DYNAMIC ANALYSIS OF ATTENDANCE BEHAVIOR WITHIN CONSTRUCTION CREWS

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ABSTRACT: Although individual-level factors (e.g., attitudes, personality) have long been associated with day-to-day attendance decisions, increasingly researchers have recognized "the social nature of attendance dynamics and their susceptibility to social control (Johns, 2008)." Implications of this social approach for research would be to focus attention on the causes and effects of absence culture (i.e., absence-related perceptions, beliefs, values), and the effects of absence culture on individual and group attendance within social units. Construction projects typically require workers to work in teams or crews on highly interdependent projects, and, thus, are particularly relevant contexts to study absence culture. In this paper we apply a system dynamics (SD) model to study absence culture by utilizing the advantages of SD in capturing a feedback process and state changes. We were particularly interested in: (a) the awareness of social norms within construction crews that pertained to attendance, (b) the interplay between formal attendance rules (policy) and these social norms, and (c) how these sources of influence affected the decision-making process of construction crew members. We expect that the results of this work will help construction organizations evaluate (or re-consider) the effects of their attendance control policies (e.g., timing, strength, and frequency) within a social context. Moreover, our findings suggest that the key to reducing excessive absences might be to invest time in influencing absence culture directly rather than imposing frequent and strict regulations – which, in turn, may inadvertently fortify a culture that works against the organization's interests.

Keywords: Construction Worker, Absenteeism; Absence Culture; Organizational Behavior; System Dynamics

1. INTRODUCTION

Workers' consistent, punctual attendance is an indispensable condition for successful construction projects. This is because most of the operations in construction projects are carried out by the manpower [1]. In other words, the manpower provided by construction workers is the most importance resource in projects, and therefore, its supply has to be reliable. The foundation for the reliable supply of the manpower is workers' consistent attendance.

Workers' unexpected absence is one of the main factors of productivity loss in construction projects [2]. Hanna et al. (2005) report that their survey revealed that when the absence rate was between 0% and 5%, productivity increased by 3.8%, whereas when absence rate was between 6% and 10%, productivity decreased by 24.4% [2].

To effectively and efficiently manage construction workers' attendance, we need to understand the cause of workers' absence behavior. However, there is no easy answer to the question, "What is the cause of workers' absenteeism?", because in order to understand the cause of absence behavior we need to understand the principles of human behavior, including human beings' decision-making process. There have been some efforts to survey the causes of construction workers' absenteeism. Their surveys revealed a variety of reasons that were perceived by respondents to be the main cause of workers' absence behavior [2][3], which are not necessarily the root cause of the behavior. In the absence of the understanding of the root cause, construction managers have mainly used formal controls (e.g., penalty) that target individuals who present excessive absence behavior or individual reasons that are perceived to be the factors of workers' absence behavior (e.g., transportation, safety).

However, many social science works have affirmed that there are deeper-level causes of absence behavior (e.g., job satisfaction, attendance motivation, ability to attend, personal characteristics) [4], which may manifest themselves only through the behavior. Particularly, many research papers in last two decades have testified to the paramount role of social factors, such as social norm, on workers' absence behavior [5]. Therefore, in order to have a means to effectively and efficiently manage workers' attendance, we need to have an understanding of

social aspect of workers' absence behavior. Further, if we have a clear idea of how the social control mechanism works in regulating workers' absence behavior, we might be able to influence the social mechanism such that the mechanism works in favor of the attendance management.

With this background in mind, the objective of this paper is to study the dynamic relationship between the group absence norm and workers' absence behavior. Here, the word "dynamic" implies that the group absence norm and workers' absence behavior are not static but change over time by the influences of each other. Further, we discuss on the worker attendance control effect of different managerial approaches using simulation. To fulfill the research objective, we develop a system dynamics model because this research methodology is effective for both modeling the complex, dynamic behavior of a system and conducting simulation research to gain insights into how we can improve the state of the system.

2. LITERATURE REVIEW

2.1 Absence behavior models

Many researchers in social sciences have developed and tested absence behavior models. Among them, Steer and Rhodes' (1978) attendance model has been regarded as the result of the first attempt to develop a comprehensive model of absence behavior. Although, their model provides a comprehensive view to the various factors that can affect absence behavior, it gives little information of how an employee makes the decision of taking an absence.

Although not directly designed to be absence behavior model, Bandura's (1991, 1986) social cognitive theory of self-regulation provides a causal process model of human behavior, of which we can take advantage for the purpose of modeling the process of workers' absence-taking [6][7]. Bandura argues that a self-regulatory system (also known as a self-control system) provides the explanation for human beings' purposeful action [6]. In the process of producing behavior, people first form a personal standard (i.e., reference value of the behavior control) regarding a behavior, and behave in a way to reduce the discrepancy between the standard and behavior [6]. Bandura also asserts that social modeling is a powerful mechanism of transmitting standards [7]. That means people obtain the how-to-behave information, at least partially, by observing others and learning from others' behavior.

2.2 Absence culture, absence norm and group dynamics

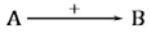
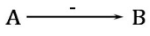
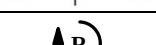
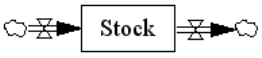
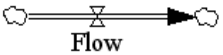
Findings from the absenteeism literature coincide with what we can expect from Bandura's theory. A seminal finding in the absenteeism research in last few decades was the susceptibility of workers to social control and the attendance dynamics involving the interplay between the social norm and the behavior [5]. Absence culture is defined as "the set of shared understandings about absence legitimacy in a given organization and the established 'custom and practice' of employee absence behavior and its control…" (p.136) [8]. Also, Gellatly and Luchak argued that absence behavior is not determined only by individuals' disposition or situations; it is also controlled by absence-related shared belief at the group level [9]. From this, we can infer that there is a dynamic relationship between the absence-related social norm and individuals' absence behavior, because the former serves as a cause of the latter, and vice versa.

2.3 System dynamics

The feedback system between social absence norm and absence behavior underlies the attendance dynamics in workgroups. The causal feedback system can be best modeled by system dynamics (SD). SD has been applied in various areas to model systems, including industrial, economic, social, and environmental systems [10]. SD enables us to focus on causal relationships between variables that are the factors of an observed system behavior and to understand the dynamic system behavior produced by these causal feedback systems. Also, an SD model provides a means to find analytical solutions for complex nonlinear dynamic systems [11]. Typically, an SD model consists of two kinds of feedback loops: balancing loop, which is the process that produces balance and stability in a system; and reinforcing loop, which is the growth process through which actions produces greater action [12].

The feedback loops in SD are capable of capturing the mechanism of a dynamic system behavior, not only for physical systems, but also for the systems that involve intangible variables (e.g., policies, human behavior) [13]. For this reason, SD is a useful approach to studying the dynamic and complex human organization systems, including work organizations.

Table 1. Notations in the Causal Loop Diagrams (Sterman 2000)

Legends	Explanation	
	When other conditions are the same	When Factor A increases (decreases), Factor B increases (decreases)
		When Factor A increases (decreases), Factor B decreases (increases)
	Including weighted delayed time between two factors	
	Positive feedback or self-reinforcing loop	
	Negative feedback or self-balancing loop	
	Stocks : Define the state of a system and represent stored quantities, also called 'Levels'	
	Flows : Define the rate of change in system states and control quantities flowing into and out of stocks, also called 'Rates'	

3. SYSTEM DYNAMICS MODEL FOR ANALYZING GROUP DYNAMICS OF ABSENTEEISM

To analyze the group dynamics of workers' attendance behavior (i.e., how workers' absence rate and the absence norm interplay over time) and to suggest effective approach to absenteeism problem, this research constructs a system dynamics model by mainly using the findings from literature.

3.1 Causal loops in the absence behavior dynamics

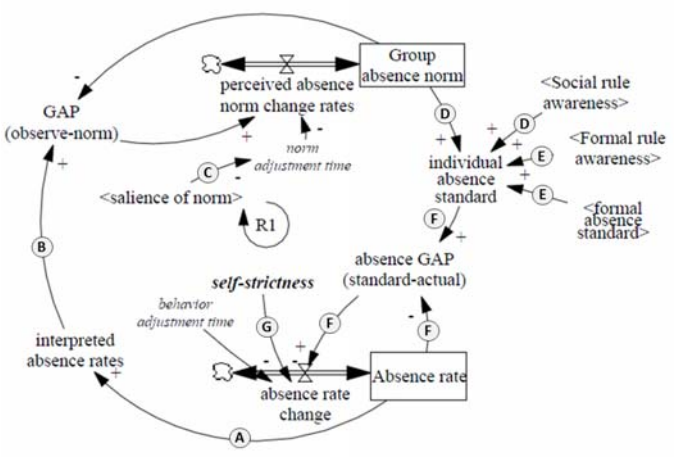


Figure 1. Group absence norm model

The feedback relationship between the group absence norm and the group absence rate (i.e., the mean of individuals' absence rate) is described in Figure 1. When the absence rate in the project (*Absence rate*) is high, workers can observe the occurrence, and therefore, workers' perceived absence rate (*interpreted absence rate*) should also be high (A in Figure 1). Then, workers' shared belief about the legitimate level of absence behavior (*Group absence norm*) can increase accordingly (B in Figure 1), because the difference between the observed occurrence and the previous group absence norm (*GAP (observe-norm)*) can be perceived by the group members [9][14][15]. In this process of group norm updating, the visibility of norm (*salience of norm*) may expedite the change by decreasing the time needed for workers' perceiving of new norms (*norm adjustment time*) (C in Figure 1) [15][16][17]. Once increased group norm is established in the work group, the workers' standards regarding absence will increase [6][7]. However, the individual workers' absence standard will be increased by the increased group absence norm only to the degree of workers' awareness of social controls (*Social rule awareness*) (D in Figure 1). Not only by the social norms, individuals' standards are affected also by the formal rules regarding worker's absence, and the formal rules' effect take place according to the degree of workers' awareness of formal rules (*Formal rule awareness*) (E in Figure 1). Once individuals' standards regarding absence behavior is established, they will behave according to the standards, in a way to reduce the discrepancy between their standards and the absence behavior (*absence GAP (standard-actual)*) (F in Figure 1) [6]. In the process of applying the standards to the behavior, workers may have different levels of strictness (*self-strictness*))(G in Figure 1)—which is defined as the degree to which workers over-regulate their absence behavior beyond the individual standards, e.g., taking absence less than 1 day/month even when the individual absence standard is 1.5 day/month. Finally, the produced absence-taking decisions of individuals will affect the total absence rate, and again, this absence rate will be perceived by workers in the group.

As we see here, the causal relationship between the group absence norm and the group absence rate form a closed, reinforcing feedback loop (i.e., increased group absence norm will induce the further increase of absence rate, and vice versa), R1. The work of this reinforcing feedback also holds true in the case of decrease of both the absence rate and the absence norm. With this model, we can clearly understand the causal mechanism of the dynamic interplay between group absence behavior and group absence norms.

3.2 Causal loops in the absence-related attitude dynamics

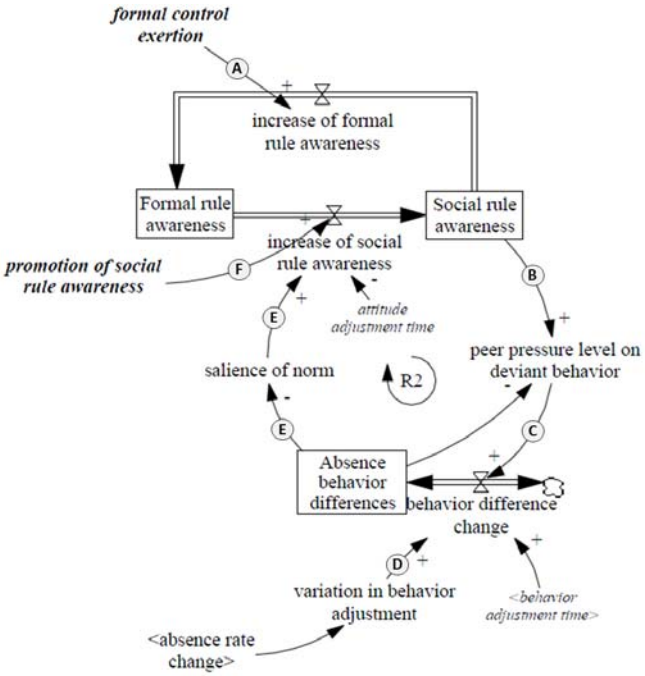


Figure 2. Rule awareness model

The model of the relationship between workers' awareness of different rules (formal rules and social rules) is described in Figure 2. This model is for *Formal rule awareness* and *Social rule awareness* appearing in the Group absence norm model (Figure 1).

Workers can learn how to behave by either direct educations (e.g., formal rules) or social modeling (i.e., social rules), and sometimes the information provided from these two sources may not be in an accordance [6].

Then, the dominance of a rule in affecting workers' behavior can be determined by the different level of awareness of the rules. We assume that this theory can also be applied in the case of workers' control of absence behavior. Therefore, we model that formal rule awareness (*Formal rule awareness*) and the social rule awareness (*Social rule awareness*) is in a competitive relationship. According to the organizational setting, every organization should initially have a certain level of formal rule awareness and social rule awareness. However, the awareness may be not static but dynamic. If there is a high presence of exertion of formal rules (*formal control exertion*) (e.g., strict regulation of workers' absenteeism, such as layoff, that can remind the workers of the formal rules), workers will pay more attention to the formal rules, which means the formal rule awareness increases (A in Figure 2). However, if not formal control exertion clearly present, workers may be more under influences of social controls, which tend to evolve over time. When there is high social rule awareness in the organization, peer pressure on deviant behavior (*peer pressure level on deviant behavior*) will be also high (B in Figure 2)[18]. In turn, this high peer pressure will contribute to the decrease of the absence behavior difference among workers (*Absence behavior differences*) (C in Figure 2). The difference of absence behavior can increase also when the organization observes a large degree of absence rate change (D in Figure 2), because workers may have different adjustment speed of their behavior (*variation in behavior adjustment*). When there is a small difference in workers' absence behavior, the absence norm is more salience because everyone's behavior is uniform so the social norm is clearly visible [17]. The increased salience of norm can contribute to the increase of social rule awareness (E in Figure 2). Also, social rule awareness should increase when there is a managerial action that aimed to promote the social control in the organization (*promotion of social rule awareness*) (F in Figure 2). Examples of such managerial action can be to foster social gathering and cohesion in the group.

The reinforcing feedback between the social rule awareness and the absence behavior difference is the mechanism of the natural increase of social rule awareness over time (R2).

4. SIMULATION RESULTS

This section presents the simulation setting and the results on the SD model.

4.1 Model settings for simulation

The simulation is designed to reproduce a problematic situation, in which both the actual absence rate and the group absence norm are rather high (the initial value of *Group absence norm* and *Absence rate* is set as 0.5 day/week, while *formal absence standard* is 0.25 day/week). This initial condition simulates that workers currently have a high absence norm and it is the cause of high absence rate in the project. The initial value of both *Formal rule awareness* and *Social rule awareness* is set as 0.5, implying none of these two are dominant in the organization initially. With simulations, we test the effect of different input values of those variables that represent managerial actions to deal with absenteeism (i.e., *formal control exertion* and *promotion of social rule awareness*). In the simulation we observe how a high absence rate is controlled over time as the result of the formal rule and the social norm during 50 simulation weeks in the model.

To produce the "Base" case, the value of the two control variables are set as 0.0, implying that the model will run without any impacts of additional factors to the original model. In order to generate different scenarios in the model, we apply different input values for *formal control exertion* and *promotion of social rule awareness*, and observe their impact on the system. Those input value specification is described in Table 2.

Table 2. Input value settings for control variables

	formal control exertion (Dimensionless)	*promotion of social rule awareness* (Dimensionless)
"Base" case	0.0	0.0
"Formal" case	0.1	0.0
"Social" case	0.0	0.1

"Formal" case represents a managerial action taking place to increase the formal rule awareness, and on the other hand, "Social" case represents a managerial action taking place to increase social rule awareness.

4.2 Simulation results and implications

Figure 3 and 4 show the simulation result for the variable *Social rule awareness* and *peer pressure level on deviant behavior*. The simulation results reaffirm our anticipation that social rule awareness will tend to increase over time due to the reinforcing feedback process introduced in Figure 2. Expectedly, when managerial actions focus on the increase of formal rule awareness as a means of reducing workers' high absence rate, the social control is not as much dominant as in the "Base" case or "Social" case (Figure 3). Likewise, the peer pressure is not as strong in the "Formal" case as in the "Base" case or the "Social" case (Figure 4).

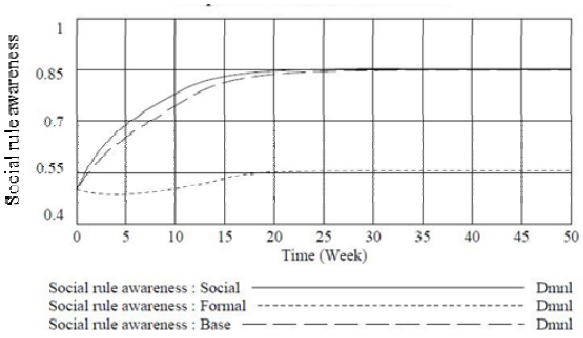


Figure 3. Graph for Social rule awareness

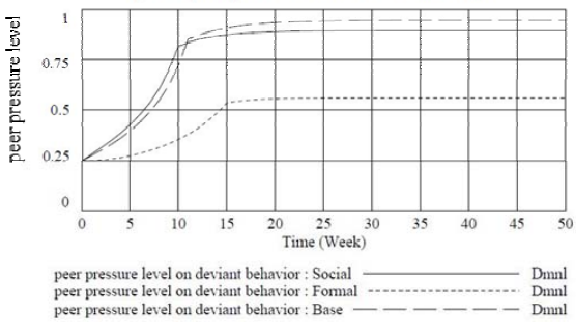
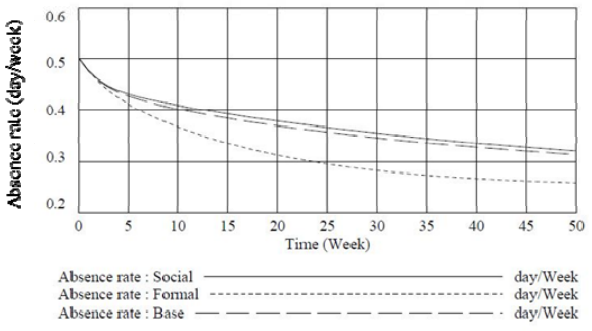
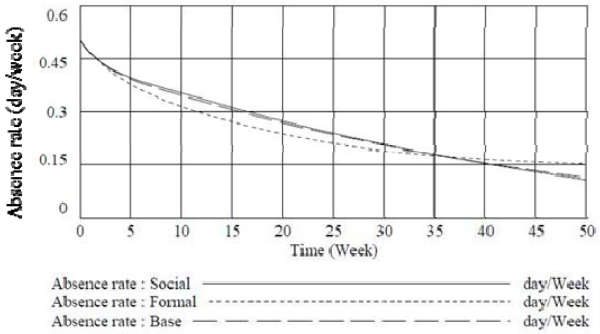


Figure 4. Graph for pressure level on deviant behavior

Figure 5 shows the graphs for Absence rate for two cases, one when *self-strictness* is set as 0 ((a) in Figure 5) and the other when *self-strictness* is set as 0.05 ((b) in Figure 5). Interestingly, when *self-strictness* is 0, the *promotion of social rule awareness* is not as effective as the *formal control exertion*. However, when *self-strictness* is positive (i.e., workers tend to overly regulate their absence behavior), the long-term effect of the *promotion of social rule awareness* is great in terms of reducing absence behavior. This is because *self-strictness* leads to the improved attendance behavior beyond the group norm, and in turn, this behavior leads the group norm to a lower level. This simulation results imply that the promotion of social rule awareness (e.g., promotion of group cohesion) can be effective approach to improving attendance behavior of construction workers only when workers have a tendency to behave well beyond their perceived absence standards.



(a)



(b)

Figure 5. Graph for Absence rate

5. VALIDATION

In order to pursue the construct validity of the variables in the SD model, we draw those variables on the findings from the literature. Then, the validation of a complete simulation model can be evaluated by how sufficiently the model serves its purpose. Since the SD model was developed to reproduce the workers' attendance dynamics that we can observe from the reality, the simulation results have to be compared to the observation from the real worlds to see the validity of the model. In this sense, the SD model sufficiently reproduce the phenomena qualitatively same as the observations in the literature in terms of the control effect of social norms [19].

6. CONCLUSION

To analyze the effect of dynamic relationship between the group absence norm and workers' absence behavior and gain insights into the effective approach to absenteeism, this paper developed a SD model. The model not only theorizes the relationship between factors of workers' absence behavior, but also serves as a foundation for simulation research to search for effective approach to absenteeism. The simulation results show that social norm has an impact on absence as much as formal rules, and also show the promotion of social rule awareness can be even more effective than focusing on formal controls in the long-term if self-strictness is present among workers. Because too strict exertion of formal controls over workers' behavior might lead to the development of adversarial culture among workers, appropriate level of utilization of social norms can be a more "constructive" solution to absenteeism.

We expect this result can help construction organizations realize the mechanism and the potential effect of social norms in favor of management. Also, we expect that, from the result of our research construction managers can gain insights into how to effectively and efficiently manage workers' attendance beyond focusing on individuals who present excessive absenteeism. Continuous study efforts are needed for further validating the simulation results.

APPENDIX: THE EQUATIONS OF VARIABLES IN THE MODEL

perceived absence norm change rates =
IF THEN ELSE(Group absence norm<=5, IF THEN ELSE(Group absence norm>=0,"GAP (observe-norm)"/norm adjustment time,0),0)
*Unit: day/(Week*Week)*

norm adjustment time =
1/salience of norm
Unit: Week

GAP (observe-norm) =
interpreted absence rates-Group absence norm
Unit: day/Week

interpreted absence rates =

Absence rate
Unit: day/Week

absence rate change =
IF THEN ELSE (Absence rate<=5, IF THEN ELSE (Absence rate>=0, ("absence GAP (standard-actual)"-"self-strictnessl")/behavior adjustment time, 0),0)
*Unit : day/(Week*Week)*

absence GAP (standard-actual) =
individual absence standard-Absence rate
Unit: day/Week

individual absence standard =
*formal absence standard*Formal rule awareness+Group absence norm*Social rule awareness*
Unit: day/Week

increase of formal rule awarness =
*formal control exertion*Social rule awareness*
Unit: dimensionless

increase of social rule awareness =
(Formal rule awareness(salience of norm+promotion of social awareness)-Social rule awareness*unit formal rule strength)/(salience of norm+unit formal rule strength)*
/attitude adjustment time
Unit: /Week

peer pressure level on deviant behavior =
Social rule awareness(1/Absence behavior differences)*
Unit: dimensionless

behavior difference change =
IF THEN ELSE (Absence behavior differences<MAX absence difference, IF THEN ELSE(Absence behavior differences>MIN absence difference
*,-(peer pressure level on deviant behavior*Absence behavior differences)*
/behavior adjustment time + ABS(variation in behavior adjustment)
,0),0)
Unit: /Week

variation in behavior adjustment =
*absence rate change * coefficient of variation in behavior adjustment*
Unit: Dimensionless

salience of norm =
1/Absence behavior differences
Unit: Dimensionless

REFERENCES

[1] Maloney, W. (1983). "Productivity Improvement: The Influence of Labor." Journal of Construction Engineering and Management, ASCE, 109(3), 321–334.

[2] Hanna, A. S., Menches, C. L., Sullivan, K. T., and Sargent, J. R. (2005). "Factors Affecting Absenteeism in Electrical Construction." Journal of Construction Engineering and Management, 131(11), 1212-1218.

[3] Sichani, M. S., Lee, S., and Fayek, A. R. (2011). "Understanding construction workforce absenteeism in industrial construction." Canadian Journal of Civil Engineering, 38(8), 849-858.

[4] Steers, R. M., & Rhodes, S. R. (1978). "Major influences on employee attendance: A process model." Journal of Applied Psychology, 63, 391-407.

[5] Johns, G. (2008). "Absenteeism and presenteeism: Not at work or not working well." The Sage handbook of organizational behavior, 1, 160–177.

[6] Bandura, A. (1991). "Social cognitive theory of self-regulation." Organizational Behavior and Human Decision Processes, 50, 248-287. [7] Bell, J., "Mixed-use Property Review E Pluribus Unum: The Synergies of Mixed Use", *Midwest Real Estate News*, April, pp. 35-57, 2000.

[7] Bandura, A. (1986). Social foundations of thought and action: A social cognitive theory. Englewood Cliffs, NJ: Prentice-Hall.

[8] Johns, G., & Nicholson, N. (1982). The meaning of absence: new strategies for theory and research. In B. Staw, & L. L. Cummings (Eds.), Research in organizational behavior, 4, 127–172. Greenwich, CT: JAI Press.

[9] Gellatly, I. R., and Luchak, A. A. (1998). "Personal and Organizational Determinants of Perceived Absence Norms." Human Relations, 51(8), 1085-1102.

[10] Richardson, G. (1985) "Introduction to the System Dynamics Review." System Dynamics Review, 1(1), 1-13.

[11] Sterman, J. (2000). Business Dynamics: System Thinking and Modeling for a Complex World, Boston: Irwin Mcgraw-Hill, 1-39, and 191-232.

[12] Ahmad, S., and Simonovic, S. (2000). "System Dynamics Modeling of Reservoir Operations for Flood Management." Journal of Computing in Civil Engineering, ASCE, 14(3), 190-198.

[13] Tarek, A. (1993). "Thinking in Circles." American Programmer, 6(5), 3-9.

[14] Bamberger, P., and Biron, M. (2007). "Group norms and excessive absenteeism: The role of peer referent others." Organizational Behavior and Human Decision Processes, 103(2), 179-196.

[15] Rentsch, J., and Steel, R. P. (2003). "What does unit-level absence mean? Issues for future unit-level absence research." Human Resource Management Review, 13, 185-202.

[16] Xie, J. L., and Johns, Gary. (2000). "Interactive effects of absence culture salience and group cohesiveness: A multi-level and cross-level analysis of work absenteeism in the Chinese context." Journal of Occupational and Organizational Psychology, 73(1), 31-52

[17] Nicholson, N., and Johns, Gary. (1985). "The Absence Culture and the Psychological Contract-Who's in Control of Absence?" The Academy of Management Review, 10(3), 397.

[18] Barker, J. R. (1993). "Tightening the Iron Cage: Concertive Control in Self-Managing Teams." *Administrative Science Quarterly,* 38(3), 408-437.
[19] Xie, J. L., and Johns, Gary. (2000). "Interactive effects of absence culture salience and group cohesiveness: A multi-level and cross-level analysis of work absenteeism in the Chinese context." Journal of Occupational and Organizational Psychology, 73(1), 31-52