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UNDERSTANDING DETERRENCE THEORY IN SECURITY COMPLIANCE BEHAVIOR: A QUANTITATIVE META-ANALYSIS APPROACH

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ABSTRACT

Nowadays, one of the major concerns in information systems security (ISS) management is the employees' non-compliance behavior. Several studies have investigated compliance behavior by utilizing several behavioral theories and models. Deterrence theory is one of the widely used theories in ISS literature in order to investigate compliance behavior. Based on this theory, behaviors can be controlled by the threat of severe, certain and swift sanctions. This study aims to conduct a quantitative meta-analysis of existing literature to investigate relationship between constructs of deterrence theory (severity, certainty and celerity) and compliance behavior of employees. Results show that deterrence theory has not a remarkable impact on employees' compliance behavior.

Keywords: Deterrence theory, security compliance, meta-analysis, information systems security, sanctions

INTRODUCTION

Several studies have investigated compliance behavior (e.g. (Bulgurcu et al., 2010) (Herath and Rao, 2009) (Ifinedo, 2012) (Vance and Siponen, 2012). These studies utilize different behavioral theories and models in order to assess employee's intention to comply with IS security policies. Deterrence theory is widely used in IS security literature to explore compliance behavior (D'Arcy and Herath, 2011). This theory indicates that more severity, certainty and celerity of sanctions for an illicit action cause more deterrence from engaging in that action (Gibbs, 1975). In information systems security (ISS) literature, sanction severity, sanction certainty, and sanction celerity are used as constructs in order to investigate employees' compliance behavior. However, there are contradictory results for these constructs. Herath and Rao (2009) show that certainty but not severity has a positive relationship with ISS compliance intention. Siponen and Vance (2007) indicate that none of these constructs has significant effect on compliance behavior. So the impact of the sanction components on compliance behavior is not clear.

By considering that several studies have used deterrence theory for investigating compliance behavior and there are contradictory results in empirical studies, it seems useful to investigate this issue by analyzing the existing research in the ISS field to assess the impact of deterrence constructs on compliance behavior. In this paper, we use a meta-analysis approach to synthesize quantitative results of published empirical studies in the ISS field. This gives us a more comprehensive and precise view of the relationship between deterrence constructs and compliance intention.

RELATED WORK

Deterrence Theory

Deterrence theory is grounded in classical criminology (Beccaria, 1963). The theory proposed by Beccaria suggests that people engage in or avoid criminal action based on tradeoff between subsequent benefits and costs of that action. Deterrence theory proposes that sanctions deter individuals from engaging in unlawful acts proportionally to the level of sanction severity, sanction certainty and sanction celerity causes high level of individual deterrence from engaging in that act (Gibbs, 1975). Sanction celerity is the swiftness of sanctions after violation of certain laws or rules. Sanction severity is the degree of severity applied in penalties for violation of certain laws or rules. Finally, sanction certainty is defined as the risk of getting caught after engaging in a prohibited act. Based on deterrence theory, these constructs have positive correlations with an individual's deterrence from illicit acts.

Compliance Behavior

The success of ISS policies is closely related to the behavior of employees, because without their compliance, the ISS policies will not be fruitful. There have been several studies in the information systems (IS) field that investigate employees' compliance behavior with ISS policies (e.g. Bulgurcu et al., 2010; Herath, 2009; Ifinedo, 2012; Vance, 2012). These studies help understand how the intention to comply (or resist) with ISS policies can be assessed in employees. Deterrence theory is broadly used in

the ISS literature, especially in compliance related studies (D'Arcy and Herath, 2011). Many researchers have integrated components of deterrence theory (severity, certainty and celerity) with other constructs from various theories (e.g. awareness) in order to investigate security compliance intention. Deterrence theory has a strong foundation in criminology, and several empirical studies support this theory in predicting prohibited acts in organizations (Paternoster and Simpson, 1996; Pratt et al, 2006). However, there are inconsistent results with respect to the impact of deterrence on compliance intention. Some studies in the IS literature (e.g. Straub, 1990) support the influence of deterrence constructs on compliance behavior, but others (Lee et al, 2004; Pahnla et al, 2007; Siponen and Vance, 2010) suggest that the deterrence construct has no significant influence on compliance behavior. In addition there are some studies (e.g. Herath and Rao, 2009) that suggest sanctions certainty, but not severity, has a positive relationship with the intention to comply with ISS policies. This paper attempts to address this inconsistency by conducting a meta-analysis of several research papers in the ISS field.

RESEARCH METHODOLOGY

Literature Search

To conduct our meta-analysis, we searched related articles in available academic databases, including Web of Science, ACM Digital Library, Springer Link, and IEEE. Considering that there are many deterrence related articles in other research fields, such as criminology and psychology, the first criterion for choosing an article as a candidate article was that it should be in the ISS field. A second criterion was that candidate article should empirically investigate deterrence constructs with intention to comply with security policies. Finally, a criterion for selection was that candidate articles should include required quantitative information, including correlation matrix and constructs reliabilities. After refining our search results according to these criteria, we ended up with 9 articles (13 studies) for our meta-analysis. Table 1 shows the journal and proceedings names and the number of selected articles from these sources.

Journal or Proceeding Name	Number of Articles
Decision Support Systems	1
MIS Quarterly	2
Information & management	3
Information Systems Journal	1
Journal of Management Information Systems	1
Proceedings of 40 th Hawaii International Conference on System Sciences	1

Table 1. Sources for the Selected Studies

Meta-Analytic Method

After selecting the candidate articles for further analysis we obtained and coded the correlation coefficients (r) and sample sizes (N) for all studies. Considering that most of the studies reported correlation coefficients and it is simpler to interpret r in terms of practical importance (Glass, McGaw, and Smith, 1981), we chose Pearson's correlation coefficient as primary estimator of effect size. By using reliabilities of constructs we corrected each of correlations, since measurement errors can weaken and reduce the correlation coefficients (Hunter and Schmidt, 1990; Schepers and Wetzels, 2007).

We used Fisher Z transformation to calculate each r 's corresponding Z_{ri} for direct effect size analysis. The weighted mean Z_r or effect size (ES) is computed based on sample sizes, and are provided in table 2. By using standard errors of the weighted mean ES, the 95% confidence intervals for each ES are calculated. After obtaining confidence intervals, inverse Z_r transformation is used to transforming back the correlations (r) of each pairwise relationship. The meta-analysis formulas that we have used in this study are provided in appendix A.

DATA ANALYSIS

Descriptive Results

For each relationship, table 2 shows total number of studies, range of correlations, number of significant and non-significant relationships found, and cumulative sample size. Results show that sanction severity is used more than other constructs in

compliance studies. Studies that used sanction celerity are rare, because there are difficulties in sanction celerity measurement (D'Arcy and Herath, 2011).

Pairwise Relationship	Number of Studies	Range of Correlations		Correlations			Cumulative Sample Size
		lower	upper	# significant	# non-significant	% significant	
SSEV-IC	13	0.22	0.45	7	6	53.84	7045
SCER-IC	10	0.24	0.33	7	3	70.00	4765
SCEL-IC	2	0.14	0.15	1	1	50.00	799

Table 2. Descriptive Results (SSEV: perceived sanction severity; SCER: perceived sanction certainty; SCEL: perceived sanction celerity; IC: intention to comply with IS security policies.)

Direct Effect Size Results

Table 3 provides weighted mean effect size (ES) values that are calculated based on Fisher’s Z-transformed sample size. ES is valuable for investigating the strength of relationships because larger sample size correlations provide a mean correlation that is closer to the population mean (Hunter and Schmidt, 1990). The data in Table 3 shows that ES for the relationship between sanction certainty and compliance intention is the largest among all relationships. This implies that sanction certainty is a stronger predictor of compliance intention than either severity or celerity. However, all three relationships have small effect sizes and thus only small impact on compliance intention when looking at the cumulative sample.

Pairwise Relationship	Weighted Mean ES	Standard Error of the Mean ES SE _{ES} (z-test)	95% Confidence Interval	
			lower limit	upper limit
SSEV-IC	0.15	0.0001(1500)	0.149	0.150
SCER-IC	0.21	0.0002(1050)	0.209	0.210
SCEL-IC	0.13	0.0012(108.33)	0.127	0.132

Table 3. Meta-Analysis Results For Relationships Between Deterrence Constructs and Compliance Intention

By using inverse of Zr transformation we calculated correlation (r) indexes for all weighted average effect sizes (ES). According to Cohen (1988), effect sizes of r=0.1, r=0.3 and r=0.5 are indicators of small, medium and large effect sizes respectively. As we can see in table 4, none of the relationships has medium or large effect size. These results confirm that sanction certainty is a stronger predictor for compliance behavior. The effect size of celerity is smallest and it has a weak relationship with compliance intention. Considering that there are contradictory results for relationships between deterrence constructs and compliance intention, results show that all relationships have significant but small effect sizes.

Statistics	1	2	3	4
Sanction celerity (1)	1			
Sanction severity (2)	*	1		
Sanction certainty (3)	*	*	1	
Intention to comply (4)	0.11	0.14	0.19	1

Table 4. Correlation Matrix for Deterrence Constructs and Compliance Intention (* Relationship is not reported in selected studies)

DISCUSSION

This study utilizes meta-analysis in order to explore the relationships between deterrence theory constructs and intention to comply with ISS policies. Descriptive results show contradictory findings in literature. These results also show that severity is studied more than other constructs to investigating compliance behavior. On the other hand, studies that have used sanction celerity are rare because of measurement difficulties and lack of theoretical importance. According to Paternoster (2010), formal punishments generally have low certainty. Formal punishments also have low celerity because they are usually applied long after crime commitment. Therefore, certainty and celerity of sanctions are usually low and there is not remarkable variation in individuals’ perception of celerity and certainty. This could be an important reason for neglecting certainty and celerity in

several studies. However, the meta-analysis results show that certainty has more influence on compliance intention than severity. So the low certainty does not necessarily mean that this construct should be neglected. In addition, celerity depends on violation type and individual's perception of swiftness. For example for one individual, punishments and sanctions need to occur within one day to be considered swift, for other individuals one week or even one month may still be considered swift. Furthermore, the swiftness perception of individuals is different for a minor policy violation than for a major policy violation. This makes the measurement of celerity difficult.

CONCLUSION

Results show that for better understanding of the impact of deterrence constructs on compliance intention, more studies are needed. Future research may discuss possible ways for measuring sanction celerity. In addition, few studies have used sanction components as control variables.

Based on the cumulative sample and all statistical results in the selected studies (e.g. direct effect size analysis) we found that deterrence constructs are not strong predictors of compliance behavior. All relationships between deterrence constructs and compliance intention are weak. However, all of the sanction components do affect compliance intention. Therefore future research should not neglect any of deterrence constructs in studying compliance behavior. However, these constructs perhaps should be considered alongside other constructs from other theories or models (e.g. awareness) for exploring compliance behavior. The tendency to use severity more than other sanction components lacks an important fact that certainty could be a stronger predictor of compliance behavior than severity. Managers also might consider that deterrence and punishment by themselves are not strong predictors or control factors for employees' compliance behavior. Sanctions and punishments may need to be combined with other factors, such as awareness, in order to predict or control compliance behavior. Moreover, if managers want sanctions to be more effective in compliance behavior of employees, they should focus on certainty of sanctions, as certainty is stronger predictor of compliance behavior than other sanctions components.

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Appendix A. Formulas Used in this Study

Statistics	Description	Formula
r	Corrected r (Wu & Lederer, 2009)	$R_{\text{corrected}} = r_{\text{uncorrected}} / (\sqrt{\text{reliability}_x} \sqrt{\text{reliability}_y})$
Z _i	Fisher's r to Z transformation	$Z_i = (1/2) \log_e [1+r/1-r]$
ES	Weighted mean ES (Rosenthal, 1984)	$ES = \sum((N_i - 3)Z_i / (N_i - 3))$
SE _{ES}	Standard error of the mean ES (Lipsey & Wilson, 2001)	$\sqrt{1/\sum(N_i - 3)}$
Z-test	z-test (Lipsey and Wilson, 2001)	$z\text{-test} = ES/SE_{ES}$
CI	Confidence interval (Lipsey and Wilson, 2001)	$CI = ES \pm 1.96(SE_{ES})$
R	Inverse of the Z transformed correlation (Lipsey & Wilson, 2001)	$R = (e^{2ES} - 1) / (e^{2ES} + 1)$