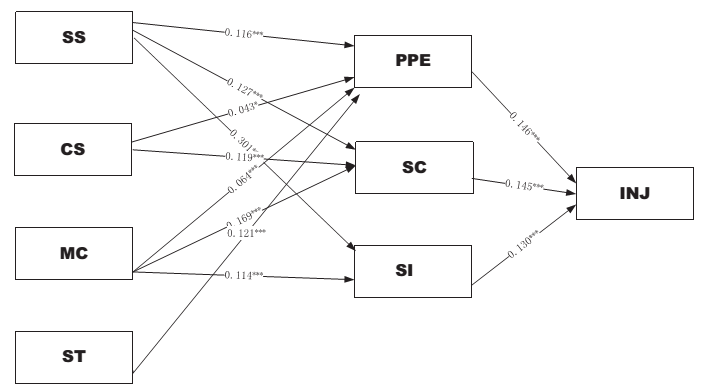
***Safety and Social Identity***

***Liu et al. (2015) "Safety climate, safety behavior, and worker injuries in the Chinese manufacturing industry."***

Motivation

* Western countries에서 확인된Safety climate, safety behavior, and occupational injuries 의 관계가 중국 제조업에서도 존재하는지 확인 (Empirical study)

Result



Safety climate 정의

* Employees’ shared perceptions of the policies, procedures, and practices relating to safety in their work environment (Zohar, 1980; Huang et al., 2006)

Safety climate 요소

* Safety climate generally include management commitment, supervisor support, safety awareness, safety training, safety policy, safety knowledge, safety communication, and co-worker support (Seo et al., 2004; Olsen, 2010; O Connor et al., 2011; Brondino et al., 2012; Huang et al., 2012).

Safety behavior 유형

* Safety participation and safety compliance (Griffin and Neal, 2000).
* Safety compliance as ‘‘complying with safety procedures and carrying out work in a safe manner,’’ and safety participation as a ‘‘safety-oriented behavior that involves the individual providing safety suggestions within the organization, promoting the safety program within the workplace, demonstrating initiative, and putting effort into improving safety in the workplace’’

Safety climate 와 safety performance 관계

* A recent meta-analytic review revealed that safety climates offer robust predictions of objective safety criteria (the occurrence of occupational injury) and subjective safety criteria (better self-reported safety behavior) across industries (Clarke, 2006a) and countries (Christian et al., 2009).
* Indirect relationship: (Zohar, 2000; Clarke, 2006b) (Griffin and Neal, 2000; Zohar and Luria, 2003).
* Direct relationship: (Zohar, 2000; Siu et al., 2004; Smith et al., 2006; Clarke, 2006a; Wu et al., 2008; Brondino et al., 2012; Zohar et al., 2014).

Safety behavior measurement 절차 관련 (expression)

* We used onsite observations and discussions with occupational physicians and safety managers to develop a Chinese scale to measure workers’ occupational safety behavior. Each of the twenty-one items asked a participant to state how often he followed the relevant behavior; for example, ‘‘Use the machine shield correctly.’’

Mediation effect의 중요성 (expression)

* The study of mediation factors is important because it allows us to understand the mechanisms through which safety climate operates on workers’ behavior and reduces the risk of injury.

Safety에서 supervisor의 중요성

* Zohar and Luria (2003) carried out an intervention in which supervisors were trained to participate in safety-oriented communication with subordinate workers.
* Zohar (2002) found that improved communication between line workers and supervisors resulted in decreasing micro accidents and increasing PPE use. Sampson et al. (2014) suggested that supervisors’ use of communication had a positive effect on safety compliance and safety participation (Sampson et al., 2014).
* Supervisors can increase safety initiatives among employees by inspiring safety and improving PPE use, and they can increase employees’ safety compliance by using safety monitoring (Griffin and Hu, 2013).

Safety에서 coworker의 중요성

* If an employee perceived that his/her coworkers were concerned about safety, the whole group tended to practice safe behavior (Hayes et al.,1998)
* Coworkers’ safety climate had a stronger influence on safety behavior, especially on safety participation, than supervisors’ safety climate (Brondino et al., 2012)

Safety에서 management commitment의 중요성

* MC is a major factor in safety climate and is critical to employee safety performance (Christian et al., 2009).
* Kao used a structural equation model to test the relationship between management commitment and safety performance, including safety initiatives, compliance behavior, and occupational injury (Kao et al., 2009)

Safety에서 training의 중요성

* Safety training (one dimension of the safety climate) could predict the actual levels of safety behavior among manufacturing employees (Cooper and Phillips, 2004; Huang et al., 2012).
* This study does not show significant relationship between safety training and safety compliance and between safety training and safety initiatives.

Safety behavior의 dimensionality

* Safety research literature toward conceptualizing safety behavior as multi-dimensional (Griffin and Neal, 2000; Martínez-Córcoles et al., 2011; Zhang and Wu, 2014).
* Personal protective equipment was distinguished from safety compliance behavior as in the other recent studies (Cavazza and Serpe, 2009; Arcury et al., 2012; Tholén et al., 2013).

Limitations of cross-sectional survey (expression)

* First, like other safety climate studies, the results of this study were derived from a cross-sectional survey, preventing us from making definitive causal conclusions due to the nature of the cross-sectional design. In further field studies, a longitudinal design could be used to clarify these associations

Limitations of self-report questionnaire (expression)

* We used a self-reported questionnaire to measure occupational safety climate, behavior, and injury, although the injury reports were confirmed using the companies’ medical records, the data need to be interpreted cautiously.

***Brondino et al. (2012) "Multilevel approach to organizational and group safety climate and safety performance: Co-workers as the missing link."***

Missing data 처리 관련

* First, we calculated the frequency of missing values for each variable in the sample, and removed all cases with more than 5% missing values (Chemolli and Pasini, 2007).

***Barbaranelli et al. (2015) "Does safety climate predict safety performance in Italy and the USA? Cross-cultural validation of a theoretical model of safety climate."***

Motivation

* The purpose of the current study was to assess the measurement equivalence of a widely-used universal measure of safety climate developed by Neal et al., 2000 (NGH, 2000) Neal et al., 2000 (NGH, 2000) and to provide a cross-cultural validation of their proposed broader theoretical model of safety climate (Griffin and Neal, 2000).

Result

* Results of the study indicated that three out of four ME levels were fully supported, whereas strict invariance was reached only in a partial sense after relaxing constraints on a small number of non-invariant error variances.

Types of Safety climate measurement

* Industry or organization-specific measurement (e.g., Dedobbeleer and Beland 1991 and Singer et al., 2007)
* Universal or general measurement (e.g., Neal et al., 2000; Griffin and Neal, 2000).

Organizational climate 이 Behavior 에 영향을 미치는 방식

* These perceptions (organizational climate) serve as a frame of reference for employees to guide adaptive work behavior by providing cues regarding expected behavior–outcome contingencies (Schneider, 1975)

Safety climate dimensionality

* management values (i.e., the extent to which management places a high priority on safety), safety communication (i.e., the extent to which there is an open exchange of information regarding safety), safety training (i.e., the extent to which training is accessible, relevant, and comprehensive), and safety systems (i.e., the extent to which safety procedures are perceived to be effective in preventing accidents; Griffin and Neal, 2000)

Safety related cost

* Estimates suggest the costs associated with workplace injuries in the US are nearly $189 billion in lost wages and productivity, medical costs, and administrative expenses (National Safety Council, 2013), representing approximately 1.2% of the US GDP (World Bank, 2014).

Cultural differences의 safety에 대한 영향 (Power distance, uncertainty avoidance)

* High PD cultures may be less likely to be proactive in raising safety concerns with their supervisors compared to employees in low PD cultures.
* In high UA contexts, where standardized and structured approaches to safety would be expected (Burke et al., 2008), employees might prefer to have strict norms and directions from safety authorities.

Measurement Equivalence (ME) test

* Configural invariance: Examining the equivalence of the general form of the pattern in different groups represents a test for the equivalence of this framework.
* Metric invariance: examined by constraining factor loading to be equal across groups
* Scalar invariance (or strong invariance) hypothesizes that the complete linear model linking latent variables to their indicators (i.e., observed variables) is invariant across groups.
* Strict invariance implies that the same score of a latent variable across different groups corresponds to the same conditional variability of its observed score.

Likert scale (expression)

* Employees responded to the items using a seven-point Likert scale ranging from “Strongly Disagree” (1) to “Strongly Agree”(7). All scales were coded such that higher numbers reflect more positive safety attitudes and behaviors.

Cut-off value for goodness of fit of Confirmatory Factor Analysis

* CFI values of .90–.95 indicating acceptable fit and values above .95 indicating good fit (Hu and Bentler, 1999).
* RMSEA is considered an absolute fit index that estimates lack of model fit and compensates for model complexity, with values of .05 or lower as indicating a well-fitting model, .05–.08 indicating a moderate fit, and .10 or greater indicating poor fit (Browne and Cudeck, 1993).

Model modification (expression)

* This first model was tested allowing the residuals of safety knowledge and safety motivation and the residuals of safety compliance and safety participation to be correlated; this is consistent with the idea that common causes do not explain all the shared variance, so covariance between residuals are needed (Kline, 2011).

Overcoming the limitations of self-report data

* However, it is important to note that Christian et al. (2009) did not find evidence of any inflationary common methods bias comparing correlations with self-reported climate measures to those based on archival or other criteria.

***Fang et al. (2015) "Impact of the Supervisor on Worker Safety Behavior in Construction Projects."***

Effect of management and workgroup on unsafe behavior

* They rarely probed substantially into the generation of unsafe behavior under the combined influences of individual and organizational factors. More specifically, organizational factors and their relationships with employees’ individual behavior have not been clearly studied and depicted (Tharaldsen and Haukelid 2009; Zhang and Fang 2013).
* Interactions occur widely among employees and between employees and the management, and have significant impact on employees’ selection of behaviors. Many previous studies (e.g., Choudhry 2007; Cao 2007; Hon et al. 2010) proved that worker safety behavior (WSB) is not only affected by their working environment and tasks, but also subject to behavior of others in the same organization, especially that of the management.

***Johnson et al. (2006) "When organizational justice and the self-concept meet: Consequences for the organization and its members."***

Result

* Interactions between the relational self-concept and interactional justice, and
* Interactions between the collective self-concept and procedural justice, such that the justice–outcome relationships were stronger for those experiencing higher activation on the relevant self-concept level.

Safety behavior 중요성과 최근의 attention (expression)

* The popularity of organizational justice research has steadily increased in the past 30 years. Much of this attention to justice is because of the important work-related consequences that have been linked to employees’ perceptions of fairness within organizational contexts.
* There has also been considerable interest in examining the antecedents of justice perceptions in the hopes of promoting fairness in organizations.

Individual differences 의 영향에 대한 연구의 필요성 (expression)

* However, the relative importance and contribution of various types of justice have been debated, and it is unclear whether their relative importance is stable across employees.
* There are likely other mechanisms that help filter incoming information and influence what sorts of justice-related information are most salient and are subsequently used when forming attitudes and behavioral intentions.
* It helps explain why the relative importance of different antecedents of fairness perceptions can vary across different employees, or vary within the same employee across time.
* Taken together, these results suggest that the self-concept is an important mechanism that moderates the importance of social information and attitudes. However, most of this research is experimental and few studies have shown the effects of the working self-concept on work attitudes and intentions.

Three different levels of self-concept

* Recent theory (e.g., Brewer & Gardner, 1996; Lord et al., 1999) has distinguished among three levels of the self-concept—the individual, relational, and collective levels.
* The individual-level involves interpersonal comparisons where one’s sense of uniqueness and self-worth are derived from perceived similarities with and differences from other individuals. (self-interest based behavior)
* The relational level is based on the extent to which individuals define themselves in terms of dyadic connections and role relationships with others. (welfare of specific others)
* The collective-level involves self-definition based on one’s social group memberships, where favorable intergroup comparisons give rise to self-worth.

Importance of working self-concept in organizational behavior (collective level)

* Ybarra and Trafimow (1998) found that, when forming behavioral intentions, people whose individual self-concepts were primed placed greater emphasis on their own idiosyncratic attitudes, whereas subjective norms (i.e., social pressure from family, friends, the media, etc.) were more salient for those whose collective self-concepts were primed.
* When collective-level social identities are activated, people also make decisions that minimize the risk of adverse outcomes and emphasize equality for their group regardless of the potential gains for themselves (e.g., Briley & Wyer, 2002)
* Forehand, Deshpande, and Reed (2002) found that the working self-concept influenced participants’ attitudes toward the content of a message and its sender.

Dimensionality of a concept (expression)

* Organizational justice is commonly conceptualized as being comprised of at least three dimensions (Colquitt, 2001; Greenberg, 1993).

Moderating effect (expression)

* The different justice dimensions are differently weighted contingent on the level of the working self-concept that is activated.
* As expected, the interactional justice–supervisor satisfaction relationship was stronger for individuals with higher relational self-concept levels compared to those with lower relational self-concept levels.

Investigating of moderation effect (expression)

* The present study was a field investigation with the goal of examining the role of the three levels of the self-concept, both main and interactive effects, with the dimensions of organizational justice for predicting several attitudes that have implications for organizations.

Measurement (expression)

* We used a measure developed to assess individuals’ chronic standing on each of the three self-concept levels (Selenta & Lord, 2005) and a measure developed to assess a multiple-dimension conceptualization of justice (Colquitt, 2001).

Use of centered value (expression)

* To minimize problems of multicollinearity, all predictor variables were centered and interaction terms were calculated using the centered values (Aiken & West, 1991).

Input control variable in regression (expression)

* In all analyses we first controlled for the effects of employee sex, age, tenure in months, and work status (full vs. part-time). We employed these demographic variables as covariates because we suspected they would have important relationships with the predictors and criteria. For example, ~~~~
* Although included in all analyses, we do not report effects associated with these covariates to simplify the presentation of our results.

Importance of immediate supervisor in organization

* Gerstner and Day (1997) argue that it is often the case that all employees organization-based attitudes are informed by interactions with immediate supervisors, with the supervisor providing ‘‘a lens through which the entire work experience is viewed’’ (p. 840).

Consistency of the relationship across the dimensions (expression)

* Furthermore, the nature of the interaction was consistent across all three criteria.

Collective self-concept 과 social identity의 연결

* At the collective-level, one can be focused on either intra-group relations (i.e., emphasizing cooperation and shared goals among in-group members) or inter-group relations (i.e., emphasizing differentiation with out-group members).

Self-concept의 organizational behavior에서의 중요성

* In sum, the results from both studies suggest that the self-concept is an important self-regulatory variable that orients employees toward certain work attitudes and behavioral intentions.

***Jiang et al. (2010) "Perceived colleagues’ safety knowledge/behavior and safety performance: Safety climate as a moderator in a multilevel study."***

Social influence from management and coworker

* Accident investigations have revealed that organizational and cultural factors
* Not only safety climate which resulting from employee perceptions regarding the actions of management (Hofmann and Stetzer, 1996), but also their peers’ behavioral pattern concerning safety is likely to affect individuals’ safety performance (Kozlowski and Klein, 2000); and the two influence processes are shown separately (Clarke and Ward, 2006).

***Cigularov et al. (2010) "The effects of error management climate and safety communication on safety: A multi-level study."***

Construction accident cost

* The costs associated with injuries in the U.S. construction industry have been estimated to exceed 10 billion dollars per year (Waehrer et al., 2007)

Importance of safety in construction (intro – expression)

* Despite continuing efforts to reduce the number of work-related accidents, every year thousands of workers die at their workplaces and millions suffer occupational injuries and illnesses (U.S. Bureau of Labor Statistics [BLS], 2008a, 2008b).
* In fact, there were 1178 fatal work injuries in the United States (U.S.) construction industry sector in 2007 (BLS, 2008c). While the construction industry comprised 6.5% of the U.S. workforce (U.S. Census Bureau, 2006), it accounted for more than 20% of the fatal occupational injuries across all industries from 2003 to 2006.
* The above statistics rank construction among the top four killer industries, along with agriculture, mining, and transportation (BLS, 2008c). Despite the increased efforts to reduce workplace accidents, fatalities in construction increased between 2003 and 2006 (BLS, 2008c).
* In spite of the attention given in the construction site injuries, the incident rate of industry is reported to be twice comparing with the industrial average (Le et al. 2014)

***Törner and Pousette (2009) "Safety in construction – a comprehensive description of the characteristics of high safety standards in construction work, from the combined perspective of supervisors and experienced workers."***

Importance of safety in construction (intro – expression)

* In most countries, the construction industry has a high rate of occupational accidents
* Much effort has been made to reduce the rate of industrial accidents, mainly through technical solutions, rules, and regulation.

***Tixier et al. (2014) "Psychological Antecedents of Risk-Taking Behavior in Construction."***

Current status of construction safety (expression)

* Construction remains one of the most dangerous industries in the United States despite the improvements that followed the inception of the Occupational Safety and Health Act of 1970. In fact, construction employs 7% of the national workforce but accounts for 17% of all work-related deaths (Bureau of Labor Statistics 2011). It is estimated that there are over 1,000 fatalities and 230,000 injuries each year that result in over $15 billion in direct costs (Bureau of Labor Statistics 2011). Agarwal and Everett (1997) have estimated that worker compensation premiums alone account for 1.5–6.9% of total costs of new construction, a figure that appears to remain stable (Waehrer et al. 2007).

Risk taking behavior의 원인

* Carter and Smith (2006) explain that risk-taking behavior originates mainly from workers’ inability to adequately perceive and respond to risk, and is not deliberate.

***Hansen (1988) "Personality characteristics of the accident involved employee."***

Previous efforts is not enough (expression)

* While these efforts are commendable and have certainly had a positive impact on the accident problem, there is another approach to reducing human error that is often neglected.

***Wang et al. (2015) "Risk Assessment of Work-Related Musculoskeletal Disorders in Construction: State-of-the-Art Review."***

Knowledge gaps (expression)

* However, there is still room for researchers and practitioners to better understand WMSD issues and their assessment techniques in construction:
* This paper helps to bridge the gap between studies in ergonomics and epidemiology and the requirements of on-site construction, non-fatal-injury assessments.

The number of construction employees

* Considering that the construction industry employs a population of 5.5 million, which accounts for 4% of the entire U.S. workforce (BLS 2013a), construction workers’ WMSDs can cause problems that affect the regional or national economy.

***Malhotra et al. (2006)***

Common method bias in CFA

* To formally compare original and CMV-adjusted correlations, we conducted a chi-square difference test (Bollen 1989). Specifically, we replaced an original correlation value with its CMV-adjusted correlation value and examined whether the substitution significantly deteriorated fit (Δχ2(1) > 3.84, p < 0.05).

***Huang and Hinze (2006a)***

Total cost of construction accident

* The research conducted by Everett and Frank (1996) concluded that the total costs of construction accidents accounted for 7.9–15.0% of the total costs of new, nonresidential projects. A more recent, but unpublished, research study by Coble and Hinze (2000) showed that the average workers’ compensation insurance costs could be conservatively estimated as constituting 3.5% of the total project costs.

***Huang and Hinze (2006b) “Owner’s Role in Construction Safety: Guidance Model.”***

Summary of the study (expression)

* The relationship between project safety performance and the owner’s influence was examined, with particular focus on the project characteristics, selection of safe contractors, contractual safety requirements, and the owner’s proactive involvement in safety management.

***Koene and van Riemsdijk (2005)*** ***"Managing temporary workers: work identity, diversity and operational HR choices."***

Limitations of temporary workers

* Lower intensity, shorter duration of contracts and reduced visibility of the employment relationship may inhibit such identification (e.g., Dutton et al, 1994).
* This suggests that temporary employees can be used rather opportunistically without serious consequences for the hiring organization. Lepak and Snell characterize the employment relationship for temporary personnel as transactional, where employees have limited association with a firm and where their psychological contract (Rousseau, 1995)
* Typical flexible staffing problems are often specifically related to attitudinal issues of temporary employees (e.g., absenteeism).
* An employment relationship with very limited mutual obligations and purely economically motivated. In such a relationship, people expect little, get even less and are not likely to give anything in return.

Importance of temporary workers

* Still, various studies have argued its importance for organizational performance (Beer et al, 1984; Gustafson and Reger, 1995; Pfeffer, 1994; Weick, 1993) and continuous operational reliability (Weick and Roberts, 1993).

Importance of organizational identification

* Dutton et al. (1994) summaries a number of possible positive effects of identification including better in-group co-operation, competitive behavior towards ‘outside’ groups, more organizational citizenship behavior and better individual association to the organization.

Importance of social and psychological aspect of temporary workers

* Temporary employees are not only motivated and bound by a rational, explicit, transactional contract with the organization, but also develop a broader, more implicit relational psychological contract that affects their performance.
* The superficial and temporary exposure to the organization, reinforced by a purely transactional employment relationship, does not offer much room for organizational identification on the part of the temporary employee.

Dutton (1994)’s organizational identification process

* The attractiveness of the perceived organizational identity is central to identification.
* Organizational socialization determines the salience of the organization’s identity and through this influences the quality and richness of the employee’s perception of it.
* Consistency of the perceived organizational identity with an individual’s self-concept
* Social identities in the organization provide a sense of distinctiveness → self-distinctiveness and self-enhancement
* Intensity and duration of contact with the employing organization.
* individual’s sense of connectedness
* Visibility of the affiliation to the organization amplifies the influence of attractiveness on organizational identification.

***Andersson and Wickelgren (2009) "Who is colonizing whom?: Intertwined identities in product development projects."***

Importance of project in our life

* It is now possible to talk about a projectified society (Lundin and Söderholm, 1998; Sahlin-Andersson and Söderholm, 2002) where projects regulate and, at some level, even control human existence (Deetz, 1995).

Limited consideration of identity issue in project settings

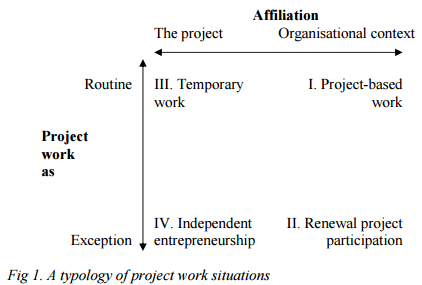
* Because project management focuses on structure, activities, and control, identity issues in project settings have been relatively unexplored.
* Yet there are actually few empirical studies that illustrate how individuals handle a projectified reality (Packendorff, 2002).

다양한 identities 중 일부만 promote 되는 현상

* In most instances, actors have the freedom to choose among a number of identity templates (Llewellyn, 2004; Andersson, 2008a), but some specific social-identities are most promoted or preferred (Rose, 1989), which greatly limits the ‘freedom’ of choice.

Dimensions of categorizing type of project

* Packendorff (2002) recognizes the heterogeneous nature of project work when he creates a typology of different project work situations, based on the following two analytical dimensions: 1) the degree to which the individual’s work is tied to the temporary project or the organizational context; and 2) the degree to which project work is either routine or exceptional for the individual.



***Parent and Foreman (2007) "Organizational image and identity management in large-scale sporting events."***

Definition of organizational identity

* Organizational identity is the set of self-definitions that members use to answer the question “Who are we as an organization?”

Relationship between organizational image and identity

* Several studies have shown that the impressions that outsiders have of the organization (image) affect members’ views of themselves and their organization (identity; Dutton & Dukerich, 1991; Elsbach & Kramer, 1996; Gioia et al., 2000).

Limited previous study on social identity in temporary organization

* Furthermore, few studies have examined temporary organizations, such as those that facilitate movie projects, political campaigns, or fund-raising drives.

***Peters et al. (2013) "Working With Subgroup Identities to Build Organizational Identification and Support for Organizational Strategy: A Test of the ASPIRe Model."***

Limited previous efforts to identify how to promote employee’s organizational identification

* To date, the literature has provided little empirically grounded guidance for organizations that are trying to develop organizational identification among their employees.

Limitations of the previous studies regarding organizational identification

* First, they tend to pay minimal attention to the fact that the organization as a whole is not the only source of social identity available to employees (although see Gaertner, Dovidio, & Bachman, 1996, for a discussion of dual identity).
* Second, it seems reasonable to suppose that many strategies for building identification will backfire since they are likely to be met with cynicism, reactance, or resistance from employees because they are at odds with alternative valued identities (Brehm, 1966; Kelly & Kelly, 1991).
* Finally, empirical evidence of this form is rarely provided by researchers and, as a result, their recommendations remain largely speculative

ASPIRe Model aims to

* To increase employees’ awareness and positive perceptions of different subgroups within the organization
* To build organizational identification by respecting those subgroup differences, and
* To increase support for the organization’s strategic objectives (i.e., “buyin”) by ensuring that they are informed by the diverse aspirations of the important subgroups.

Procedure of ASPIRe Model

* Construction of an identity map that serves to chart the contours of significant and meaningful subgroup identities within the organization.
* Subgroup Caucusing – to increase the salience of subgroup identity
* Superordinate Consensualizing - bring the goals of each subgroup into alignment through the specification of higher-order organizational goals → to increase organizational identification
* Organic goal setting

Statistical remedies for regression using

* To control for the lack of independence within participants, we followed Wooldridge’s (2003) recommendations and clustered the standard errors of the OLS estimation at the level of the individual participant.

***He and Brown (2013) "Organizational Identity and Organizational Identification: A Review of the Literature and Suggestions for Future Research."***

Previous studies on the relationship between organizational identification and performance

* Earlier meta-analyses showed that a moderate positive relationship between OID and employee performance exists (Riketta, 2005; van Knippenberg, 2000; van Knippenberg & van Schie, 2000).
* Indeed, some recent studies have found that OID is positively related to both task and job performance (Walumbwa, Avolio, & Zhu, 2008; Weiseke, Ahearne, Lam, & Von Dick, 2008).
* Two recent studies have offered promising evidence on the positive effect of aggregated OID at the organizational level on financial performance (Homburg, Wieseke, & Hoyer, 2009; Weiseke et al., 2008).

**Antecedents of organizational identification**

* Organizational factors relating to perceived organizational identity attributes (e.g., attractiveness, distinctiveness, prestige, construed external image, etc.) have been traditionally conceptualized as the major antecedents of employee OID (Dukerich, Golden, & Shortell, 2002; Dutton et al., 1994). → Static and Impersonal approach
* Employee OID has been found to be positively related to a number of leadership styles, including transformational leadership (Carmeli et al., 2011; Epitropaki & Martin, 2005; Liu, Zhu, & Yang, 2010) and ethical leadership (Walumbwa et al., 2011).
* Research has also suggested that the effect of leadership on OID may be conditional.
* The social exchange perspective argues that the employee–organization relationship rests upon employees’ unspecified obligations to reciprocate the benefits of the organization due to the fair and beneficiary treatment they experience from the organization (Coyle-Shapiro & Conway, 2005; Cropanzano & Mitchell, 2005).
* It has also been shown that leader–member exchange, which refers to how leaders develop meaningful and long lasting personal relationships with subordinates, is an important antecedent of OID (Tangirala, Green, & Ramanujam, 2007).
* Finally, perceived organizational support—defined as the perceived extent to which the organization values employees’ contributions and cares about their well-being and socioemotional needs—tends to have a positive effect on employee OID (Edwards, 2009; Edwards & Peccei, 2010; Gibney, Zagenczyk, Fuller, Hester, & Caner, 2010; Sluss, Klimchak, & Holmes, 2008).

Glance into future research

* Conditional effect of organizational identification on performance
  + The extent to which employees believe that their own performance may make a difference to the overall performance of the organization.
  + The extent to which they are (or think they are) able or empowered to deliver better job performance.
  + Contextual factors such as job design/characteristics, the presence of external rewards, and justice climate
* Relationship between leadership and organizational identification
  + For example, it is not clear how individual differences or situational factors may affect the impact of leadership on employee OID.
  + only a limited number of leadership styles
  + Mainly on immediate supervisors or team leaders → how leadership at different levels may differently affect employee OID at different levels of the hierarchy of the organization.
* Corporate social responsibility (CSR) and Organizational identification
* Personality and organizational identification
* Organizational identification and other type of identity (e.g., professional identity, moral identity, etc.)
  + Based on the notion of multiple identities, a person has a network of identities that can be categorized at personal, interpersonal and social/collective levels (Brewer & Gardner, 1996; Brickson, 2000b), or at personal, social and material levels (Ashforth et al., 2008; Skitka, 2003)
  + How OID interacts with other employee identities in regulating employee behaviors.
* Self-concept orientation and organizational identification motive

Moderating effect of tenure on the effect of organizational prestige and respect on the OID

* Hameed, Roques, investigated (a) how employee organizational tenure moderates the effects of perceived organizational respect and organizational prestige on employee OID, and (b) how OID affects employee readiness for organizational change.

Effectiveness of external intervention in promoting employee’s organizational identification

* To provide initial evidence on how external intervention (e.g., via workshops) may enhance employee OID among senior military health services personnel in the United Kingdom and support for the organization’s strategy.

***Sluss et al. (2008) "Perceived organizational support as a mediator between relational exchange and organizational identification."***

Importance of organizational identification

* Organizational identification, as a result, has been found to be associated with job satisfaction, job involvement, turnover intentions, and in role and extra-role performance (see meta-analyses, Riketta, 2005).

**Mediating effect of perceived organizational support (POS) on the relationship between LMX and OID**

* Positive ‘subordinate experiences’ (e.g., supportive human resource practices, few political maneuverings) engender perceptions of organizational support which, in turn, increase behaviors and attitudes that reciprocate that support.

***Walumbwa et al. (2011) "Linking ethical leadership to employee performance: The roles of leader–member exchange, self-efficacy, and organizational identification."***

Definition of ethical leadership

* the demonstration of normatively appropriate conduct through personal actions and interpersonal relationships, and the promotion of such conduct to followers through two-way communication, reinforcement, and decision-making

LMX and performance

* This process can be explained by a core principle of social exchange theory called the ‘norm of reciprocity,’ which suggests that individuals who are treated favorably by others feel a sense of obligation to respond positively or return favorable treatment in some manner (Blau, 1964; Gouldner, 1960).

***Nakra (2006) “Relationship between Communication Satisfaction and Organizational Identification: An Empirical Study”***

Importance of workers in an organization (expression)

* Now, due to the ease of access, technology is having an equalizing effect, leaving employees as the key to securing and maintaining competitive advantage.

Importance of organizational identification among diverse identities

* In view of the amount of time people spend at work, it is theoretically plausible that work organizations provide such identities (Ashforthand Mael,1989), and indeed, numerous studies speak about the empirical reality of organizational identification (Haslam2001).

Impact of organizational identification

* Research on member identification suggests that the strength of identification determines some critical beliefs and behaviors. Among them are employees' feelings of interpersonal trust, goal-setting processes, internalization of organizational norms and practices, desire to remain with the organization, and willingness to cooperate with others (Dutton, Dukerich and Harquail, 1994).

***Bartels et al. (2007) "Multiple organizational identification levels and the impact of perceived external prestige and communication climate."***

Impact of organizational identification on worker’s behavior

* Strong organizational identification leads, for example to a more positive attitude towards the organization (Ashforth & Mael, 1989), a higher work satisfaction (Hall & Schneider, 1972; Van Dick et al., 2004a)
* a lower intention to leave the organization (Scott et al., 1999; Van Dick, Wagner, Stellmacher, & Christ, 2004b; Van Dick, Wagner, & Lemmer, 2004c)
* the willingness to make financial sacrifices (Mael & Ashforth, 1992).
* Dutton, Dukerich, and Harquail (1994) argue that when employees identify themselves with the organization, they will show behaviour that is conducive to the organization.

**Antecedents of organizational identification**

* Perceived external prestige (Bhattacharya, Rao, & Glynn, 1995; Dutton et al., 1994; Smidts, Pruyn, & Van Riel, 2001),
* Perceived distinguishing ability of the organization (Mael & Ashforth, 1992)
* The degree of contact between employee and organization (Hall, Schneider, & Nygren, 1970; Mael & Ashforth, 1992), and
* The degree of overlap between organizational identity and personal identity in the employees’ perception (Bergami & Bagozzi, 2000; Elsbach & Bhattacharya, 2001).
* Communication (DiSanza & Bullis, 1999; Riordan & Weatherly, 1999; Scott, 1997)

Not considering multiple identities in the previous studies

* To date, the majority of research on organizational identification has focused on the organization as a holistic construct.
* Only a few recent studies on organizational identification view organizations as multiple entities (Foreman & Whetten, 2002; Johnson, 2002; Johnson, Morgeson, Ilgen, Meyer, & Lloyd, 2006; Larson & Pepper, 2003).
* Although the concept that multiple identities in organizations actually exist is not new, empirical evidence for the relationships between these identities is limited (Foreman & Whetten, 2002) and not always unequivocal (Allen, 1996; Barker & Tompkins, 1994; Scott, 1997, Scott et al., 1999).

Relationship between distance of the organization and salience of the identity

* There are, moreover, initial indications that the identification of employees with their closest organizational department (there where the daily duties are carried out) is experienced as being the most important (Moreland & Levine, 2001; Riordan & Weatherly, 1999; Van Knippenberg & Van Schie, 2000).

Different effects of workgroup identification and organizational identification

* Riketta and Van Dick found that team-related variables, such as team climate perceptions, satisfaction with co-workers or supervisors and altruistic behaviours were closely related to work group identification, whereas satisfaction with the organization, organization-related extra-role behaviour or intentions to leave the organization, were more strongly related to organizational identification.

**Relationship between perceived prestige and organizational identification**

* A number of studies have shown a correlation between PEP and organizational identification (Bergami & Bagozzi, 2000; Carmeli, 2005; Carmeli & Freund, 2002; Iyver, Bamber, & Barefield, 1997; Mael & Ashforth, 1992; Smidts et al., 2001).

Limitation of this study – common background assumption

* In other words, the work group is part of the department, the department part of the business unit, and the business unit part of the organization.

Workgroup is more salient than other big groups in an organization

* It is moreover expected that work group identification is experienced as the most visible (Van Knippenberg & Van Schie, 2000), thus forming the basis for identification with other organizational levels.

Proper response rate

* Although several authors (Badger & Werret, 2005; Keeter & Miller, 2000; Krosnick, 1999) have claimed evidence that a response rate of 20–40 per cent should be accurate to be representative of the target group,

***Ramsey et al. (2013) "The effects of an academic environment intervention on science identification among women in STEM."***

Importance of environmental cue on social identification

* The “stereotype inoculation model” argues women can develop stronger implicit STEM identities through exposure to positive cues in their surroundings (Dasgupta 2011; Stout et al. 2011).
* Instead of weakening implicit stereotypes, environmental messages that highlight women’s presence in STEM may dissuade women from defining themselves in terms of those stereotypes.
* Research suggests that small changes to women’s environments can improve these outcomes (Cheryan et al. 2009)

Impact of short-term intervention

* Study 2 tests whether a short-term intervention modeled after the WISE environment can improve outcomes relevant to women’s STEM participation.

Importance of self-relevance during intervention

* This suggests that the intervention needed to be made self-relevant to influence implicit beliefs, a finding that echoes evidence that students benefit more from ingroup role models when they personally identify with them (Cheryan et al. 2011; Stout et al. 2011).

***Ding et al. (2017) "Linking Transformational Leadership and Work Outcomes in Temporary Organizations: A Social Identity Approach."***

The result of this study

* Transformational leadership is found to positively relate to subordinates' work engagement and negatively relate to subordinates' project turnover intentions.
* Furthermore, project identification completely mediates the TFL-WEG relationship, whereas it partially mediates the TFL PTI relationship.

Definition of transformational leadership

* “charismatic, visionary, and inspirational actions that influence followers to broaden their goals and perform beyond the expectations specified in their formal work roles and job descriptions” (Qu et al., 2015, Page 286),→ team-supporting behaviors

The positive impact of transformational leadership on the performance of the organization

* Transformational leadership acts as a crucial enabler of improved employee work outcomes, including attitude, behavior, and performance (Avolio et al., 2004; Bono and Judge, 2003; Yammarino et al., 1993; Zhu and Akhtar, 2014a).

The basic assumption in the studies for the permanent organization

* Rests on the assumption that leader-follower constellations are stable and continuous (Antonakis et al., 2003; Shamir, 2011).

Definition of temporary organization and popularity of temporary organization

* “a set of organizational actors working together on a complex task over a limited period (Bakker, 2010, Page 468),”
* an increasingly common form of organization, due to the current ‘fast-change’ business environment (Lundin and Steinthórsson, 2003)

Rationale of the differences between permanent organization and temporary organization

* many scholars argue that transformational leadership within the context of a project is expected to explain additional variance, aside from that which is within the context of permanent organizations, as projects' unique characteristics are not considered by general leadership research (Gundersen et al., 2012; Kissi et al., 2013; Müller and Turner, 2010).
* First, there is a repeated call to undertake leadership research within a specific organizational context (Avolio et al., 2009; Dinh et al., 2014; Porter and McLaughlin, 2006),
* Accordingly, more needs to be known about the effectiveness of transformational leadership in particular organizational contexts.

Previous studies on the relationship between leadership, organizational identification, and work outcome

* A great deal of empirical studies support the notion that organizational identification is related to leadership and/or work outcomes (van Dick et al., 2004; van Knippenberg and Sleebos, 2006).

Knowledge gaps regarding temporary leadership and organizational identification in the temporary organization

* Researchers argue that transformational leadership stimulates subordinates' performance by fostering their organizational identification (Bass, 1985; Kark et al., 2003); however, to our best knowledge, empirical studies scrutinizing the mediating role of subordinates' identification with their immediate organization (such as a project) in the transformational leadership process is still tenuous (Liu et al., 2010).

Project as a typical form of temporary organization

* as projects are a typical form of temporary organization that are widely adopted primarily by modern companies on a regular basis (Engwall, 2003).

Characteristics of temporary organization (project)

* As Tyssen et al. (2014a) summarize, the main characteristics of temporary organizations (as opposed to permanent organizations) are: a “limited and predefined duration”, “nonroutine work content”, “higher uncertainty and risks”, and “interdivisional collaboration of heterogeneous teams”.

**Mediating role of project identification in the relationship between transformational leadership and work outcomes**

* This study (Tse and Chiu, 2014). recommends social identity theory as an alternative, with which to better our understanding of the transformation process, on the basis of self-conception and self-categorization rather than exchange and reciprocity.
* It is argued that transformational leadership helps to foster the important social-psychological needs of self-esteem, self-enhancement, and self-worth (Epitropaki and Martin, 2005; Tse and Chiu, 2014), which in turn lead to subordinates strongly perceiving psychological attachment to the organization and subsequently including organizational membership in their social identity (Epitropaki and Martin, 2005).
* Hogg's (2001) social identity of leadership theory
* From the perspective of self-concept theory, Walumbwa et al. (2008) and Cregan et al. (2009) also confirm the positive effect of transformational leadership on subordinates' organizational identification

Introduction of Partial Least Squares (PLS)

* PLS is considered to be a “softer” modeling method with fewer stringent requirements (including multivariate normality, measurement levels of manifest variables, large samples, and so on) (Bernroider et al., 2014).

***Wiesenfeld et al. (2001) "Organizational Identification among Virtual Workers: The Role of Need for Affiliation and Perceived Work-Based Social Support."***

Psychological issues related with virtual workers

* Virtual workers are often separated from coworkers, supervisors, and other organization members, leading to feelings of isolation, greater need for self-organization, and sometimes greater stressed

Virtual workers’ concern on their relationship with the organization

* Whether the distance and dispersion it creates will weaken the relationship between virtual employees and their organizations (Wiesenfeld et al., 1999a).

Characteristics of virtual workers in terms of their perception of the organization

* Virtual work diminishes emphasis on the visible, tangible dimensions of organizations (e.g., offices, colocated employees), instead relying primarily on psychological dimensions (e.g., the perceptions of employees and others) to represent an organization.

Importance of organizational identification for the virtual workers

* Especially in the information age when tangible dimensions of organizations may be less salient, organizational identification may be an important factor shaping employee behavior.

Predictors of OID in previous studies

* the extent of contact between the individual and the organization,
* the visibility of organizational membership,
* the attractiveness of the organizational identity
* artifacts and symbols (e.g., signs and logos over doorways and on coffee mugs, architecture, dress),
* rituals and ceremonies (e.g., orientation programs, recognition ceremonies, customs)

***Grant (2008) "The Significance of Task Significance: Job Performance Effects, Relational Mechanisms, and Boundary Conditions."***

The use of repeated ANOVA

* I conducted repeated-measures ANOVAs to examine the between-subjects and within-subject effects of the intervention from the pretest to the posttest on each dependent variable

Mediating effect test using the repeated measures

* I calculated difference scores to represent changes in job dedication, helping behavior, perceived social impact, and perceived social worth by subtracting pretest scores from posttest scores.
* With these difference scores, I followed standard OLS regression procedures for mediation (Baron & Kenny, 1986; Kenny, Kashy, & Bolger, 1998).

***Bakker (2010) "Taking Stock of Temporary Organizational Forms: A Systematic Review and Research Agenda."***

Examples of temporary organization

* project ventures (Grabher 2002a; Schwab and Miner 2008), movie sets (Bechky 2006; DeFillippi and Arthur 1998) and task forces (Bigley and Roberts 2001; Weick 1993) as temporary organizational forms.
* R&D projects (Katz 1982), theatre productions (Goodman and Goodman 1972), film sets (DeFillippi and Arthur 1998), emergency response teams (Weick 1993), task forces (Saunders and Ahuja 2006), construction projects (Scarbrough et al. 2004b) and sports event organizing committees (Løwendahl 1995).

Growth of temporary organizations in the future

* seem to be becoming increasingly prevalent in our globalized fast-paced economy (Ekstedt et al. 1999; March 1995)
* a myriad of other industries are increasingly adopting this mode of operation, including software development, advertising, biotechnology, consulting, emergency response, fashion, television, and complex products) and systems (DeFillippi 2002; Grabher 2004a; Hobday 2000; Powell et al. 1996; Sydow and Staber 2002; Uzzi 1996; Weick 1993).

Definition of temporary organizational form

* temporary organizational form itself, which can be defined as a set of organizational actors working together on a complex task over a limited period of time (see Goodman and Goodman 1976;2 Grabher 2002a; Jones 1996; Meyerson et al. 1996).

Four basic themes in temporary organizational form

* team (skills (‘a set of diversely skilled people’) + interaction (‘working together’)), task (‘on a complex task’) and time (‘over a limited period of time’) and context

Effect of limited time in temporary organization

* There seems to be agreement that, in general, issues such as leadership (Bryman et al. 1987b) and group interaction (Saunders and Ahuja 2006) in temporary organizational forms would favour a task focus over a relationship focus

Group development model to justify the effectiveness of one-time short term intervention in temporary organization

* On the other hand, non-sequential group development models such as the punctuated equilibrium model have been observed in temporary project teams (Engwall and Westling 2004; Gersick 1988, 1989), which draws attention to moments of sudden change (Engwall and Westling 2004) in the form of midpoint transitions (Gersick 1988, 1989) halfway through the life of a temporary system.
* Meyerson et al.’s (1996) theory of ‘swift trust’, which proposes that, in temporary organizational systems, groups work on a different kind of trust, which swiftly emerges presumptively, rather than slowly over gradual experiences

The effect of time on social interactions

* Areas which are probably affected by the duration of temporary organizational forms are, for instance, trust and social relations.

***Bakker et al. (2016) "Temporary Organizing: Promises, Processes, Problems."***

Growth of temporary organization

* Research has documented a concomitant rise of temporary organizing principles in and across firms (Bakker, 2010)—ranging from managing short-term projects (Sydow, Lindqvist, & DeFillippi, 2004) and forming temporary organizations (Kenis, Janowicz-Panjaitan, & Cambré, 2009), through to navigating short-term networks (March, 1995), orchestrating field-configuring events (Lampel & Meyer, 2008), maintaining temporary clusters (Maskell, Bathelt, & Malmberg, 2006), and hiring temporary contract workers (Kalleberg, 2000).

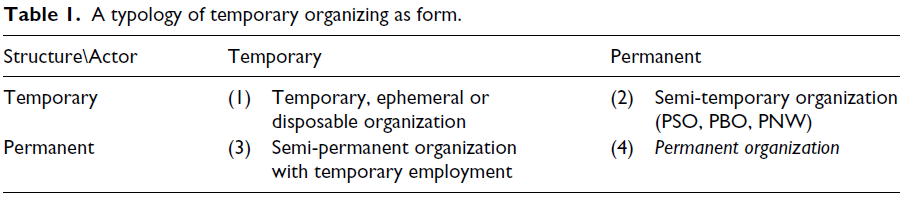
Definition of temporary organization

* Temporary organizing captures the activities and practices associated with collectives of interdependent individual or corporate actors who pursue ex ante agreed-upon task objectives within a predetermined time frame (see Burke & Morley, 2016; Goodman & Goodman, 1976; Lundin & Söderholm, 1995).

Uniqueness of temporary organization

* This “institutionalized termination” (Lundin & Söderholm, 1995, p. 445) separates temporary organizing not only from mainstream organizational theory that is primarily concerned with open-ended organizational settings, but also from Mintzberg’s (1979) adhocracy.

Classification of organizational form



***Van Dick et al. (2004) "The Utility of a Broader Conceptualization of Organizational Identification: Which Aspects Really Matter?"***

Social identity studies in organization context – organizational identification

* Recently, social psychologists have successfully attempted to translate ideas of the social identity approach into organizational contexts (e.g. Dutton, Dukerich, & Harquail, 1994; Haslam, 2001; Hogg & Terry, 2000; Kramer, 1991; Ouwerkerk, Ellemers, & de Gilder, 1999; Tyler, 1999; Tyler & Blader, 2000; van Knippenberg, 2000).

Changes in levels of self-categorization

* Levels of self-categorization become salient through contextual changes

Ellemer’s social identification process for the dimensionality of social identity

* Ellemers, de Gilder, and Haslam (in press) assume three intra-psychological processes underlying group-based social identity, namely: (1) social categorization, (2) social comparison, and (3) social identification.
* Social categorization: the cognitive tool that helps the individual organize social information,
* Social comparison: provides meaning by evaluating one’s own group in comparison to relevant others
* Social identification: person’s emotional involvement with that particular group

Importance of the cognitive dimension of social identity

* Once an individual perceives him- or herself as a member of a social group (→ cognitive dimension), the other three components come into play and the individual also feels (weak or strong) affective ties towards this group, positively or negatively evaluates the group’s characteristics and is susceptible for evaluation by others (in-group and out-group members), and he or she is ready to stand for the group and to behave in a way which is supportive of the group.

Category fit of foci of the identification and behavior

* The relationships between identification on the one hand and criteria on the other should depend on the correspondence between criteria and foci of identification. This follows the assumptions of SCT about self-category fit (see Haslam, 2001; Haslam, Powell, & Turner, 2000).

Knowledge gaps on the relationship between the dimensions of organizational identification and work-related attitude

* For identification, however, the question is not answered yet as to which of its components is of greater explanatory power.
* As far as we are aware on the basis of a review of the relevant literature, no previous work was undertaken to operationalize the multidimensionality of social identification in such a comprehensive way.

Differences between organizational commitment and organizational identification

* The main argument for distinguishing between commitment and identification resides in the fact that commitment research largely ignores the affective, evaluative and cognitive perception of being an organizational member (cf. Pratt, 1998; Abrams, Ando, & Hinkle, 1998) that is the individuals’ sense of ‘oneness’ with an organization

Justification of self-reported measures

* in our view the use of self-reported measures is not only more economical than other types of data collection but is also closer to the individuals’ reality: in this sense it is more the individual perception and feeling which counts.

Importance of specified interventions to promote organizational identification

* It seems more appropriate and more likely to have positive effects if one implements interventions that are carefully planned to correspond with the desired focus or dimension of identification managers want to change.

***Johnson et al. (2012) "Cognitive and Affective Identification: Exploring the Links between Different Forms of Social Identification and Personality with Work Attitudes and Behavior."***

Limited consideration of individual differences in social identity literature

* Social identification researchers have tended to focus solely on the situational determinants of identification and have neglected potential dispositional antecedents (see Riketta [2005] for a review)

Differences between organizational commitment and organizational identification

* The primary difference between identification and commitment, however, is not a cognitive versus affective one.
* Instead, it is that identification reflects the sense of oneness with a group, whereas commitment reflects the relationship strength between separate psychological entities (Ashforth and Mael, 1989; Meyer & Allen, 1991; Pratt, 1998; van Knippenberg & Sleebos, 2006).

Knowledge gaps with respect to dimensionality of organizational identification

* The lack of attention to the affective dimension of social identification may be responsible for the surprising lack of support for one of the main reasons why people are thought to identify with groups—to make themselves feel better.

Importance of the cognitive dimension in organizational identification

* Self-categorization, or what we call cognitive identification, may be the precondition for someone to feel any type of emotions related to their identification

Feedback between cognitive and affective social identity

* Thus, cognition and affect reciprocally reinforce identification (e.g., Kessler & Hollbach, 2005). Indeed, Pratt and Ashforth (1993, p. 313) suggested that “work, over time, tends to implicate one’s sense of self such that behavior, cognition, and affect converge over time.”

Importance of individual differences in the organizational identification context

* Although much existing research on social identification has examined its situational antecedents, the degree to which individuals identify with their organizations and other work-based groups may be affected by dispositional differences, such as individuals’ innate need for identification (Kreiner & Ashforth, 2004).

Previous studies on the relationship between organizational identification and job satisfaction

* Second, satisfaction with the organization and job satisfaction have been shown to significantly correlate with organizational identification in various settings (Ashforth & Saks, 1996; Mael & Ashforth, 1992; Mael & Tetrick, 1992; van Knippenberg & van Schie, 2000).

Previous studies on the effect of organizational identification

* Mael’s measure (1989) has been used in numerous studies and has been shown to be a valid predictor of organizational commitment (Ashforth & Saks, 1996; Bergami & Bagozzi, 2000), job satisfaction (Ashforth & Saks, 1996; Mael & Tetrick, 1992; van Knippenberg & van Schie, 2000), OCB (Bergami & Bagozzi, 2000), and organizational involvement (Bhattacharya, Rao, & Glynn, 1995; Mael & Ashforth, 1992; van Knippenberg & van Schie, 2000).

Precedence of the cognitive dimension of organizational identification

* For example, Carmeli, Gilat, and Weisberg (2006) suggested that cognitive identification preceded affective commitment in external organizational audiences (customers, suppliers, competitors).
* Together, these surfaces point to a critical role for year 1 cognitive identification in facilitating identification for both dimensions in year 2. → empirical result of this paper.

Defense against the common method bias

* Many of the correlations between the variables are near zero, suggesting that common method variance was not necessarily a problem.
* Second, common method variance could not account for the fact that the identification measures provided independent predictive validity of most of the outcomes.

***Burke and Morley (2016) "On Temporary Organizations: A Review, Synthesis and Research Agenda."***

Ascendency of temporary organizations

* Temporary organizations (TOs) have ascended to common practice in many industries with empirical examples evident in the literature from contexts as diverse as crisis response teams, software development, inter-organizational strategic alliances and theatre productions.

Challenges in temporary organizations

* TOs challenge widespread assumptions of the antecedents of effective organization (Ibert, 2004), undercut the coherence and integrity of the firm (De Fillippi and Arthur, 1998; Grabher, 2002a) and ‘turn upside down the traditional notion of organizing’ (Meyerson et al., 1996: 167).

Definition of temporary organization

* ‘a temporally bounded group of interdependent organizational actors, formed to complete a complex task’

Changes in the interest of temporary organization (intra-organization → inter-organization)

* TOs; ‘temporary organizations within organizations’ (Shenhar, 2001b: 395). More recently, scholars are drawing attention to alternative configurations of TOs: inter-organizational project ventures (Bakker, 2011), project-based organizations (Davies et al., 2011) and project-based enterprises/firms (Whitley, 2006).

Characteristics of inter-temporary organization

* Although inter-organizational TOs are also temporary, they span multiple organizations reflecting the increasing tendency for activities to cross individual organizational boundaries (Sinha and Van de Ven, 2005).

Types of temporary organization

* Intra-organizational temporary organization / Inter-organizational temporary organization / Project-based organization / Project-based firm

Different backgrounds in temporary organization

* From the perspective of intra- and inter-organizational TOs, several scholars point to the fact that typically TO members have other ‘home bases’ (Clegg and Courpasson, 2004; Grabher 2002a).
* Arvidsson (2009) to suggest that tensions are created by the coexistence of fundamentally different organizing principles and the way employees identify themselves with either the permanent or the temporary system.

Limited consideration of multiple backgrounds in temporary organization

* We know little about the implications of part-time membership of a TO, or concurrent membership of multiple TOs, or what the effects of the composition of team members changing over the life of the TO are.
* fruitful avenue for further research would be to examine the process of how mental models are developed in TOs

Research questions related to the temporal phenomena in temporary organization

* We understand very little about the implications of the linear time conception in TOs (Ibert, 2004; Lundin and Söderholm, 1995).
* We do not yet understand how homogeneity or heterogeneity of temporal individual differences affects group dynamics within TOs, nor what might moderate or mediate these effects.
* A related question is whether individual time-related differences should be considered in the selection of team members in terms of achieving fit

***Huang et al. (2017) "An Item-Response Theory Approach to Safety Climate Measurement: The Liberty Mutual Safety Climate Short Scales."***

Dilemmas related to the length of survey questionnaire

* We understand very little about the implications of the linear time conception in TOs (Ibert, 2004; Lundin and Söderholm, 1995).

Correlation coefficient criteria to have sufficient discriminant validity

* Generally, a correlation between two variables of greater than 0.80 (Brown, 2006) or 0.85 (Kenny, 1979) indicates the two variables are measuring the same construct

***Huang et al. (2016) "Beyond Safety Outcomes: An Investigation of the Impact of Safety Climate on Job Satisfaction, Employee Engagement and Turnover Using Social Exchange Theory as the Theoretical Framework."***

Traditional safety climate research: long term organization

* Most safety climate research thus far has focused on traditional work environments in which supervisors and workers interact regularly under the same roof.

The social exchange theory and the reciprocity norm

* The reciprocity norm (Gouldner, 1960) specifies that favorable treatment received by one party obligates him/her to provide favorable treatment in return.
* That is, when one party provides a benefit, the receiving party is obligated to respond in kind.

Social exchange theory and effects of safety climate

* Employees who work in a company with positive safety climate are more likely to perceive organizational commitment to and support for safety as beneficial to their personal well-being.
* They are also more likely to reciprocate by engaging in safer behaviors, thereby reducing the occurrences of accidents and injuries (Hofmann et al., 2003).
* According to the social exchange framework and its associated reciprocity norm, employees' perceptions of organizational support and favorable treatment obligate employees to respond positively to the organization

***Risk Behavior and Genetics***

***Sitkin and Pablo (1992) "Reconceptualizing the Determinants of Risk Behavior."***

Relationship between experience and risk-taking behavior

* The escalating commitment model (Staw & Ross, 1987) is also consistent with the notion that individual experiences can foster increasingly risky behavior over time. Slovic, Fischoff, and Lichtenstein (1980) proposed an alternative to the linear model of experience and risk when they argued that the prior experience of decision makers influences risk behavior by encouraging higher levels of confidence in extremely experienced or inexperienced individuals.
* As experience increases, decision makers are more likely to focus on their own abilities and past successes rather than on current situational constraints. As a result, they may simultaneously underestimate the actual risks involved in achieving success and overestimate their abilities to overcome unforeseen problems (Jemison & Sitkin, 1986; March & Shapira, 1987)

Social influence (informational influence)

* Salancik and Pfeffer (1978) proposed that social information processing was the root mechanism by which organizations and organizational members come to influence the perceptions, the beliefs – and, ultimately, the actions – of individuals.

***Verbeke et al. (2014) "The role of attachment styles in regulating the effects of dopamine on the behavior of salespersons."***

Limitations of construct validity (expression)

* One shortcoming of our research concerns the construct validity of our phenotype measures for CO, SO, and the three attachment styles. We acknowledge that full analysis of construct validity requires a multi-trait, multimethod matrix investigation to assess convergent and discriminant validity. We did not conduct such a study, but some of the features of our approach suggest that construct validity may not be a significant problem. All our measures of variables were drawn from scales used before in a number of studies, thereby receiving some support for validity of measures in different research contexts with different samples. Second, all our measures achieved satisfactory reliabilities, and our factor analyses revealed that convergent and discriminant validity of measures were achieved, albeit with a mono-method approach. Future research could use confirmatory factor analysis in a multimethod design to better establish construct validity (Bagozzi, 2011).

Limitation of small sample size (expression)

* However, we employed a hypothesis-driven approach, targeting only two genes and based on theory from biology and psychology, which reduces the need for large sample sizes required by exploratory searches across many genes.

***Dreber et al. (2009) "The 7R polymorphism in the dopamine receptor D4 gene (DRD4) is associated with financial risk taking in men."***

전체 중 일부에게만 Incentive 주는 procedure의 validity

* Thus, introducing a small probability of winning money is likely enough to ensure that risk preferences are measured with reasonable precision.

Social desirability issue in the experiment

* Ultimately, noise would merely lead to attenuation bias in the estimated correlation between risk and the selected polymorphisms

Multiple round experiment의 validity

* This provides support for the hypothesis that behavior is not entirely contingent upon the probability that the outcome will be realized, at least in the simple experiment designed to measure risk aversion that Laury considered.

Bonferroni correction (expression)

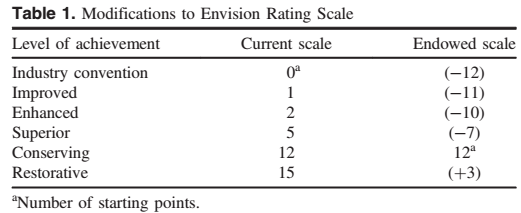
* In order to make our analysis more stringent, we also performed a Bonferroni correction. This is common when multiple hypotheses, such as multiple candidate genes, are tested. Since our p value is 0.023, our result remains significant also when corrected.

***Shealy et al. (2016) Using Framing Effects to Inform More Sustainable Infrastructure Design Decisions.***

Result

* The paper empirically measures the effects of changes in choice structures of the Envision rating system. How information is presented or framed within Envision may inadvertently limit engineers’ consideration for the highest achievable levels of sustainability.
* A choice posed as a loss rather than a gain significantly improved engineers’ consideration for sustainability achievement
* More engineering professionals agree that high levels of sustainability achievement are possible with the endowed version of Envision, and the variance between levels of achievement is less in the endowed group.

Modification of choice structure



Hypothesis

* Engineers make decisions in reference to alternative options and the beginning number of points will frame how participating engineers construct preferences about subsequent choices in Envision.

Excluding other factors (expression)

* To include additional time or cost variables in this study may create biases that are not controlled.

Implications

* However, the results of this study indicate that losing points for not meeting a high level of sustainability encourages engineers to consider even greater achievement.
* Thus, if the purpose of Envision is to guide infrastructure development to the highest levels of achievement possible, then the shift in frame from gain to possible loss appears to help users better attain this goal.

***Shealy and Klotz (2016) Choice Architecture as a Strategy to Encourage Elegant Infrastructure Outcomes.***

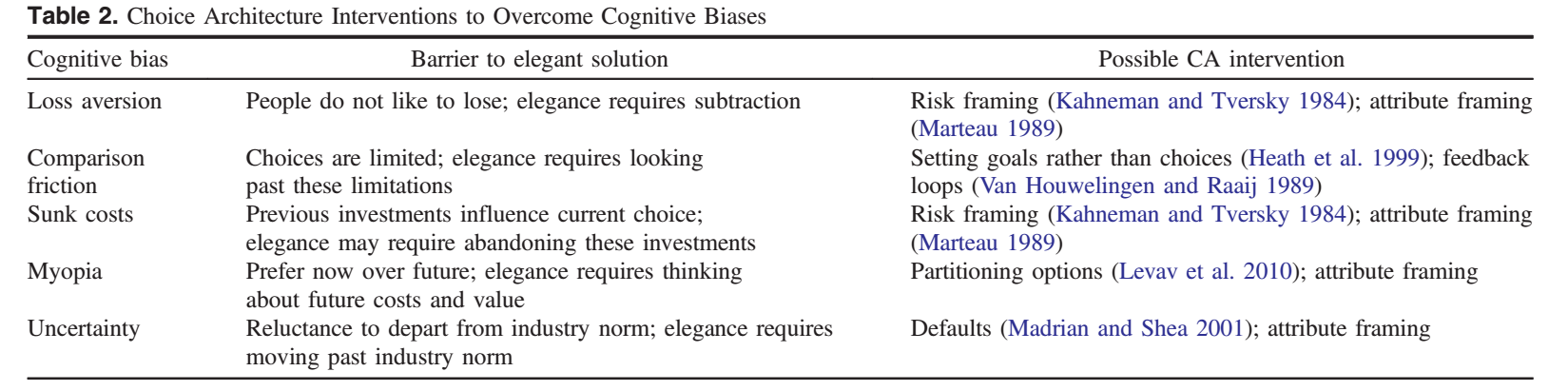
Summary

* Using a metasynthesis research approach, this article describes cognitive biases that can inhibit elegant infrastructure and then presents strategies to mitigate these biases with choice architecture interventions.

Objective

* The focus of this article is on how various types of choice architecture can lead to infrastructure outcomes that are elegant.

Result



***Thaler et al. (2014) “Choice architecture”***

Competing instinct in decision making

* Reflective system - a deliberate and self- conscious thought process by which humans use logic and reasoning to help them make decisions.
* Automatic system - a rapid, intuitive process that is not associated with what we would traditionally consider thinking.

Defaults

* These behavioral tendencies toward doing nothing will be reinforced if the default option comes with some implicit or explicit suggestion that it represents the normal or even the recommended course of action
* Software installation, automatic renewal for magazine subscription, automatically included seat reservations or travel insurance, double-sided printing, etc.
* Opt-in and opt-out arrangement

Expect error

* A well designed system expects its users to err and is as forgiving as possible.
* Paris subway ticket, seat belt alarm, automatic switch for car lighting, gas cap, ATM card, diesel nozzle, drug dosage schedule, checklist, missing attachment, etc.

Feedback

* Well- designed systems tell people when they are doing well and when they are making mistakes.
* Digital camera, Chicago highway painting, etc.

Understanding “Mappings” – from choice to welfare

* A good system of choice architecture helps people improve their ability to map and hence to select options that will make them better off.
* One way to do this is to make the information about various options more comprehensible by transforming numerical information into units that translate more readily into actual use.

Structure Complex Choice

* But when the choice set gets large, alternative strategies must be employed, leading to serious problems.
* One strategy to use is what Tversky (1972) called elimination by aspects. Someone using this strategy first decides what aspect is most important (say, commuting distance), establishes a cutoff level (say, no more than a thirty minute commute), and then eliminates all alternatives that do not meet this standard.
* Painting color, movie directory, collaborative filtering

***Saad and Hegazy (2014) “Behavioral Economic Concepts for Funding Infrastructure Rehabilitation”***

Decision support tools in previous studies

* To support these difficult decisions, researchers strive to develop adequate decision support systems to guide human experts and avoid possible human misjudgments.

Limitations of previous decision support tools

* Artificial intelligence and other decision support tools, however, share the quest to rationalize problem solving and maximize benefits (utility or gain) → assumption of rationality

***Klotz et al. (2010) “Unintended anchors: Building rating systems and energy performance goals for U.S. buildings”***

Research objective

* The aim of this paper is to investigate whether and how the anchoring bias may influence the setting of energy performance goals for building design.

Definition of anchoring effect

* The ‘‘anchoring’’ cognitive bias refers to the tendency to gravitate towards a pre-defined standard regardless of its relevance.

***Bakht and El-Diraby (2015) “Synthesis of Decision-Making Research in Construction”***

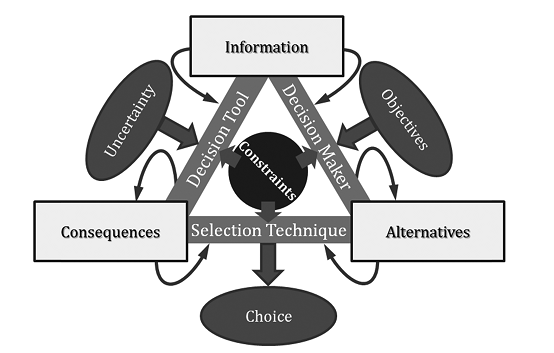
Changes in decision making context in CEM

* A variety of influencing factors reshape the AEC decision-making environment into a complex network of heterogeneous decision criteria, an unprecedented flux of information flow among decision makers, a crowding pool of diversified participants, and a plethora of options for design and construction alternative

Definition of decision making in CEM

* A decision-making problem can therefore be rephrased as the problem of making a choice among various options (alternatives) through evaluation and assessment of outcomes (consequences) of each alternative, and reaching the conclusion in selecting one alternative that presents a satisfactory trade-off among criteria of the problem (objectives).

Major components of decision making problems



Categorization of decision making problems

* Sanvido and Paulson (1992) presented a generic decision matrix and divided decisions into three main types: programmed, semiprogrammed, and unprogrammed.
* They also classified the site decision makers in three levels: project manager (strategic decision level), superintendent (management decision level), and general foreman (operational decision level).

***Arvey et al. (2016) "Genetics and Organizational Behavior."***

Why do we need genetic approaches in organizational behavior?

* What is the relative potency of the person and the environment in explaining organizational attitude or behavior?
* to examine the aggregate contributions of all possible individual difference variables as reflected in the estimates of overall genetic influences ( Johnson et al. 2009), because virtually all individual characteristics are under genetic influence (Bouchard 2004, Turkheimer 2000)
* One reason for the observed genetic influence on measured environmental variables is that individuals are not randomly assigned into their environments; instead they select, and/or are selected into, the environment compatible with their individual characteristics (nature of nurture)
* Behavioral genetics and molecular genetics in particular, provide a useful way to unpack intriguing interplays between the human body and the work environment.

Mediation effect of personality on the relationship between gene and behavior

* Theoretically, such investigations (Neale & Cardon 1992) imply that personality traits mediate genetic influences on work attitude and behavior because (a) genetic factors affect both personality traits and work attitude or behavior, and (b) personality theories suggest causal influences of personality traits on attitudes and behaviors. Thus, if genetic factors play a role in explaining such relationships, it theoretically means that personality traits are one of the pathways through which genetic factors exert their influences on work attitude or behavior (Jocklin et al. 1996)

Definition of genotype and phenotype

* In genetics research, genotype refers to the genetic makeup of the organism, whereas phenotype refers to the physical, psychological, or behavioral features considered as outcomes of the specific gene(s) and the related environments (Plomin et al. 2013a)

What are the practical implications of behavioral genetics research?

* Enriching our understanding of (a) the effects of the person, (b) influences of organizational environments, (c) causal interpretations of studied relationships in OB, and (d) the person-environment correlation and interaction.
* From the perspective of employees, enhanced understanding of the influences of their genetic endowments has the potential to guide their career choices and proactivity (e.g., crafting their work and careers) to optimize their development.
* Such knowledge can also help promote employees’ hedonic and eudemonic well-being.
* Organizations should consider using more personalized or individualized practices to meet employees’ distinct needs, as suggested by some organization researchers (Lawler 1974, Rousseau 2005).

***Ilies et al. (2006) "Darwinism, behavioral genetics, and organizational behavior: a review and agenda for future research."***

Definition of genotype

* The biochemical code providing the individual’s genetic composition

Justification of mediation effect of personality on the relationship between genetic factor and attitude

* First, it is extremely unlikely that there are direct, one-to-one connections between genes and attitudes (e.g., a gene that causes attitudes toward capital punishment) or even many-to-one connections (e.g., a set of genes that, together, cause attitudes toward capital punishment). Rather, genes probably establish general predispositions or natural inclinations, which then shape environmental experiences in ways that increase the likelihood of the individual developing specific traits and attitudes
* In short, genes do not directly cause attitudes or behaviors, but they encode evolved neurophysiological systems that have adaptive value (e.g., the behavioral approach system promotes fitness by facilitating the acquisition of resources related to reproductive success).
* These systems, in turn, are connected to personality, which influences attitudes and behaviors (e.g., individuals with more active behavioral approach systems tend to be more aggressive and dominant).
* The evidence from these studies suggests that genetic effects on attitudes, affect, and behaviors are partially mediated, or explained, by an integrated framework of personal characteristics composed of a set of heritable constructs from the domains of physical characteristics, cognitive ability, and personality.

Expected contribution of behavioral genetics

* First, biometric studies have the potential to advance our understanding of between-individual differences in organizational behavior outcomes such as leadership, motivation, and job performance.
* Second, specific operational models explaining the mechanisms through which genetics influence certain organizational outcomes can and should be developed and tested. One issue that deserves investigation is the causal flow of effects from the genotype.
* Third, examining how genetics and environment interact in influencing behavioral constructs is a developing area of research that offers great promise and has fascinating implications. → How early experiences and environmental conditions and opportunities influence the relative contribution of genes and environment in explaining individual differences in such outcomes.

***Wray et al. (2014) “Research Review: Polygenic methods and their application to psychiatric traits”***

Definition of heritability

* Heritability on the liability scale, h2, quantifies the proportion of variance of liability to disease attributable to inherited genetic factors.

Limitation of heritability study

* While heritability on the liability scale expresses the proportion of the variance in liability that is attributable to genetic factors, it tells nothing about the underlying genetic architecture of the disease in terms of number, frequency and effect sizes of individual causal variants, nor of the mode of action of causal loci (i.e. additive or nonadditive).

Purpose of polygenic risk score or genomic profile risk score (GPRS) study

* GPRS analyses aim to provide insight in the genetic architecture using evidence for association from variants that do not pass the stringent threshold of association.

Determining the sample size in polygenic risk score study

* Once target sample sizes reach a reasonable size there is little to be gained in increasing them as they already have excellent power to detect a variance explained as different from zero.
* In contrast, increasing the discovery sample size will continue to increase the variance explained and the GPRS for each individual become more accurate, which is advantageous for other analyses (e.g. relating GPRS to subphenotypes).

Necessity of exploring non-genetic factors

* However, predictive ability will increase if non-genetic risk factors are combined with the genetic predictors.

***Martin et al. (2015) "Common genetic risk variants are associated with positive symptoms and decision-making ability in patients with schizophrenia."***

Strength of polygenic risk score

* Although each common variant represents a very small increase in disease risk, aggregate measures of common variants, such as the polygenic risk score(PRS), have greater probabilistic predictive ability (Purcell et al., 2009; Wray et al., 2014).

Implication of polygenic study

* Identifying associations between genetic risk variants for schizophrenia and cognition will increase our understanding of the pathway from genotype to phenotype (Gur et al., 2007).

***McIntosh et al. (2013) "Polygenic Risk for Schizophrenia Is Associated with Cognitive Change Between Childhood and Old Age."***

PRS result (expression)

* No study has determined whether cognitive impairments can be attributed to schizophrenia’s polygenic architecture using data from GWAS.
* We tested the hypothesis that having more of the common, risk-associated genetic variants for schizophrenia is associated with lower cognitive ability in childhood and old age and relatively more decline in between.

Quality control before conducting GWAS

* Single nucleotide polymorphisms were excluded from the polygenic analysis where the minor allele frequency was less than 2%, if the call rate was less than 98%, or if the chi-squared test for Hardy–Weinberg equilibrium was less than .001.

***de Zeeuw et al. (2014) "Polygenic scores associated with educational attainment in adults predict educational achievement and ADHD symptoms in children."***

Meaning of polygenic risk score study

* Polygenic scores also allow for exploration of the underlying etiology of the association between two phenotypes, such as, ADHD and educational achievement.
* Here, it is expected that genetic variants associated with one phenotype, will explain part of the variance in the other phenotype.
* This suggests that some of the genetic variants are involved in both general cognitive ability and schizophrenia.

Using different thresholds for polygenic risk score (expression)

* The polygenic scores were calculated for different subsets of SNPs, selected on the bases of their p-value in the discovery sample, with thresholds of 5x10-8, 1x10-5, 0.001, 0.01, 0.05, 0.1, 0.5 and 1.0.

Result

* Up to ~3 per cent of the variance in educational achievement and up to~4 per cent of school performance in children was explained by the polygenic scores that were based on educational attainment in adults.
* The polygenic scores, representing educational attainment in adults, explained up to~2 percent of the variance in attention problems and ADHD symptoms in 12-year-olds, indicating that some of the genetic variants that have a positive influence on educational attainment have a protective effect against ADHD.

***Belsky and Israel (2014) "Integrating Genetics and Social Science: Genetic Risk Scores."***

The reasons now is the time to integrate genetics and social science

* Data are available (HRS, Wisconsin longitudinal study, etc.)
* Data are analytically tractable (well established software and standardized quality control procedure)
* Data are meaningful

When can we use the candidate gene approach?

* When there is extensive knowledge of the biological pathway in which the gene is implicated.
* When there is evidence for modulation of the function of that pathway by the gene
* When there is evidence that a specific variant alters the function of the gene within the targeted pathway

When can we use the candidate gene approach?

* When discovery sample sizes are very large.
* When independent replications are positive.
* When the technical quality of the GWAS is high.

Role of Polygenic Risk Score

* It provides a quantitative measure of genetic predisposition that is calculated using information from multiple genetic variants.

PRS from the candidate gene approach

* In a hypothesis-driven approach, the goal should be biological coherence of the variants included in the score.

PRS from the GWAS

* In a hypothesis-free approach, the goal should be statistical coherence—the same standard of evidence should be applied to all variants in the genome to select SNPs into the score.

Suggestions for PRS in social science research

* Genetic risk scores can be used to study developmental processes (e.g., whether early life growth mediated genetic influences on the pathogenesis of obesity in adolescence, young adulthood, and middle life (Belsky et al.2012)). → longitudinal mediating mechanism study
* How genetic factors contribute to relationships between behavioral and social processes and health outcomes. → mediation mechanism study
* How individuals become exposed to certain environments and what the outcomes of those exposures are, that is, to study polygenic risk-environment correlations (rGE) and interactions (G×E)
* There is growing molecular genetic evidence that rGE is a real and empirically tractable phenomenon (Fowler, Settle, and Christakis 2011; Boardman, Domingue, and Fletcher2012; Conley et al. 2014).
* Testing the G+E, rGE, and GxE model

***Spain and Harms (2014) “A sociogenomic perspective on neuroscience in organizational behavior." Frontiers in Human Neuroscience”***

Phenotype (expression)

* Phenotype means that the trait is observed or measured. Examples of phenotypic traits are height, eye color, measured intelligence, or the occupation of a leadership role.

Shared genetic causes (expression)

* Such a design allows the researcher to determine how much of the correlation between two measured variables is determined by shared genetic causes.
* These researchers found substantial genetic correlations between transactional leadership and Conscientiousness, Extraversion, and Agreeableness (−0.49, −0.46, and −0.23).

Mediation effect of personality on the relationship between gene and leadership

* This meta-analysis also provided evidence that personality traits mediate the influence of genes on leader emergence, such that genes → personality → leader emergence, as causal structure consistent with the “leaders are born” thesis

Moderating effect of environmental factors on the relationship between gene and leadership

* Experiencing leadership roles in high school moderated the genetic effect on work leadership.
* These findings raise the possibility that the heritability of work leadership may be affected by environmental variables, in this particular case, earlier investment in leadership roles (Avolio, 1994).
* Specifically, higher levels of enrichment were associated with lower heritability estimates (Zhang 2009b).
* The second mechanism is that gene expression can be influenced by variations in environmental conditions, consistent with the position that “Leaders are made” (nurture).

Theoretical implication (expression)

* A sociogenomic leadership theory that embraces gene environment interplay points to new avenues of research.

***Meyers et al. (2013) "Interaction between polygenic risk for cigarette use and environmental exposures in the Detroit neighborhood health study."***

Moderation effect (express)

* The association between genetic risk and smoking was greater among individuals who had experienced an increased number of traumatic events in their lifetimes, and diminished among individuals who lived in a neighborhood characterized by greater social cohesion. Phenotype means

Increased attention to the polygenic risk score (expression)

* Polygenic risk scores, which aggregate common genetic risk variants, have been increasingly used to model the genetic architecture of complex traits.
* In addition to circumventing the statistical stringency of multiple test corrections necessary for GWAS, this method may more accurately reflect the underlying genetic architecture of complex behaviors, such as cigarette use.

No previous research efforts (expression)

* Although investigators have examined gene–environment interactions in smoking using individual genetic variants (candidate genes) or latent genetic influences (twin studies), no study to our knowledge has used polygenic risk scores in the context of GxE for smoking behaviors.
* To our knowledge, no previous study has specifically examined the relationship between genetic risk factors and neighborhood social cohesion, as measured here.

Theoretical contribution (expression)

* In this study, we expand upon the literature by examining the interaction between an aggregate measure of genetic risk for cigarette smoking and three environmental exposures that have previously been associated with increased substance use: traumatic life events, neighborhood social cohesion and neighborhood physical disorder.

Operationalization of a measure using summation of the responses (expression)

* The number of items endorsed was summed to create a score that could range from 0–19. Higher scores reflect having experienced a greater number of traumatic events.

Including product term to examine interaction effect (expression)

* We assessed the interaction between the GRS and each environmental variable on the additive scale by including a cross-product term in separate linear-Poisson regression models.

Effect size of polygenic risk score in general

* In the current literature, polygenic risk scores typically account for 0.5–4% of the variance in a complex behavioral trait.

***Duncan and Keller (2011) "A Critical Review of the First 10 Years of Candidate Gene-by-Environment Interaction Research in Psychiatry."***

Evidence on G x E from twin study

* Consistent with this expectation, twin analyses convincingly demonstrate that at least some responses to the environment are heritable.

***Rietveld et al. (2014) "Replicability and Robustness of Genome-Wide-Association Studies for Behavioral Traits."***

Introduction of candidate gene study

* In psychology, the standard approach for identifying such associations is the candidate- gene study. In a candidate-gene study, a small set of genetic variants (polymorphisms) are selected on the basis of their hypothesized or known biological function, and these polymorphisms are tested for association with a given trait. Most candidate-gene studies have been based on samples of several hundred participants and have applied a significance threshold of .05 (for a review, see Ebstein, Israel, Chew, Zhong, & Knafo, 2010).

Low statistical power of candidate gene approaches

* Despite the fact that such studies continue to be published in prominent journals, the successful replication of published genetic associations with behavioral traits is the exception, not the rule (Benjamin et al., 2012; Hewitt, 2012).

Population stratification issue in candidate gene approaches

* Candidate-gene studies also cannot always adequately control for the well-known problem of population stratification, in which genotypes covary with unobserved environmental factors (Hamer & Sirota, 2000).

Background of emergence of GWAS

* Around 2005, as a result of the methodological limitations of candidate-gene studies and the dramatic decline in the cost of genotyping, medical research experienced a paradigm shift, moving away from candidate-gene studies to what are called genome-wide-association (GWA) studies

GWAS introduction

* These are hypothesis-free studies in which researchers test the phenotype of interest for association with all of the (typically millions of) measured single-nucleotide polymorphisms (SNPs).
* Because of the large number of hypotheses tested, a SNP association is considered established only if it (a) reaches the “genome-wide significance” threshold of p < 5 × 10−8 and (b) is subsequently successfully replicated in an independent sample at a nominal significance level of .05 (McCarthy et al., 2008).

Quality controls in GWAS

* Estimate the first four principal components of all the genotypes measured by the gene chip (the number 4 having emerged as a convention)
* Drop individuals who are genetic outliers as measured by these principal components, and then
* Include the principal components as control variables in the genetic-association analysis. → can eliminate spurious association due to population structure.

Constructing polygenic risk score (expression)

* constructed a polygenic score (gi) for each individual (i) as equal to a weighted sum of the number of reference alleles (0, 1, or 2) across a set of SNPs, where the weights were derived from the regression coefficients from a GWA study of either years of schooling (EduYears) or receipt of a college degree or its equivalent (College).

***de Moor et al. (2012) "Meta-analysis of genome-wide association studies for personality."***

Influence of personality on individual’s behavior (general sentence)

* Personality can be thought of as a set of characteristics that influence people’s thoughts, feelings and behavior across a variety of settings.

Heritability of personality

* Twin, adoption and family studies have convincingly shown that each of the FFM personality dimensions is heritable, with heritability estimates ranging between 33 and 65%.

***Consortium (2015) "MEta-analysis of genome-wide association studies for neuroticism, and the polygenic association with major depressive disorder.***

Heritability of personality

* Twin studies of neuroticism, harm avoidance, or negative emotionality generally find that between 40% and 60% of the trait variance is explained by genomic variation, and it has been found that there are no large age-by-genotype or sex-by-genotype effects, modest assortative mating, and large genetic and phenotypic stability across the life span.

To our knowledge (expression)

* Herein, we report results of the largest GWA study for neuroticism so far, to our knowledge, conducted in 63 661 participants from 29 cohorts.

Polygenic risk score approach

* The PGSs were calculated for all individuals of the NTR and NESDA target set by taking a set of most significant SNPs from the analysis in the PGS discovery set, multiplying the individual’s genotypic score (0, 1, or 2 for genotyped SNPs, or any value between 0-2 for imputed SNPs) by the effect size of a particular SNP (unstandardized regression coefficient based on the meta-analysis), and summing this over SNPs. The PGSs were calculated for 6 p value thresholds (P<1×10−5, P < 1×10−4, P < 1×10−3, P< .01, P<.05 and P< .50).
* Next, linear regression was conducted to predict neuroticism from the PGSs in 8648 NTR participants.

Results

* The most significant result was found for the SNP set with a threshold p= .50, with an explained variance of 0.66% and p=1.09×10−12 in the linear regression analysis.

***Vinkhuyzen et al. (2012) "Common SNPs explain some of the variation in the personality dimensions of neuroticism and extraversion."***

Heritability of neuroticism and extraversion

* Causes of individual differences in both neuroticism and extraversion have been studied extensively using twin and adoption studies, showing heritability estimates ranging from 13 to 58% for neuroticism and from 34 to 57% for extraversion.

Low statistical power of candidate gene approach

* Candidate studies have reported associations with markers within several genes, but again, replication generally failed.

Limitation of GWAS related to sample size

* Yang et al. showed (i) that 45% of the phenotypic variance (roughly half of the heritability) of human height can be explained by considering all single-nucleotide polymorphism SNPs simultaneously in a linear model analysis, implying that most of the heritability is not missing but is as yet undetected due to effect sizes of individual variants being too small to reach significance in GWAS conducted to date;

***Benjamin et al. (2012) "The genetic architecture of economic and political preferences."***

Importance of risk preference study

* Measures of risk preferences predict diverse risky behaviors, such as smoking, drinking, and holding stocks rather than bonds (11, 12).

Education attainment (more distal than other traits related to preference)

* We also study educational attainment because, even though it is probably more distal from basic biological processes, it is available for a larger sample of genotyped individuals.

Heritability of risk preference from twin study

* The implied heritability of the economic preferences are typically about 30% and the estimates for political preferences are typically around 40%.
* We obtain heritability estimates that are consistent with typical estimates previously reported for both political attitudes (19) and economic preferences (20, 23, and 24).
* Because the economic and political preference measures have twin-based heritability around 0.30 (20) and 0.40 (19), respectively, the hypotheses of one-half magnitude would be GREML point estimates of around 0.15 and 0.20.

Limitation of this study with regard to size of discovery sample

* Evidently a discovery sample of 2,900 individuals (about 90% of 3,200) is far too small to obtain predictive power for standard measures of economic or political preferences.

***Choe and Leite (2016) "Assessing Safety Risk among Different Construction Trades: Quantitative Approach."***

Dynamic nature of construction process

* Unlike other industries, which have static and indoor work environments, construction sites are very dynamic in terms of, for instance, ground condition, temporal structure, weather conditions, and equipment (Fredericks et al. 2005).
* The coexistence of work teams with different tasks working in a common area increases the complexity of safety risk profiles.

Quantification of risk

* Risk is considered as a product of probability and severity.
* Probability is typically defined in terms of the number of injuries or illnesses per worker-hours; severity is defined by the average outcome of the injury or illness.
* Jannadi and Almishari (2003) defined risk as a measure of the probability, severity, and exposure of all the hazards of an activity.

Limitation of the subjective measure (expression)

* This approach cannot escape from biases of subjective judgment.

Different safety risk across different trades (occupation)

* The underlying assumption of this study is that every worker within a specific trade has a unique pattern of safety risk in terms of common injury severities, hazards, and sources of injury due to the unique activity assigned to them.
* Depending on the nature of an activity assigned to different occupations, common injury severities vary. (e.g., roofer, iron worker, and rebar worker)
* Therefore, safety risk of different occupations should be analyzed by different injury severities and hazard types to understand the dynamic nature of safety risk.

***Baradan and Usmen (2006) "Comparative Injury and Fatality Risk Analysis of Building Trades."***

Different risk levels in different trades

* There are varying degrees of hazards and risks associated with the different types of work performed by these trades.
* It is important to recognize that a large volume of data is required for risk quantification and risk analysis using injury, illness, and fatality statistics for each trade.

Definition of hazard and risk

* hazard can be defined as the potential for an activity or condition to produce harmful effects such as illness, injury, or fatality.
* Risk, on the other hand, is the measure of both the likelihood and the consequences of the hazards associated with an activity or condition.

***Technology Acceptance Studies***

***Yang et al. (2016) "User acceptance of wearable devices: An extended perspective of perceived value."***

Scope of wearable devices

* Wearable devices are used external to the body, either attached as an accessory or embedded in clothes (Raskovic et al.,2004). They can be used in various applications equipped with sensors, internet connections, processors, and operating systems as well as user-friendly interfaces with touch pads/screens.

Limited research efforts to investigate user’s acceptance of wearable devices

* Despite the positive prospects and functionality of wearable devices, little research has been done on user acceptance and behaviors concerning them because they are still in the very early stage of commercialization.

***Gerpott (2011) "Attribute perceptions as factors explaining Mobile Internet acceptance of cellular customers in Germany – An empirical study comparing actual and potential adopters with distinct categories of access appliances."***

Previous studies to investigate potential user’s intention to adopt technology

* Current examples of this category of investigations are Chen (2008), Chen, Yen, and Chen (2009), Kim and Garrison (2009), López-Nicolás, Molina-Castillo, and Bouwman (2008), Lu, Liu, Yu, and Wang (2008), Mallat, Rossi, Tuunainen, and Öörni (2009).

Previous studies used mixed sample

* Examples of the third kind of adoption investigations areBina, Karaiskos, and Giaglis (2008), Fogelgren-Pedersen (2005), Groeppel-Klein and Koenigstorfer (2007), Kuo and Yen (2009), Turel, Serenko, and Bontis (2007), Verkasalo (2008), and Wu and Wang (2005).

***Modeling Construction Worker’s Unsafe Behavior***

***Anderson et al. (2014a) "Social Learning's Effect on Absenteeism: The Effect of Project Turnover."***

Motivation

* While this work (Seungjun’s ABM model) is novel and insightful, it is not without limitation. The role and effect of social learning was simulated in an organizational structure which features essentially permanent employees

Formal rule 에 대한 강조의 한계 (expression)

* In combating absenteeism, construction managers have often used formal controls (e.g. warnings, penalties, suspension, dismissal); however, these approaches have frequently proved ineffective at eliciting desired changes in improving workers attendance motivation (Sichani et al. 2011).

Social norm에 대한 증가하는 관심 (expression)

* Given the previous shortcomings of individual formal controls, researchers have begun investigating the social aspect of construction workers’ absence behavior, more specifically the role of social norms and absence culture on construction projects (AbouRizk et al. 2010; Ahn et al. 2013a; Sichani et al. 2011)

Observation as a source of perception of social norm

* Workers become aware of social norms by observing the behavior of coworkers with whom they have social relationships in the organization.

기존의 연구는 permanent organization 중심 (expression)

* The concept of absence culture is well-established by empirical evidence, but the evidence to date has concentrated on organizational structures with permanent employees, i.e. non-project based organizations unlike the construction industry.
* Consequently, there is a limited understanding of the impact of social influence on workers’ absence behavior in the construction industry where most of workers exist temporarily on projects and crews (i.e. subcontractors) frequently enter and exit the project.

다른 Crew member와는 interaction이 적음

* In addition, workers have relatively little interaction and social ties with member of other crews; this is based on antidotal reports from construction workers.

***Lu et al. (2016) "Understanding the relationship between safety investment and safety performance of construction projects through agent-based modeling."***

Basic assumptions of top-down approach (empirical studies)

* Construction agents (e.g., construction workers and superintendents) are homogenous resources that have identical quality to work safely (Watkins et al., 2009)
* Interaction of construction agents, and their work environment (e.g., construction sites and peers) have a minimal impact on safety investment and safety performance (Sawhney et al., 2003)

Introduction of ABM (expression)

* ABM is a computer simulation technique that allows us to exam how system rules and patterns emerge from the behaviors of individual agents (Epstein and Axtell, 1997).
* ABM is regarded as a modeling technique that matches more closely with the real-world situation than traditional EBM (Wilensky and Rand, 2015)
* Agent based modeling (ABM) is an appropriate technique to develop computational models of construction safety performance because of its ability to model human behaviors in a bottom-up approach and repetitive decentralized interactions (Palaniappan et al., 2004).
* Furthermore, ABM can be used as a laboratory method to explore what-if scenarios and redesign the organization through self-adaptation (Bonabeau, 2002).

Three main components of safety investment

* Safety equipment, safety administration personnel, and safety training and promotion.

Three components of Agent Based Model

* Agents’ properties, behaviors, and environment,
* Agents’ interactions with the environment
* Agents’ relationships and interactions with other agents (Macal and North, 2010).

Role of safety supervisor in the site

* The safety supervisors occupy an intermediate position between the management and the workers (Khosravi et al., 2013).

Relationship between safety and productivity

* Safety and productivity are two main concerns for the construction industry. Often compliance with safety requirements is considered to conflict with productivity (Mitropoulos et al., 2005).
* Some workers might choose to worker faster in a risky way or skip performing some safety procedures since they consider salary before safety (Koehn et al., 2000).

General proportion of safety supervisor in Hong Kong construction sites

* From investigations of the Hong Kong construction industry, usually one safety supervisor inspects 20 workers’ safety performance, thus, supervisor% is 0.05.

***Ekmekci and Casey (2011) "Computer simulation exploring organizational identification for contingent workers."***

Importance of the initial time period for temporary workers

* Contingent workers do not have a well-defined and permanent time contract with organizations (Kirk and Belovics, 2008), making the initial period they spend with the organization highly important in terms of their cooperation and willingness to stay.

Recent incensement of using nontraditional workforce

* Over the last decade organizations have started to use an increasing number and variety of nontraditional work arrangements that involve the integration of contingent workers in their workforce (Albert et al., 2000; Way et al., 2010).

Definition of the orgnaizational identifcation

* “the degree to which a member defines himself or herself by the same attributes that he or she believes define the organization” (Duttonet al., 1994, p.239).

Assumption of the previous studies (expression)

* These strategies are largely grounded in the assumption that contingent workers will be attracted to and stay in an organization if they think that their individual values match those represented in and through the organization’s identity (Coldwell et al., 2008; Judge and Cable, 1997)

Relationship between tenure and organizational identifcation

* Research also concludes that a shorter tenure reduces a member’s exposure to organizational mechanisms for promoting identification (Rousseau, 1998).
* Stating that a contingent worker’s strength of organizational identification is dependent on the passage of time or tenure is incomplete without accounting for the frequency of interactions with organizational members or the amount of information received about the organization.

***Smith and Conrey (2007) "Agent-based modeling: A new approach for theory building in social psychology."***

Social and Psychological Phenomena – The result of repeated interactions

* Most social and psychological phenomena occur not as the result of explicit choices by isolated individuals but rather as the result of repeated interactions between multiple individuals over time.

Limitations of the previous approach to consider dynamic interaction process

* The most commonly used theory-building and modeling techniques in our field are less than ideal for this type of task.

Multiple agent systems

* A multiagent system, then, is a system that contains multiple agents interacting with each other and/or with their environments over time.

Purpose of ABM in terms of theory building

* An ABM is a simulated multiagent system constructed with a particular goal: to capture key theoretical elements of some social or psychological process (for a review of simulation approaches in social psychology generally, see Hastie & Stasser, 2000).
* In such a system, each agent typically represents an individual human acting according to a set of theoretically postulated behavioral rules.
* ABM is a tool to conceptually bridge between the micro level of assumptions regarding individual agent behaviors, interagent interactions, and so forth and the macro level of the overall patterns that result in the agent population.
* As Epstein (2005) has observed, the importance of this demonstration (i.e., segregation model) is not that the model is right in all its details—it certainly does not claim to be, and humans obviously have a far more complex set of race-related attitudes, motives, behaviors, and so on. “It’s important because—even though highly idealized—it offers a powerful and counter-intuitive insight”

Simple rule → Complex Phenomena

* “We get macro-surprises despite complete micro-level knowledge” (Epstein, 1999, p. 48). The term emergenceis frequently applied to this sort of surprising, unpredicted, or counterintuitive outcome from multiagent simulations (Kauffman, 1995; Resnick, 1994; Wilensky & Resnick, 1999).

Comparison between VBM (variable based model) and ABM

* Most psychologists, indeed most social scientists in general, endorse a positivist “covering-law” or “statistical regularity” notion of causation and explanation, broadly deriving from David Hume (Bechtel & Richardson, 1993; Cederman, 2005; Doreian, 2001).
* Following the covering-law model of explanation would seem to be a profoundly unsatisfying type of explanation that gives no real insight into the phenomenon, despite its formal resemblance to the covering-law explanations used in physics and other fields.
* The generative (or mechanistic) approach explains phenomena by postulating processes of interaction among agents or other entities, whereas the statistical or regularity approach does so by identifying patterns of covariation among variables (Epstein, 1999; Wilensky & Reisman, 2006; Wilensky & Resnick, 1999).

Different roles of ABM and VBM

* Variable-based equations often offer concise, quantitative descriptions of phenomena.
* ABM offers insights into generative processes.
* Equations may allow formal proofs of important properties.
* VBM often requires simplifying assumptions of rationality. But, ABM approaches generally do not require such simplifying assumptions. Instead, they can assume that agents are smart or stupid, self-interested or altruistic, in accordance with whatever theory is guiding model construction
* Causal models often require strict causal-ordering assumptions. In contrast, multi-agent models as well as dynamical system approaches can readily incorporate multiple causal directions.
* ABM allows incorporation of nonlinear, conditional, or qualitative effects.
* VBM and ABM focus on different levels of abstraction. ABM focuses on a more concrete level than does the VBM approach.

Advantages in ABM in terms of experiment

* This is one of the key advantages of ABM, that it does not restrict a theorist to a single level of analysis.
* Unlike real social life, however, the values of parameters in a multi-agent model can be set to arbitrary values. We can test the consequences of varying the ratio of males to females, the time to agent maturity, or the variance in food acquisition over time.

Argument for more complex ABM

* Several modelers (Sallach, 2003; Sun, 2001) have argued that ABM of human behavior needs to go beyond simple rules to incorporate relatively sophisticated models of individual agent cognition.

Opposition to more complex ABM

* First, the question of whether the increased complexity actually furthers or impedes a deep conceptual understanding of a model’s behavior must always be kept in mind.
* Second, serious arguments can be made that adaptive human behavior actually results from the application of cognitive simple heuristics rather than extensive, resource-demanding cognitive processes (e.g., Gigerenzer, Todd, & the ABC Research Group, 1999).

Balancing between complexity and simplicity in ABM

* Adding complexities such as these might be reasonable in a model whose goal is a close match to a specific set of empirical data. But closer fit to data comes at a cost: Additional processes obscure the fundamental elements of the generative theory, while adding nothing that is conceptually critical.
* ABM is a representation of a theory about social behavior, not a representation of some slice of complicated social reality.

Validation of the ABM

* Validation of ABMs can be done at both the micro and macro levels (Moss & Edmonds, 2005), so their falsifiability is really of two separate kinds.

***Hughes et al. (2012) "Agent-based modelling and simulation: The potential contribution to organizational psychology."***

Limited utilization of computer simulations in organizational studies

* Nevertheless, computer models and simulations are still not well utilized in organizational psychology and related fields (Harrison, Lin, Carroll, & Carley, 2007; Smith & Conrey, 2007).

Debates about the optimal complexity of ABMs

* There has been considerable debate in the literature regarding the optimum complexity of ABMSs (Jennings, 2000; North & Macal, 2007).
* Axelrod (1997) has advocated researchers therefore follow the KISS principle – ‘keep it simple, stupid’.

Limitations of empirical validation in ABMs

* Thus to assess a model’s validity solely by matching (correlating) the output of an ABMS with input data, or using it to predict future organizational behaviour, may not be the best assessment of the model’s validity, because an ABMS will only ever provide a forecast of what could happen (Carley, 2009).

***Anderson and Lee (2016) . "An empirically grounded model for simulating normative energy use feedback interventions."***

Limitations of previous ABMs related to energy use behavior

* The models made to date have provided unique insights into potential energy savings as a result of improved occupant behavior and how complex factors can affect intervention success, but have not yet reached the capability to be used for predictive modeling purposes.
* In the previous studies most models have only achieved the first tier of performance—model performance is in qualitative agreement with micro level structures.

Incorporating noise in the Behavior Rules

* However, the model does account for ‘unexplained’ behavior changes by incorporating in stochasticity in behavior change.
* Allowing for factors beyond the feedback messages to change an occupants’ energy use is required to make agent behavior more realistic.
* It is well known that how humans determine to make decisions regarding behavior is extremely complex and subject to numerous determinants.

***Anderson et al. (2014b) "Impact of Social Network Type and Structure on Modeling Normative Energy Use Behavior Interventions."***

Definition of social norm

* Social norms can be considered as general codes of conduct, i.e., shared understandings of what is acceptable behavior and what is not acceptable behavior for a group (Bendor and Swistak 2001).

Diffusion of social norms via social network

* In the models, as in reality, the transmission of social norms occurs through social networks.

Importance of social network type and structure to change occupants’ behavior in the building

* If these models are to be used for predictive purposes, understanding the importance of social network type and structure (SNTS) is necessary since SNTS are not identical across buildings

Introduction to ABM and its advantage

* Agent-based modeling (ABM) is an analytical method that allows the modeling of heterogeneous agents in various types of environments with explicit decision rules (Gilbert 2008).
* This form of modeling permits adaption and learning, which can be difficult to model using alternative methods (e.g., variable-based approaches).
* For that reason ABM is appropriate for exploratory studies on how individual behavior changes in social networks due to social influence.
* These attributes make ABM particularly well-suited for modeling and understanding complex adaptive systems (Miller and Page 2007).

Time -step (unit less) – expression

* Time-steps in the model do not represent actual time-units and are used relatively as measures.

Variations in susceptibility of social norms

* Not all occupants are equally susceptible to influence from others.
* Susceptibility to influence from others is correlated with individual intelligence [presented in Bearden et al. (1989) from Petty and Cacioppo (1981), pp. 80–84], self-confidence (Cox and Bauer 1964), self-esteem (Janis 1954), and interpersonal confidence (Berkowitz and Lundy 1957).

Sensitivity analysis result reporting

* Each input value (EUS and susceptibility) derived from previous studies were subjected to sensitivity analysis and demonstrated only relative changes in system behavior (e.g., lowering susceptibility would make the simulation times larger across all network types a comparable amount).

Equilibrium determination

* The first checks for convergence of behavior of all occupants. This is done by checking the standard deviation between all occupants’ EUS and if it returns a value less than or equal to 1 W the behavior of occupants has converged.
* The second method measures rate of change in the mean and standard deviation of occupant EUS in the system. When these values have slowed down beyond a certain threshold the simulation run is said to have reached equilibrium by grouping of behavior.

Experiment Results

* Each social network type resulted in different distributions of energy-use change over time, with comparable means of roughly zero energy-use change at equilibrium
* Time to reach equilibrium depended on level of social connectivity and network type.
* Mean EUS change for each scenario remained around zero, but again the range of potential outcomes depended on network type and network size (Fig.4).
* The time to reaching equilibrium was not significant with respect to the network type alone but was for the interaction terms between network type and building size, expect one instance (Table3).
* Adding the EC resulted in substantial declines in energy use upon reaching equilibrium (Fig.5).

Types of model validation

* (1) the model has replicative validity or that it is able to replicate data acquired from a real system
* (2) the model possesses predictive validity (i.e., the model is able to generate data that fits data from real-world systems prior to being created)
* (3) the model can have structural validity (i.e., the model accurately reflects how the real system operates).

Justification of conceptual validation

* This model aims to provide insight into the impact of SNTS modeling assumptions on intervention outcomes and not to make accurate predictions of the interventions itself, making conceptual validation appropriate and meaningful.
* Although these theories have been previously validated, it is important to be aware of the inherent difficulties in modeling human behavior. This is why the writers must evaluate the validity of the model considering its purpose, a comparative analysis of SNTS as opposed to making detailed and definitive predictions of intervention outcomes.

***Chen et al. (2012) "Modeling building occupant network energy consumption decision-making: The interplay between network structure and conservation."***

Generative purpose of this study

* In this paper we will utilize a simulation algorithm to quantify the energy conservation parameters utilizing data from the Peschiera et al. experiment to predict network level energy consumption and conservation patterns.
* We aim to qualitatively describe the degree to which various types of network structure influence individual energy-saving behavior.

Association between relation quality and strength of the social norms

* For each decision making iteration, the probability of whether or not the agents take action to save electricity is correlated with the quality of relationship.
* Quality of relationship refers to the strength of the relationship, or the weight of the connection between agents in the network. This is determined by how close of friends two agents are in the model.

Calibration coefficient (expression)

* tau is the scalar that can convert edge weight to proper probability so that the model output can fit the experiment data.

Types of model validation

* Zeigler characterizes three types of model validity: (1) replicative validity (i.e. whether the model fits the data already acquired from a real system), (2) predictive validity (i.e. whether the model fits data before data are acquired from a real system), and (3) structural validity (i.e. whether the model completely reflects the way in which the real system operates).

Using empirical data and structural validity

* Utilizing data from an experiment to develop the decision influence model for the agent norm provides a level of structural validity to the model.

Limited predictive validity in computer simulation models

* The post-simulation statistical analysis testifies to the replicative validity of model. However, predictive validity is hard to achieve merely through simulation and emulating a single experiment. Therefore, we conducted a replication of the experiment with a second set of building occupants to test whether results from the simulation model have similarity with target systems.

***Korobow et al. (2007) "An Agent-Based Model of Tax Compliance with Social Networks."***

The role of social norms in explaining noncompliance behavior

* In fact, researchers have tried to incorporate social drivers (e.g., social norms) in explaining noncompliance as conventional economic models over–predict the amount of noncompliant behavior one should observe (Alm, McClelland, and Schulze, 1992).
* Specifically, the literature has focused on social drivers of compliance such as social norms, individual ethics, and how taxpayers reference themselves to others in their social network.

Limited consideration of social network

* To date, little research has explicitly modeled the role that social networks might play in noncompliant behavior.

ABM introduction (expression)

* Agent–based computational social science involves analyzing social phenomena from the bottom up—i.e., modeling the individual agents of a system.
* One of the most important characteristics and advantages of agent–based models (ABM), as compared to traditional comparative static models, for example, is the notion of emergent behavior—global, macroscopic patterns of behavior that originate from individual, microscopic agents following a set of rules and interacting with one another.

ABMs for compliance behavior (Tax evasion)

* Bloomquist (2004) developed the tax compliance simulator (TCS)—an agent–based model designed to analyze taxpayer behavior under different enforcement regimes.
* Mittone and Patelli (2000) constructed an agent–based simulation model by building on the research of Myles and Naylor (1996).
* Davis, Hecht, and Perkins (2003) develop a computational agent model where agents possess limited knowledge of true enforcement parameter levels and base their reporting strategies on perceived enforcement severity, social norms, and neighboring agent behavior.

***Jain et al. (2013) "Can social influence drive energy savings? Detecting the impact of social influence on the energy consumption behavior of networked users exposed to normative eco-feedback."***

Limited understanding of the mechanism (expression)

* While prior studies have found correlations between energy savings and normative comparisons, the inherent drivers motivating the observed energy conservation behaviors of eco-feedback system users are still unknown.
* They fall short of defining the impact of normative comparison on a per user level. Without this level of granularity, it is difficult to ascertain what specific factors are driving the success of normative eco-feedback systems in modifying user behavior.

Types of network effect

* Homophily, confounding factors, and social influence

Statistical test to identify social influence

* Shuttle test and Edge-reversal test

***Glendon and Walker (2013) "Can anti-speeding messages based on protection motivation theory influence reported speeding intentions?"***

Speeding driver’s motivations

* Speeding drivers perceive crash risk lower than other driving behaviors.
* Speeding drivers also perceived emotional (e.g., enjoying going fast) and instrumental (e.g., reaching a destination faster) associated with speeding (Corbett and Simon 1992)

Relationship between risk perception and attitude toward risk behavior

* Links have confirmed between risk perception, attitude toward speed limit compliance (Deery 1999; Glendon 2005; Lam 2003).

Immediacy hypothesis regarding interventions affecting behaviors

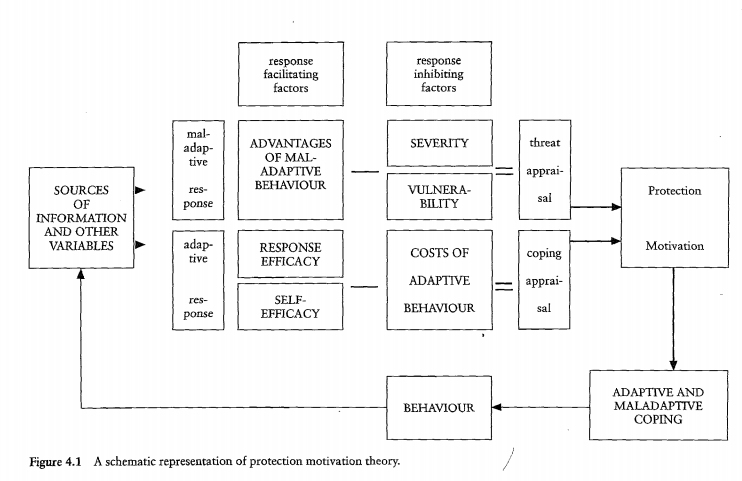
* Behavior effects are maximized when messages are presented neat the relevant situation or when the behavior is occurring (Rooijers 1988).

Potential of identifying psychological mechanism (expression)

* If the psychological mechanisms that motivate or deter drivers form speeding can be identified, then there is potential to develop interventions than could lead to change in speeding behavior by influencing those mechanisms (Parker et al. 1996)

Protection Motivation Theory (PMT)

* People’s intention to engage in certain behaviors are influence by their cognitions about both the maladaptive responses (e.g., speeding) and alternative adaptive responses (e.g., driving within speed limit) (Floyd et al. 2000)
* Threat appraisal includes perceived severity, perceived vulnerability, and perception about the reward associated with maladaptive responses
* Coping appraisal includes self-efficacy, response efficacy, and potential cost associated with performing adaptive behaviors.



Limited effect of threat based interventions

* High threat-based messages conveying potentials for death and injury may not be the most appropriate way to change dangerous behavior (Ben-Ari et al. 2000)
* Manipulating coping appraisal variables has been shown to be more effective than has manipulating threat appraisal variables (Maddux and Rogers 1983; Pechmann et al. 2003; Prentice-Dunn et al. 2001)

***Rodríguez-Garzón et al. (2014) "Association between Perceived Risk and Training in the Construction Industry."***

Definition of risk (perceived risk)

* Hallowell (2010) defines it as an individual’s subjective judgment of the frequency and severity of a particular danger.

Theories about risk perception and protective behaviors

* Risk perception has been included in theoretical models of preventive health (Janz and Becker 1984) and in the protection motivation theory (Rogers 1975).

Importance of context of construction in a risk perception study

* Although psychologists have widely examined the influence of perceived risk in a number of professions, they have avoided it in the context of construction (Lu and Yan 2013).
* Although research is available for other sectors, its findings cannot be applied to construction as they focus on specific sector-related types of risks (Gierlach et al. 2010).
* Moreover, construction is uniquely characterized by its great dynamism where work environments and their resulting risks are constantly changing. Therefore, this sector requires specific research since borrowing findings from other sectors can lead to errors

Limited understanding of perceived risk in construction domain

* Perceived risk in this industry has barely been studied (Lu and Yan 2013).

***Hallowell (2010) "Safety risk perception in construction companies in the Pacific Northwest of the USA."***

Importance of worker’s unsafe behavior and violation

* Unsafe worker actions contribute greatly to the frequency and severity of construction injuries.
* In recent focus group discussions at a conference in the Pacific Northwest region of the US (NexCon, 2006), large contractors described recent reductions in recordable injury rates but expressed concern with a high rate of low severity injuries that result from violations of predefined safety rules.
* Furthermore, this difference may help to explain the relatively high rate of incidents that result from routine violations of safety rules as observed by industry practitioners.

Association between violation and risk perception

* Bailey (1997) explains that violations may be symptoms of heterogeneity in safety perceptions among varying levels within the organization.

Limited previous studies regarding risk perception in construction domain

* No study has attempted to quantify safety risk perceptions and tolerances in absolute units of risk.

Definition of risk tolerance

* The level of safety risk that workers are willing to accept as a part of their job function.
* This definition, used to describe one’s perception of acceptable risk, is consistent with literature that discusses risk tolerance and the theories associated with acceptable risk

Two different ways to quantify risk perceptions

* Current perceived risk and risk tolerance.
* Comparing perceived risk and risk tolerance could be a measure of safety climate

Definition of risk perception

* Risk perception is defined as the subjective judgment that one makes about the frequency and severity of particular risks.

Bias in risk perception process

* A number of cognitive shortcuts to evaluate risks and these shortcuts are highly influenced by recent events.
* When biases are controlled and the impacts of cognitive shortcuts are minimized, risk perceptions can be an accurate measure of actual risk.

Justification of using a survey in risk perception study

* A safety perception survey was used to quantify risk perception and risk tolerance.
* Typically, perceptions are obtained through subjective surveys that utilize ratings on Likert-type scales to compare employee views among organizational levels, geographic regions and firm types.

Differences in risk tolerance between workers and managers

* The results of the test indicated that workers, on average, have a risk tolerance that is 0.0044 S/w-h greater than that of managers (p-value = 0.14).
* The results also support the findings of previous research that indicate that managers and workers do not tend to share the same safety perceptions (Lee, 1998; Collinson, 1999; Harvey et al., 1999; McDonald et al., 2000; Smallwood and Haupt, 2005).

***Weidman et al. (2016) "Effective Intervention Strategy to Improve Worker Readiness to Adopt Ventilated Tools."***

Adoption Readiness

* Adoption Readiness has been defined as a “state-of-mind about the need for an innovation and the capacity to undertake technology transfer”
* Individual and organizational readiness for change are said to involve beliefs, attitudes, and intentions regarding (1) the extent to which changes are needed, and (2) the level of capacity available to make the requisite changes.

Slow adoption of new technologies in the construction

* The construction industry has been viewed as an industry that is resistant to technology and slow to adopt new innovations (Koebel 1999).

Criteria for the design of empirical evaluation of OHS interventions

* (1) clear objectives, (2) experimental or quasi-experimental design, (3) external validity, (4) internal validity, (5) statistical analysis, and (6) conclusions that address the objectives.

Importance of education and training regarding safety behavior

* Hale et al. (2010) found that educational and learning strategies, as well as communication among managers and workers, were among the most successful intervention techniques.
* Champoux and Brun (2003) conducted telephone interviews with owners and managers in small firms to identify barriers to OHS performance and found that a lack of education about risks and controls was a key factor.
* Robson et al. found strong evidence for the effectiveness of training on worker OHS behaviors (Robson et al. 2012).

Barriers in construction to adopt safety behaviors

* The intensity of work, time pressures, frequent changes of work locations, and the trades’ pattern for working in small firms are some of the factors that make it difficult to introduce safe work practices in the construction industry (Jensen and Kofoed 2002).

***Wang et al. (2016) "Critical factors and paths influencing construction workers’ safety risk tolerances."***

Limited understanding of risk tolerance

* While workers’ safety risk tolerances have been regarded as a main reason for their unsafe behaviors, little is known about why different people have different risk tolerances even when confronting the same situation.
* Nevertheless, which factors influence workers’ safety risk tolerance and to what extent the factors can affect remained as important and unsolved problems.

Importance of unsafe behaviors in construction safety

* Garrett and Teizer (2009) also pointed out that human error is a main reason for up to 80% of all incidents and accidents in complex high-risk industry such as mining, construction and nuclear power.
* Fang (2012) asserted that workers’ unsafe behaviors have been recognized as the direct and common reason for construction accidents.

Difficulties in construction safety management

* Since the characteristics of construction work determine workers usually work on separate sites, this decentralization makes it more difficult to identify and manage unsafe behaviors (Olson and Austin, 2001; Gould and Joyce, 2003)

Factors affecting workers’ unsafe behavior

* Internal factors: which means personal characteristics, such as risk perception, risk attitude, risk tolerance, self-efficacy and stress (Hallowell, 2010; Wang and Yuan, 2011; Wang, 2014; Dixit et al., 2014; Leung et al., 2012);
* External factors, which refers to the environment in which individuals are living, such as culture, regulations and weather (de Camprieu et al., 2007; Liu et al., 2014; Acar and Göc, 2011).

Worker’s underestimation of the risk

* Lichtenstein et al. (1978) pointed out that people tend to overestimate their ability to control or prevent accidents, thus leads to an underestimation of the risks.

Importance of risk tolerance in safety behavior

* Basically, individuals with higher (lower) risk tolerance are more (less) likely to take a risk.

Definition of risk tolerance

* Your ability and willingness to lose some or all of your original investment in exchange for greater potential returns (SEC, 2010).
* Hunter (2002) gave a definition as “the amount of risks that individuals are willing to accept in the pursuit of some goal”. Roszkowski and Davey (2010) also agreed that this definition can provide better understanding of decision makers’ risk tolerance.

Feedback loop in safety behavior

* It should be pointed out that the feedback loops shown in Fig. 9 also mean that the system output (i.e., safety performance in this case) also affects the system inputs (i.e., safety management and work characteristics).
* This circular analysis means it is difficult to clearly differentiate which factors are absolute root causes but instead they have a circular effect to each other.

Effect of coworkers and supervisors on workers’ safety behavior

* Effects from co-workers’ behaviors are also of great importance. For instance, when workers find peers completed more works or doing faster than them, willingness to take risks may increase due to they want to “doing better and getting more pay than others”.
* As for attitude of immediate supervisor, Huang et al. (2004) indicated that managers with higher safety conscious tend to talk more and supervise more carefully with workers. Since immediate supervisors are the ones that have the most contact with workers, to what extent and how they emphasize on safety issues contribute a lot to workers’ risk tolerance.

***McPhee-Knowles (2015) "Growing Food Safety from the Bottom Up: An Agent-Based Model of Food Safety Inspections."***

ABM model – to provide intuition not predictive purpose (expression)

* The model is intended to provide insight into these interactions, rather than serve as a predictive tool (Epstein 2008).
* Epstein (2008) notes that there are many other reasons to build models, including explaining a phenomenon, guiding data collection, discovering new questions, illuminating uncertainties and dynamics, demonstrating trade-offs, challenging theory, and opening new opportunities for policy discussion.
* Importantly, since all models are simplified abstractions, Epstein (2008) notes that "all the best models are wrong. But they are fruitfully wrong.
* "Stylized models that are designed to offer insight to a complex system or problem so that further discussion of policy alternatives, legislative changes, or other adjustments may take place may still be very useful, even if they are incapable of prediction.

Risk perception → subjective

* The perception of risk by people exposed to a hazard tends to be fundamentally different from the technical assessment of risk.
* When social and psychological aspects are included, consumers tend to consistently overestimate some risks while underestimating others, and they are often keen to listen to negative information while ignoring positive information (Thaler & Sunstein 2008 ; Verbeke et al. 2007; Yeung & Morris 2001).

ABM’s Strength

* ABM's ability to deal with heterogeneous populations that can use individual data, rather than aggregate data, is a unique feature with strong application to the social sciences.

How to determine the maximum number of inspectors (managers)

* The marginal returns of adding additional inspectors are minimal once there are five inspectors in the model; therefore, more detailed runs were conducted using 100 repetitions each of one, three, and five inspectors.

***Epstein (2008) "Why model?"***

Definition of generative explanation

* I call generative explanation, in which macroscopic explananda emerge in populations of heterogeneous software individuals (agents) interacting locally under plausible behavioral rules (Epstein 2006; Ball 2007).

***Ji et al. (2011) "The impact of risk tolerance, risk perception and hazardous attitude on safety operation among airline pilots in China."***

Definition of risk tolerance

* Their tolerance for risk, defined by Hunter (2002) as the amount of risk an individual is willing to assume in pursuit of a goal.

Risk tolerance and general tendency

* Generally, risk tolerance may be mediated both by the general tendency to risk aversion of the person and the personal value attached to the goal of a particular situation.

Effectiveness of training to change hazardous attitude

* Hazardous attitude nevertheless can be changed or modified through training

Individual’s underestimation of risk

* Underestimation of the external situation or overestimation of personal capacity leads to a misperception of the risk and is frequently seen as a factor contributing to aircraft accidents.
* Hunter (2006) found the significant, negative correlations between measures from the Risk Perception-Self and previous involvement in hazardous events.

Negative relationship between risk tolerance and risk perception

* Individual’s perception of risk is inversely related to the individual’s tolerance for risk.

Risk tolerance measure: using a specific event or situation

* Risk tolerance scale was developed on the base of Hunter (2002) and Pauley et al. (2008), which was consisted of 16 sentences describing an event or situation.

Risk perception measure: using a specific event or situation

* Risk Perception-Self measure developed by Hunter (2006) consisted of 26 sentences describing an event or situation.

***Shin et al. (2014) "A system dynamics approach for modeling construction workers’ safety attitudes and behaviors."***

The reason of focusing on unsafe work condition

* However, when an accident or near miss happens on a construction site, attention has tended to focus on the site conditions because physical evidence can be easily gathered to account for the accident so that subsequent changes can be made to prevent similar accidents in the future (Gould and Joyce, 2009).

Difficulties in quantitatively measuring safety attitude

* However, it is challenging to quantitatively measure workers’ safety attitudes and thus assess the impact of safety program on workers’ safe behaviors.

Intentional unsafe behavior

* Unsafe acts are often intentional (Donald and Cantor, 1993), and attitudes are one of the key factors to foresee workers’ intentions on behaviors (Ajzen, 1991).

Cognitive process from perceived risk to risk attitude

* Thus, once a worker perceives risks by collecting various kinds of information, the worker establishes his/her safety attitude based on the perceived risks.

Feedback process regarding cognitive process regarding safety behavior

* Lastly, the outcome becomes an important source of the worker’s risk perception, which forms a feedback loop (i.e., risk perception → safety attitude → intention → behavior → outcome → risk perception).

Definition and characteristics of risk perception

* Risk perception is defined as a worker’s ‘subjective’ judgment on a risk (Lavino and Neumann, 2010). Hence, perceived risks may vary from worker to worker according to the worker’s risk perception, even in the case of the same accident.

Workers’ underestimation of the risk

* People tend to overestimate their ability to control or prevent accidents, leading to an underestimation of the risks (Lichtenstein et al., 1978). This is the main reason why workers behave unsafely intentionally.

Importance of study a cognitive process to understand safety behavior

* In order to understand how workers’ safety attitudes lead to safe behaviors, their mental processes need to be closely investigated.

Optimistic aspect of risk attitude

* If an accident is not severe, the worker’s attitude toward risks becomes pessimistic at first but can gradually return to the optimistic state by forgetting the accident as time goes by.

Trade-off related to safety behavior

* Trade-off between the expected risk reduction and the inconvenience resulting from the safe behavior.

Possible outcomes of unsafe behavior (difference between accident and incident)

* Outcomes are results of behaviors and can be classified as safe or unsafe. The unsafe outcomes include accidents and incidents that are incurred either by a worker or other related workers.
* An accident is a sequence of events leading to undesirable results, and an incident is a near-accident in the sense that the sequence of events was triggered but stopped before leading to the undesirable consequence (Svenson, 2001).

Range of workers’ risk perception

* Although it is possible for a worker to evaluate the risk of an accident as being exceptionally high or low, this research assumes that PC (i.e., perceiving coefficient) lies in the range of 50% to 200%.

Information sharing about an accident at a construction site and feedback process

* If an accident occurs at a construction site, information about the accident will be diffused across the workers and the diffusion rate depends on how effectively and/or how often workers communicate regarding the accidents.
* The informed accidents can significantly affect the workers’ safety attitudes if the workers recognize the necessity for modifying their risk perception.
* The workers may not be fully aware of all the accidents that have happened in the construction site unless they are immediately and thoroughly informed of the accidents. Thus, the workers’ awareness on the total number (or extent) of the accidents can differ from the actual number (or extent) of the accident depending on the effectiveness of communication. → testing different communication levels

Applied validation tests from confidence-building tests (Forrester and Senge, 1980)

* Test of model structure - Structural verification/boundary adequacy, Parameter verification, and Dimensional consistency
* Test of model behavior – Behavior reproduction, Abnormal behavior/surprise behavior, and behavior sensitivity

***Jiang et al. (2014) "Understanding the Causation of Construction Workers’ Unsafe Behaviors Based on System Dynamics Modeling."***

Rate of unsafe behavior from a field observation

* Sa et al. (2009) investigated workers’ behaviors toward the use of fall protection equipment, and found one-third of the workers actually did not behave safely.

Limitations of previous statistical analysis

* Traditional research methods in accident investigations follow a linear process of root-cause analysis, and ignore the effect of interactions between various factors of a system (Cooke 2003; Goh et al. 2010; Qureshi 2007).

Information processing model to understand cognitive process of unsafe behavior

* The information processing models are widely used to analyze human errors and unsafe behaviors (Furnham 1994; Kontogiannis 1997; Shorrock and Kirwan 2002; Kines 2003; Chang and Mosleh 2007).

5 cognitive process of workers’ unsafe behavior

* Detecting hazards → Recognizing hazards → Perceiving responses → selecting a safe response → executing the safe response

Factors affecting the perceptions of responses

* because of deficiency of relevant knowledge, low frequency of using the knowledge, negative impacts from management, negative impacts from coworkers.

Factors affecting the selection of a safe response

* because of not recognizing the importance of the safe response, not convenient, not comfortable, negative impacts from significant others, perceived internal control, perceived external control.

Factors affecting executing of the safe response

* because of fatigue, deficiency of relevant knowledge, no supportive external conditions.

Connecting the violation and TPB

* In Stage 4, if a worker has perceived the safe response but does not select it, this kind of unsafe behavior is classified as “violation,” and the theory of planned behavior (TPB) is proper to be used to explore the causes (Reason 1990; Zhang and Fang 2013). In TPB, attitude, subjective norm, and perceived behavioral control are the three main constructs that affect behavior (Ajzen 1991).

Three motivation of construction workers

* There are basically three motivations for construction workers—motivation for safety (Edelson et al. 2009), motivation for convenience (Lipscomb et al. 2008), and motivation for comfort (Bohm and Harris 2010).

Differences in hazardous exposure

* The conditions of site arrangement that may let workers be exposed to certain hazards.

Effects of management’s behaviors and communications (feedback) on workers’ safety behavior

* Self-example refers to management’s commitment to safety and management’s own behaviors, which are usually regarded as role models for workers (Hinze 2006).
* If workers are spoken to when changes in work practices are suggested, their safety awareness would be improved (Glendon and Litherland 2001; Wachter and Yorio 2014).
* If the inspection is frequent enough to make workers feel pressure on unsafe behaviors, the motivation for convenience and comfort will decline, and in turn the motivation for safety will rise, so as to affect workers’ attitude (Neal et al. 2000).

Sharing information about incidents at construction sites

* Strong willingness to investigate incidents can lead to a systematic learning from past wrongdoing, and through appropriate dissemination such as posting and other means among workers as regular warnings, workers’ safety awareness can be improved.

Definition of incident and usage in simulation model

* When more incidents happen, management will react with positive feedback through the emphasis on safety (Cooke 2003; Han et al. 2014).
* Here “incident,” which is a broader definition that includes any abnormal event which could possibly lead to an accident, is intentionally used. The data of incidents could serve as a foundation for management actions and learning (Cooke and Rohleder 2006).

Process of an expert interview to examine the preliminary model (expression)

* With reference to Hallowell and Gambatese (2009), the experts are chosen upon certain prequalification, and three distinguished experts have responded. They are all prominent scholars with experience in the industry. The results show that the experts generally agree to the structure of the model. And the preliminary model has been properly adjusted according to the experts’ suggestions.

Extreme condition test to verify the structure of the model (expression)

* Before the implementations of specific model tests, to make sure that the SD-CUB model is structurally verified, a variety of extreme conditions tests are conducted. By examining the correspondence between the model-generated behavior and the theoretical reality under extreme conditions (i.e., imaginary maximum and minimum values of each variable), the tests are crucial for flaw discovery (Forrester and Senge 1980; Saysel and Barlas 2006). The extreme conditions tests show that the model behaves as expected.

Introduction of social influence on workers’ safety behavior (expression)

* Workers are working in a social environment, so their behavior patterns are highly affected by management, from whom they get praise or criticism, benefits or penalties.

***Axelord (2006) “Evolution of Cooperation”***

Meaning of the abstract fomulation

* The value of an anlysis without ehm is that it can help to clarify some of the subtle features of interacton – feature which might otherwise be lost in the maze of complexities of the highly particluar circumstance in which choice must actually be made.

***Grimm et al. (2006) “A standard protocol for describing individual-based and agent-based models”***

Wide usage of ABM

* “agents”, have become a widely used tool, not only in ecology (DeAngelis and Gross, 1992; DeAngelis and Mooij, 2005; Grimm, 1999; Grimm and Railsback, 2005; Huse et al., 2002; Shugart et al., 1992; Van Winkle et al., 1993) but also in many other disciplines dealing with complex systems made up of autonomous entities, including the social sciences (Epstein and Axtell, 1996; Gilbert and Troitzsch, 2005), economics (Tesfatsion, 2002), demography (Billari and Prskawetz, 2003), geography (Parker et al., 2003), and political sciences (Axelrod, 1997; Huckfeldt et al., 2004).

Strength of ABM

* Individual-based models (IBMs) allow researchers to study how system level properties emerge from the adaptive behaviour of individuals (Railsback, 2001; Strand et al., 2002) as well as how, on the other hand, the system affects individuals. IBMs are important both for theory and management because they allow researchers to consider aspects usually ignored in analytical models: variability among individuals, local interactions, complete life cycles, and in particular individual behaviour adapting to the individual’s changing internal and external environment.

ODD – purpose

* This element informs about why you need to build a complex model, and what, in general and in particular, you are going to do with your model.

ODD – State variables and scales

* First, the full set of state variables should be described. The term ‘state variables’ refers to low-level variables that characterize the low-level entities of the model (e.g., age, sex, social rank, location,parents; habitat units might be characterized by location, soil type, predation risk (for a certain species), percentage cover).
* It is important not to confuse low-level state variables with auxiliary, or aggregated, variables, such as population size or average food density in a given area.
* If the set of (low-level) state variables is large, as is the case with many IBMs, it should preferably be presented in a table in which the variables are grouped according to the entities represented in the model (e.g., individuals, habitat units, abiotic environment).
* Finally, in addition to the state variables, the scales addressed by the model should be stated, i.e. length of time steps and time horizon, size of habitat cells (if the model is grid-based), and extent of the model world (if the model is spatially explicit).

ODD – Process overview and scheduling

* At this stage, a verbal, conceptual description of each process and its effects is sufficient because the main purpose of this element ofODDis to give a concise overview
* In addition, the scheduling of the model processes should be described. This deals with the order of the processes and, in turn, the order in which the state variables are updated.
* In many cases it will be convenient to visualize scheduling by using flowcharts.

ODD – Design concpet

* The design concepts provide a common framework for designing and communicating IBMs.
* Emergence, Adaption, Fitness, Prediction, Sensing, Interaction, Stochasticity, Collectives, and Observation

ODD – Initialization

* This deals with such questions as: How are the environment and the individuals created at the start of a simulation run, i.e. what are the initial values of the state variables?
* Is initialization always the same, or was it varied among simulations?

ODD – Input

* All these environmental conditions are “input”, i.e. imposed dynamics of certain state variables.
* The model output gives the response of the model to the input.
* Readers need to know what input data are used, how they were generated and how they can be generated or obtained.

ODD – Submodels

* All submodels representing the processes listed above in “Process overview and scales” are presented and explained in detail, including the parameterization of the model.
* The mathematical “skeleton” of the model. This skeleton consists of the model equations and rules and one or more tables presenting the model parameters and their dimensions.
* A full model description. This version has exactly the same structure as the “skeleton” (i.e., the same subtitles and equation numbers), but now each equation and parameter is verbally explained in full detail and deals with questions

***Potentials of physiological sensory data to study risk perception***

***Wang et al. (2002) Safety in the road environment: a driver behavioural response perspective***

Low specificity of electrodermal activity to identify perceived risk

* Therefore, it would be possible to measure perceived risk by looking at changes in the electrodermal activity while driving. However, it was found that the use of electrodermal activity as a measure of perceived risk is highly problematical, mainly because of the low specificity of the electrodermal responses for changes in the perceived level of risk. That is, a rise in the perceived level of risk will cause the electrodermal responses, but an electrodermal response does not necessarily indicate a rise in the perceived level of risk.

***Herrero-Fernández et al. (2016) “Risky behavior in young adult pedestrians: Personality determinants, correlates with risk perception, and gender differences."***

Risk homeostasis theory

* One such theory that has been widely supported in the literature is the risk homeostasis theory (Wilde, 1982, 1988). It states that there are two main dimensions that determine the risk of an action: risk perception and acceptable risk.

Previous studies that use electrodermal activity to measure risk perception

* In experimental studies of drivers’ behaviors, risk perception has frequently been measured by physiological arousal due to its covariation with electrodermal activity (Crundall, Chapman, Phelps, & Underwood, 2003; Hashimoto, 1970; Kinnear, Kelly, Stradling, & Thomson, 2013; Taylor, 1964; Wickramasekera, Pope, & Kolm, 1996).
* Fear, an emotion associated with perceived risk, has a specific and unique pattern of electrodermal activity that is different from other emotions like anger or dislike (Williams et al., 2005).

Reason for differences between risk perception measured by self-reported measure and electrodermal acitivity

* The differences found between subjective (self-reported) and objective (physiological arousal) risk perception support the idea that physiological arousal could reflect automatic processes of risk assessment (Crundall et al., 2003; Kinnear, Stradling, & McVey, 2008), which could be unrelated to the conscious analysis of risk (Slovic, Finucane, Peters, & MacGregor, 2002, 2004).

Experiment protocol to control the effects of body movement on electrodermal activity

* Participants were told that nine 15-s video clips would be presented with 50 s of black screen between each video, and that their only tasks were to pay attention to the presented videos and to remain completely still while the videos were playing.

How to adjust individual differences in basic level of arousal in the experiment

* For the physiological variables, partial correlations were calculated to assess the relation between risky pedestrian behavior and the differences in physiological arousal when watching videos involving risky pedestrian behaviors versus when watching videos of neutral situations, controlling for basal arousal.

Reltaionship between arousal measurement and risk behavior

* There was no significant relation with respect to heart rate, r = -.08, p = .283 (1 - b = .10), nor with respect to skin conductance response, p = .02, p = .453 (1 - b = .05). However, a significant correlation was observed with respect to skin conductance level, p = -.32, p = .011 (1 - b = .74), indicating that the greater the risky pedestrian behavior, the smaller the difference in skin conductance level when watching videos about risky pedestrian behaviors versus when watching neutral situations.

***Schmidt-Daffy (2013) "Fear and anxiety while driving: Differential impact of task demands, speed and motivation."***

Differences between fear and anxiety

* According to this distinction, fear represents a bottom-up emotional bias driven by the perception of threatening stimuli. In contrast, anxiety reflects a top-down emotional bias based on higher-order evaluation of threat in relation to one’s intentions and action goals.

Correlation between fear and perceived risk

* Depending on the model, the correlate of fear is termed perceived risk (Wilde, 1982), fear aspect of risk sensation (Koornstra, 2009), feelings of risk (Fuller, 1984; Näätänen & Summala, 1974), body responses related to negative outcome (Vaa, 2007), negative arousal (Zuckerman, 2007), or more specifically the number of electrodermal responses (Taylor, 1964).

Previous studies about risk acceptance (threshold approach)

* Or risk is behaviourally compensated only if the risk exceeds a certain threshold (Näätänen & Summala, 1974; Summala, 2007) or indifference range (Koornstra, 2009).

Reltationship between anxeity and driving speed and between anxeity and physiological response

* Self-reported increases in anxiety, attention, and arousal confirmed that the speed reduction was accompanied by subjectively experienced symptoms of anxiety.
* Overall, however, the number of electrodermal responses did not increase significantly with the amount of money at stake and thus did not support the expected increase in physiological arousal.

Low specificity of EDA

* The number of electrodermal responses is often regarded as a more specific indicator for threat-related emotional arousal (e.g., Fowles, 1980) but this measure is also highly sensitive to the frequency of external stimuli triggering these responses.

***Kinnear et al. (2013) "Understanding how drivers learn to anticipate risk on the road: A laboratory experiment of affective anticipation of road hazards."***

Previous studies regarding Skin Conductance Response during drive

* Interestingly there have been some historical studies measuring skin conductance during driving. Hulbert (1957), Michaels (1960) and Taylor (1964) all reported finding that skin conductance responses were related to observable traffic events.
* Helander (1978), from a study of sixty Volvo drivers, reported that SCR and brake pressure were correlated to the order of .95 during on-theroad driving. While this is suggestive of an influence of affect,
* Helander (1978) also reports that SCR preceded accelerator release by 0.2 s and brake application by 1.9 s suggesting that the affective component may indeed be anticipatory.
* Although Helander (1978) accounted for skin conductance response latency, these results must still be viewed with caution due to the methodological difficulties involved in determining precise SCR timing.
* More recently Crundall et al. (2003) measured drivers’ SCR in relation to hazardous events.

Sensitivity of SCR

* However, as SCR is an extremely sensitive measure, interference caused by respiration or movement could cause a change in SCR that compromises the reliability of measuring a psycho-physiological response to the experimental stimuli. Participants were monitored during the experiment for behaviour that could cause a SCR artifact (e.g. deep breaths, yawning, sneezing, body movement).

***Wang et al. (2017) "Monitoring Workers' Attention and Vigilance in Construction Activities through a Wireless and Wearable Electroencephalography System."***

Limitations of previous assessment (e.g., survey)

* However, current attention-assessing approaches are post hoc and subjective and difficult to implement in construction practice
* Current studies rely on questionnaires to assess workers' unsafe behaviors and attention/vigilance levels from the perspective of behavioral psychology [7], but many researchers challenge the objectivity and reliability of the aforementioned method [8].
* however, none of them could quantitatively and objectively assess the perceived risk level of construction workers.

Construction workers’ optimism regarding the risk at their site

* Being exposed to constant potential hazards on construction sites, construction workers get used to the hazardous environment and become insensitive to risks over time [5].
* Such discrepancies between the actual work environment risks and workers' perceived risks result in aggressive work behaviors and unsafe activities.

Potentials of wearable systems in construction management

* The functionality of wearable systems in construction falls into two categories: site inspection and work behavior monitoring

Knowledge gaps

* However, none of the information collected by these wearable systems can be used to assess the subjective risk perception of construction workers, which is crucial to identifying the origin of unsafe behaviors.

Link the arousal state and perceived risk

* Therefore, it is possible to monitor the workers' attention level at risky conditions as an indirect reflection of their perceived risks.

Previous studies on the relationship between EEG and Vigilance

* Lin et al. also developed an experiment on drivers and confirmed that the EEG activities correlated well with vigilance variation [46].

Empirical findings regarding the significance of frontal region in vigilance

* Similarly, in the first component, left cluster (AF3, F3, F7) and right cluster (AF4, F4, F8) shows their peak intensity mainly in A3, A4, and A5, which are object avoiding activities.

***Aryal et al. (2017) "Monitoring Fatigue in Construction Workers Using Physiological Measurements."***

Limitations of the previous subjective assessment of fatigue

* Existing established methods of assessing fatigue include surveys and questionnaires, which are cumbersome to implement at construction sites.

Global statistics regarding fatalities in the construction

* Based on a report released in 2005, the International Labor Organization (ILO) estimated there are at least 60,000 construction related fatalities around the world each year [1,2]. In the industrialized countries, the ILO estimates 35% to 40% of the fatalities to occur in the construction industry, which employs less than 10% of the total workforce [1].

Slow improvement of construction safety in recent days

* Although safety performance in the U.S. construction industry improved significantly between 1973 and 2004 due to adoption of highly effective injury prevention strategies, there has not been any significant improvement in the injury statistics in the past decade, indicating that the industry has reached saturation with respect to the traditional injury prevention strategies and new safety innovations are needed [6,7].

Knowledge gap

* Although it is difficult to quantify the direct impacts of fatigue on construction safety due to lack of robust methods for real time fatigue monitoring, resulting in lack of fatigue related studies in occupational safety studies [14], it is one of the factors that has a negative impact on workers' safety and performance [15].

***Hwang and Lee (2017) “Wristband-type wearable health devices to measure construction workers' physical demands.”***

Excessive physical demands of construction tasks and its detrimental impacts

* Due to the labor-intensive nature of construction work, many construction workers face excessive demands beyond their physical capabilities [1,31,41].
* The consequences of workers' frequently high physical demands include chronic fatigue, a high number of injuries and illnesses, stagnant on-site productivity, work-related musculoskeletal disorder, and early retirement among others [2,27,62].
* 37.9% of the U.S. workforce experiences serious fatigue that may result in devastating consequences related to workers' safety, health, and productivity [48].
* The outcomes of physical fatigue have been widely recognized in the construction industry, which include decreased productivity and motivation, inattentiveness, poor judgment and quality work, low job satisfaction, and high accidents and injuries [2].

Heart rate as a reliable measure of physical demands

* Among diverse physiological signals from the wristband, heart rate (HR) has been widely used in physical demand measurement because HR is proven as a reliable indicator from the perspective of cardiovascular loads [9].

% HRR to reflect individual differences (i.e., normalizing)

* Specifically, the percentage of HR reserve (%HRR), which is a relative measurement of physical demands by normalizing original absolute HR considering individual difference [4,32,61], has been reliably and widely used for diverse dynamic muscular work [12,22,26,52,63].

Differences in the impacts on the HR between physical demands and other factors (e.g., emotion)

* Many other mental factors, such as emotions (e.g., fear), can also affect HR [3,64]. However, the effect of physical demands on HR changes is more dominant in the long term than others' effects while mental factors acutely change HR:
* Therefore, while mental factors are generally estimated in the short term based on the variation of beat-to beat interval which is less than one seconds [16,64], relatively longterm measurement (e.g., half-hourly, hourly, or daily basis) of HR and conversion into %HRR can be more useful for investigating physical demands [4,26,49].

Importance of continuous monitoring of construction tasks

* This continuous measurement is particularly meaningful in construction, where diverse types of tasks are performed under various work conditions (e.g., indoor vs. outdoor and hot vs. cold).

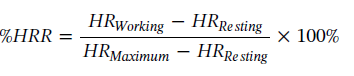
Limitations of measuring physical demands using workloads

* Because physical performance is greatly influenced by diverse factors such as individual factors (e.g., age, training, and nutrition) or environmental factors (e.g., temperature, humidity, and noise) [9,34,39], reliable physical demand measurement should consider not only workloads but also all these factors [9,58].

Noise sources of PPG signals

* Because HR from PPG is indirectly estimated by blood volumes through the wrist and PPG signals can be contaminated by noises during a user's intense movements, accurate HR calculation from the PPG sensor in the wristband during intensive physical activities has been challenging [20,54].

%HRR Equation



* The maximum heart rate estimated by the equation of age: 208–0.7 × age [bpm]

Justification of using HR during the middle of resting time for HRResting

* HR during the middle of each subject’s 30 min of scheduled resting time (10–15 min later after starting to rest) has been acceptable in previous experiments [17,26], given that over 80% of peak HR are recovered within 2–3 min during resting [50].

Differences in physical demands between different trades (mason and carpenter vs. electrician)

* Masons and carpenters experienced higher physical demands than electricians, because masonry and carpentry operations include heavy material handling (e.g., lifting concrete blocks, drywalls, or doors: average 3.6 kcal/min of metabolic demands and 105 bpm of HR for concrete block laying; and average 3.88 and 4.17 kcal/min metabolic demands and 109 and 114 bpm of HR for drywall installation and carpentry works, respectively) while electric operations include light arm works or hand works (average 3.09 kcal/min of metabolic demands and 98 bpm of HR for concrete block laying).

***Gatti et al. (2014) "Physiological Condition Monitoring of Construction Workers."***

Adverse effects of physiological demands on performance

* Further, several authors [9–21] suggest that excessive work physiological demands can negatively affect safety and productivity due to a decrease in workers' well-being, attentiveness, motivation, and capacity to perform muscular work.

Limitations of previous methods to assess physiological demands

* Some studies used monitoring tools that could not continuously monitor the subjects.
* Other studies employed cumbersome and/or uncomfortable monitoring devices that would hinder construction workers during routine activities if used as standard construction equipment.
* In addition, some monitoring methods were suitable only for small groups in experimental settings.

Differences between construction tasks and tasks in other domains (e.g., sports and medicine)

* Routine construction worker movements include walking but also lifting and carrying, and repetitive motions, such as arm lifting and thoracic rotations [44–46].
* Therefore, sports science and medical testing procedures can hardly simulate routine construction worker movements in a comprehensive manner.
* Further, these studies demonstrated that PSM accuracy in measuring heart and breathing rate depends on the subject movement intensity and characteristics. It is, therefore, necessary to implement testing procedures capable of simulating routine construction worker movements to effectively investigate the PSM validity in monitoring construction workforce.

Data correlation (validity) assessment method

* Data analysis was performed by calculating Pearson product moment correlation coefficient (r), and by using the Bland–Altman technique [59] as done in many similar studies dealing with the validation of a physiological monitoring device [38–43,60–65].

***Lee et al. (2017) "Wearable Sensors for Monitoring on-Duty and Off-Duty Worker Physiological Status and Activities in Construction."***

Excessive physical demands of construction task and its adverse impacts

* Construction activities involve intensive workloads and are physically demanding.
* It is therefore not surprising to see that the industry suffers from high rates of musculoskeletal and cardiovascular diseases, in addition to injuries and fatalities [1]

Construction workers’ poor lifestyle

* Construction workers also often have poor overall health and lifestyle factors, such as poor eating, physical fitness, and sleeping habits [3].

Importance of understanding workers’ on and off duty activities

* A deep understanding that looks into the interactions between construction workers' on- and off-duty activities is necessary for the development of effective interventions which reduce injuries and illnesses, and at the same time improve worker wellbeing.

Total Worker Health

* Total Worker Health® (TWH) is based on understanding and integrating efforts to improve occupational health and safety with interventions that can improve workers' off-duty lifestyles [6].
* The TWH approach aims to evaluate the relationship between triggers of unsafe worker behaviors and the workers' off-duty wellbeing and lifestyles [7].

The use of new technologies to improve workers’ safety and health

* Physiological status monitoring [16–18], inertial measurement units for gait stability measurements [19,20], ergonomics posture analysis [21], and electromyogram systems [22] have been applied to measure and predict the level of health hazards faced
* by workers in various construction and material handling activities

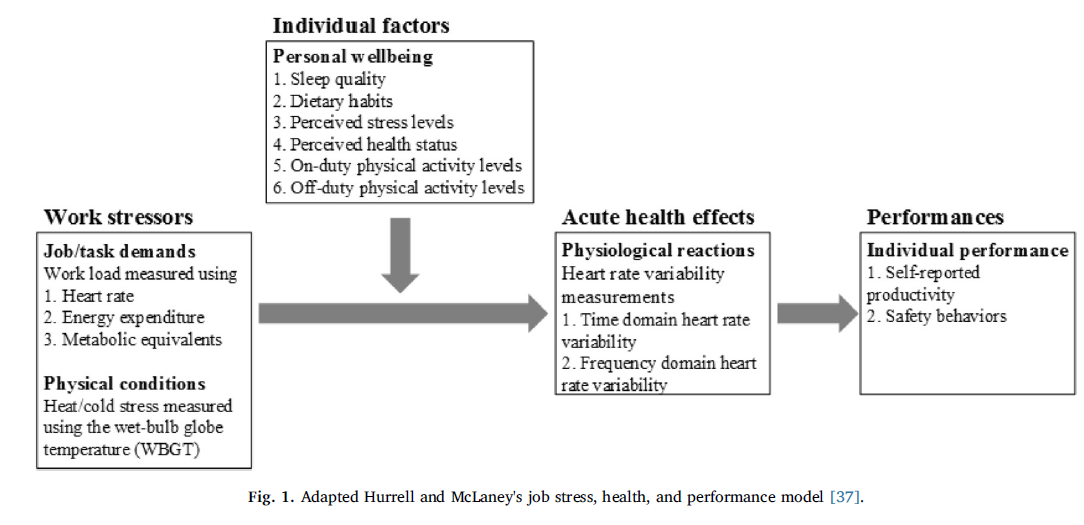
Relationship between HR and HRV

* Heart rate has been adopted as a measurement to estimate workers' workload while its variability has been adopted to estimate the health outcomes related to workload or environmental stressor exposures [34,35].
* This pattern of changes in R-R intervals (i.e., inter-beat intervals per R wave) depends heavily on the behavior of the autonomic nervous system, which responds to a worker's stress level [45]. (HRV)
* Decreased SDNN and HF power and an increased LF/HF ratio indicate decreased HRV, which signals increased autonomic arousal [69].

Environmental factor to influence construction workers’ health (Heat stress)

* Heat stress is one of the work stressors generated in a work environment and influences a worker's fatigue level and performance.
* As one of the indices to measure heat stress, WBGT is widely used, with the intention of examining a worker's heat tolerance limit [36].

Structure of this research



* In the model, workload (measured by HR) influences their physiological fatigue and stress, and this can be measured objectively by HRV.
* The degree of influence may differ according to each individual's sleep quality, and this can be quantified by measuring the individual's sleep efficiency using an activity tracker.
* Psychological fatigue induced by excessive workload may have an adverse effect on a worker's attention to ergonomic postures that can quantify as the extent of exposure to a non-neural posture by using an accelerometer sensor.

Energy expenditure calculation from wristband

* ActiLife was used to score the participants' EEs based on the Freedson Combination algorithm, which combines Williams's work-energy formula [53] and Freedson's equation [54].

Metabolic equivalent calculation using wristband

* Tasks' METs were calculated using Swartz's Adult Overground and Lifestyle algorithm [55] because the participants' activities in this study included the occupational as well as free living conditions for both the hip and the wrist sensor placements, and the cut-off values were identified using the Troiano Adult algorithm [56]

Sleep quality estimation using wristband

* The Tudor-Locke algorithm [57] was used for sleep detection that ActiLife provided.
* The Cole-Kripke method [58] was selected for measuring adult roofers' sleep score variables (e.g., sleep efficiency) validated with adult populations.

The use of repeated ANOVA and ICC to examine the daily variations of the measured variables and reliability

* To investigate the daily variation of the measured variables, we used repeated measures ANOVA with Bonferroni adjustments for multiple comparisons.
* ICC values were calculated to evaluate the reliability of the data collected during the study

***Guo et al. (2017) "The Availability of Wearable-Device-Based Physical Data for the Measurement of Construction Workers' Psychological Status on Site: From the Perspective of Safety Management."***

Challenges in collecting workers’ psychological data

* Instantaneity: Psychological status varies continuously with time. Therefore it is necessary and important to collect relevant data in a real-time way
* Contextuality: Psychological data has a close relationship with construction environments, thus relevant data needs to be collected on site.

Limitations of previous measures for workers’ psychological status

* Not objective enough
* Not timely enough
* The questionnaire method requires much time and labor force to send out and collect questionnaires.

Three categories of physical (or physiological) indicators to estimate psychological status

* Physical indicators include three categories: cardiovascular system indicators, electrodermal indicators, and respiratory indicators [24].
* Cardiovascular system indicators include heart rate, heart rate variability, stroke volume, etc. [3,14,28,34,41].
* Electrodermal system indicators mainly measure skin conductance, which varies because of sweat [12,16].
* Respiratory indicators include respiration rate, respiration depth, end-expiratory pCO2, etc.

Differences between construction and other domains in terms of the use of physiological sensory data collected from wearable devices

* On the contrast, construction workers' operating activities are more tiring and diversified.
* These activities can also lead to changes in physical indicators, disturbing the potential relationships between psychology and unsafe behaviors.

Research objectives

* This research proposes a real-time and objective method to collect workers' psychological data by using wearable technology and demonstrates its feasibility with real data collected from real construction sites.

Better usability of wristband than chest trap sensor

* However, the ActiGraph (worn on the wrist) was favored over the Zephyr sensors (worn on the chest)

***Lee and Migliaccio (2016) "Physiological Cost of Concrete Construction Activities."***

Harmful work condition and its negative impact on workers safety and health

* However, construction is still a strenuous occupation with construction workers being subject to numerous job stressors, including high fatigue and exertion caused by exposure to physical workload and heat stress, which can all badly influence their health and safety.
* In addition to the fact that the physical and mental demands of construction tasks are intensive, workers are continuously exposed to environmental factors that can harmfully affect health, safety and productivity (Rowlinson et al., 2014; Spielholz et al., 2006; Suter, 2002; Verma et al., 2003).

Negative impacts of physical strains and stress

* Previous research confirmed that increased physical strain and stress lead to decline in work quality and productivity (Bernold and AbouRizk, 2010; Ringen et al., 1995).
* Also, fatigue accumulation has an adverse impact on safe work behaviour and quality of life (Hallowell, 2010).

Research objectives

* Investigate the physiological cost of concrete construction activities using physiological status monitoring (PSM) devices and a wireless weather station

Importance of managing physical demands

* Hence, monitoring workers’ physiological status within an acceptable physiological strain level can be used to prevent workers from experiencing excessive physical exertion, cardiovascular overload and potential injuries (Lee and Migliaccio, 2014; Lee et al., 2015).

Knowledge gaps

* While numerous studies have been conducted to assess how physical demand affects different trades and occupations, a lack of understanding of the relationship between physiological variables, work performance and occupation constitutes a gap in knowledge.

The use of HR matrices to estimate physiological cost

* Several HR indexes in occupation safety and health have been used to estimate the physiological cost of work, including relative HR, the ratio of working HR to resting HR and so forth (Kirk and Sullman, 2001).
* Studies in the steel, farming, forestry, automobile manufacturing industry and nursing occupations have provided physiological cost estimates for the intensity of workload based on HR measurement indexes (Costa et al., 1989; Fordham et al., 1978; Goldsmith et al., 1978; Kirk and Sullman, 2001; Vitalis et al., 1994).
* HR has been frequently been used as a predictor of physiological strain and exertion levels in workers (Borg, 1998; Chan et al., 2013).
* HR is a measure of metabolic rate to gauge the level of workload and a key factor to determine optimised work–rest regimens and work paces by applying the predicted heat strain model (Rowlinson and Jia, 2014).
* The autonomic nervous system (ANS) controls HR (Robinson et al., 1966), and work-related stress increases the possibility of an ANS imbalance (Thayer et al., 2010).
* If HR exceeds acceptable levels, it increases the chance of physical failure that could lead to lost-time injury and, eventually, losses in safety and productivity performance (Brouha, 1967; Saha et al., 1979; Buller and Karis, 2007).

Limitations of short term measurements

* However, after the body starts an activity, energy is consumed and fatigue and stress are accumulated during the whole working shift so that the duration of task is a key element to measure strain level (Moore and Garg, 1995).
* Conversely to workers in manufacturing, construction workers often operate outdoor, which means daily changes in outdoor environments also affect the daily changes in the physiological cost of work.

Difficulties in concurrently recording the video many workers (expression)

* As a researcher was allowed to stay onsite and observe the subject throughout the whole time, the authors would have preferred full video recording of the work sessions.
* However, this approach was impractical because the researchers were observing three to four workers at any given time and were allowed to have only one researcher onsite.
* In addition, the contractor staff did not allow the authors to video-record subjects throughout the whole observation period, but allowed short video-recordings of specific activities.

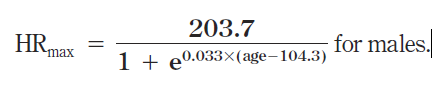
Impact of dehydration on heart rate

* Dehydration can increase HR by up to 7.5 per cent when the core temperature is constant (Achten and Jeukendrup, 2003).

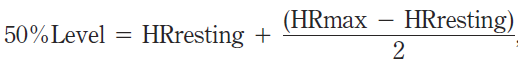
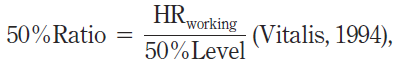
Removing potential outliers

* Grubbs’ tests were performed to detect and remove outliers from the data sets (Grubbs and Beck, 1972).

HR metrics equations

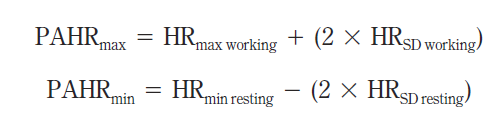
* 
* The relative HR normalises the effect of individual characteristic variations such as an individual fitness level and age, to the absolute HR (Gatti et al., 2014b)

* , 

Accepatable range of HR from previous studies

* By adapting the research of Buller and Karis (2007), this study describes an approach for identifying construction workers’ physiological acceptable bounds for HR, including maximum and minimum physiologically acceptable HRs (PAHRs).



Emotional HR zones

* Target HR (THR) zone calculation method introduced by Karvonen (1957), the authors of this paper classified the zones into 100-90, 90-80, 80-70, 70-60 and 60-50 per cent levels of “HR reserve”.



* Hence, qualitative emotional descriptors were used for each HR zone, similar to those adopted by Swaim (2012, p. 153) to expand the original THR zone for occupational use to preventive recognition of workers’ overexertion reflecting the states of feeling.

Measurement of environmental heat level

* The wet-bulb globe temperature (WBGT) is an index

Practical implication of wearable dveice studies in construction

* Industrial hygienists and safety professionals could use wearable PSM to gain real-time knowledge of potential overexertion among workers, which could be used to individually customise recovery time to return below the threshold HR levels.
* Second, field managers could apply wearable PSM to reschedule workers’ assigned tasks or assign additional labour to a crew to adjust the daily and hourly variation of the physiological cost for each labourer.
* Lastly, labourers could use local response by wearable PSM to self-pace and control their own overexertion that is objectively sensed by HR.

***Gatti et al. (2013) "Using Workforce’s Physiological Strain Monitoring to Enhance Social Sustainability of Construction."***

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***Taylor et al. (2015) “Automatic Identification of Artifacts in Electrodermal Activity Data”***

The use of EDA in emotion research

* When the body responds to stress, temperature, or exertion, the sympathetic nervous system (SNS) increases sudomotor innervation, causing EDA to increase and perspiration to occur.
* Because the SNS is influenced by the hypothalamus and limbic system — structures in the brain that deal with emotion — EDA has frequently been used in studies related to affective phenomena and stress

Knowledge gaps in arifacts and noise detection in EDA studies

* Despite its popularity, little research has been done into detecting noise and artifacts in an EDA signal.
* Continuous and unobtrusive measurement of EDA using wearable devices makes the signal collected vulnerable to several types of noise.

Sourece of artificats

* Artifacts can be generated from electronic noise or variation in the contact between the skin and the recording electrode caused by pressure, excessive movement, or adjustment of the device.

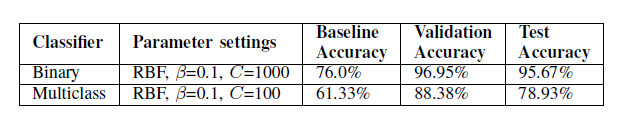
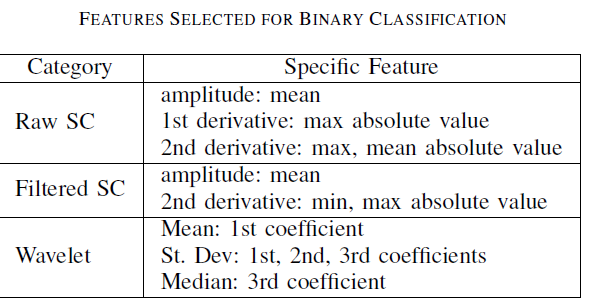
General characteristics of SCR

* the response typically lasts between 1-5 seconds, has a steep onset and an exponential decay, and reaches an amplitude of at least :*01μS*

Previous approaches to deal with artifacts and their limitations

* Currently, many researchers deal with signal artifacts and noise by simply applying exponential smoothing (e.g. [6]) or a low-pass filter (e.g. [8] [9] [12]).
* While these techniques are able to smooth small variations in the signal, they are not able to compensate for large-magnitude artifacts that can result from pressure or movement of the device during ambulatory recording.
* Kocielnik and colleagues [8] chose to discard portions of their data where the signal increased more than 20% per second or decreased more than 10% per second
* These heuristic thresholds were developed for particular studies and participants, and verified only through visual inspection by the researchers conducting them; they may not generalize beyond those contexts.

The results

* 
* 

***Kocielnik et al. (2013) “Smart Technologies for Long-Term Stress Monitoring at Work”***

Current approaches of stress monitoring

* Current approaches to stress monitoring are mostly based on applying questionnaires or carrying out individual/group meeting with psychologists

Physiological signals of stress

* The physiological signals of stress, as reflected by changes in blood pressure, heart rate, pupil dilation, sweat gland activity, reflected in skin conductivity, can be objectively measured in unobtrusive ways using modern sensor technology.

Research hypothesis

* Our hypothesis is that collecting sensor data for prolonged periods and presenting it in relation to digital life data enables the user to discover personal stress and relief patterns

Limitations of previous efforts

* Unlike our work, most of the works in the area of stress detection were performed in lab conditions, where the environment is strictly controlled, the stressful conditions are administered artificially and, as a consequence, do not necessarily conform to the ones experienced in real life.

Advantage of continuous monitoring

* Continuous measurement allows for capturing reactions to different events, avoiding the pitfalls of approaches based on taking the “snapshots” of stress picture.

Advantage of wrist band type sensor

* A wrist-worn device is perceived by the majority of our users as more comfortable than solutions such as chest belts for heart-rate monitoring, and not violating privacy, which is often the case with cameras used for facial expression analysis.

Artifacts in signals

* Sensor measurements obtained from field trials suffer from artifacts caused by occasional movements of the device on the wrist, excessive motion, electrical artifacts and other sources [4].

Limitations of low frequency in detecting EDR

* 2Hz sampling frequency, which is sufficient for estimating EDL, but may not be enough for separating the tonic (EDL) and phasic (EDR) components of the signal [4].

Stress level estimation procedure

* Remove the first 15 minutes and the last 10 seconds of the series of skin conductance measurements
* Remove signal affected by losing contact with skin
* Identify and remove anomalies
  + Based on experimental results, we set the maximal possible increase of the signal value to 20% per second and the maximum decrease to 10% per second and eliminate those (sequences of) samples that do not meet these criteria, going in the forward and the backward directions.
* Smooth the signal
  + We smooth the signal using a moving median filter for a window size of 1 minute
* Define a slicing of skin stress estimation values into five arousal categories in order to ease the interpretation by the user:

***Wang et al. (2017) "Monitoring Workers' Attention and Vigilance in Construction Activities through a Wireless and Wearable Electroencephalography System."***

Difficulties in assessing individual worker’s perceived risk

* however, assessing individual construction worker's perceived risk is extremely difficult.

Limitation of the current practices to measure workers’ attention levels

* Current studies rely on questionnaires to assess workers' unsafe behaviors and attention/vigilance levels from the perspective of behavioral psychology [7], but many researchers challenge the objectivity and reliability of the aforementioned method [8].
* however, none of them could quantitatively and objectively assess the perceived risk level of construction workers.

Expected contribution of objective and quantitative approach to monitor workers’ attention levels

* it is necessary to develop an objective and quantitative approach that can monitor and measure construction workers' perceived attention/vigilance levels.
* The outcomes of such an approach could help to improve field monitoring, safety management, and training programs
* Measurement of construction workers' risk perception plays a vital role in construction site safety management.
* The research outcome from the experiment suggests the viability of EEG monitoring as a means to collect the vigilance data of construction workers.

Importance of perceived risk in safety

* Individual workers' hazard evaluations and risk perceptions in the occupational environment determine how they respond to the risks.
* Understanding how workers perceive the risks or risk factors to which they are exposed is of paramount importance for construction safety management [9,10].
* Deery described drivers' risk perception behavior in a hazardous environment as having four major steps [11]: hazard detection, risk perception/acceptance, self-assessment, and action.

***Chen et al. (2016) "Revealing the “Invisible Gorilla” in Construction: Estimating Construction Safety through Mental Workload Assessment."***

Challenges in construction safety management

* The biggest challenge in identifying hazards and recording accidents is the dynamic environment of construction jobsites and workers' unpredictable behavior patterns [34].

Possible contribution of focusing on vulnerable workers

* In other words, construction site safety interventions can be improved by strategically targeting individuals who are more susceptible to accidents.

Importance of perceived risk

* Classic psychological theories suggest that people's decision making on risk-taking behavior is negatively correlated with their risk perception [46].
* According to Endsley's findings (1995) [19], there are three steps that people who experience dangerous events proceed through, including (1) detection of hazardous signals, (2) perception and comprehension of risks, and (3) projection of the consequences associated with decision options.

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