered as most relevant in the different perspectives are the Process Level Model of Violations (PLMV, proposed by the author) described in the Human Factors Perspective and the Integrated Model of Behavioural Prediction applied to Violations (IMV, Kluge, 2010; Kluge, 2010), which is addressed in the Decision-Making Perspective. The current findings will be integrated in the PLMV in section 7.3.1 and in the IMV in section 7.3.3.

Whereas the PLMV summarizes the theories, models and insights of the Human Factors perspective and the IMV can be seen as the most relevant theory with respect to the description of the decision-making regarding rule violations, there is no comparable central theory in the area of Industrial and Organisational Psychology. Since the personality traits which were investigated in the impact of personality section were selected due to their correlation with deviant behaviour investigated in the area of industrial and organisational psychology, the findings of this study will be used to determine the correlation between safety-related rule violations and deviant behaviour summarized under the general term of counterproductive work behaviour (CWB), which is the most central construct in the Industrial and Organisational Psychology perspective (cf. 7.3.2).

7.3.1 Integration of findings into the Human Factors Perspective

The PLMV was already described in the Human Factors perspective (cf. section 5.1.6). Hence, the following section will address only the aspects of the model for which the present investigation provides new evidence. The adapted PLMV is displayed in Figure 30. All variables which were investigated in some way within the scope of the present investigation are displayed in red font. The investigated determinants which were previ-

ously not part of the model, but are included due to the present investigation, are additionally underlined.

The empirical investigations addressed level-related as well as process-related determinants of safety-related rule violations depicted in the PLMV. First, the level-related aspects will be addressed, followed by a description of the process-related aspects.

Empirical evidence regarding the level-related aspects of the PLMV

On the individual level, the impact of *(audit-) experience, (task-related) knowledge, skills, gender* and *personality* was investigated. Since the *gender,* and the *task-related knowledge* were associated with safety-related rule violations in only one of the three experimental assessments, it is assumed that both determinants have only a minor influence on the rule-related behaviour.

Additionally, the influence of *personality traits* is assumed to be marginal. Only two of the large number of investigated traits were identified as influential with respect to the determination of rule violations. One of these, the regulatory focus at work subscale *prevention focus,* was only investigated in one study. The subscale of integrity *cautiousness* was investigated in two studies, but was only a significant predictor of safety-related rule violations in one of the studies. This shows that personality-related aspects are somewhat relevant, but play a minor role, at least with respect to the determination of safety-related rules as they were investigated in the present investigation.

On the individual level, the determinants *experience* and *skill* seem to be much more influential. The *experience* factor, which was investigated in the current studies, does not refer to experience in terms of work, but rather to *audit experience*. It was investigated whether participants who had just experienced an audit were more likely to violate a rule at the next opportunity, or whether an early *audit experience* (audits experienced just after a rule has been prescribed) would lead to more rule compliance overall. Based on the findings, the *audit experience* is very influential. When participants had just experienced an audit, they underestimated the probability that another audit would follow subsequently, and therefore violated the rule more frequently shortly after they had experienced a safety audit. On the other hand, the early implementation of audits led to more compliance with rules at least as long as the audits were continued at relatively regular time periods. This seems to be contradictory at first glance, but whereas the increase in rule violations after an audit has just occurred is a short-lasting effect which refers only to the next possibility to violate the rule, the effect of early *audit experience* acts in a more long-lasting manner as it leads to a decrease in rule violations on the next few occasions.

When audits are not accomplished regularly, even this effect diminishes after a while. Although there was an increase in violations when an audit had just occurred, in general, early and continuous auditing is good method to reduce the amount of rule violations. By contrast, if there was a lack of *audit experience*, just after the rule had been prescribed, people decided more frequently to violate the rule, even if they were audited after a certain time. This may be not only an effect of *audit experience* but also of *violation experience.* As the participants violated the rule quite frequently, violation became a habit. Furthermore, they became accustomed to the benefits associated with rule violation. When audits started late, the experience regarding audits (occurring not at all or only rarely) as well as their experience regarding violation (associated with benefits almost every time and is never or only rarely linked to negative consequences) led to a persistently high amount of decisions in favour of a rule violation.

All of this evidence proves the importance of *(audit) experience* as factor which influences (safety-related) rule violations. The degree of experience seems to be an important informational resource which is used to estimate future situations and the probability of certain events, which in turn influence the rule-related decision. Future investigations should focus on the impact of other facets of experience, such as work experience or violation experience.

The *skill* determinant was added to the PLMV on the basis of the present investigation. The PLMV already contains the determinants training and education, which can be interpreted as an influence of *skill*. But actually, the same amount and type of training and education can result in different skill levels. Although all of our participants received the same training, they differed with respect to their *skill* level acquired during training. Since all investigations showed that at least the *skill* with respect to the more complex 11-step procedure was significantly negatively related to the amount of committed rule violations, it is assumed that it is beneficial to add the *skill* determinant to the individual level of the PLMV.

On the situational level, the impact of the PLMV components *organisational rule characteristics, safety audits* and *financial resources* and *organisation goals (framing)*, as well as the impact of *social norms* and *conflicting goals* were considered by the studies conducted within the scope of the present investigations.

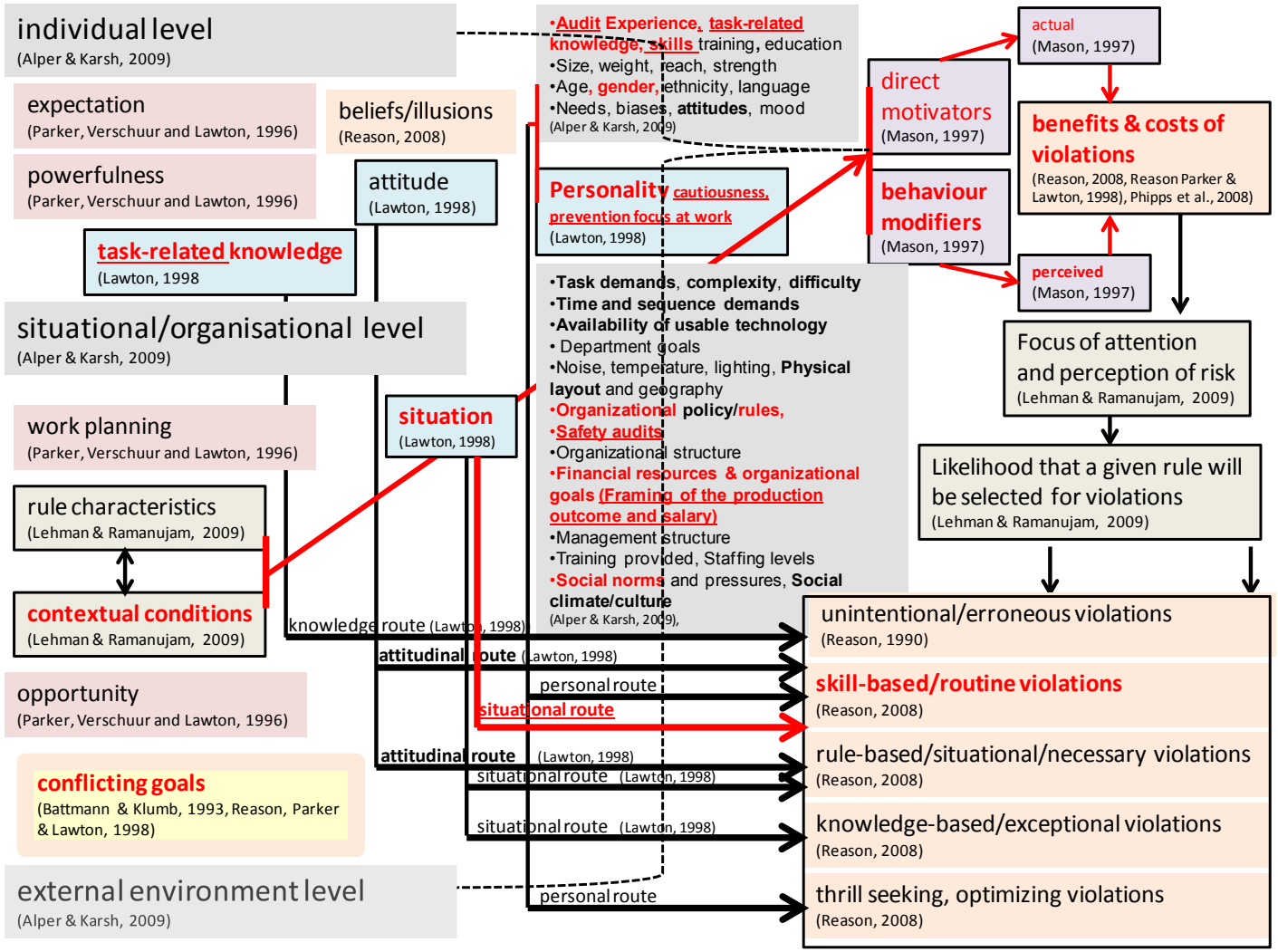

Figure 30. Adapted Process-Level-Model of Violations PLMV (investigated processes and determinants are marked in red)

The characteristics of *organisational rules* were considered, as the effectiveness of the rule prescription was compared with respect to the information which was provided during the prescription of the organisational rule. It was compared whether the consequences which are hazarded when a rule is violated change the rule-related decisions. In this regard, it was compared whether the rule violation can trigger the destruction of property or the endangerment of the health of residents (goods at stake). It was hypothesised that due to the activation of different social norms, which are also considered as one situational component in the PLMV, the endangerment of human health would result in more rule compliance. As the rule characteristic goods at stake had no significant impact on the rule-related decision, for the time being, it has to be assumed that this rule characteristic is irrelevant for the rule-related decision. Since this effect was assumed to be due to *social norms*, it may be further assumed that social norms are less influential than assumed in the previous PLMV. This determinant was not removed, as this was only found by one investigation. Further studies should be conducted to clarify whether these situational determinants really play such a minor role as the present findings suggest.

As a further situational determinant, the impact of *safety audits* and the communication of audit-related information was investigated and added as a new situational/organisational determinant of rule violations to the PLMV. Depending on the perspective, the factor *safety audit* can be either assigned to the individual level as an impact of *audit experience*, or to the situational level as an impact of the organisation`s scheduled implementation and communication regarding *safety audits*. Hence, as the impact of audit timing, as well as the bomb crater effect was already described in the section about *audit experience*, in the following, only the impact of audit frequency and accuracy of information about audit probability investigated in the current study will be addressed.

The current findings suggest that minor variations of audit frequencies have no impact on the rule-related decision. Only when changes in the audit frequencies were communicated did the participants adapt their rule-related behaviour to the changing probabilities. The investigation of the impact of the accuracy of information about audit probability provided the insight that precise information leads to significant more rule violations than if only vague or no information about audit probability was supplied. Since the timing of audits, the communication of different audit probabilities as well as the accuracy level of information about audit probability had a significant influence on the frequency of rule violations, it is assumed that *safety audits* are a very influential determinant of rule violations and need to be considered as a situational/organisational influencing factor in the PLMV.

The situational influences *financial resources* and *organisation goals* are considered by the investigation of the *framing* of the production outcome and salary as gain or loss (the perception of gain or loss emerges due to the comparison of the organisational goals with achieved performance and the gained financial resources/salary). By varying the reference points, which are the goals prescribed by the organisation, participants were given the impression that they were behind the *organisational goals* and would lose *financial resources* (loss framing) or that they would meet the prescribed goals and gain *financial resources* (gain framing), even though they achieved the same production output and earned the same salary in both conditions. The findings reported within the scope of the present investigation corroborate the impact of *framing*, as in two of the three studies which investigated the framing, the loss framing led to significantly more rule violations than the gain framing. Since the framing effect was furthermore also found by Kluge et al. (2013), it can be assumed that the effect of framing is stable across different conditions and is therefore added to the PLMV as an example of the influence of *organisational goals* and *financial resources*.

Conflicting goals, which are also a determinant on the situational level of influences of the PLMV, were considered because in all experimental studies of the present investigation, the participants were confronted with incompatible goals. They had to decide whether to maximise the performance (which was requested by the organisation and would presumably determine the financial compensation for participation) or to comply with the safety procedure (which is also an organisational request, guarantees safety, but is associated with less performance and a lower salary).

Based on the assumption that *goal conflicts* are very common in most organisations, a goal conflict was induced to improve the validity of the experimental environment and to create the necessity to violate the safety-related rule. It can be assumed that in the majority of the cases, people will comply with the rule in an experimental environment in which they feel observed and evaluated, unless there are incentives which betray them to violate. This goal was accomplished, as a quite high variance in rule-related behaviour was achieved in all investigations. In the study investigating the impact of the goods at stake, 29% of the participants decided to violate the rule (in this investigation, the participants had to decide only once, meaning that only the between-subject value can be calculated). In the studies conducted to investigate the impact of audit probability and audit timing, the participants violated the rule on average in 25 % (audit timing study) and 37 % (audit probability study) of the 36 times they had to make the rule-related decision. The quite high level of rule violations, despite the fact that the participants were aware that

they were in an investigation situation, suggests that goal conflicts promote rule violations. Moreover, it can be seen as indicator that the participants did not know that the financial remuneration was not really performance-based (cover story), but was the same for all participants.

Empirical evidence regarding the process-related aspects of the PLMV

The process-related aspects of the PLMV which were investigated within the present studies are the impact of the *contextual conditions* (e.g. the framing, audit probability or audit timing), which are either perceived as *direct motivators* (e.g. the variation of audit frequencies, which changes the actual benefits and costs of violations) or *behaviour modifiers* (e.g. the variation of information about audit probability, which only changes the perceived benefits and costs of violations). The current investigations found evidence for the significance of the *behaviour modifiers* (such as the information about audit probability or the impact of framing) on skill-based/routine violations. The current studies found that the perceived, and not the actual, benefits and costs of violations are more influential regarding the determination of rule violations.

Based on the current findings, a new rule violation path also has to be added to the PLMV. The current studies addressed the determinants of skill-based/routine rule violations. As the previous sections already demonstrated, the rule violations were influenced not only by personal and attitudinal influences as it was previously proposed, but also by various situational/organisational determinants (such as safety audits, framing). Hence, the situational routes/paths are proposed to lead not only to rule-based and knowledge-based but also to skill-based/routine violations (cf. red arrow, Figure 30).

7.3.2 Integration of findings into the Industrial and Organisational Psychology Perspective

On the basis of the findings of the studies conducted to determine the impact of personality (cf. section 6.2), the construct of safety-related rule violations will be related to various constructs investigated in the area of industrial and organizational psychology. The personality traits were selected due to their correlation with several deviant behaviours (cf. Table 22). It is assumed that the personality traits which correlate with these deviant behaviours are also associated with deviations from safety-related rules (safety-related rule violations).

Table 21. Summary of investigated personality traits, their association with deviant behaviour and their correlation with the rule violation intention and rule violation behaviour

Personality trait		**Associated behaviour**	**Correlation with intention**	**Correlation with behaviour**
Self-control		(-) various criminal or imprudent behaviours (Arneklev et al., 1993)	No	No
Integrity		(-) CWB (Marcus et al., 2013)	Yes, (-), medium, with subscales **cautiousness**, **non-rationalisation** and **reliability**	(Only **cautiousness** measured), Yes, (-) low (in one of two studies in which the trait was measured, in the other no correlation)
Belief in a just world		(-) use of unjust means to achieve long term goals (Hafer, 2000),	No	Not measured
Sensitivity towards injustice		(-) prosocial and (+) unsocial behaviour (Gollwitzer et al., 2005)	Yes (-), medium	Not measured
Self interest		(+) lying behaviour(Grover & Hui, 1994),	Yes (+), medium	No
Self-responsibility		(+) performed safety observations (DePasquale, 1999)	No	Not measured
Regulatory focus at work	**Prevention focus**	(+) safety-performance (Wallace, Johnson, & Frazier, 2009)	No	Yes (-), low
	Promotion focus	(+) productivity and (-) safety performance (Wallace et al., 2009)	No	No

Note. (-) negative correlations, (+) positive correlations, low = .10 > r <.30; medium = .30 > r <.50

In the pilot study of the impact of personality investigation, the personality traits were correlated with the intention to violate a rule in daily life situations. Regarding the intention to violate a rule, the personality traits integrity (subscales *cautiousness*, *non-rationalisation* and *reliability*), *sensitivity towards injustice* and *self-interest* turned out to be relevant determinants (cf. Table 22). These personality traits are related to CWB, anti-

social behaviour and lying behaviour. Hence, it can be assumed that rule violations in these daily life situations (which are covered by the scale assessing the intention to violate a rule) might be associated with CWB, antisocial behaviour and lying behaviour. To ascertain whether there are correlations between rule violations and these deviant behaviour patterns, further investigations should be conducted.

Based on the findings of the prestudy and the different analyses several personality traits were investigated with respect to their correlation with rule-related behaviour in the simulation (for a summary of the results, cf. right column of Table 22). Only the traits *cautiousness* and the *regulatory focus at work* subscale *prevention focus* correlated significantly with safety-related rule violations. Hence, it can be assumed that safety-related rule violations as they were investigated in the scope of the present investigation may be negatively related to CWB (assumption based on the negative correlation between integrity and CWB) and positively related to safety-performance (assumption based on the positive correlation between *prevention focus* and safety performance).

Although most personality traits, which were selected due to findings from the area of industrial and organisational psychology, cannot be used to predict safety-related rule violations in a process-control task, the researcher of industrial and organisational psychology as well as the human factors researcher should consider the findings in the respective other area in order avoid repeatedly investigating the same objects. Furthermore, the respective other perspective can be used to generate new research objectives.

7.3.3 Integration of findings into the Decision-Making Perspective

To improve the validity of the Integrated Model of Behavioural Prediction applied to violations (IMV) of Kluge (2010) and Kluge et al. (2013), and consequently also the understanding of the decision-making process regarding rule violations, the current findings will be integrated into the IMV in the following section. As the IMV was already described in detail in a previous section (cf. 5.3.4), in the following, only the modifications made due to the empirical evidence of the present investigation will be described. The modified IMV is displayed in Figure 31, the investigated aspects are depicted in red font, the new added aspects are underlined, the significant aspects are in bold, and the insignificant aspects are crossed out.

In the empirical investigations, the variables *age* and *sex* are summarized under the new heading *Demographics*. Since there was almost no variance regarding *age* due to the student sample, the impact of *age* on rule violations could not be determined. Al-

though *sex* showed a small correlation with rule violations in one investigation (indicating that men are more prone to rule violations than woman), on the basis of the current findings it is assumed that the demographic determinant *sex* has only a minor impact on the occurrence of safety-related rule violations. To explore the impact of other demographic factors, further investigations should assess a sample which is more diverse regarding several demographic variables like age, cultural or educational background, citizenship or family status.

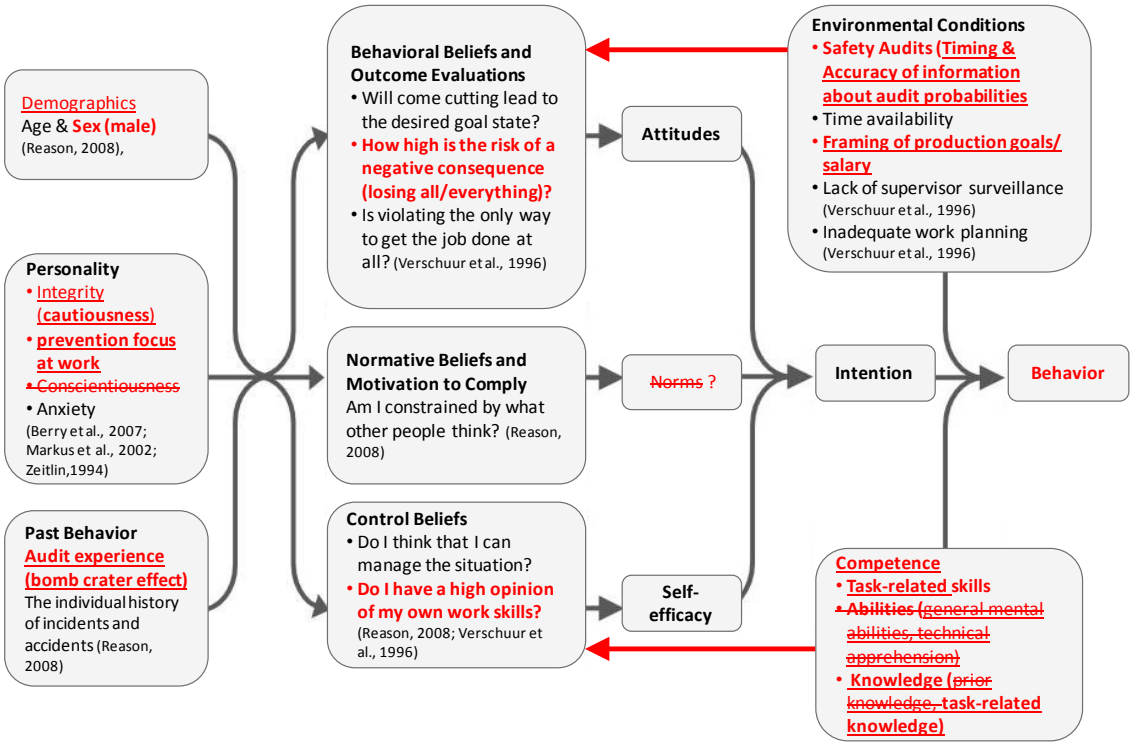

Figure 31. Adapted Integrated Model of Behavioural Prediction, the investigated determinants are depicted in red, the newly added components are underlined, the bold-marked factors have an impact on the behaviour, the factors which had no impact are crossed out

The next cluster of influences of the IMV refers to the impact of personality on rule violations. In the present investigation, several personality traits were ascertained (for an overview of all investigated personality traits cf. section 7.2.3). *Conscientiousness*, which was assumed to be negatively correlated with rule violations in the previous IMV, turned out to be unrelated to the rule-related behaviour according to the present findings. Therefore this trait was crossed out in the model (cf. Figure 31). Since *cautiousness* and *prevention focus* correlated negatively with rule violations, these two traits were added as new determinants to the IMV.

With respect to the *past behaviour* cluster, the impact of *audit experience* was considered in the empirical evidence part. *Audit experience* was added as new determinant to the model since the investigation of the bomb crater effect as well as the audit timing revealed that audit experience is quite influential with respect to the determination of rule-related behaviour. When people experience audits early after the rule has been prescribed and at regular intervals, they violate the rule less often. By contrast, when people initially experience an audit later on, this leads to more rule violations not only in the early period when they have not experienced an audit, but also later on once the audits have begun. Furthermore, people who have just experienced an audit decide more frequently to violate a rule subsequently (bomb crater effect). Both effects corroborate the impact of past experience on rule violations. Whereas the previous IMV only considered the past behaviour with respect to accidents and incidents, the current findings suggest that audit experience also influences rule related behaviour.

The influence of *norms* was addressed in the study described in the impact of goods at stake section. It was assumed that the description of different consequences of rule violations (goods at stake), which are either the destruction of property or the injury of residents, will activate different norm types, which result in more rule compliance when people can be endangered by the rule violation. The fact that no effect of the goods at stake was detected can be either due to the fact that *norms* have no influence on the rule-related decision, or that the manipulation of the goods at stake did not activate different norm types. Furthermore, the investigation context might be responsible for the results (cf. section 6.1). Either way, the impact of *norms* on rule violations should be explored by further investigations.

The main goal of the empirical evidence part was to explore the impact of several *environmental conditions*. *Safety audits* were investigated with respect to the best implementation method, which refers to the frequency (audits were accomplished 1 of 12 or 3 of 12 possible times) and timing of audits (early vs. late; bomb crater effect) as well as the best communication method, which refers to the accuracy of information supplied about audit probability (no, vague or precise information). Since significant effects regarding the accuracy of information about audit probability, as well as audit timing were found (although they were not congruent with the proposed hypothesis) and, moreover, the bomb crater effect was also detected, the impact of safety audits on rule violations is assumed to be high. Additionally, the framing of the production outcome and salary, which is assigned to the environmental conditions, influenced the rule-related behaviour in two of the

three studies conducted within the scope of the present investigation in which the framing was explored.

The *environmental conditions* safety audits, as well as the framing of the production outcomes, influence the occurrence of rule violations. It is assumed that they do not only influence the behaviour directly. Furthermore, it is assumed that the impact of the environmental conditions, such as the implementation and communication of safety audits or impact of framing, are mediated by a person`s behavioural beliefs. For example, it is assumed that for example the timing of audits or a loss-framed depiction of the production outcome influence the evaluation of the riskiness of rule violations, or the attractiveness of the compliance option, respectively. The *behavioural beliefs* in turn influence the *attitudes,* which determine the *intention*, which influences the rule-related behaviour. To represent the assumed relationship between the environmental conditions and the behavioural beliefs, a red arrow from the *environmental conditions* to the *behavioural beliefs* is added to the model (cf. Figure 31).

The previous model proposed the *skills* and *abilities* of a person as influencing factors, which determine whether or not the rule-related intention is realized or not. This cluster is supplemented by several new determinants which were explored within the scope of the present investigation. Under the added heading *Competence,* the impact of *task-related skills, abilities (general mental ability*, *technical comprehension)* and *knowledge (prior knowledge and task-related knowledge* after the training*)* on rule-related behaviour was summarised. In all three experimental studies conducted within the scope of the present investigations, the *skills* regarding the more complex 11-step procedure was negatively related to rule violations. People`s *abilities* (general mental ability as well as the technical comprehension) were not related to rule violations at all. In one investigation, the *task-related knowledge* after the training was weakly negatively related to rule violations, whereas the *prior knowledge* had no impact across all three experimental investigations. All in all, according to the present findings, mainly the *skill* level, and possibly the *task-related knowledge*, seem to be relevant for the determination of rule violations.

C*ompetence* is assumed to influence the behaviour though the mediator *control beliefs* (as it is assumed that the impact of environmental constraints is mediated by the behavioural beliefs). Hence, a red arrow symbolising the proposed cause-and-effect relation was added to the model (cf. Figure 32).

Future studies should address the assumed mediating roles of the behavioural beliefs/control beliefs for the impact of environmental conditions/competences on rule viola-

tions. Furthermore, the impact of the *beliefs* on the *attitudes, norms* and *self-efficacy* and their impact on the *intention* to violate a rule should be investigated.

7.4 Practitioner summary

In accordance with leading Journals in Human Factors and Ergonomics, which encourage authors to be explicit about the implications for practice, the following section gives guidance to practitioners who wish for a short overview of how to use the findings of the present investigation to implement evidence-based safety-management measures to reduce safety-related rule violations.

7.4.1 How to consider person-related determinants

To improve safety by achieving a high level of compliance with safety-related rules, it is recommended to select employees who score high on cautiousness (measured by the subscale of the German integrity questionnaire of Marcus, 2006) and have a high prevention focus at work (measured by a subscale of the prevention focus at work questionnaire of Wallace et al., 2009). Since a high skill level as well as good knowledge about the work task is also associated with a high level of rule compliance, it is recommended to select employees with a high skill level and good knowledge, and to regularly implement human resource development measures to maintain and improve the competence of the employees.

7.4.2 How to determine goals and give performance feedback

When the depiction of the production outcome and salary leads to the impression that the production goal will not be achieved, or that money will be lost (loss framing), people violate the safety-related rule more frequently. This information can be used for different purposes. If the goal is to enhance safety, it is recommended to give performance feedback in a gain-framed manner, meaning that the reference point (prescribed goal) should be sufficiently low that the employees will have the impression that they will certainly achieve or even exceed their production goals and the expected salary. If, on the contrary, the achievement of performance goals is prioritised over safety goals, the loss-framed depiction of performance goal, which can be achieved by comparatively high goals which cannot or only barely be achieved, is recommended.

7.4.3 How to implement and communicate safety audits

Regarding the implementation of audits the following insights should be regarded. The results of the present investigation suggest that a quite small amount of safety audits is sufficient. There is no difference whether an audit is conducted 1 in 12 or 3 in 12 times. If the amount of rule violations should be reduced to a significantly lower level, the frequency of audits must be increased more intensely. Moreover, audits should be conducted just after the rule has been prescribed. If a reduction in the amount of audits is essential, this could be done, but it is highly recommended not to stop the conducting of audits entirely since the amount of rule violation will increase immediately. Furthermore, it should be demonstrated that audits can occur at any time, even when an audit has just taken place. In this regard, sometimes two audits should be conducted in succession.

The communication of increased audit probabilities either in a precise or in vague manner will reduces the amount of rule violations, independently of the real audit frequencies. Since precise information about the probabilities of audits (e.g. there will be an audit in 1 in 20 cases) leads to significantly more rule violations independently of the information which is communicated, it is mostly recommended to provide vague information (such as the audit probability is small, medium or large) about increasing audit probabilities to achieve maximum rule compliance.

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11 Appendix of the empirical evidence parts

11.1 Appendix of the Impact of Goods at Stake, Impact of Audit Probability and Impact of Audit Timing

The amount of material used in the three experimental investigations (cf. 6.1,6.3 and 6.4) is vast, as in every experimental condition, different documents were used in order to manipulate the different independent variables. Moreover, all of the documents are in the German language. For these reasons, it was decided not to include the documents as an appendix in the present investigation. Nevertheless, interested readers are invited to request the documents from the author or her reviewer at ananda.vonderheyde@googlemail.com or annette.kluge@rub.de.

11.2 Appendix: Impact of Personality

11.2.1 Self-control

Seipel, C. (1999). Die Bedeutung von Gelegenheitsstrukturen in der 'general theory of crime' [The importance of opportunity structures in the ‘general theory of crime’] by Michael R. Gottfredson and Travis Hirschi. *Soziale Probleme, 10(2), 144-156.*

Seipel (1999) derived the scale from:
Grasmick, H. G., Tittle, C. R., Bursik, R. J., & Arneklev, B.J. (1993). Testing the core empirical implications of Gottfredson and Hirschi's general theory of crime. *Journal of Research in Crime and Delinquency,* 30(1), 5-29.

Please indicate to what extent the following statements apply to you! Please mark a number from (1) “Not at all true” to (5) “Completely true”.

I frequently say ill-considered things.	Not at all true	❶❷❸❹❺	Completely true
I never allow myself to lose control.	Not at all true	❶❷❸❹❺	Completely true
I am good at making myself get tasks done which I don’t really like working on.	Not at all true	❶❷❸❹❺	Completely true
I find it difficult to say no.	Not at all true	❶❷❸❹❺	Completely true
Other people would describe me as impulsive.	Not at all true	❶❷❸❹❺	Completely true
I wish I had more self-discipline.	Not at all true	❶❷❸❹❺	Completely

			true
I am reliable.	Not at all true	❶❷❸❹❺	Completely true
I don't let myself be led too much by my feelings.	Not at all true	❶❷❸❹❺	Completely true
I do lots of things on the spur of the moment.	Not at all true	❶❷❸❹❺	Completely true
Other people would say that I have iron self-discipline.	Not at all true	❶❷❸❹❺	Completely true
I find it difficult to complete tasks that I don't enjoy.	Not at all true	❶❷❸❹❺	Completely true
I have trouble concentrating.	Not at all true	❶❷❸❹❺	Completely true
I lose patience too quickly.	Not at all true	❶❷❸❹❺	Completely true
I often interrupt other people.	Not at all true	❶❷❸❹❺	Completely true
I am always punctual.	Not at all true	❶❷❸❹❺	Completely true

11.2.2 Integrity

Marcus, B. (2006). *Inventar berufsbezogener einstellungen und selbsteinschätzungen (IBES)*. Göttingen: Hogrefe.

a. Low Distribution

Please indicate to what extent the following statements apply to you! Please mark a number from (1) "Do not agree at all" to (5) "Agree completely".

Sometimes one hears about criminal machinations in industry, but I think that these are really rare exceptions.	Do not agree at all	❶❷❸❹❺	Agree completely
There are more criminals in the world than most people suspect.	Do not agree at all	❶❷❸❹❺	Agree completely
Pretty much everybody has committed a little theft or fraud at some point if there was a good opportunity.	Do not agree at all	❶❷❸❹❺	Agree completely
People who earn their money with honest work are nowadays in the minority.	Do not agree at all	❶❷❸❹❺	Agree completely
If someone gets their luggage stolen on holiday, they mostly claim to the insurance company that the	Do not agree at all	❶❷❸❹❺	Agree completely

damage is higher than it really was.			
Pretty much everyone cheats on their tax return.	Do not agree at all	❶❷❸❹❺	Agree completely
If everyone who steals at work got fired then companies would be fairly empty.	Do not agree at all	❶❷❸❹❺	Agree completely

b. Non-Rationalization

Please indicate to what extent the following statements apply to you! Please mark a number from (1) “Do not agree at all” to (5) “Agree completely”.

Lots of employers take advantage of their employees wherever they can. They shouldn’t be surprised when employees act in just the same way in return.	Do not agree at all	❶❷❸❹❺	Agree completely
To be successful in one’s professional life, one mustn’t be too particular about rules and guidelines.	Do not agree at all	❶❷❸❹❺	Agree completely
The fact that an employee feels underpaid is no reason to improve his/her wages through illegal activities.	Do not agree at all	❶❷❸❹❺	Agree completely
Whoever is smart and works hard gets furthest in their professional life with honesty.	Do not agree at all	❶❷❸❹❺	Agree completely
Our companies must work with all the tricks, be they legal or illegal, to survive in the face of international competition.	Do not agree at all	❶❷❸❹❺	Agree completely
Some employers simply don’t deserve honest employees.	Do not agree at all	❶❷❸❹❺	Agree completely

c. Reliability

Please indicate to what extent the following statements apply to you! Please mark a number from (1) “Do not agree at all” to (5) “Agree completely”.

When I enter into a commitment, I can be relied upon one hundred percent.	Do not agree at all	❶❷❸❹❺	Agree completely
I often act in the moment without stopping and thinking.	Do not agree at all	❶❷❸❹❺	Agree completely
I think long and carefully before I make a decision.	Do not agree at all	❶❷❸❹❺	Agree completely

I work on tasks quickly rather than thoroughly.	Do not agree at all	❶❷❸❹❺	Agree completely
I would waste less time at work if I had someone looking over my shoulder.	Do not agree at all	❶❷❸❹❺	Agree completely
Before I start something I consider carefully how I want to proceed.	Do not agree at all	❶❷❸❹❺	Agree completely
I don't agonise over decisions, rather I do them first and then see what happens.	Do not agree at all	❶❷❸❹❺	Agree completely

d. Cautiousness

Please indicate to what extent the following statements apply to you! Please mark a number from (1) "Do not agree at all" to (5) "Agree completely".

I am sensible rather than adventurous.	Do not agree at all	❶❷❸❹❺	Agree completely
Sometimes I find it exciting to do risky things in order to feel a thrill.	Do not agree at all	❶❷❸❹❺	Agree completely
At the fairground, I'd rather go on the rollercoaster than the Ferris wheel.	Do not agree at all	❶❷❸❹❺	Agree completely
When the situation gets a bit exciting, that's when I really flourish.	Do not agree at all	❶❷❸❹❺	Agree completely
I'd rather be a cameraman on a film than a stuntman.	Do not agree at all	❶❷❸❹❺	Agree completely
I love variety in life.	Do not agree at all	❶❷❸❹❺	Agree completely
Peace and quiet are more important to me than fun and excitement.	Do not agree at all	❶❷❸❹❺	Agree completely

e. Conflict avoidance

Please indicate to what extent the following statements apply to you! Please mark a number from (1) "Do not agree at all" to (5) "Agree completely".

If I deem somebody to be incapable then I tell him/her so.	Do not agree at all	❶❷❸❹❺	Agree completely
I don't mind getting into an argument with someone if I have a different opinion.	Do not agree at all	❶❷❸❹❺	Agree completely
I could never tell somebody that I can't stand them to	Do not agree at all	❶❷❸❹❺	Agree completely

their face.			
I try to avoid conflict if possible.	Do not agree at all	❶❷❸❹❺	Agree completely
It happens that I make others my enemy for the sake of something which is important to me.	Do not agree at all	❶❷❸❹❺	Agree completely
I'm rather a person with rough edges.	Do not agree at all	❶❷❸❹❺	Agree completely
I prefer not to get into arguments with people who have power over me.	Do not agree at all	❶❷❸❹❺	Agree completely

11.2.3 Belief in a just world

Schmitt, M., Maes, J., & Schmal, A. (1997). *Gerechtigkeit als innerdeutsches Problem: Analyse der Meßeigenschaften von Meßinstrumenten für Einstellungen zu Verteilungsprinzipien, Ungerechtigkeitssensibilität und Glaube an eine gerechte Welt*. Universität Trier: Fachbereich I - Psychologie. *[Justice as an inner-German problem: Analysis and measurement properties of measurement instruments for attitudes towards distribution principles, injustice sensitivity and belief in a just world] Universität Trier: Fachbereich I - Psychologie.]*

Please indicate to what extent the following statements about justice and injustice in life apply to you! Please mark a number from (1) "Does not apply at all" to (5) "Completely applies".

What goes around comes around.	Does not apply at all	❶❷❸❹❺	Completely applies
There's barely any crime that wouldn't be punished in the long run.	Does not apply at all	❶❷❸❹❺	Completely applies
At some point you have to atone for all the bad things you've done.	Does not apply at all	❶❷❸❹❺	Completely applies
Anyone who does wrong will be called to account for it one day.	Does not apply at all	❶❷❸❹❺	Completely applies
Anyone who brings suffering to others will one day have to pay for it.	Does not apply at all	❶❷❸❹❺	Completely applies
Anyone who gets rich at the expense of others will pay bitterly for it in the end.	Does not apply at all	❶❷❸❹❺	Completely applies

11.2.4 Sensitivity towards injustice

Schmitt, M., Maes, J., & Schmal, A. (1997). *Gerechtigkeit als innerdeutsches Problem: Analyse der Meßeigenschaften von Meßinstrumenten für Einstellungen zu Verteilungsprinzipien, Ungerechtigkeitssensibilität und Glaube an eine gerechte Welt*. Universität Trier: Fachbereich I - Psychologie. *[Justice as an inner-German problem: Analysis and measurement properties of measurement instruments for attitudes towards distribution principles, injustice sensitivity and belief in a just world] Universität Trier: Fachbereich I - Psychologie.]*

Please indicate to what extent the following statements about justice and injustice in life apply to you! Please mark a number from (1) “Does not apply at all” to (5) “Completely applies“.

It bothers me if I get something that someone else deserves.	Does not apply at all	❶❷❸❹❺	Completely applies
I feel guilty when I get recognition that others have earned.	Does not apply at all	❶❷❸❹❺	Completely applies
I find it difficult to bear when I unilaterally profit from others.	Does not apply at all	❶❷❸❹❺	Completely applies
It takes me a long time to forget when others have to iron out my negligence.	Does not apply at all	❶❷❸❹❺	Completely applies
It saddens me when I get more opportunities to develop my skills than others.	Does not apply at all	❶❷❸❹❺	Completely applies
I feel guilty when I am undeservedly better off than others.	Does not apply at all	❶❷❸❹❺	Completely applies
It bothers me when things fall into my lap which others have to toil for.	Does not apply at all	❶❷❸❹❺	Completely applies
I mull over it for a long time if I am treated in a more friendly way than others for no reason.	Does not apply at all	❶❷❸❹❺	Completely applies
It burdens me when others are criticised for things which are overlooked for me.	Does not apply at all	❶❷❸❹❺	Completely applies

11.2.5 Self-interest

Mohiyeddini, C., & Montada, L. (2004). *" Eigeninteresse" und" zentralität des wertes gerechtigkeit für eigenes handeln": Neue skalen zur psychologie der gerechtigkeit*. Universi-

tät Zürich: Fachrichtung Persönlichkeitspsychologie und Diagnostik. Universität Trier: Fachbereich 1. Psychologie: Fachbereich I - Psychologie.*["Self-interest" and "centrality of the value of justice for one's own actions": New scales on the psychology of justice] Universität Zürich: Fachrichtung Persönlichkeitspsychologie und Diagnostik. Universität Trier: Fachbereich 1. Psychologie: Fachbereich I - Psychologie.*

Please indicate to what extent the following statements apply to you! Please mark a number from (1) "Do not agree at all" to 5 "Agree completely".

It is more important for me to follow my interests than to be fair.	Do not agree at all	❶❷❸❹❺	Agree completely
I think it is more important to follow my interests than the interests of others.	Do not agree at all	❶❷❸❹❺	Agree completely
Asserting my interests is more important to me than the relationship with my friends.	Do not agree at all	❶❷❸❹❺	Agree completely
In the conflict between my own interests and fairness, I will decide in favour of my interests.	Do not agree at all	❶❷❸❹❺	Agree completely
To protect my interests, I would be prepared to decide against the interests of people close to me.	Do not agree at all	❶❷❸❹❺	Agree completely

11.2.6 Self-responsibility

Bierhoff, H., Wegge, J., Bipp, T., Kleinbeck, U., Attig-Grabosch, C., & Schulz, S. (2005). Entwicklung eines Fragebogens zur Messung von Eigenverantwortung oder:"Es gibt nichts Gutes, außer man tut es". [Development of a questionnaire for the measurement of self-responsibility or: "Actions speak louder than words"] *Zeitschrift Für Personalpsychologie, 4(1), 4-18.*

Please indicate to what extent the following statements apply to you! Please mark a number from (1) "Do not agree at all" to (5)"Agree completely"

.

If one is pursuing an important goal and meets resistance, it is justifiable to use arguments whose validity cannot be proven.	Do not agree at all	❶❷❸❹❺	Agree completely
One can contribute a great deal to achieving one's	Do not agree at all	❶❷❸❹❺	Agree completely

goals in life.			
If wearing a seat belt was voluntary, I would not regularly buckle up.	Do not agree at all	❶❷❸❹❺	Agree completely
I always try to prepare for a decision by intensively thinking about advantages and disadvantages.	Do not agree at all	❶❷❸❹❺	Agree completely
I think everyone can contribute to improving their daily life.	Do not agree at all	❶❷❸❹❺	Agree completely
Before I decide on an alternative, I reflect for longer than most people do.	Do not agree at all	❶❷❸❹❺	Agree completely

11.2.7 Regulatory focus at work

Solga, M. (in prep.). Felt accountability and job performance: The mediating effects of work regulatory focus.

Solga (in prep) derived the scale from: Wallace, J. C., Johnson, P. D., & Frazier, M. L. (2009). An examination of the factorial, construct, and predictive validity and utility of the regulatory focus at work scale. *Journal of Organizational Behavior,* 30, 805–831.

How frequently do you concentrate on the **following things** at work? For each statement, mark a number from 1 to 5.

I concentrate on …

rfaws01 1. following the rules and regulations at work. (prevention focus)	never	❶❷❸❹❺	always
rfaws02 2. accomplishing a lot at work. (promotion focus)	never	❶❷❸❹❺	always
rfaws03 3. completing work tasks correctly. (prevention focus)	never	❶❷❸❹❺	always
rfaws04 4. getting the work done, no matter how. (promotion focus)	never	❶❷❸❹❺	always
rfaws05 5. meeting the work obligations. (prevention focus)	never	❶❷❸❹❺	always
rfaws06 6. completing lots of work in a short time. (promotion focus)	never	❶❷❸❹❺	always

rfaws07 7. fulfilling responsibilities at work. (prevention focus)	never	❶❷❸❹❺	always
rfaws08 8. devoting myself to things which get me ahead at work. (promotion focus)	never	❶❷❸❹❺	always
rfaws09 9. fulfilling duties at work. (prevention focus)	never	❶❷❸❹❺	always
rfaws10 10. performing, achieving successes. (promotion focus)	never	❶❷❸❹❺	always
rfaws11 11. satisfying the details at work. (prevention focus)	never	❶❷❸❹❺	always
rfaws12 12. completing as many work tasks as possible. (promotion focus)	never	❶❷❸❹❺	always

11.2.8 Rule violation Instrument

The following statements are about moral conflicts. Please indicate to what extent the statements apply to you! Please mark a number from (1) “Do not agree at all” to (4) “Agree completely”.

I would rather risk being caught speeding than be late for an important appointment.	Do not agree at all	❶❷❸❹	Agree completely
Although I have a blood alcohol level of 0.8 per cent (blatantly above the legal limit), I give my injured friend a lift to the hospital.	Do not agree at all	❶❷❸❹	Agree completely
Although an opposing player lies injured on the ground due to my foul, I continue the match to make the final score for my team.	Do not agree at all	❶❷❸❹	Agree completely
I would cross the street when the lights are red in order to catch the bus, even though a family with small children is standing next to me.	Do not agree at all	❶❷❸❹	Agree completely
I would rather risk missing the last train than get on it without a valid ticket.	Do not agree at all	❶❷❸❹	Agree completely
I would rather risk failing an important exam than cheat using illegal means.	Do not agree at all	❶❷❸❹	Agree completely
Although I notice that I’ve damaged another car while backing out of a parking space, I drive on so that my insurance doesn’t go up.	Do not agree at all	❶❷❸❹	Agree completely
Although I suspect the Smart phone (list price 600€)	Do not agree	❶❷❸❹	Agree

being offered to me by an acquaintance for 200€ is stolen, I buy it	at all		completely
Since my favourite film is out of stock in the shops, I download it illegally off the internet	Do not agree at all	❶❷❸❹	Agree completely
Although I do not feel well, I offer my bus/train seat to a frail person.	Do not agree at all	❶❷❸❹	Agree completely

12 Statement of authorship

Hiermit versichere ich, dass ich die vorgelegte Dissertation gemäß §9 der Promotionsordnung der Fakultät für Ingenieurswissenschaften der Universität Duisburg-Essen vom 9. Juni 2009 eine selbstständig durchgeführte und eigenständig verfasste Forschungsleistung darstellt und ich keine anderen als die angegebenen Hilfsmittel und Quellen benutzt habe. Die Arbeit hat weder in gleicher noch in ähnlicher Form einem anderen Prüfungsausschuss vorgelegen.

Duisburg, 02.10.2014 _____

Dipl. Psych. Ananda von der Heyde