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Arving A. Abella, Yogi Tri Prasetyo, Michael Nayat Young, Reny Nadlifatin, Satria Fadil Persada, Anak Agung Ngurah Perwira Redi & Thanatorn Chuenyindee. *The effect of positive reinforcement of behavioral-based safety on safety participation in Philippine coal-fired power plant workers: a partial least squares structural equation modeling approach.* Pages: 951-962.

The power plant accident is considered one of the man-made disasters in many developing countries, including the Philippines. This study aimed to identify the factors influencing behavioral-based safety (BBS) of coal-fired power plant workers which subsequently led to their active safety participation (SPT). In total, 201 coal-fired power plant workers in the Philippines answered the questionnaire consisting of 60 items using a purposive sampling approach. Partial least squares structural equation modeling (PLS-SEM) revealed that personal measures (PM) had significant effects on safety incentives (SI), safety management system (SMS) and safety perception (SP). SP also had significant effect on BBS which subsequently led to SPT. Finally, SMS had significant effect on safety culture (SC) which subsequently led to safety communication (SCM), BBS and SPT. This study is the first to explore BBS in the Philippine coal-fired power plant, and can positively reinforce SPT of workers in the coal-fired power plant industry.

- **Keywords:** safety culture, behavioral-based safety, coal-fired power plants, partial least squares structural equation modeling

Rajat Kamble, Sangeeta Pandit & Avinash Sahu. *Occupational ergonomic assessment of MSDs among the artisans working in the Bagh hand block printing industry in Madhya Pradesh, India.* Pages: 963-969.

Objectives. The hand block printing technique practiced in Dhar District of Madhya Pradesh involves highly repetitive tasks with awkward posture, which contribute to the development of musculoskeletal disorders (MSDs) among the artisans, The aim of this study was to determine the prevalence of MSDs and the risks factors involved. *Methods.* An observational study and a self-reported questionnaire study were conducted with a sample of 70 artisans. The working postures of the artisans were analyzed using rapid upper limb assessment (RULA) and the occupational repetitive actions (OCRA) method. $p \leq 0.05$ was considered significant throughout the

study. *Results.* MSDs in the neck, shoulders, elbows, wrist/forearm, lower back and hips/thighs were found to be highly prevalent among artisans of age greater than 31 years and experience greater than 11 years. Most complaints were reported in the wrist, neck and lower back region. *Conclusion.* From the findings, it was evident that artisans working in Bagh printing are at high risk of the development of MSDs; thus, an immediate intervention is needed to eliminate the ergonomic risks among the artisans.

- **Keywords:** hand block printing, musculoskeletal disorder, rapid upper limb assessment, ergonomic risks, handicrafts

Betül Çiftçi & Fulya Demirhan. *Investigating the impacts of working at home among office workers with neck pain on health status, depression and sleep quality during the COVID-19 pandemic.* Pages: 970-978.

Objective. This study aimed to assess the effect of workplace and ergonomic features on neck pain intensity, sleep problems, depression and health status in office workers during the COVID-19 pandemic. Methods. One-hundred and thirty-nine office workers with neck pain aged 18–55 years were enrolled in the study. Sociodemographic features including ergonomic features of the workplace were evaluated. The Beck depression inventory (BDI), Nottingham health profile (NHP), Pittsburgh sleep quality index (PSQI) and neck pain and disability scale (NPDS) were administered to all participants. Results. All participants were grouped based on workplace into Group 1 (working in office, n = 84) and Group 2 (working at home, n = 55). There was a statistically significant difference between the groups according to the rate of absence of back support and flexible back (respectively p = 0.020 and p = 0.029). The neck pain and disability index (NPDI) scores of the participants who work with a computer for >3 h without a break was higher in Group 2 than in Group 1, and the differences between groups were statistically significant (p = 0.001). Conclusions. The health-related quality of life was worse and neck pain intensity was severe in the working at home group than in the working in office group.

- **Keywords:** COVID-19, neck pain, occupational health, pain, quality of lifework

Ruihua Xu, Fan Luo, Gaoming Chen & Fenghua Zhou. *Identification of risk factors for air traffic controllers' unsafe acts based on online reviews.* Pages: 979-988.

Online reviews may influence unsafe acts and are significant in the context of big data. This study acquired online reviews related to air traffic control from social media websites. The word frequency statistics and coding of negative comments were taken to mine risk factors. Combined with the human factors analysis and classification system (HFACS), a conceptual model of the risk factors associated with the unsafe acts of air traffic controllers (ATCers) was constructed. The results indicate that the frequency of risk factors in online reviews, ranked from high to low, is organizational influences, ATCers' adverse states, environmental factors and unsafe supervision. Organizational influences, environmental factors and unsafe supervision indirectly affect the unsafe acts through the ATCers' adverse states. It is demonstrated that the combination of HFACS and online reviews to identify risk factors enables the identification of problems in the air traffic control industry and demands of ATCers.

- **Keywords:** online reviews, air traffic controllers, unsafe acts, risk factors, human factors analysis and classification system

Patience Erick, Modimooteng Sethatho, Tshephang Tumoyagae, Baemedi Letsholo, Roy Tapera & Bontle Mbongwe. *Self-reported neck and back pain among supermarket cashiers in Gaborone, Botswana.* Pages: 989-997.

Objective. This study aimed to investigate the prevalence, risk factors and impacts of neck and back pain among supermarket cashiers in Botswana. *Results.* A total of 174 supermarket cashiers participated in this study, the majority of whom were females (72%). The prevalence of lower back pain was 69%, upper back pain 53% and neck pain 37%. Increasing age was associated with neck (95% confidence interval [CI] [1.43, 5.15]) and upper back (95% CI [1.43, 3.60]) pain. Cashiers working at a low work surface and overreaching for items were 19 and 11 times more likely to report neck (95% CI [1.7, 255.9]) and lower back (95% CI [1.84, 62.1]) pain, respectively. Almost 6% of cashiers who reported lower back pain reported considering changing jobs due to pain. *Conclusions.* More than two-thirds, one-half and about two-fifths of supermarket cashiers reported lower back, upper back and neck pain, respectively. Individual and work-related factors were associated with neck and/or back pain. To reduce their prevalence and progression, supermarkets should introduce occupational health and safety talks.

- **Keywords:** grocery workers, musculoskeletal pain, ergonomic hazards

Jiayun Hu, Chunling Liang, Yan Zhang, Yuanyuan Li & Ping Wang. Preparation and characterization of flexible laminated composites impregnated with TPU/SiO₂ for static puncture resistance. Pages: 998-1006.

At present, people face the danger of various occupational exposures, resulting in the rapid development of protective composites among which puncture-resistant materials are an essential component. In this article, composites impregnated with polyester polyurethane (TPU)/SiO₂ are used to improve static puncture resistance. Different types of TPU and different concentrations of SiO₂ in the impregnation solution are selected. The mechanical and wearing-related properties of composites are systematically explored and analyzed. The results show that static puncture resistance and tensile strength are improved after impregnation. Meanwhile, the composites can still maintain a good water-vapor transmission rate. The air permeability, tearing strength, elongation at break and flexibility of the composites decrease slightly. This study provides a novel and feasible strategy to prepare a flexible composite with high static puncture resistance as well as excellent wearability which is a desirable candidate as a garment accessory or gasket protecting the human body from puncture risk.

- **Keywords:** flexible laminated composite, impregnation, static puncture property, polyester polyurethane, SiO₂

Emad Adel Shdaifat. Presenteeism and productivity loss among nurses. Pages: 1007-1015.

Objectives. Presenteeism is a significant problem among the working force, and nurses are not an exception from these phenomena. The purpose of the study was to determine the productivity loss due to presenteeism from three dimensions and to evaluate the associated factors among nurses. *Methods.* A cross-sectional study was conducted among 309 nurses to evaluate presenteeism using the Stanford presenteeism scale (SPS), the health performance questionnaire (HPQ) and the work productivity short inventory (WPSI). *Results.* The study found that nurses had a high level of presenteeism using the SPS (21.0 ± 4.3) and the HPQ (80.0 ± 18.2). On both scales, presenteeism was significantly associated with nurses who were older than 32 years, with experience of more than 10 years, having children and specifically having two children. The results of the WPSI showed that the productivity loss of presenteeism per nurse annually was USD 1959 and for all nurses was USD 605,283. *Conclusion.* Eventually, evaluating the presenteeism level will help policymakers to understand the working conditions and related personal characteristics.

- **Keywords:** presenteeism, productivity loss, nurses, work performance

Saman Ahmad & Mohammad Muzammil. *Predicting the load constant of the revised NIOSH lifting equation based on demographics.* Pages: 1016-1024.

Manual materials handling (MMH) and lifting activities have been identified as risk factors for lower back pain (LBP). Of the many tools available to analyse and design lifting tasks, the revised NIOSH lifting equation (RNLE) is perhaps the most widely used. However, the equation is based on data primarily from the West. To make the model universally applicable, the effect of worker characteristics like age, gender, weight and anthropometry on maximum acceptable weight limits (MAWLs) was studied. A psychophysical methodology was adopted to arrive at the MAWLs. In total, 58 industrial workers (30 men and 28 women) participated in the study. Based on the observations of the study, an equation was developed that would allow the RNLE load constant to be modified for different populations based on simple anthropometric data. The load constant for the Indian population was found to be comparable to the RNLE recommendations.

- **Keywords:** manual materials handling, manual lifting, revised NIOSH lifting equation, anthropometry, load constant

Kristina Stosic, Nicklas Dahlstrom & Chantinee Boonchai. *Applying lessons from aviation safety culture in the hospitality industry: a review and road map.* Pages: 1025-1036.

It is widely accepted that positive safety culture improves organizations' safety performance and reduces the number of injuries and deaths. Safety culture has been well researched in high-risk industries; however, the hospitality industry until recently had no research of the concept unless related to food safety. This article explores theoretical grounds for research of safety culture in hospitality, based on the aviation safety culture body of knowledge. Using aviation as a foundation is motivated by the similarities in operations between aviation and hospitality, especially when hospitality is compared to other high-risk industries. The article proposes that aviation safety culture models and their dimensions could be valuable for hospitality industry's safety culture improvements. Its goal and aspiring contribution is to begin a discussion and build a theoretical base for future research about advancement of safety in hospitality operations and reduction of the industry's relatively high numbers of employee injuries.

- **Keywords:** safety culture, aviation, hospitality, maturity models

Xiaorong Zhu, Jiazhen He, Ke Rui & Qianwen Zhou. *Investigation of the dual performance of thermal protective clothing with deformation under low radiant heat exposure.* Pages: 1037-1046.

Occupational workers in thermal exposure have frequent physical activities that may lead to fabric deformation of thermal protective clothing. To deeply understand the impact of fabric deformation on its dual thermal protective and thermal hazardous performance, a modified experimental instrument was used to simulate different extents of fabric tensile deformation and compression deformation. The results demonstrated that increasing tensile ratios during exposure decreased heat storage within a fabric system, but increased the skin absorbed energy. Tensile ratios had a more negative impact on the thermal protective performance of a single-layer fabric than of a double-layer fabric system. Increasing tensile ratios during cooling decreased heat discharge to the skin, but the applied compression significantly improved the heat discharge. In addition, regression models were established to examine the effect of fabric deformation and

demonstrated that the thermal hazardous performance of fabrics was more affected by compression than by tensile deformation.

- **Keywords:** thermal protective clothing, fabric deformation, heat storage, thermal hazards, heat discharge

Pavanaditya Badida, Selvan Janakiraman & Jayapriya Jayaprakash. *Occupational health and safety risk assessment using a fuzzy multi-criteria approach in a hospital in Chennai, India. Pages: 1047-1056.*

Objectives. Hospitals provide direct and indirect employment benefits to medical professionals. Accidents in hospitals often lead to disastrous consequences such as fatalities, property damage and economic losses. It is, therefore, imperative to have an occupational health and safety (OHS) policy that aims to reduce work-related accidents to acceptable levels. This study aims to investigate health risks to staff from various hazards and suggest control measures to prevent recurrence of accidents. *Methods.* A two-stage fuzzy multi-criteria decision-making (MCDM) approach incorporating the fuzzy analytical hierarchical process (FAHP) and fuzzy technique for order preference for similarity to ideal solution (TOPSIS) was applied to assess the hazards in a leading multi-speciality hospital in Chennai. *Results.* The top three hazards identified in the workplace were electrical hazards, faulty medical equipment, and ventilation and air conditioning hazards. Subsequently, control measures were suggested to reduce the recurrence of hazards. Finally, a survey of hospital accidents occurring in India between 2010 and 2020 was conducted and compared with the results of this study. *Conclusions.* The survey findings show similarity to the hazard rankings obtained in this work, thus validating the methodology used for the assessment of hazards in hospitals. Electrical hazards and faulty medical equipment should be monitored.

- **Keywords:** occupational health and safety, risk assessment and management, fuzzy logic fuzzy analytical hierarchical process, fuzzy TOPSIS, hospital safety

Jonathan Witte, Alexandra Corominas, Benjamin Ernst, Uwe Kaulbars, Robert Wendlandt, Hans Lindell & Elke Ochsmann. *Acute physiological and functional effects of repetitive shocks on the hand–arm system: a pilot study on healthy subjects. Pages: 1057-1066.*

Objectives. Exposure to hand-transmitted shocks is a widespread phenomenon in the workplace. Separate risk assessments for shocks do not exist in current international hand–arm vibration regulations, leading to potential underestimation of associated health risks. *Methods.* In a pilot study approach, eight healthy males were exposed to sets of 3 × 5 min of repetitive shocks and 1 × 5 min of random vibration, controlled at a weighted vibration total value of 10 m/s². Baseline and post-exposure measurements of vibration perception thresholds, finger skin temperature, maximal grip/pinch force and the Purdue pegboard test were conducted. Muscle activity was monitored continuously by surface electromyography. *Results.* Shock exposures evoked a temporary increase of vibration perception thresholds with high examination frequencies. A decrease of skin temperature was hinted for shocks of 1 and 20 s⁻¹. Electromyographical findings indicated an additional load on two forearm muscles during shock transmission. Maximum grip force and manual dexterity were not affected, and pinch force only partially reduced after the exposures. *Conclusion.* Physiological effects from shock exposure conform to those described for hand–arm vibration exposure in principle, although some divergence can be hypothesized. Randomized designs are required to conclusively assess the need of occupational health concepts specifically for hand-transmitted shocks.

- **Keywords:** occupational health, pilot projects, vibration, touch, skin temperature, electromyography, hand strength

Abdulqadir Mohamad Suleiman & Imran Abdalla Said. *Design, development and utility validation of TIPA: a tool for inspection performance assessment.* Pages: 1067-1074."

Objectives. Workplace inspection supports improving the working environment. Changes in workplaces following inspections are construed as the inspection's outcome. This study aimed to develop a tool for inspection performance assessment (TIPA) based on identified inspection prerequisites and evaluate the tool's appropriateness for performance assessment. *Methods.* Occupational safety and health experts ranked the prerequisites for effective inspection performance, based on their experiences and perception of importance of the prerequisites. The outcome formed the basis for weighting and assignment of values to the prerequisite subgoals. An assessment tool interface, with which inspectors can assess their workplace inspection performance was designed. Inspectors from different national authorities provided feedback on the tool's appropriateness for measuring inspection performance. *Results.* Results showed much agreement between the inspectors. A five-level performance consideration based on inspection performance index attained was implemented. High average ratings for the test criteria were obtained, with high inter-rater consistency, and reliability. *Conclusion.* TIPA provides a systematic inspection performance quantification supporting inspectors' self-actualization, improving performance. Furthermore, the tool's generality allows for use irrespective of the inspection area without affecting inspection areas' specificity adjustments. In addition, the ease of use adds to its utility, with agreement on the tool's appropriateness for inspection performance assessment.

- **Keywords:** workplace inspection, performance assessment, enforcement, self-assessment, assessment tool, inspection prerequisites

Hamid Jahangiri, Reza Kazemi, Hamidreza Mokarami & Andrew Smith. *Visual ergonomics, performance and the mediating role of eye discomfort: a structural equation modelling approach.* Pages: 1075-1079.

The purpose of this study was to model the visual ergonomic factors affecting performance in human-computer interaction. A cross-sectional study using structural equation modelling was performed with a sample of 200 participants. The measuring instruments included the office lighting survey questionnaire, performance assessment questionnaires, visual ergonomics assessment and an eye discomfort assessment. The hypothetical model evaluated workplace lighting status and visual ergonomics as precursors, performance as the output and eye discomfort as a mediator. The results showed that eye discomfort directly affected performance. Visual ergonomics also had a significant direct effect on eye discomfort. The final model suggested a significant new path between the quality of lighting and visual ergonomics. Also, the quality of lighting had an indirect effect on eye discomfort and performance, and the effect of visual ergonomics on performance was the same. Improving the lighting quality and visual ergonomics can reduce eye discomfort and increase performance.

- **Keywords:** visual ergonomics, performance, office workers, eye discomfort

Jessica Stanhope, Dino Pisaniello, Angus Cook & Philip Weinstein. *Are music students at 'high-risk' of experiencing musculoskeletal symptom outcomes compared with other students?* Pages: 1080-1087.

Musicians have been described as a 'high-risk' group for experiencing musculoskeletal symptoms (MSSs), yet few studies have tested this assumption. We aimed to determine whether the prevalence and profile of MSS outcomes differed between university music students and a reference group (science students). A survey was conducted of university

music and science students. Reported MSS outcomes among the two groups were compared using regression analyses. The majority of participants in both groups reported experiencing MSSs in the last 12 months and 7 days. Music students reported a higher prevalence of wrist/hand MSSs compared with science students. Compared with symptomatic science students, music students reported a higher emotional impact of MSSs. We recommend prioritizing research into interventions for music students that address MSSs in the wrist/hand region, and the emotional impact of MSSs. Addressing these MSS outcomes could reduce the MSS burden for musicians during and beyond their studies.

- **Keywords:** music, musician, university, student, pain, musculoskeletal, prevalence, comparison

July B. Macedo, Plinio M. S. Ramos, Caio B. S. Maior, Márcio J. C. Moura, Isis D. Lins & Romulo F. T. Vilela. *Identifying low-quality patterns in accident reports from textual data.* Pages: 1088-1100.

Accident investigation reports provide useful knowledge to support companies to propose preventive and mitigative measures. However, the information presented in accident report databases is normally large, complex, filled with errors and has missing and/or redundant data. In this article, we propose text mining and natural language processing techniques to investigate low-quality accident reports. We adopted machine learning (ML) to detect and investigate inconsistencies on accident reports. The methodology was applied to 626 documents collected from an actual hydroelectric power company. The initial ML performances indicated data divergences and concerns related to the report structure. Then, the accident database was restructured to a more proper form confirming the supposition about the quality of the reports investigated. The proposed approach can be used as a diagnostic tool to improve the design of accident investigation reports to provide a more useful source of knowledge to support decisions in the safety context.

- **Keywords:** occupational safety, automatic classification, natural language processing, machine learning, topic modeling, safety culture, accident analysis

Parnia Bagheri, Yahya Salimi, Gholamreza Abdoli & Farid Najafi. *Validity and reliability of the Persian version of the sedentary behavior questionnaire among office employees.* Pages: 1101-1106.

Objectives. This study aimed to evaluate the validity and reliability of the Persian version of the sedentary behavior questionnaire (SBQ) among university office employees in Kermanshah province in the west of Iran. *Methods.* A validation study was performed among 701 university office employees in Kermanshah province. The content validation process was conducted using interviews with content and lay experts. The intraclass correlation coefficient (ICC) was calculated as test-retest reliability. In addition, exploratory and confirmatory factor analyses were used to assess the validity of the questionnaire structure. *Results.* The scale content validity indices using two general agreement approaches and the mean approach were 88.88 and 97.77%, respectively. The ICC was estimated at 1.00 (95% confidence interval [0.99, 1.00]). The exploratory factor analyses suggested nine-factor solutions, and in the independent sample the confirmatory factor analysis fit indices showed that the model had acceptable fit to the data. *Conclusion.* The Persian version of the SBQ had acceptable reliability and validity for assessing sedentary behavior (SB) among office employees. This questionnaire is a simple and self-report tool for measuring SB in daily life and would be useful in the design and evaluation of preventive programs among administrative staff and for high-risk population surveillance.

- **Keywords:** validity, reliability, sedentary behavior, questionnaire, employees

Leonardo Ensslin, Alex Gonçalves, Sandra Rolim Ensslin & Ademar Dutra. *Bibliometric and systemic review of the state of the art of occupational risk management in the construction industry.* Pages: 1107-1120.

Objectives. The objective of this study is to use bibliometric and systemic terms to select and analyze a set of articles dealing with occupational risk management in the civil construction industry. *Methods.* Knowledge development process – constructivist (ProKnow-C) methodology was used as an intervention instrument to guide the selection of the bibliographic portfolio and to support systemic analysis. *Results.* The bibliographic portfolio was created and included 20 articles. Bibliometric highlights were relevant articles, authors, countries of origin, journals and keywords. Systemic analysis showed opportunities to contribute to the state of the art in all areas of knowledge, enabling the researcher to understand theoretical bases, gaps and research opportunities for the theme and thus establish their research question in accordance with the established knowledge vision. *Conclusions.* The systemic analysis of each article in the bibliographic portfolio based on the decision support model and areas of knowledge present in each stage of its construction measures the amplitude of the knowledge at each stage, and therefore the completeness of or gaps in each article. This clarifies the overall state of and gaps in the field, showing opportunities for new research.

- **Keywords:** risk management, occupational accidents, civil construction, knowledge development process – constructivist

Maxwell Kwame Boakye, Selase Kofi Adanu, Eric Kodzo Adzivor, George Harrison Coffie & John Coker Ayimah. *Factors influencing health and safety performance at construction sites in Ghana: the perspective of building artisans.* Pages: 1121-1127.

The construction industry is considered one of the most hazardous industries, and implementing a safety program is regarded as one of the most effective approaches to improving safety performance. However, any safety program's success depends on specific factors for satisfactory outcomes. Identifying factors influencing safety performance from a worker's perspective is key to improving safety management. This study determined the critical factors contributing to the construction industry's safety performance by building construction artisans in Ghana. Through a literature review, 55 factors influencing safety performance were selected from previous studies and evaluated by the building construction. An exploratory factor analysis was used for dimension reduction, and seven components clustering the 55 factors were revealed. The results showed that management support and commitment toward safety performance was the most influential component. The findings of this study can be utilized to enhance health and safety performance in the building construction industry.

- **Keywords:** construction artisans, safety factors, exploratory factor analysis, management support, management structure, project nature

Cahit Korku & Sıdıka Kaya. *Relationship between authentic leadership, transformational leadership and innovative work behavior: mediating role of innovation climate.* Pages: 1128-1134.

Objectives. This study aimed to demonstrate the effect of transformational and authentic leadership characteristics of healthcare managers on employees' innovative work behavior and the mediating role of innovation climate. *Methods.* The study was conducted in 19 hospitals in Turkey and 263 managers participated. The data were collected using the transformational leadership questionnaire, the authentic leadership questionnaire, the innovative climate assessment tool and the innovative work behavior scale. Path analysis was performed to demonstrate the relationship between the

variables. *Results.* When transformational and authentic leadership were put into the model separately through innovation climate, transformational leadership had an effect of 0.39 units (0.22 units direct, 0.17 units indirect) and authentic leadership had a 0.44-unit effect (0.29 units direct, 0.15 units indirect) on innovative work behavior. When transformational and authentic leadership were put together in the model, the total (direct and indirect) effect of them increased to 0.52 units. In this case, the effect of authentic leadership characteristics of health managers on innovative work behavior of their followers (0.42 units) was greater than the effect of transformational leadership characteristics (0.10 units). *Conclusions.* Although both types of leadership affect innovative work behavior, authentic leadership was more effective than transformational leadership.

- **Keywords:** healthcare managers, authentic leadership, transformational leadership, innovation climate, innovative work behavior

Reza Yeganeh, Iraj Mohammadfam, Alireza Soltanian & Mostafa Mirzaei Aliabadi. *An integrative fuzzy Delphi decision-making trial and evaluation laboratory (DEMATEL) study on the risk perception-influencing factors.* Pages: 1135-1146.

Objectives. Risk perception is one of the factors that can guide human behavior in the workplace. The present study aimed to identify the most important factors affecting risk perception. *Methods.* This cross-sectional study had three phases. In the first, factors affecting risk perception were extracted based on librarian resources and studies. Then, using the fuzzy Delphi method and based on the expert's opinion, the most important factors affecting risk perception were identified. Finally, using the fuzzy decision-making trial and evaluation laboratory (DEMATEL) technique and relying on the opinions of experts, the relationships between these factors were analyzed and their role as cause or effect was determined. *Results.* Eleven variables were identified as the most important factors influencing risk perception, among which safety knowledge, quality and quantity of safety training, and safety climate had the greatest effect on risk perception with defuzzified scores of 0.826, 0.817 and 0.808, respectively. Seven of the variables had the role of cause and four of them had the role of effect. Experience of accident along with safety climate had the highest interaction with other variables. *Conclusion.* Precise investigation of risk perception-influencing factors can play an important role in improving risk perception and safe behaviors.

- **Keywords:** safety risk perception, behavior-based safety, Delphi study, DEMATEL technique, fuzzy numbers

Min Gao, Xiuyu Wu & Yanqing Fang. *How employees' lean construction competence affects construction safety performance.* Pages: 1147-1159.

This study empirically tested the relationship between sub-dimensions of employees' lean construction (LC) competence and construction safety performance (SP), while incorporating organizational LC competence as a mediator. Data were collected from 710 employees on 300 construction projects. The hypothesis model was validated using multiple regression analysis. The results show that employees' cognitive competence can positively influence construction SP both directly and indirectly via organizational LC competence. However, employees' social competence had a direct negative effect on construction SP, but it can have an indirect positive effect on construction SP via organizational LC competence. Coincidentally, employees' continuous improvement competence had no direct effect on construction SP, but it can have an indirect positive impact via organizational LC competence. This article clarifies the definition of LC competence and empirically validates its influence on construction SP, enriching LC management theory and guiding managers on how to improve construction SP in LC practice.

- **Keywords:** lean construction, competence, construction safety performance

Krzysztof Grala. *Relationships between perceived stress at work, occupational burnout and ego-resiliency in a group of public administration employees: testing the assumption about the moderating role of ego-resiliency (replication study in Poland)*. Pages: 1160-1168.

Objectives. The job demands–resources (JD-R) theory assumes that job demands can be balanced by resources, which ultimately leads to the development of engagement and prevent burnout. Research shows that human resources weaken the relationship between job demands/stress and employee health. However, some reports do not confirm this. The overriding goal of the research was to empirically verify the theory of the buffering role of personal resources in the JD-R model with a sample of public administration employees in Poland. *Methods.* The participants were 144 administrative employees. The study was carried out in a correlation scheme. Correlations between the variables of perceived stress at work, burnout and ego-resiliency were established. It was also checked whether ego-resiliency moderates the relationship between perceived stress at work and burnout. *Results.* As expected, burnout significantly correlated with perceived stress at work (positively) and ego-resiliency (negatively). However, there was no statistically significant relationship between ego-resiliency and perceived stress at work. Ego-resiliency did not moderate the relationship between stress and burnout. *Conclusion.* More research is required to test the role of different personal resources in the relationships between job demands and burnout, as well as between organizational resources and work engagement.

- **Keywords:** perceived stress at work, occupational burnout, ego-resiliency, moderation analysis, extended job demands–resources model

Wenchao Wang, Fayi Huang & Jingjing Wang. *Evidence-based evaluation of safety management in port labor outsourcing*. Pages: 1169-1181.

Port enterprises resort to external resources, e.g., outsourcing of labor services during loading and unloading operations. The low safety management ability of labor service enterprises causes frequent hazards and unsafe incidents. This study sets out to identify safety system deficiencies that are likely to occur when port enterprises outsource operations, as well as the causes of system hazards and impact on safety management. A quantitative research design was implemented in this study, where the data were collected through evidence-based practice techniques with the participation of safety management experts selected by purposive sampling. The study reveals six themes that may potentially affect safety. Compared with the extensive supervision and management method, the evidence-based evaluation of the safety management mode brings about a striking optimization effect which results in classification accuracy and targeted control. This finding triggered a management requirement for establishing sustainable, direct, legal measures in association with outsourcing safety improvement.

- **Keywords:** evidence-based safety management outsourcing of labor services port production

Rouzbeh Ghousi, Mostafa Khanzadi & Mahdiyar Mokhlespour Esfahani. *Human reliability analysis in deep excavation projects using a fuzzy Bayesian HEART-5M integrated method: case of a residential tower in north Tehran*. Pages: 1182-1195.

Objectives. Numerous labourers lose their lives or suffer from injuries and disabilities yearly due to the lack of safety enforcement in construction projects and accidents caused by excavation collapses. The identification and ranking of human errors have

always been a central concern in civil engineering. Previous studies on excavation work and related risks have focused on retaining structure methods, while human errors may be a significant contributor to accidents and near misses. *Methods.* This study identified human errors in deep excavation projects using hierarchical task analysis (HTA) and a systematic human error reduction and prediction approach (SHERPA). *Results.* The fuzzy Bayesian human error assessment and reduction technique (HEART)-5M method was implemented to determine the human error probability (HEP) for all case-study tasks. Critical tasks were obtained as 'drainage system execution', 'water and wastewater pipes', 'gas pipes', 'checking cracks in surrounding buildings' and 'checking soil slippage' with probability levels of 0.46, 0.44, 0.44, 0.37 and 0.37, respectively. Finally, remedial measures were presented for crucial tasks. *Conclusions.* Six unbiased experts approved the model's desirability. The suggested approach can serve as a valuable guide for all project stakeholders in identifying, evaluating and taking corrective actions in similar projects.

- **Keywords:** human reliability analysis, human errors, excavation projects, Bayesian networks, fuzzy logic, HEART method

Katharina F. Pfaffinger, Julia A. M. Reif, Erika Spieß, Jan Philipp Czakert & Rita Berger. *Using digital interventions to reduce digitalization-related stress: does it work?* Pages: 1196-1211.

Digitalization entails positive and negative consequences for employees. In a longitudinal, randomized control group design over 14 days (N = 95 participants), we piloted and expected each of three app-based interventions to positively influence general well-being, well-being related to information and communication technology (ICT) and recovery compared to the control group with no intervention. The meditation intervention significantly increased general well-being (satisfaction) and recovery (detachment) compared to the control group but did not reduce general stress. The cognitive-behavioural intervention significantly increased general well-being (less stress). The informational intervention, however, increased the general stress level. No intervention changed the level of ICT-specific well-being. Thus, classic stress interventions conveyed via ICTs (app-based) may be effective for addressing classic stress symptoms, but not yet for new forms of stress. Future research should investigate structural differences between classic stressors and new kinds of ICT-related stressors to identify starting points for new types of interventions.

- **Keywords:** stress management, intervention, app-based, digitalization, well-being

B. M. Zailani, H. Moda, Y. M. Ibrahim & M. Abubakar. *Improving the antecedents of non-compliance to safety regulations toward an optimized self-regulated construction environment in Nigeria.* Pages: 1212-1219.

The construction industry has been plagued with safety challenges, resulting in a wide occurrence of devastating accidents and fatalities. As previous studies have attributed the persistent safety challenges in Nigeria to non-compliance to safety regulations, this study builds on the existing literature by assessing the antecedents of non-compliance to safety regulations amongst construction workers. To achieve this, the study pursued two main objectives which involved the assessment of workers' safety attitude and workers' safety behavior as the antecedents of safety regulation compliance. A quantitative research approach was adopted using a questionnaire to elicit responses from randomly selected respondents. Data collected were analyzed using both descriptive and inferential statistics. Findings from the study showed relatively low levels of safety attitude and behavior amongst construction workers, which limit their ability to be comply to

instituted safety regulations. Thus, improving the attitude and behavior of construction workers toward better compliance was recommended.

- **Keywords:** safety, regulations, compliance, construction, Nigeria

Jikun Liu, Yiming Huang, Yiwen Zhang, Xingming Wang & Jie Yang. *Effects of personal protective clothing on firefighters' gait analyzed using a three-dimensional motion capture system.* Pages: 1220-1230.

Objectives. The effects of personal protective clothing (PPC) on firefighters' gait were investigated to develop high-performance PPC. *Methods.* Thirteen participants participated in human trials with three types of PPC (firefighter protective clothing [FPC], semi-enclosed chemical protective clothing [CPC_semi] and fully enclosed chemical protective clothing [CPC_full]) and a T-shirt (control clothing [CON]). A three-dimensional (3D) motion capture system was used to obtain gait parameters (step length, step width, stride frequency, gait speed and toe-out angle) and the range of motion (ROM) of the joints (hip, knee and ankle). *Results.* PPC produced an increase in step width (23.4%, $p > 0.05$), but the gait speed (9.1%) and stride frequency (6.4%) decreased compared with the CON results. ROM is affected by the PPC type and joint. FPC and CPC_semi had no significant effect in terms of ROM of the hip and knee besides the landing angle of the knee. However, CPC_full had a significant effect on the maximum extension angle of the hip and maximum flexion angle of the knee, which reached up to 27.2%. *Conclusion.* The ROM of the firefighter's lower limbs was limited by PPC. This study offers insights into next-generation PPC design and development, as well as guidelines for training and firefighting.

- **Keywords:** personal protective clothing, firefighter, gait, range of motion, three-dimensional motion capture

Veronika Klara Takacs & Marta Juhasz. *The influence of team workload on team performance in the light of task complexity: a study of nuclear fire brigades.* Pages: 1231-1240.

The aim of the study was to explore the effect of perceived team workload on team performance among nuclear fire brigades of the Hungarian nuclear power plant. Our sample consisted of six firefighting teams (N = 42 individuals) who were involved in two high-fidelity simulated scenarios with different task complexity. Team workload was measured by the NASA Task Load Index, while team performance was evaluated by a team of experts. Our results showed that teams generally managed to maintain a standard performance in both cases, although they perceived there to be a higher workload during the complex scenario. Our results further revealed that perceived 'physical demand' and 'effort' factors contributed to the increased level of workload in the complex task. Finally, in the case of the simple simulated scenario, workload and team performance were not related to each other, while the two were positively correlated in the complex scenario.

- **Keywords:** firefighters, NASA Task Load Index, nuclear industry, simulation, team performance, workload

Kinga Wasilkiewicz Edwin. *Sharing incident experiences: a roadmap towards collective safety information in the Norwegian construction industry.* Pages: 1241-1251.

This article presents a study on sharing practices after incidents across organizations in the Norwegian construction industry as a means towards improvement of occupational safety. Interviews were performed with safety personnel from different actors, including

clients, contractors and designers. The findings show that several arenas for sharing of safety-related information across actors exist; however, the sharing is limited, not structured, and occurs occasionally. Furthermore, the information is not widely shared across all actors in the industry for whom the information could be valuable, e.g., early phase actors. As a willingness to share and an excitement for new technology are present, the work goes on to propose how and where the industry can improve on information sharing after incidents to move towards inter-organizational learning. A roadmap for the Norwegian construction industry is suggested for collective information sharing with a focus on technological and digital solutions.

- **Keywords:** occupational safety, accident prevention, inter-organizational learning, safety information sharing, digitalization

Damien Burlet-Vienney, François Gauthier & Bertrand Galy. *Risk-based inspection applied to two-post above-ground automotive lifts*. Pages: 1252-1261.

The safe use of two-post above-ground automotive lifts (2PAG lifts) has received particular attention in the province of Québec (Canada) following the death of a young mechanic. The inspection and preventive maintenance of this equipment is a problem highlighted in accident investigation reports and by representatives of the sector. Therefore, the work presented in this article aimed at proposing a complete and detailed inspection grid for 2PAG lifts by establishing an exhaustive list of verification criteria, baseline states and the inspection frequency for each criterion according to their criticality. The grid was built from standards, existing grids, manufacturers' manuals, interviews and tests. The inspection frequency for each criterion was established using a decision-making algorithm, notably using the concepts of progressive and sudden failures as well as redundancy. Twenty-three of the 74 inspection criteria established in the grid require routine monitoring.

- **Keywords:** occupational safety, automotive lift, vehicle falling off, inspection checklist, risk-based inspection