S. Oppong*

RISK CHAIN PROCESS MODEL: LINKING RISK PERCEPTION TO OCCUPATIONAL ACCIDENTS

UDK 331.45/.48:614.8
RECEIVED: 2014-01-16
ACCEPTED: 2015-01-02

SUMMARY: The literature on risk perceptions and occupational accidents is replete with causal descriptions which only show the relationship between the two variables. However, there is a "black box" which needs to be illuminated as to the meditational process that links the two variables. To address this gap in the literature, this paper surveys both the theoretical (theories of risk perception) and empirical (related studies) literature and concludes by proposing a process model, so-named Risk Chain Process Model. The implications of this model for both research and practice are discussed..

Key words: *risk chain process model, risk perceptions, occupational safety*

BACKGROUND

Employees' and employers' risk perception is important in the workplace. This is because perception of the occupational risk factors is known to affect accident rates *(Mearns & Flin, 1996; Rundmo, 1996)*. Risk is conceptualized as a person's probable exposure to loss, to harm or to damage *(McGregor, 2006)*. Thus, it is a situation or an event where something of human values (including humans themselves) is at stake and where the outcome is not known *(Rosa, 2003)*. Risk perception may, therefore, be considered as the lens through which individuals view the objective risk. Others define it as an individual's judgment of the likelihood that a loss or harm will occur, and the judgment about the seriousness of its likely consequences *(Fischoff, Slovic, Lichtenstein, Read, & Combs, 1978)*. Cox and Tait *(1991)* have also defined risk perception as an acknowledgement of a hazard's capacity to harm and an estimation of the probability of the harm occurring.

In the practice of occupational health and safety management, risk is often considered to have two components: *severity* and *probability (Clemens & Simmons, 1998)*. When assessing risk for the purpose of guarding against it, risk assessments are often based on the probability of a hazard occurring, and/or the severity of the loss, which will result from the occurrence of the hazard *(Lehmann, Haight, & Michael, 2009)*. Similarly, Leiter and Cox *(1992)* also suggested a model for occupational risk assessment that considers three major components: *lethality, prevalence and control*. According to Leiter and Cox *(1992)*, *lethality* is the amount of harm or injury that a particular workplace hazard is expected to inflict on a victim, whereas *prevalence* estimates how frequently a particular hazard is expected to inflict the injury. *Control* is defined by Leiter and Cox *(1992)* as the worker's perception of his or her own ability to cope with a given situation. This means that in practice risk assessments only

*Seth Oppong, PhD (oppon.seth@gmail.com), Discipline of Human Resource Management, Sam Jonah School of Business, African University College of Communication, P. O. Box LG 510, Legon, Accra, Ghana.

capture lethality (severity index) and prevalence (likelihood index). Just as individuals make daily judgments about what risks are acceptable to them outside of work, judgments are made by workers regarding what risks are acceptable in their workplaces.

In a similar fashion, Lehmann et al *(2009)* argue that these risk judgments are often controlled by two distinct factors – risk tolerance and risk perception. *Risk tolerance* is the amount of risk an individual is willing to take on. The limit of risk is determined by the employer and that reflects the employer's expectations. By specifying limits the employers partly define risk boundaries for the workers *(Lehmann et al, 2009)*.

Risk perception differs from person to person even in the same situation, and risk preferences even differ by context for the same person *(Yang, 2004; Hunter, 2002)*. An examination of risk tolerance and risk perception in self-selected pilots found that an individual's perception of risk is negatively related to the individual's tolerance for risk *(Hunter, 2002)*. In other words, the lower the hazard level a person believes is inherent in a specific situation, the more willing that the person is likely to engage in risky behaviour related to that hazard. Thus, one is likely to behave dangerously if he or she perceives an activity to be associated with lower risk. This has been corroborated by Cordeiro *(2002)* in a matched case-control study in a large metallurgical factory in south-eastern Brazil.

THEORIES OF RISK PERCEPTIONS

Two theories about risk perception and their implications for accident prevention will be discussed. The theories are *risk preference theory* and *risk homeostasis theory*. Risk preference theory is related closely to the epidemiological theory of accident causation. According to the risk preference theory, people have a natural predisposition towards risk that is determined by their personality, experience, values and beliefs. This theory also proposes that people act often in accordance with their preference *(Deckop, Merriman, & Blau, 2004; Escher, 2010; Kapp, 2007; Roth & Kroll, 2007)*. Based on the internal disposition, three categories of workers can be identified: risk-seeking, risk-neutral, and risk-averse. This means that there are some workers who seek risk while others avoid risk, and others who are indifferent to risks. Empirical studies suggest that age, gender, personality, parent's risk preference, income level, marital status, and educational level can all determine risk preference of an individual *(Hibbert, Lawrence, & Prakash, 2008; Hyrshko, Luengo-Prado, & Sørensen, 2011; Gallagher; 2005)*.

Risk preference theory is consistent with accident-proneness theory that suggests that few people suffer several accidents and such individuals must have some characteristics that make them more vulnerable to experiencing accident *(Raouf, 1998; Larsson, 1999, cited in Suutaniren, 2003)*. However, this theory is considered both scientifically and politically incorrect *(Raouf, 1998; Larsson, 1999, cited in Suutarinen, 2003)*. There is some empirical evidence in support of the risk preference theory, at least in terms of the link between risk-taking and personality. Gallagher *(2005)* examined the relationships among the big five factors and risk-taking during war and reported evidence for positive correlations between risk-propensity and openness to experience, while negative correlations between risk-propensity and conscientiousness on one hand and between risk-propensity and neuroticism on the other, were reported. Again, Miner *(2002)* also concluded that extant empirical evidence provides support for the personality-accident relationship. His conclusion was that external locus of control, extraversion, aggression, social maladjustment, general neurotic conditions, specific neurotic conditions such as anxiety and depression, and impulsivity are all associated strongly with higher accident rates.

The implications of the risk preference theory for accident prevention lie in the recommendations for personnel selection and placement. The theory suggests that employers should not hire risk-takers or risk-seekers because they are accident-prone. However, given the scientific and political incorrectness of the theory, employers are encouraged to hire such persons but they must place them in positions where great harm would not result from their risky behaviours. After all, it takes both unsafe acts and unsafe conditions for accident to occur though unsafe acts create unsafe conditions.

Risk homeostasis theory was originally developed by Gerald Wilde for studying driver behaviour. However, this theory has been expanded to the analysis of workplace behaviour *(Kapp, 2007; Wilde, 1989)*. The theory proposes that each human being has a target or bearable level of risk with which they are comfortable, and that when we encounter situations that cause variation in risk we adjust our behaviour so as to move to the level of risk with which we are comfortable. The theory suggests that in situations in which the risk is perceived as greater than our target level, we adjust our behaviour to lower the risk, whereas in situations in which the risk is perceived as lower than our target level, we are likely to modify our behaviour to increase the risk on condition that there is some other benefit to increasing the risk such as saving time, saving money, looking good, becoming popular, and even being seen as "the brave man."

Hunter *(2002)* has found, among pilots, a negative relationship between risk tolerance and risk perception such that an individual is likely to behave dangerously if he or she perceives an activity to be associated with lower risk. However, it is worth noting that Lehmann et al *(2009)* have indicated that the limit of risk tolerance (the amount of risk an individual is willing to take on) of workers is determined by the employer via employer expectations. By specifying limits, the employers partly define risk boundaries for the workers. This means that the employer has the capacity to define the range of acceptable risk that can compel the individual to redefine their personal target level of risk. After all, what is inspected is to be expected and what is ignored will be neglected. Thus, once employers fail to reward risky behaviour, high tolerance for risk can be discouraged *(Oppong, 2011)*. Safety professionals are reported to express dislike towards risk homeostasis theory because safety recommendations following from the risk homeostasis theory suggest that any engineering and administrative changes or provision of personal protective equipment will be perceived as a decreased risk for those who have high tolerance or threshold for risk *(Oppong, 2011)*. As a result, this theory suggests, individuals will adjust their behaviour accordingly to increase risk; this implies that the actual risk in the situation will remain intact.

There are implications of this theory for accident prevention. These include disguising the safety changes so that the workers do not realize that some modifications have been made to the workplace or work procedures. Again, the theory implies that safety professionals should attach negative consequences to unsafe behaviour in the form of sanctions applied when risky behaviours are engaged in, even if they do not result in incidents or accident *(Oppong, 2011)*. Lastly, safety professionals should educate workers so they realize the true "objective" risk inherent in a particular situation and consequences of accidents. The purpose of such workplace risk education is to lower their target level of risk. However, there is something that all safety professionals should recognize: often the risky behaviour does not immediately result in a dangerous occurrence and, as a result, there is always a weak link between the risky behaviour and the ultimate accident *(Oppong, 2011)*. This view is consistent with the contingency trap proposed by experimental psychologists. Chance *(1994)* has argued that the immediate, high-probability events have greater impact on behaviour than the remote, low-probability events. Often, accidents appear to be remote, low-probability events and constitute a less compelling reason for behaviour change by both management and employees *(Oppong, 2011)*.

EMPIRICAL LITERATURE REVIEW

Risk perception is hypothesized to be linked to accidents. Sheehy and Chapman *(1987)* state that the link hypothesized between risk perception and accident is a perceptual one, so that discrepancies between subjective estimates of risk and their "objective" counterparts leave people poorly prepared to detect and cope with potential hazards. Indeed, Bohm and Harris *(2010)* have reported there was a significant difference between driver risk perception and measures of objective risk; they also reported that these drivers engaged in perceived high-risk behaviours. Thus, it can be concluded that the larger the underestimation of objective risk, the greater the probability that potentially dangerous situations will become accident situations *(Oppong, 2011)*.

While some researchers are of the view that risk perception can influence safety behaviour *(Barsky, Juster, Kimball, & Shapiro, 1997; Rundmo, 1996; Sheehy & Chapman, 1987)*, others are of the opinion that peer influence is a better predictor of safety behaviour than risk perception. For instance, Walters *(2009)* concluded from a review of the literature that peer influence was a better predictor of farmers' use of personal protective equipment (PPE) than risk judgments. Specifically, she reported that PPE use was more greatly influenced by peer-related and farm-specific factors than by farm workers' perceptions of pesticide risk, their belief in the value of using PPE, or the amount of training they had received relating to pesticides and their use. She added that individuals who belonged to farm groups that believed that other farms used protective equipment were more likely to wear PPE themselves.

To explain the peer influence proposition, Cohen and Smetzer *(2009, cited in Oppong, 2011)* argue that bystander apathy resulting from diffusion of responsibility may be responsible for such an occurrence. Bystander apathy is the tendency for people not to offer help in an emergency when others are present while diffusion of responsibility is the tendency for people not to feel personally responsible to take a needed action because they think others are equally responsible and will do it. This is in agreement with Neal and Griffin's *(2006)* suggestion that noncompliance with safety procedures and refusal to participate in activities that enhance the safety of other people can create the unsafe conditions that make it more likely that someone else will be injured later on.

Oppong *(2011)* proposes another possible explanation for peer influence. He argues that co-workers exert social influence on individual employees to conform to group safety norms/standards. Conformity involves adjusting our behaviour or thinking to bring it into line with some group standard *(Myers, 2001)*. This may result due to two reasons: normative social influence and informational social influence. According to Myers *(2001)*, normative social influence occurs as a result of a person's desire to gain approval or avoid disapproval from a group to which he or she belongs, while information social influence refers to the influence that results from a person's willingness to accept other people's opinions about reality. In terms of workplace safety, it can be said that employees may conform to work team's poor safety standards (e.g. cutting corners to increase speed of work, risk-taking seen as display of bravado, etc.) given the human need for affiliation *(Oppong, 2011)*. However, newly hired employees may be more susceptible to both informational and normative social influence. To the extent that safety behaviour is conceptualized to include safety initiatives/participation (things workers do to create safe work environment for themselves and co-workers), it can be said that most safety researchers usually "take care of" peer influence in studies in which they measure safety behaviour.

Flin, Mearns, Fleming, and Gordon *(1996)*, drawing on Rundmo's *(1996)* research, predicted that risk perception would be a causal factor of accident involvement. As expected, using a total sample of 622 offshore workers, Flin et al *(1996)* reported that risk perceptions directly influence accident. Similarly, Jahangiri, Mirzaei and Aansari *(2008)* reported that there was a significant positive relationship between use of hearing protector and worker's risk perception and also their knowledge about hearing protection. Again, they found a statistically significant positive relationship between general attitude of workers to safety and risk perception. Jahangiri et al's *(2008)* investigation was a cross-sectional study of 236 randomly selected workers in the Iranian petrochemical industry whose work environment exposed them to a noise level of 85 dB. The major limitation associated with their study is the kind of analysis performed. Simple correlations were computed; however, a multiple regression analysis could have been performed to determine the amount of variance accounted for by, for example, health information (knowledge about hearing protection) and risk perception in the use of hearing protector among the employees.

However, a major strength associated with Jahangiri et al's *(2008)* study is the fact that the evidence that general attitude of employees towards safety affects use of hearing protector could be taken as indicative of evidence in support of a relationship between safety climate and risk perception. Böhm and Brun *(2008)* stated that although

judgmental processes involved in risk perception have traditionally been conceptualized as cognitive in nature, intuition and emotion also affect the processes. The fact is that attitude involves emotions as well as cognitive processes, so it may be concluded with caution that employees' own attitude towards safety should, must and could be an important aspect or precursor of organisational safety climate.

Another study of relevance is the Federal Railroad Administration (FRA)'s study. FRA *(2008)* reported that their Changing At-risk Behaviour (CAB) programme being implemented at Union Pacific's San Antonio Service Unit resulted in steady decline in risky behaviours among the workers. Specifically, FRA *(2008)* concluded from an examination of a linear graphical representation of data collected by the workers themselves that risky behaviour has reduced from nearly 8% to roughly 3% of all observed behaviour; this represented a decrease of over 60%. Though the report did not specifically examine the relationship between risk perceptions and safety behaviour, a number of inferences can be derived from it. For instance, FRA *(2008)* reported that their most recently acquired worker data indicated a strong trend toward increasing safe practices from month to month *(*$r = 0.823$, $n = 21$, $p < 0.0001$); 85% of the questionnaire items for the observation showed a trend toward increasing safety. The implication is that as a result of CAB program, risky behaviour decreased while safe practices increased. However, a spurious relationship can be said to exit between risky behaviour and safe practices, as the third-variable problem exists in this case; thus, CAB program accounts for the observed relationship between risky behaviour and safe work practices.

Despite this shortcoming, this evidence can be taken to mean that there is a negative correlation between risky behaviour and safe practices. In terms of risk perceptions, this evidence can also mean that risk perception relates positively to safety behaviour, so that the more accurate the risk judgment of a worker is, the more likely that the worker will comply with workplace safety regulations. This conclusion about the inverse relationship between risk perception and risky behaviour stems from the conclusion reached by Hunter *(2002)* that the lower the hazard level a person believes is inherent in a specific situation, the more willingly will that person engage in risky behaviour related to that hazard.

Another possible inference from the FRA report is that safety climate can influence risk perceptions. This is because the involvement of FRA through the Human Factors Program of its Office of Research and Development, Union Pacific Railroad (UP), the Brotherhood of Locomotive Engineers and Trainmen (BLET), and the United Transportation Union (UTU) all creates an atmosphere that makes safety a priority in the rail sector in the U. S. Activities of such a high-power coalition communicate to the employees that safety is very important to all the stakeholders. It is the view of this paper that this could have resulted in changes in the safety climate of the workers at the UP's San Antonio Service Unit and, subsequently, this could have resulted in reduction in risky behaviour by the workers. In effect, it can be inferred that there is a positive correlation between safety climate and risk perception due to Hunter's *(2002)* proposed inverse relationship between risky behaviour and risk perception. However, note that no data were collected on safety climate.

Further, Bohm and Harris *(2010)* also explored and found a relationship between risk perception and risk-taking among construction site dumper drivers in the UK. They also reported that the drivers' risk perceptions were related to the "perceived dread" or danger associated with an accident rather than its likelihood of occurrence. This suggests that the drivers cared more about the degree of harm of the potential event or action. In a matched case-control study, Cordeiro *(2002)* reported that employees who have suffered occupational injuries have lower risk perceptions compared to their matched controls. Cordeiro's *(2002)* finding suggests that lower risk perceptions among employees who have suffered occupational injuries may have led to their involvement in the accident in the first place. Together these studies suggest that accurate risk perceptions will be associated with lower accident frequency.

Another area of research on risk perception seems to focus more on the content of risk perception and its antecedents or correlates rather than how it relates to employee outcomes such

as injury and health. For instance, Alexopoulos, EKavadi, Bakoyannis, and Papantonopoulos *(2009)* identified content (hazards) and assessed the risk perception among bakery workers. In another study, Akinboro, Adejumo, Onibokun, and Olowokere *(2012)*, among other objectives, sought to explore the effects of years of experience on risk perception among healthcare workers (HCWs) regarding occupational exposure to HIV and AIDS. Akinboro et al *(2012)* reported a very high risk perception among the HCWs but found low safety compliance behaviour in their professional duties. Similarly, Osagbemi, La-Kadri, and Aderibigbe *(2010)* explored the perception of occupational hazards, health problems and use of safety measures among sawmill workers in Ilorin (Nigeria). However, Osagbemi et al *(2010)* documented that there was low level of awareness of various occupational hazards. The review of the research domain of risk perception and occupational safety suggests that it is possible to categorize the studies into two: (1) those that examine the link between risk perception and occupational accidents, and (2) those that focus on the conceptualization of risk perception itself and its antecedents. What is, therefore, known is that the numerous studies that explore the link between risk perception and safety behaviour have largely been causal description of this relationship (see Figure 1). These studies hardly paid attention to the process through which risk perceptions lead to occupational accidents. As a result, the current study addresses this gap in the literature by proposing a causal explanation that links faulty risk perceptions to industrial accidents in the form of a process model. This paper advances knowledge by expanding the model that was previously referred to as Risk Chain Model *(Oppong, 2011)*.

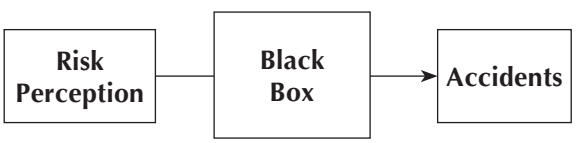

Figure 1. Black box of the link between risk perception and accidents

Slika 1. Crna kutija povezanosti percepcije rizika i nesreća

TOWARDS THE DEVELOPMENT OF THE RISK CHAIN PROCESS MODEL

Ganzach, Ellis, Pazy, and Ricci-Siag *(2008)* identified and evaluated two models of risk perception, namely: (1) the bottom-up model, and (2) top-down model. According to Ganzach et al *(2008)*, the bottom-up model predicts that it is the perceived risk (perceived threat) and perceived return (perceived opportunities or pay-offs) associated with an event or action that determines its attractiveness to an individual. On the other hand, top-down model suggests that the overall attractiveness of a given action or event determines its perceived risk and perceived return *(Ganzach et al, 2008)*. However, their analysis only focused on the operationalization of risk perception rather than on how risk perception is logically linked to industrial accidents. This suggests that there is an urgent need for a causal explanation as to why risk perception is indeed related to industrial accidents. Owing to this gap in the literature, a process model that explains how and why faulty risk perception leads to accidents is proposed and discussed (see Figure 2) *(Adapted from Oppong, 2011)*. The process model assumes that there are four key events closely linked in a sequence: once one event is set off it triggers the next event which sets off the other until the last event occurs. The risk chain is like a set of four dominos. Based on the available literature, the only logical conclusion that one can come to is that faulty risk perceptions lead to human error which manifests in risky behaviour which leads to risk exposure or exposure to hazardous conditions. The risk exposure eventually results in injuries or accidents. This does not suggest that every risk exposure will lead to accident, as accidents are low-frequency events *(Oppong, 2011)*. Faulty risk perceptions often lead to four critical errors: eyes-not-on-task(s), mind-not-on-task(s), being in the line-of-fire, and poor balance/grip.

Research provides evidence in support of this perspective. For example, Rundmo *(1992, cited in Flin et al, 1996)* showed that job stress and perceived risk contributed significantly to injuries and errors. The importance of this model also lies in the general agreement among safety researchers that human errors or factors constitute a major cause of industrial accidents *(Petrocelly &*

Thumann, 2000). However, to assume that human error is the only cause of industrial accident is to assume that human actions are not constrained by the context within which such actions take place *(Besnard & Hollnagel, 2012)*. Thus, it is acknowledged in this paper that organizational factors can affect individual risk perception. As stated earlier, Lehmann et al *(2009)* have suggested that employers set the limit of risk that is acceptable within the organization and that influences the risk tolerance of the employees (the amount of risk an individual is willing to take on). This suggests that employee's risk perception is constrained by the risk boundaries set by the employer through its safety culture.

In addition, Krallis and Csontos *(2014)* reported that work stress, group pressure, exposure and control of risk, and workplace safety performance (which reflects safety culture) are all correlates of risk perception. Bohm and Harris *(2010)* also reported that risk-taking behaviour among construction site drivers is influenced by situational factors such as site safety rules or the safety behaviour of other personnel on the site (group influence) and a culture that prioritizes production over safety. National culture has also been implicated. Alexopoulos et al *(2009)* reported that national culture also influences employee risk perception and attitudes towards safety in a study of Greek and English workers in a bakery. This model also acknowledges that individual factors also influence risk perceptions. Individual factors that have been found to influence risk perceptions include experience, mood, memory, knowledge *(Akinboro et al, 2012; Krallis & Csontos, 2014; Jahangiri et al, 2008)*.

Research and Practice Implications

The model has two important implications for the safety practitioners and researchers. First, it can serve as a model for accident investigation where the investigation commences with the occurrence of the accident, working one's way backwards to the point of the faulty risk perceptions, and understanding why the individual underestimated the risk *(Oppong, 2011)*. The underlying causes will then be reasons for risk underestimation.

Secondly, the model also suggests that safety interventions can be targeted at parts of the risk chain *(Oppong, 2011)*. For instance, eliminating or minimizing the determinants of faulty risk perceptions (that is a second-level primary prevention) will reduce the occurrence of the faulty risk perceptions, while targeting the link between faulty human error and risk exposure via ergonomics and provision of personal protective equipments (designing out some of the risk from work task and environment that is the first-level primary prevention) will minimize risk exposure. This gives room for pardonable mistakes and assumes that *"to err is human."* In this paper, ergonomics is referred to as a first-level primary prevention because it is the stage at which the objective risk can be estimated accurately and minimized through equipments redesign before workers will use them and be exposed to the inherent danger.

Again, targeting the link between risk exposure and incidents/accidents will minimize the consequence of the accidents (that is the secon-

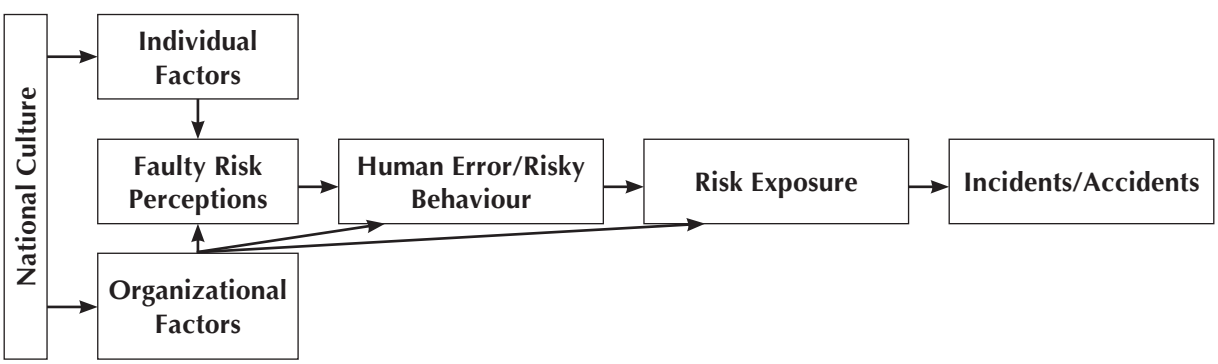

Figure 2. Risk Chain Process Model
Slika 2. Procesni model lanca rizika

dary prevention). To the extent that faulty risk perceptions can determine frequency of injuries or accidents via risky behaviours and subsequent risk exposure, it can be said that identifying the antecedents or determinants of risk perceptions is in order *(Oppong, 2011)*. This model has implications for research as well. Each link in the model represents a potential area for investigation. Similarly, the entire model can be tested using structural equation modelling.

REFERENCES

Akinboro, A. A., Adejumo, P. O., Onibokun, A. O. & Olowokere, A. E.: Community health care workers' risk perception of occupational exposure to HIV in Ibadan, South-west Nigeria. *African Journal of Primary Health Care & Family Medicine,* 4, 2012, 1, Art. #338, 9 pages. http://dx.doi.org/10.4102/phcfm.v4i1.338

Alexopoulos, E., C., Kavadi, Z., Bakoyannis, G., Papantonopoulos, S.: Subjective Risk Assessment and Perception in the Greek and English Bakery Industries. *Journal of Environmental and Public Health,* 2009. Article ID 891754, 8 pages http://dx.doi.org/10.1155/2009/891754

Barsky, R. B., Juster, F. T., Kimball, M. S. & Shapiro, M. D.: Preference Parameters and Behavioral Heterogeneity: An Experimental Approach in the Health and Retirement Study. *The Quarterly Journal of Economics,* 112, 1997, 2, 537-579.

Besnard, D. & Hollnagel, E.: *Some myths about industrial safety.* CRC Technical Report, 2012.

Böhm, G. & Brun, W.: Intuition and affect in risk perception and decision making. *Judgment and Decision Making,* 3, 2008, 1, 1–4.

Bohm, J. & Harris, D.: Risk Perception and Risk-Taking Behavior of Construction Site Dumper Drivers. *International Journal of Occupational Safety and Ergonomics (JOSE)*, 16, 2010, 1, 55 – 67.

Chance, P.: *Learning and Behaviour (3rd ed.).* Brooks/Cole Publishing Company. Pacific Grove, California, 1994.

Clemens, P. L. & Simmons, R. J.: *Safety System and Risk Management, A guide for Engineering Educators.* U. S. Department of Health and Human Services (NIOSH) Publication No. 96-37768, 1998.

Cordeiro, R.: Suggestion of an inverse relationship between perception of occupational risks and work-related injuries. *Cad. Saúde Pública, Rio de Janeiro,* 18, 2002, 1, 45 – 54.

Cox, S. & Tait, R.: *Reliability, Safety and the Human Factor.* Butterworth-Heineman. Stoneham, MA, 1991.

Deckop, J. R., Merriman, K. K. & Blau, G.: Impact of variable risk preferences on the effectiveness of control by pay. *Journal of Occupational and Organizational Psychology,* 77, 2004, 63 – 80.

Escher, D.: Revisiting Risk Preference Theory: Can It Explain the Sex Difference in Religiosity? *Paper presented at the annual meeting of the American Sociological Association Annual Meeting,* Hilton Atlanta and Atlanta Marriott Marquis, Atlanta, GA, 2010.

Federal Railroad Administration (2008). *Promising Evidence of Impact on Road Safety by Changing At-risk Behavior Process at Union Pacific.* Research Results, RR08-08. Retrieved November 2, 2009 from the World Wide Web: http://www.fra.dot.gov/us/

Fischoff, B., Slovic, P., Lichtenstein, S., Read, S. & Combs, B. How safe is safe enough? A psychometric study of attitudes towards technological risks and benefits. *Policy Sciences,* 1978, 9, 127-152.

Flin, R., Mearns, K., Fleming, M., Gordon, R.: *Risk perception and safety in the Offshore Oil and Gas Industry* (Offshore Technology Report OTH 94 454). HSE Books, Sudbury, 1996.

Gallagher, M. E.: High Rolling Leaders: The "Big Five" Model of Personality and Risk-Taking during War. *Working Paper presented at the International Studies Association-South Conference,* 2005, November.

Hibbert, A. M., Lawrence, E. & Prakash, A.: *Are Women More Risk-Averse Than Men?* Un-

published Manuscript. Retrieved May 4, 2011 from http://69.175.2.130/~finman/Reno/Papers/AreWomenMoreRiskAverseThanMen111808.pdf

Hunter, D. R.: *Risk Perception and Risk Tolerance in Aircraft Pilots.* Federal Aviation Administration Report No. PB2003100818, 2002.

Hyrshko, D., Luengo-Prado, M. J. & Sørensen, B. E.: Childhood determinants of risk aversion: The long shadow of compulsory education. *Quantitative Economics,* 2011, 2, 37–72.

Jahangiri, M., Mirzaei, R. & Aansari, H.: Risk perception, knowledge and safety attitude and hearing protector use in petrochemical industry's workers. *Audiology,* 17, 2008, 1, 11 – 18.

Kapp, A. E.: *Risk Perception and Risk Taking Behavior.* Presentation at 2007 Wisconsin State Risk Management Conference, University of Wisconsin-Whitewater. Slides # 11 – 20. Retrieved May 4, 2011 from www.doa.state.wi.us/

Krallis, D. & Csontos, A.: *From Risk Perception to Safe Behaviour.* Retrieved January 16, 2014 from http://www.sia.org.au/downloads/SIGs/Resources/From_Risk_Perception_to_Safe_Behaviour.pdf

Lehmann, C. C., Haight, J. M. & Michael, J. H.: Effects of Safety Training on Risk Tolerance: An Examination of Male Workers in the Surface Mining Industry. *Journal of SH&E Research,* 4, 2009, 3, 1 – 22.

Leiter, M. P. & Cox, T.: The impact of stress on safe working behavior in health care: Implications for training and task design. Paper presented at the *American Psychological Association/ National Institute for Occupational Safety and Health conference: A changing workforce in a changing workplace.* Washington. DC., 1992.

McGregor, S.L.T.: Reconceptualizing risk perception: Perceiving majority world citizens at risk from 'Northern' consumption. *International Journal of Consumer Studies,* 30, 2006, 3, 235-246.

Mearns, K. & Flin, R.: Risk perception in hazardous industries. *Psychologist,* 9, 1996, 9, 401-404.

Miner, J. B.: *Industrial-Organizational Psychology (International Edition).* McGraw-Hill Companies, Inc., New York, NY, 2002.

Myers, D. G.: *Psychology* (6th ed.). Worth Publishers, New York, NY, 2001.

Neal, A. & Griffin, M. A.: A Study of the Lagged Relationships among Safety Climate, Safety Motivation, Safety Behavior, and Accidents at the Individual and Group Levels. *Journal of Applied Psychology,* 91, 2006, 4, 946–953.

Oppong, S.: *Health & Safety: Theory and Practice in the Oil and Gas Sector.* VDM Publishing House Ltd., Saarbrücken, Germany, 2011.

Osagbemi, G. K., La-Kadri, R. T., Aderibigbe, S. A.: Awareness of Occupational Hazards, Health Problems and Safety Measures among Sawmill Workers in North Central Nigeria. *TAF Preventive Medicine Bulletin,* 9, 2010, 4, 325–328.

Petrocelly, K. L. & Thumann, A.: *Facilities Evaluation Handbook: Safety, Fire Protection and Environmental Compliance (2nd ed.).* The Fairmont Press, Inc., Liburn, GA, 2000.

Raouf, A.: *Theory of Accident Causes.* In: Encyclopaedia of Occupational Health and Safety (4th ed.). Vol. 2. International Labour Office, Geneva, 1998, pp. 56.1 – 56.42.

Rosa, E. A.: The logical structure of the social amplification of risk framework (SARF): Metatheoretical foundation and policy implication. In N. K. Pidgeon, and R. E. Slovic (Ed.), *The social amplification of risk.* Cambridge University Press, Cambridge, 2003.

Roth, L. M. & Kroll, J. C.: Risky Business: Assessing Risk Preference Explanations for Gender Differences in Religiosity. *American Sociological Review,* 72, 2007, 2, 205 – 220.

Rundmo, T.: Associations between risk perception and safety. *Safety Science,* 24, 1996, 3, 197–209.

Sheehy, N. P. & Chapman, A. J.: Industrial Accidents. In C. L. Cooper and I. Robertson (Eds), *International Review of Industrial and Organisational Psychology,* 1987, pp. 201 – 227.

Suutaniren, J.: *Occupational Accidents in Finnish Agriculture: Causality and Managerial Aspects for Prevention.* Unpublished Doctoral Dissertation. Faculty of Agriculture and Forestry, University of Helsinki, Finland, 2003.

Walters, M. W.: Peer Influence May Play a Greater Role than Risk Perception in Protective Equipment Use. *Agricultural Health and Injury Prevention,* 4, 2009, 1, 3.

Wilde, G. J. S.: Accident countermeasures and behavioural compensation: The position of risk homeostasis theory. *Journal of Occupational Accidents,* 10, 1989, 4, 267–292.

Yang, Y.: Measuring risk preferences. *Consumer Interests Annual,* 50, 2004, 2, 119 – 122.

PROCESNI MODEL LANCA RIZIKA: POVEZANOST PERCEPCIJE RIZIKA I NESREĆA NA RADU

SAŽETAK: Literatura o percepciji rizika i nesrećama na radu obiluje opisima uzroka nesreća koji prikazuju samo odnos između tih dviju varijabli. Međutim, postoji tzv. 'crna kutija' koja bi trebala rasvijetliti misaoni proces, tj. misaonu vezu između dviju varijabli. Članak nastoji popuniti tu prazninu u istraživanjima pregledom teorijske (teorije percepcije rizika) i empirijske (povezane studije) literature, a u zaključku nudi jedan procesni model, nazvan procesni model lanca rizika. Navode se implikacije modela na istraživanje i praksu.

Ključne riječi: *procesni model lanca rizika, percepcije rizika, zaštita na radu*

Pregledni rad
Primljeno: 16.1.2014.
Prihvaćeno: 2.1.2015.