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## A MODEL OF CONSTRUCTION WORKER'S PERCEPTIONS ON ELECTRONIC MONITORING

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**ABSTRACT:** With the growth of information and communication technologies adoption in construction projects, it could be anticipated that more property owners and construction firms will attempt to use electronic gears and gadgets for site monitoring or surveillance purposes. As the construction workers may be the major group of project team members being monitored, from managerial perspectives and for ethical reasons, it is essential to investigate their degree of acceptance on site monitoring systems. Indeed studies on office workplace monitoring suggest that a monitoring system could shape or control the behaviors of employees. With adequate refinements, their research models could be applicable in the construction industry. This paper presents a model for analyzing the antecedences that affect workers' acceptance level on electronic monitoring, and investigating if there is any behavioral change.

*Keywords:* *Quality Control; Behavioral Change; Electronic Monitoring; Information and Communication Technologies; Construction Workers.*

### 1. INTRODUCTION

Quality control represents increasingly critical concerns for the practitioners of the construction industry, and site monitoring is one of the indispensable procedures to assist quality control. There have been studies done concerning the use of information and communication technologies (ICT) for monitoring the conditions and status of objects within a construction site. For instance, a stereo vision system with two cameras was proposed for recognizing bricks a decade ago [1]. In more recent literature, researchers tried to combine cameras with robots to identify defective tiles [2] and used digital images to analyze the coating surface of bridges [3]. In order to obtain large quantities of figures describing the as-built conditions, laser scanners and embedded sensors are the target of research [4,5]. For tracking tool inventory, Goodrum et al. studied the feasibility in applying RFID technology to the tools in sites [6]. Those technologies capture useful site information and data but they cannot visualize what is happening in a site, including project progress and unexpected events. Therefore, Cheng and Chen attached a V8 video camera to a tower crane to monitor an erection operation of prefabricated structural components and the video signal was sent to the site office using a coaxial cable [7]. The approach facilitates a real-time site monitoring feature such that project team members could observe site activities in the site office. Perhaps due to the technical capabilities of the equipments, or the industry is still quite attached to the conventional means of inspection where

most of the monitoring processes are done manually, although the above-mentioned studies focus on “monitoring” and “inspecting”, they do not target on acquiring the information of construction workers' activities and behaviors.

Nowadays, as the uses of ICT within work environment has become popular, more and more employees may be monitored within their workplaces. In office environment, the use of ICT to monitor employee behavior is on the rise. A survey conducted by American Management Association in 2007 reveals that more than two thirds of the companies monitor the computers activities of the employees and about half of them use video surveillance systems (e.g., close-circuit television, CCTV) to counter theft, violence and sabotage [8]. In the construction industry, ICT has just been used to monitor site activities and behaviors of site workers. We integrate wireless network technologies, network cameras, and collaborative systems to form a monitoring and communication environment such that project team members could monitor the behavior of site workers ubiquitously [9]. As the system is beneficial to management stakeholders and cost-effective, with the growth of the adoption of ICT in construction projects, it could be anticipated that more construction firms will attempt to equip with electronic gears and gadgets for site monitoring or surveillance purposes.

Although our study shows the technical feasibility of using cost-effective information technologies to monitor

construction work environments is a step forward, we consider that the perceptions of the construction workers who are being electronically monitored should not be neglected. There is enormous of management literature concerned about the ways to acquire the behaviors of the construction workers, but limited of them try to study and understand the perceptions of the workers, or how they feel with their working environments. This may be because the construction industry is highly fragmented such that the managerial linkage between site workers and top management is not obvious, and therefore little attention was paid on the workers' level. As the construction workers may be the major group of project team members being monitored, ethically it is essential to investigate their level of acceptance on the monitoring systems. Moreover, research on office workplace monitoring suggest that a monitoring system could shape or control the behaviors of employees, it may be interesting to explore the consequences after adopting such systems. This paper presents a research model for analyzing the antecedences that affect construction workers' acceptance level on electronic monitoring, and investigating if they have any behavioral change when they know they are being monitored.

## 2. RESEARCH BACKGROUND

Construction site monitoring is an indispensable procedure in construction quality control. It could minimize construction defects and human errors, increase safety and security level, support project team members making strategic decisions at critical points throughout the construction stages, and so on. Conventionally the site monitoring procedures are performed by site inspectors, foremen, or related stakeholders manually. Even a site equips with an electronic surveillance system, it is mainly used for security purposes such as avoiding theft, where camera(s) is/are installed near the entrances or site office. It is costly to use the conventional surveillance system to monitor site activities and the behavior of workers because very long signal cables and complementary components are required in order to provide comprehensive views of the site. Recently we overcame this technical problem by using the latest long-range wireless technology and Internet technologies so that the stakeholders could acquire real-time site images anytime and anyplace with network connections (includes mobile phone networks) [9]. Figure 1 shows the screen shot of the system. It could be anticipated that more construction firms or property owners will be interested to use this technology because there were some firms approaching us for the possibilities in consulting similar projects.



**Figure 1.** The monitoring system

The construction industry is well known as being a fragmented and divisive industry such that multitude of companies, professions, and occupations involve in the construction project life cycle [10]. In fact, construction projects are becoming increasingly complex and dynamic in their nature [11]. Winch even criticizes construction projects as one of the most complex of all undertakings, because a construction project involves various kinds of organizations, where they may come from different geographic locations [12]. Therefore, when comparing with other industry, the complex characteristics of the construction industry may cause employee monitoring more challenging and unique. In fact, site workers monitoring could be considered as a kind of communication activities, but is in one-way fashion. Through a monitoring system, the observers obtain the information about the behaviors of site workers but the workers may not understand the purposes of the observers for installing such systems. Some workers may perceive positively that the system aims for safety purpose, but some may find the system is used for spotting their failures. Noticeably, unlike other monitoring scenarios such as office monitoring, the observers and the workers possibly belong to different organizations. Therefore good communications and mutual understandings between parties may be the prerequisites for monitoring of site workers.

Unfortunately, though communication between construction firms is reported to be critical to the success of an alliance [14, 15], in practice, various stakeholders usually handle different stages of the building life cycle independently and overlook the importance of communications, which results in incomplete and loosely-coupled construction processes. Bateman and Snell reported that only twenty percent of the information passed down the hierarchy from the top management might reach the site workers [16]. The Gartner group also agrees the communications between stakeholders are limited and identifies that the highest level of interaction across organizations generally occurs between the middle level managers in an organization [17]. Cheng et al. explain the possible factors of poor communication in the industry may be inappropriate / inefficient / ineffective

channels, unexpected communication breakdown, and not having open lines of communication protocols [15]. As this situation could not be changed immediately, and related studies about employee monitoring suggest that the monitoring actions may bring negative effects to the work attitudes of employees (Sarkar-Barney (2003) focus on employees' task and job performance; Aiello & Kolb (1995), Douthitt & Aiello (2001)), it may be essential to investigate the workers' perceptions on site monitoring before the actual use of a monitoring system.

Since no literature regarding the attitudes and perceptions of construction workers towards electronic monitoring is found, it is necessary to study related works done on other working environment. Fortunately there is a satisfactory amount of studies have examined various aspects on office electronic monitoring. For instance, Alge and Hovorka-Mead et al. reveal the privacy concerns [18, 19]; Aiello & Kolb, Larson & Callahan, Stanton and Barnes-Farrell, Stanton and Julian (2002), and Stanton and Sarkar-Barney focus on employees' task and job performance [20 – 22]; Aiello and Kolb, Douthitt and Aiello, and Holman et al., care about job stress and employee well-beings [20, 23 – 24]; Hovorka-Mead et al. and Stanton and Lin aim at organization attraction and turnover [19, 25]; Alge (2001), Douthitt and Aiello, Hovorka-Mead et al., and Stanton investigate how policies and practices on monitoring impact employees' perceptions on fairness and justice [18, 23, 26].

It is also important to know that employees may respond to electronic monitoring in a variety of ways. For example, they can accept the monitoring and have their privacy incrementally eroded or object and risk being called "a troublemaker" [27]. Other employees seek "blind spots" in a network of control areas where they can escape the gaze of manager, thus providing them with space to maneuver. Some express resentment, leave the organization [28], resist through negotiation [29], or engage in reverse surveillance [27]. Some research suggests few employees resist workplace surveillance, little agreement exists about what constitutes resistance, and many so-called acts of resistance do not actually sufficiently disrupt work productivity [30].

Research on office workplace monitoring suggest that a monitoring system could shape or control the behaviors of employees, it may be valuable to explore the consequences if such systems are adopted, such as whether the workers more comply with rules and regulations, whether their performance is positively (more concentrated on work) or negatively (wasted time to show their competence to observers) affected, and so on. Although there is plenty of literatures contribute on office workplace monitoring, we believe their research frameworks and models cannot be applied on construction environment without refinement, as the organizational structure and the work environment of the construction industry are quite unique when comparing with other fields. For instance, safety issues are critical in a construction site, where the workers may consider one

of the purposes of installing a monitoring system is for safety reasons, or caring. But for office employees they may not accept safety issue as an explanation of implementing electronic surveillance. By summarizing the literature reviewed and our experiences in implementing electronic monitoring systems, it is found that there are at least few fundamental variations between office monitoring and construction site monitoring:

1. Construction sites have more safety issues. All over the world, construction is one of the most hazardous industries due to its unique nature [31] and therefore one major purpose of a monitoring system may be due to caring of workers.
2. Construction workers may have less privacy concern because they get used to work in public areas, where their work behaviors could be seen by the public already (e.g., residents living in the buildings nearby).
3. The construction industry is highly fragmented so the relationship between contractors and workers are always in one-off fashion. In fact, the construction industry is persecuted by some common partnering problems such as ineffective communication, limited trust, and lack of cooperation [32]. As a result, the workers may find very little organization identification.
4. Construction workers are monitored by inspectors and foremen already, they may find electronic monitoring is just an assistance tool. Therefore they may show little awareness about the system.

### 3. RESEARCH OBJECTIVES

This study is aimed at developing a research model to explore the construction workers' degree of acceptance of the implementation of electronic monitoring and surveillance systems in their work environment. As no literature concerning construction workers' perception and awareness on monitoring is found, the research model will be established based on the existing well-developed models related to workplace monitoring in other disciplines, with adequate refinements in order to fit the uniqueness of the construction industry. It is anticipated that the proposed model and collected data could help to answer the research questions below:

1. What factors (independent variables) influence or predict the degree of acceptance (the dependent variable) of the use of electronic monitoring system in their work environment?
2. How do construction workers perceive of electronic monitoring at work, for example,

will they consider the system as a purely coercive control?

3. Do the construction workers differ in their reactions to electronic monitoring depending on whether they were initially informed that monitoring was taking place in the construction site?
4. How do the construction workers respond to electronic monitoring (actual behavior)?

#### 4. THE RESEARCH MODEL

Since the research objectives involve the perceptions of construction workers, their acceptance level on electronic monitoring, and their actual behavior, the theory of planned behavior (TPB) [33] is adopted as the framework of this study, where the theory is about the relationships between attitudes and behavior. In TPB, behavior is determined by intention to perform the behavior. Intention is predicted by three factors: attitude toward the behavior, subjective norms, and perceived behavioral control. According to the literature reviewed, a model is proposed by refining the TPB. Figure 2 shows the research model, where the arrows represent positive relationships.

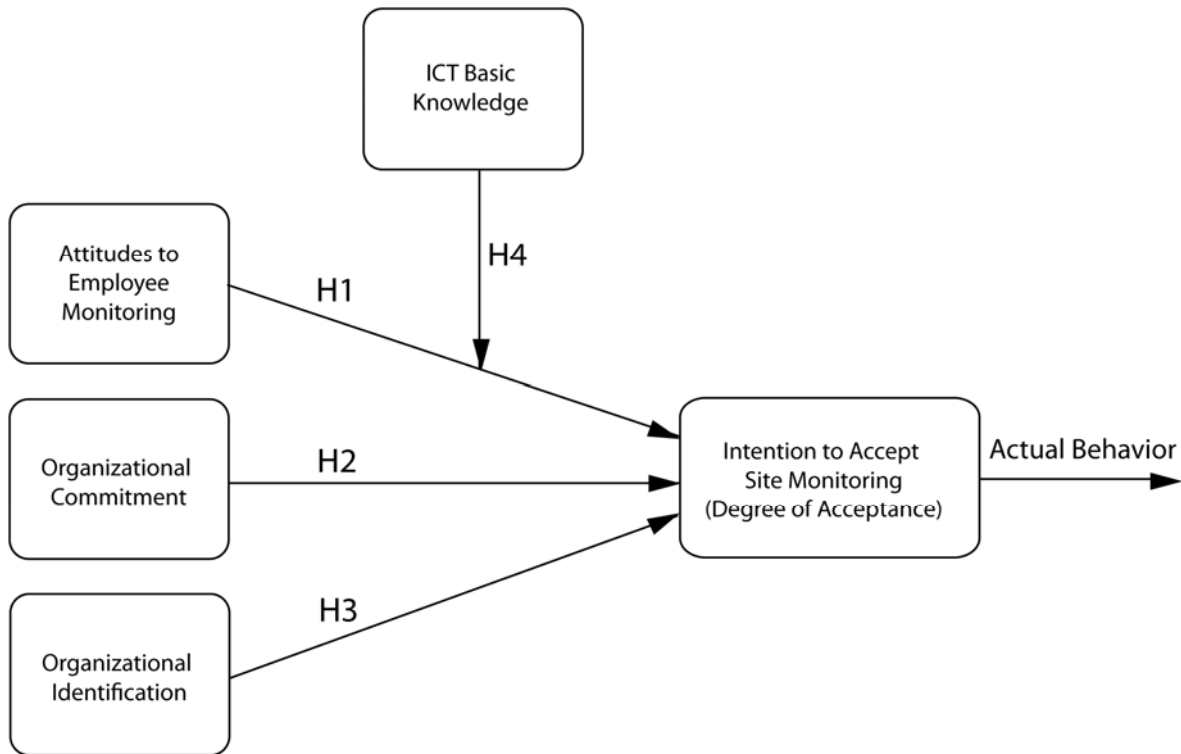


Figure 2. The Research Model

Personal evaluations of the appropriateness of employee monitoring can be considered as “proximal” attitudes, which should be likely to predict intentions and actual behavior [34]. Therefore, we hypothesize that:

*H1: Construction workers’ attitudes towards the appropriateness of employee monitoring positively affects their intention to accept electronic site monitoring.*

Allen and Meyer describe and distinguish three types of organizational commitment. In summary, it is related to “involvement in the organization”, “perceived obligation to remain with the organization”, and “perceived costs associated with leaving the organization” [35]. We make a hypothesis below:

*H2: Construction workers’ organizational commitment positively affects their intention to accept electronic site monitoring.*

Organizational identification suggests the extent to which employees feel they share their organizations’ value [36]. If a construction worker has a high organizational identification, he or she should be more unlikely to resist the decision made by the management. Therefore,

*H3: Construction workers’ organizational identification positively affects their intention to accept electronic site monitoring.*

Perhaps the ICT knowledge of most construction workers is limited, some of them many have basic knowledge in popular computer equipments. They may know a webcam captures images, the Internet can transfer information to any place with network connectivity, etc. Therefore,

*H4: Construction workers’ ICT basic knowledge moderates the relationship between attitudes to appropriateness of employee monitoring and intention to accept electronic site monitoring, such that the relationship is stronger with stronger ICT knowledge.*

## 5. CONCLUSIONS

This paper presents a research model based on the literature of planned behaviors and ethical decisions making. It aims in to investigate construction workers’ compliance and resistance intentions to electronic monitoring and surveillance systems. It will be reviewed by construction professionals, which including the stakeholders who are involved in our previous construction monitoring study (Leung et al.). Data will be collected by means of a questionnaire and it will be

used to test the hypotheses of the model. It is expected that this study could bridge the above-mentioned literature gap and provide a guideline for construction firms that intend to implement monitoring systems.

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