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Theory-Based Model and Prediction Analysis of Information Security Compliance Behavior in the Saudi Healthcare Sector

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Abstract: The adoption of health information systems provides many potential healthcare benefits. The government of the Kingdom of Saudi Arabia has subsidized this field. However, like those of other less developed countries, organizations in the Kingdom of Saudi Arabia struggle to secure their health information systems. This issue may stem from a lack of awareness regarding information security. To date, most related studies have not considered all of the factors affecting information security compliance behavior (ISCB), which include psychological traits, cultural and religious beliefs, and legal concerns. This paper aims to investigate the usefulness of a theory-based model and determine the predictors of ISCB among healthcare workers at government hospitals in the Kingdom of Saudi Arabia. The study investigated 433 health workers in Arar, the capital of the Northern Borders Province in the Kingdom of Saudi Arabia. Two phases involved in this study were the hypothetical model formulation and identification of ISCB predictors. The results suggest that moderating and non-common factors (e.g., religion and morality) impact ISCB, while demographic characteristics (e.g., age, marital status, and work experience) do not. All published instruments and theories were embedded to determine the most acceptable theories for Saudi culture. The theory-based model of ISCB establishes the main domains of theory for this study, which were religion/morality, self-efficacy, legal/punishment, personality traits, cost of compliance/noncompliance, subjective norms, information security policy, general information security, and technology awareness. Predictors of ISCB indicate that general information security, followed by self-efficacy and religion/morality, is the most influential factor on ISCB among healthcare workers in the Kingdom of Saudi Arabia. This study is considered as the first to present the symmetry between theory and actual descriptive results, which were not investigated before.

Keywords: behavioral theory; health information system; information security; information security compliance behavior

1. Introduction

The adoption of health information systems (HISs) provides many potential benefits, such as improved quality of care, the reduction of medical errors, and enhanced access to information [1,2]. A reliable and coherent information system (IS) requires a solid security framework that follows the CIA triad (i.e., confidentiality, integrity, and availability). Moreover, employee behavior is a

significant factor in maintaining information security and information policy compliance. However, this factor is not easily controlled [3]. Hwang et al. claimed that insider threats result from misuse actions, including authority abuse, unawareness of policy, technical issues with software and hardware, and information mishandling [4]. In general, insider threats may be more dangerous than outsider threats because employees have prior information about their organization's security policies and can access its IS [2,5–7]. For this reason, organizations normally establish IS policies to enhance employee awareness, which is the cornerstone of information security compliance behavior (ISCB).

To keep pace with developed countries in the field of healthcare, the government of the Kingdom of Saudi Arabia (KSA) has subsidized this field. However, issues have occurred relating to protecting patient privacy and preventing data leaks or tampering by healthcare employees, including physicians and nurses [2,7]. This study aims to develop a model based on a specific theory of ISCB in order to minimize such issues. The rest of the paper is structured as follows: Section 2 describes the problem statement and the study's contribution. Section 3 provides a brief background on existing behavioral theories. The pertinent literature is reviewed in Section 4, before Section 5 outlines the research methodology. Section 6 presents a hypothetical ISCB model and its related variables. Section 7 discusses the proposed model and findings, before Section 8 outlines the relevant conclusions and proposes future research directions on this topic.

2. Problem Statement and Study's Contribution

The KSA has pointed out weaknesses in the country's management of healthcare systems attributed to a series of obstacles and influencing factors, such as a lack of awareness or an adverse environment [8,9]. Moreover, studies conducted to date (especially those conducted in Middle Eastern countries such as the KSA) have suffered from weak study designs and academic research procedures [10,11] and/or have covered only common factors affecting ISCB. In other words, the majority of studies cover only the relevant factors of their research problems and have neglected other factors affecting information security behavior, such as environmental, social, and psychological factors of the community aspects [12,13]. This presents a difficulty in considering all factors of information security behavior, due to the existence of several theories and domains. Lebek et al., in [14], conducted a theory-based literature review of employee ISCB theories found in 113 studies. They identified several research gaps for 54 theories of security behavior, due to: the inability to generalize study outcomes, failure to involve all personal and environmental factors for each study and community, and non-matched beliefs between the theories and actual practice. Therefore, most of the studies conducted both internationally and locally (i.e., in Arab countries and the KSA) failed to cover all of the factors affecting security behavior. For example, psychological factors have been proven to be relevant [9], but they have not been studied in the KSA. Furthermore, variables such as personality traits, religion/morality, and legal consequences/punishment are believed to moderate ISCB. The main contribution of this study is its insight into the influence of such factors among healthcare employees of the KSA.

3. Background on Theories of Information Security Compliance Behavior

While there are many theories pertaining to information security behavior, the following subsections highlight those specifically related to this study.

3.1. Theory of Planned Behavior

This expectancy-value theory is used to predict behavioral intentions that in turn lead to actual behaviors and is applied in multiple research areas [15]. The theory of planned behavior (TPB) considers three main factors affecting individuals' behavior: their own attitude towards a given action, their perception of others' appraisal of said action (subjective norms), and their perceived ability to carry it out (perceived behavioral control) [16]. Attitude, as an essential factor of this theory, explains the activities of social psychology according to several studies. According to the TPB,

individuals will engage in a given behavior only if their attitude, subjective norms, and perceived behavioral control are all positive in relation to the behavior [17].

3.2. General Deterrence Theory/Neutralization Theory

In the field of criminology, Reference [18] predicted criminal behavior based on deterrence and fear beliefs. They observed that severe punishments and sanctions reduce criminal intentions, which in turn prevent criminal action. This theory is implemented by the organization as part of their policy to increase awareness of information security system violations.

3.3. Protection Motivation Theory

This theory posits that human protective behavior is based on three processes: cognitive appraisal, threat appraisal, and coping response appraisal. Threat appraisal refers to individuals' beliefs about the severity of a given threat and their perceived vulnerability to such a threat. Coping appraisal concerns individuals' beliefs about response efficacy, that is the effectiveness of actions recommended to avoid or reduce the threat in question, and self-efficacy, i.e., their own ability to execute the recommended actions. The protection motivation theory (PMT) may be applied to ISCB studies [16,17]. In the realm of information security behavior in particular, it has been expanded to include factors such as technology awareness and social aspects [19].

3.4. Diffusion of Innovation/Technology Awareness Theory

The technology acceptance model (TAM) models users' acceptance of a given technology, based mainly on two factors: perceived usefulness and perceived ease-of-use. Perceived usefulness refers to the technology's ability to enhance users' performance. Perceived ease-of-use refers to the extent to which users believe that the technology will require little effort, which is an essential factor when it comes to employee behavior in a technologically developed era [16,20]. The TAM was reformulated by [19] for adaptation to several fields, such as politics, public health, communications, history, economics, and education. Diffusion of innovation (DOI) is a new theory explaining how users' heightened awareness of a given technology affects their decision to adopt it. More specifically, there are four factors affecting adoption: the innovative technology itself, the communication channel through which it spreads, the time it takes to do so, and the social system it caters to.

3.5. Rational Choice Theory

Bulgurcu et al. [5] adapted this theory to focus on employees' compliance with their organization's information security policies. According to this theory, employees' decisions regarding compliance are based on their evaluation of its costs and benefits. Few studies are closely related to the present research in their examination of ISCB. However, to the best of the authors' knowledge, no study has explored ISCB in the KSA. This paper aims to fill that gap.

3.6. Cognitive Moral Development Theory

This theory refers to the respect of principles to determine the actions required for a situation. There are six stages of moral judgment theory; Stages 1 and 2, pre-conventional; Stages 3 and 4, conventional; and Stages 5 and 6, post-conventional. These stages are associated with the social aspects, culture, individual, rules, and laws [21].

The selection of theories considered in this study is based on acceptable models of ISCB mentioned in literature studies. Hamed Taherdoost and Lebek et al. [22] produced a review on the acceptable models of ISCB [22,23]. Table 1 illustrates the common theories used by the majority of studies and outlines the benefits in the selection of theories by this study.

Table 1. Theories and their relationships to information security compliance behavior.

Theory	Relationship to Behavior	References
Theory of planned behavior	(1) It is an expectancy-value model. (2) Causes the response of actual behaviors.	Ajzen, 1991 [15], Ifinedo, 2012 [24].
General deterrence theory (GDT)	Predicts criminal behaviors based on deterrence and fear beliefs, which in turn significantly affect the motivation and self-aspects of employees.	Gibbs, 2018 [18].
Protection motivation theory	(1) Determines the behaviors of subjects to avert the consequences induced by violations. (2) Investigates methods to protect behavior based on cognitive appraisal.	Brown, 2017 [25].
Cognitive moral development	(1) Moral reasoning influences behavior and policy violations. (2) It measures employee adherence to information security policies.	Myyry et al., 2009 [21].
Diffusion of innovation	(1) Improves the awareness of employees to support their decisions, to increase certainty and minimize uncertainty. (2) Training employees makes their security behavior more satisfactory.	Weigel et al., 2014. [26].
Rational choice theory	Supports the decisions of individuals based on the principle of cost/benefit.	Bulgurcu et al., 2010. [5].

4. Literature Studies

Li and Hoffman [27] investigated the relationship between employees' ISCB and punishment severity in a series of organizations. Using the general deterrence theory (GDT), they identified demographic and human reasons behind IS violations and deployed a series of theories (i.e., GDT, PMT, and TPB) to evaluate predictors of ISCB. They found that ISCB was influenced by awareness, sanction certainty, and self-efficacy [28]. They also evaluated the potential factors influencing ISCB and information security awareness in business contexts. These factors included security education, security policies, knowledge of a physical system, security visibility, and management participation. The results indicated that all factors except for the knowledge of a physical system affected information security awareness [4]. Furthermore, they used two theories, PMT and GDT, to determine factors related to ISCB. The domains evaluated through the PMT were perceived threat vulnerability, threat severity, response efficacy, and self-efficacy. Factors covered by the GDT included sanction certainty and severity. Self-efficacy was the only significant predictor of ISCB compared to the other variables. Hwang et al. [4] based their model on a series of domains, including employees' awareness of and satisfaction with information security, their perception of its usefulness, fairness, and quality, self-efficacy, and certain organizational factors. Results showed that awareness, perceived quality, and self-efficacy significantly influenced employees' ISCB. Ryutov et al. [9] also based their model on a series of domains, including employees' awareness of and satisfaction with information security, perception of its usefulness, fairness, and quality, self-efficacy, and certain organizational factors. The results also showed that awareness, perceived quality, and self-efficacy significantly influenced employees' ISCB. Ryutov et al. [9] focused on examining the impact of human factors on ISCB. In particular, they considered behavior deterrence, policy stringency, employee commitment to and awareness of information security systems, management support, information security culture, and demographic characteristics. All factors except for policy stringency and employee commitment were demonstrated to influence security behavior. Bauer and Bernroider [29] used the theory of reasoned action, the knowledge/attitude/behavior model, and the neutralization theory to study several factors in relation to ISCB, namely: attitude, social norms, neutralization techniques, information security awareness, and demographic characteristics. They found that only

the first three significantly affected ISCB. Guhr et al. [30] examined how management leadership style influenced employees' ISCB. They considered transformational leadership, transactional leadership, and passive/avoidant leadership. The findings showed that transformational leadership was the only significant factor. Humaidi and Balakrishnan [31] used the TPB and other theories to build their model. They considered management support, self-efficacy, perceived trust, and compliance behavior as potentially relevant predictors of ISCB, all of which were found to be significant. Likewise, Rogers [19] relied on TPB to determine the factors influencing ISCB. The findings revealed that behavioral belief, social pressure, and compliance knowledge had a positive and significant impact. Herath and Rao [32] studied attitude, perceived behavioral control, and subjective norms as factors, but only the latter was shown to have an impact on ISCB. AlKalbani et al. [3] implemented institutional theory to examine the impacts of legal punishment, security benefits, social pressure, and management commitment, and all were found to be influential.

5. Research Methodology

A questionnaire-based survey was used to collect responses from participants related to their information security behavior and knowledge. This method is similar to that employed by several existing studies [5,17].

5.1. Objectives

The primary goal of this study is to investigate the usefulness of the proposed model for determining predictors of ISCB among healthcare workers at governmental hospitals in the KSA. The following objectives were pursued to achieve the main goal of this study:

1. to investigate the effect of non-common factors (e.g., religion/morality, personality traits, and legal consequences/punishment) on ISCB among healthcare employees in the KSA;
2. to explore the effect of moderators on ISCB among healthcare employees in the KSA;
3. to examine the impact of demographic characteristics on ISCB among healthcare employees in the KSA;
4. to propose a final, theory-based model of ISCB among healthcare workers in the KSA.

5.2. Population

Participants were drawn from governmental healthcare centers in Arar, the capital of the Northern Border Province in the KSA. A total of 2297 workers from five different hospitals and centers were considered, as shown in Table 2.

Table 2. Hospitals and healthcare centers In Arar, KSA.

Hospital	Number of Healthcare Workers
Arar Central Hospital	750
Prince Abdulaziz Bin Musaad Hospital	466
Maternity and Children Hospital	697
Al-Amal Complex for Mental Health	248
Extended Care Facility	100
Total	2297

The only exclusion criterion was having been previously punished or reported for a work-related violation. The study was conducted between November and December 2019.

5.3. Sampling of the Present Study

Study participants were selected using the random sampling technique and were chosen randomly from one pool. They were then invited to enroll in the study using an electronic survey. All participants were involved voluntarily, and signed consent forms were collected from all participants.

5.4. Statistical Analysis

SmartPLS v3 and SPSS Statistics v22 were used for data analysis. The purpose of using SmartPLS software was to develop the theory of ISCB for Saudi employees, while SPSS is a program used to determine predictors, where the predictor with the greatest influence can be observed alongside the other domains. Kim et al. also investigated the effects of security behavior using the multi-theory model. They believed that theory and descriptive analysis was required to approve the performance of this model, i.e., that performance depends on the mix between the theory and actual results [17]. Therefore, the present study developed the model in a pilot study as a first phase and determined the predictors in a second phase. The reasons for using a regression test to predict factors influencing the information compliance behavior were as follows: (1) the assumptions of any statistical test should meet the requirements, which cannot be achieved using the SmartPLS; (2) the SmartPLS determines the influence of each variable separately without taking into account the influence of other variables; (3) the objective of the present study is to identify the predictors having the greatest impact on the ISCB, which could not be measured using the SmartPLS; (4) the regression test and results using SPSS are more robust than results obtained from SmartPLS; and (5) the influence of demographic characteristics, as predictors, showed weaker results with the use of SmartPLS than other software [33]. Results were considered significant when their p -values were lower than 0.05. SmartPLS was used to implement structural equation modeling (SEM), confirmatory factor analysis, and exploratory factor analysis in the first phase. Then, SPSS was used to determine the predictors of ISCB in the second phase. Confirmatory factor analysis was used to determine the impact of independent variables (domains) on the main dependent variable (ISCB) and to approve the construction of the model. Exploratory factor analysis was applied to determine the validity of the study's instruments. Cronbach's alpha was used to determine the internal consistency of separate items and overall instruments, while multiple linear regressions were used to determine the predictors of ISCB and the impact of their interactions on ISCB. The dummy method of a regression test was used to determine which variable was more influenced compared to other variables. This type of regression identifies the most significant sub-variables, such as female, single, etc.

5.5. First Phase and Pilot Study

A pilot test was conducted in order to improve the clarity of the survey questions and address critical issues concerning statistical variables. Several steps were performed to approve the validity of questionnaire items. These steps involved panel validity, domain validity, and item validity. For statistical approval, SEM was performed to identify the dimensions and path coefficients of the theory. The number of participants was 100.

5.5.1. Panel Validity

Eight field professionals, academics, and researchers in the KSA evaluated every domain and item considered in the pilot study, as well as their potential influence on ISCB and made recommendations to omit or merge certain items. A Cohen's kappa test was conducted to determine inter-rater reliability, that is the coefficient of agreement among panelists. Values ranged between 0.89 and 1.00 (the optimal standard value being 0.80). The total number of factors involved in this study was 33, which fell to 15, as shown in Table 2.

5.5.2. Domain Validity

Of the 15 domains obtained from the literature, as well as previous content and panel validity tests, only 10 were included in the final model, as shown in Table 3.

Table 3. Domain selection sources and criteria. SEM, structural equation modeling.

	Domains Selected from the Literature	Domains Selected by Field Evaluators	Domains Selected According to SEM
1	Information security compliance behavior (ISCB)	✓	✓
2	Self-efficacy	✓	✓
3	Subjective norms	✓	✓
4	Attitude towards information system security policy (ISSP) compliance	✓	
5	Response efficacy		
6	Response cost		
7	Perceived vulnerability	✓	
8	Perceived severity		
9	General information security	✓	✓
10	Technology awareness	✓	✓
11	ISSP awareness		
12	Normative beliefs		
13	Perceived cost of compliance	✓	✓
14	Work impediment	✓	
15	Intrinsic benefit		
16	Rewards		
17	Safety of resources	✓	
18	Perceived benefit of compliance		
19	Sanctions		
20	Vulnerability of resources		
21	Perceived cost of non-compliance		
22	Information security policy	✓	✓
23	Information security policy provision		
24	SETAprograms		
25	IT knowledge		
26	Negative experience		
27	Influence of secondary sources		
28	Peer behavior		
29	Risky behavior		
30	Attitude towards cyber security	✓	
31	Legal consequences/punishment	✓	✓
32	Religion and morality	✓	✓
33	Personality traits (extraversion, agreeableness, conscientiousness, neuroticism, intellect/imagination)	✓	✓

5.5.3. Hypothetical Dimensions, Statistical Validity, and Reliability

Partial least squares (PLS-SEM) was used to test the dimensions and identify the path coefficients (Figure 1). According to the requirements for approving the dimensions of the theoretical model, three values must be within the standards, namely the t-values (path coefficients), significance, and goodness of fit. Since the t-values of dimensions were greater than 1.96, they were deemed to be the main valid dimensions of ISCB. As mentioned by Kim et al. [17] and Chin et al. [34], the best goodness of fit for any model in PLS-SEM should be classified as low, middle, or high. The ranges for each category are $0.02 \leq 0.13$, $0.13 \leq 0.26$, and above 0.26 for the low, middle, and high forecasting goodness of fit, respectively. High-ranging R squared values of the present theoretical model were observed in the influence of personality traits, followed by technology awareness, subjective norms, general information security, information security policy, legal punishment, and compliance/noncompliance cost. Mid-level

R squared values were observed for the effect of self-efficacy and religion on ISCB. The overall goodness of fit for this model achieved about 78% ($R^2 = 0.780$), as shown in Figure 1. Therefore, this model is considered to meet the requirements for employee ISCB in Saudi Arabia. Additionally, statistical validity was performed by using confirmatory and exploratory factor analysis. Cronbach's alpha was used to determine the internal consistency of questions and variables as one set. Reliability values were found to be 0.942 for ISCB, 0.937 for subjective norms, 0.901 for self-efficacy, 0.868 for religion and morality, 0.876 for personality traits, 0.893 for general information security, 0.984 for information security policy, 0.866 for legal consequences/punishment, 0.789 for the perceived cost of compliance/non-compliance, and 0.858 for technology awareness. The overall Cronbach's alpha for the survey was 0.936. After factor analysis was conducted, sixty-two survey items were retained across domains. They were distributed as follows: 9 on religion/morality, 8 on legal consequences/punishment, 10 on the Big-Five personality traits, 9 on ISCB, 10 on self-efficacy, 4 on subjective norms, 3 on the cost of compliance/non-compliance, 3 on general information security, 2 on information security policy, and 4 on technology awareness.

Figure 1. Model and domains of information security compliance behavior (ISCB) generated by SmartPLS.

5.6. Second Phase and Prediction Analysis

5.6.1. Dependent and Independent Variables

However, the present study aimed to identify the impact of other non-common variables, such as religion, punishment, and personality traits, alongside the common theories. Figure 2 depicts the influence of independent and moderator variables (as identified by existing theories) on the dependent variable. The study's independent and moderator variables include legal consequences/punishment (GDT), personality traits and self-efficacy (PMT), cost of compliance/non-compliance (rational choice theory (RCT)), subjective norms (TPB), religion and morality (cognitive moral development theory), and information security policy, general information security, and technology awareness (DOI). Demographic characteristics were the only controlled variable.

Figure 2. Independent and dependent variables as presented in relevant theories.

5.6.2. Hypotheses of Variables in the Main Study

The hypotheses of the present study are classified into common, non-common, moderators, and demographic effects. The corresponding abbreviations and explanations of these hypotheses are as follows. H01: There are no predictors of ISCB among healthcare employees in the KSA. H02: Non-common factors (e.g., religion/morality, personality traits, and legal consequences/punishment) have no effect on ISCB among healthcare employees in the KSA. H03: Moderators have no effect on ISCB among healthcare employees in the KSA. H04: Demographic characteristics have no impact on ISCB among healthcare employees in the KSA.

Figure 3. Independent and dependent variables as presented in relevant theories.

As shown in Figure 3, null hypotheses concerning religion/morality, legal consequences/punishment, and personality traits are abbreviated as H02R, H02LP, and H02P, respectively. Null hypotheses concerning subjective norms, self-efficacy, cost of compliance/non-compliance, technology awareness, general information security, and information security policy are abbreviated as H01SN, H01SE, H01CC, H01TA, H01GIS, and H01ISP, respectively. Hypothesis 3 relates to moderators, and Hypothesis 4 refers to the effects of demographics on ISCB.

6. Results and Analysis

The response rate of participants for this survey was 62.1%, which is considered an excellent rate, especially amidst the inconvenient health conditions of the COVID-19 pandemic. Of the surveys, eleven-point-five percent were considered as incomplete and were excluded from the study, while 26.4% provided no response. Participants' responses on ISCB and its domains were recorded in terms of percentages and frequencies. Predictors of ISCB were determined, and those with the highest impact were considered. In addition, the moderating influence of their interactions on ISCB scores was measured. Finally, the factors affecting the main domains of ISCB were examined.

6.1. Demographic Characteristics

The average age of participants was 33.2 years. Table 4 details the percentages of every category according to the demographic characteristics of participants. The majority of participants' characteristics were male (53.10%), married (80.10%), with a BSc degree (40.90%), 6–10 years' work experience (33.90%), nurse specialty (42.50%), and work location at the Al-Amal Center (22.20%).

Table 4. Percentage of categories for each demographic characteristic for participants.

Characteristic	Category	Result	Characteristic	Category	Result
Gender	Male	53.10%	Specialty	Nurse	42.50%
	Female	46.90%		Administrator	18.20%
Marital status	Married	80.10%		Pharmacists	6.50%
	Single	15.50%		Physicians	3.50%
	Divorced	3.70%		Other	29.30%
	Others	0.70%	Work location	Al-Amal Centre	22.20%
Education	BSc	40.90%		Central Hospital	15.20%
	Diploma	43%		Al-Riaya Hospital	14.30%
	Higher education	7.60%		Prince Abdulazizi Hospital	12.00%
	Secondary school	7.90%		Obstetrics and Pregnancy Hospital	8.10%
	Others	0.70%		Other	28.20%
Work experience	<1 year	11.10%			
	1–5 years	17.3%			
	6–10 years	33.9%			
	10–15 years	20.6%			
	>15 years	17.10%			

6.2. Participants' Responses

Appendix A lists participant responses to a number of statements within each examined domain. Answers were provided on a five-point Likert scale ranging from: strongly agree (SA) to agree (A), neither agree, nor disagree (N), disagree (D), and strongly disagree (SD). Statements were selected for inclusion in the table below according to two relevance criteria within each domain: (a) high level of overall agreement on the Likert scale (i.e., most people answered A or SA) and (b) high mean level of agreement. For instance, in the "religion and morality" domain, the selection of "SA" had the highest score (54.43%). The response of A by participants towards ISCB was 52.48%. The response of participants towards punishment, self-efficacy, subjective norms, cost of compliance/noncompliance, general information security, information security policy, technology awareness, and personality was mostly A (42.21%, 49.45%, 42.09%, 37.57%, 50.04%, 48.73%, 47.86%, and 44.85%, respectively), as outlined in Appendix A.

6.3. Predictors of ISCB

Multiple linear regression (dummy method) was used to determine ISCB predictors among study participants. Calculated ISCB predictor values are shown in Table 5. The proposed model was found to have a predictive value of approximately 60% (adjusted $R^2 = 0.595$), which indicates a relatively high goodness of fit. General information security had the greatest positive effect on the ISCB model ($\beta = 0.250$), followed by self-efficacy ($\beta = 0.223$), religion/morality ($\beta = 0.217$), personality traits ($\beta = 0.166$), subjective norms ($\beta = 0.152$), and legal consequences/punishment ($\beta = 0.147$). However, the extent of positive increments in the ISCB score was highest for general information security ($B = 0.603$), i.e., increasing one unit of general information security yields an increase in the ISCB score by 60.3%. This effect is followed by personality traits (33.5%, $B = 0.335$), subjective norms (26.3%, $B = 0.263$), religion/morality (23.7%, $B = 0.237$), self-efficacy (17.8%, $B = 0.178$), and legal punishment (13.9%, $B = 0.139$). The final ISCB model achieved about 59.5% and is thus considered a good model to describe employee perceptions in Saudi Arabian health settings. This result is slightly lower than the value obtained in the theoretical model during the first phase of theoretical modeling. This indicates that there is a slight difference in determining the domains of ISCB between the theory and actual settings.

Table 5. Predictors of ISCB.

Predictors	Unstandardized Coefficient		Standardized Coefficient	t	Sig.	95.0% CI for B	
	B	SE				LB	UB
(Constant)	−6.028	2.503		−2.408	0.017	−10.95	−1.106
Religion/morality	0.237	0.039	0.217	6.110	<0.001	0.161	0.313
Personality traits	0.335	0.070	0.166	4.794	<0.001	0.198	0.472
Legal consequences/punishment	0.139	0.038	0.147	3.704	<0.001	0.065	0.213
Self-efficacy	0.178	0.036	0.223	4.939	<0.001	0.107	0.249
Subjective norms	0.263	0.073	0.152	3.601	<0.001	0.119	0.406
General information security	0.603	0.110	0.250	5.480	<0.001	0.386	0.819

Multiple linear regression: $R^2 = 0.775$ (adjusted $R^2 = 0.595$), $df (6)$, $p < 0.001$.

Based on the above results, the null hypotheses H01 (there are no predictors of ISCB among healthcare employees in the KSA) and H02 (non-common factors such as religion/morality, personality traits, and legal consequences/punishment have no effect on ISCB among healthcare employees in the KSA) can be rejected.

6.4. Moderators of ISCB

Table 6 illustrates the impact of moderators on ISCB. Information security policy and technology awareness only showed significant effect, where the impact on the ISCB as the Beta value is equal to 0.642 of the model. The low value of the R squared of moderators can be attributed to the use of the dummy method of regression, as this method generally showed low R squared values when using a small number of variables in the same model. However, about 35% was obtained for the moderating effect of information security policy and technology awareness on the ISCB. Interestingly, the t-value obtained from the regression model showed a good relationship between the moderating effects of these variables on the ISCB. Based on the above results, null hypothesis H03 (information security policy and technology awareness have a moderating impact on ISCB among healthcare employees in the KSA) can be rejected.

Table 6. Impact of domain interaction on information security compliance behavior (ISCB).

Predictors	Unstandardized Coefficient		Standardized Coefficient	t	Sig.	95.0% CI for B	
	B	SE				LB	UB
Information security policy and technology awareness (Constant)	28.814	2.805		10.272	<0.001	23.299	34.330
Information security policy	−0.356	0.429	−0.111	−0.830	0.407	−0.198	0.487
Technology awareness	0.095	0.210	0.058	0.452	0.652	−0.318	0.508
Technology awareness * Information security policy	0.077	0.026	0.642	2.912	0.004	0.025	0.129

* Multiple linear regression: $R^2 = 0.596$ (adjusted $R^2 = 0.350$), $df (3)$, $p < 0.001$.

6.5. Final Model of ISCB

In line with the fifth objective of this study, namely to present a final theory-based model of ISCB among healthcare workers in the KSA, Figure 4 depicts the relevant domains. Regression models were run, and Beta coefficient values were used to determine the impacts of these domains on ISCB. General information security had the highest impact, followed by self-efficacy, religion/morality, personality traits, subjective norms, and legal/punishment. Influences of other factors are also stated, with the significant results of these variable among each. For example, legal/punishment influences self-efficacy only. Personality weakly influences self-efficacy. Therefore, the non-common factors may directly influence ISCB.

Figure 4. Model and predictors of ISCB among healthcare workers in the KSA NS = not significant.

7. Discussion

Models have previously been formulated to detect and manage violations of information security systems. They have been implemented to identify factors commonly associated with the weaknesses of healthcare systems, such as technical problems, personal problems, security architecture, information security governance, and business and recovery planning [35–37]. Several Saudi studies have attempted to determine the factors influencing information security systems, especially those related to employee behavior, but were either categorized as review studies or deemed methodologically insufficient [38,39]. This paper aims to bridge this research gap by formulating an integral model of the broad dimensions influencing ISCB among employees at governmental healthcare centers in Arar City, KSA. Some scholars have highlighted the influence of psychological parameters on

the protection of information technology systems at hospitals [9]. However, these psychological parameters vary in nature based on type, severity, risk, and the relationship to violation of information security of healthcare professionals at medical institutions. All of these variables are particular to the requirements of specific theories and policies when creating models of ISCB. Kim et al. [17] proposed a hybrid model derived from four theories: TPB, RCT, naturalization theory, and PMT. Along those lines, the present study examines several dimensions that directly and indirectly affect ISCB among healthcare employees in the KSA. Moreover, the country's unique culture has impacted employees' psychological and information security behavior in domains such as religion, personality, and commitment to legal consequences [12]. The proposed model constitutes a novel addition to the literature, especially as it combines psychological, technical, management, and cultural parameters involved in ISCB. Kim et al. [17] proposed self-efficacy as one of the variables that may be influenced by ISCB. However, they found no significant impact of self-efficacy on ISCB. The present study demonstrates a significant impact of self-efficacy on ISCB, with better association results ($\beta = 0.223$) than their outcome. The value of self-efficacy in the present study is similar to previous outcomes [31]. The controversial results about the impact of self-efficacy on information security behavior are probably due to the inconsistency of the definition, use, and measurement of the level of self-efficacy and the method of evaluating the relationship within the context of security behavior [40]. For this reason, the present study passes through several precise methodological and validation steps to define the items and scales of self-efficacy. Klein et al. detected the relationship between punishment severity and security behavior. Unfortunately, although they stated the importance of punishment and severity, no significant relationship could be observed [41]. Ryutov et al. [9] noticed the substantial association between severity of punishment and security compliance behavior, with a regression coefficient of 0.132. Remarkably, the present study reveals a significant association between punishment/legal predictor and ISCB, almost similar to the outcomes obtained by [9]. Therefore, punishment/legal concerns are considered as an exclusive result, and a new domain should be considered when conducting future research, especially in the context of Saudi Arabian culture. A previous study found that religious and moral factors are strong predictors of commitment to self-improvement and personal behavior [42]. Bansal et al. also found an association between the non-compliance of employees with religious/moral beliefs, where a significantly negative relationship was observed between negative compliance and high levels of morality/religiosity. Kurpis et al. found that the standardized coefficient, implying the strength of the relationship, of the religiosity factor significantly influenced the intention and compliance behavior, with a value of 0.234 [42]. This result is in line with the outcomes of the present study, where the regression standardized coefficient ($\beta = 0.217$) is significantly influenced by the ISCB of healthcare employees of the governmental hospitals and clinical centers in Arar, KSA. This outcome is considered to answer many researchers' questions concerning the impact of religion/moral beliefs on the information security behavior of healthcare workers, particularly in countries with specific environments like that of the KSA [12]. Establishing the significant relationship between religion and security behavior is considered as another novelty of the present study, as this new dimension (religion/morality) should be considered in future studies conducted in the KSA. The assessment of personality has received the attention of several researchers, especially regarding its relationship with information security and social behavior. Vance et al. confirmed this association and the impact of personality on the failure or success of employees at protecting patients' confidential information. Moreover, they attributed the influence of personality to protection motivation and habit theories [43]. All studies conducted in Saudi Arabia lacked a systematic and broad view of the common domains that influence the culture, such as personality traits, which may differ in each region of the country, or from nearby countries [12]. This privileged the present study to highlight the common psychological and habitual parameters that influence behavior in Saudi Arabian culture. Kim et al. [17] categorized subjective norms as one of the three social psychological parameters, in addition to attitude and perceived control, which influence information security behavior within planned action and behavior theory. Subjective norms, as reported by a previous study, encourage someone to do certain things

under pressure, which reveals the extent of compliance to rules [44]. Ryutov et al. [9] investigated the impact of subjective norms on the ISCB, but they could not observe significance in their hypothesis. Borena and Bélanger [45] justified the nonsignificant result of their hypothesis on subjective norms and information security behavior by citing the lack of a direct effect. This opinion is rejected by the present study and in studies conducted by Herath and Rao [32]. Borena and Bélanger [45] found a significant association between subjective norms and ISCB, with a coefficient equal to 0.313 [45]. Their subjective norm value supports the findings of the present study. Haeussinger and Kranz [46] found that general information security awareness significantly influences security awareness and thus security behavior. This view supports the model of the present study, where the general information security variable directly influences information security compliance behavior ($\beta = 0.250$). Regarding research related to the outcome of this study, no previous studies have revealed the value of their coefficients, despite the significant influence of general information awareness on ISCB. In general, most studies found in the literature have formulated their theoretical models without taking into consideration co-factors such as moderators and socio-demographic characteristics. However, these were investigated in the present study, which is considered a novel achievement for predictors of ISCB for Saudi Arabian healthcare workers.

8. Conclusions and Future Work

The adoption of HISs by healthcare organizations offers several benefits, such as improved service quality, the reduction of medical errors, and greater accessibility of information. The government of the KSA has subsidized this field to keep pace with developed countries. However, like those of other less developed nations, organizations in the KSA struggle to secure their HISs. This stems from a number of factors, including a lack of awareness of information security and technological barriers. Most existing studies do not consider all factors affecting information security compliance, which include psychological traits, cultural beliefs, religion, and legal concerns. This paper investigates the usefulness of the proposed model in determining the predictors of information security compliance among healthcare workers at governmental hospitals in the KSA. It is conducted on 433 healthcare personnel at five key hospitals and health centers in Arar, the capital of the Northern Border Province. To strengthen the results, multiple validation tests (e.g., content validity and panel validity tests) are conducted on the study's instruments. In addition, statistical tests are run on the data collected from participants. The results indicate an impact of moderators and non-common factors (e.g., religion and morality) on ISCB. However, demographic characteristics (e.g., age, marital status, and work experience) appear to have no impact. This theory-based model of ISCB among healthcare workers could be useful in similar contexts. The present study presents a significant model of ISCB and significant predictors on the theoretical and practical observational levels. Risk factors of ISCB obtained in present study are religion/morality, personality traits, legal consequences/punishment, self-efficacy, subjective norms, and general information security. The moderating impact of information security policy and technology awareness significantly influence the ISCB of employees in the KSA. This study possesses some limitations, which invite future research in the area. First, its cross-sectional design has weaknesses in certain research aspects, including time and updating of knowledge and experience about information security. Second, the study should extend beyond governmental healthcare centers and hospitals in a single Saudi city (i.e., Arar), to include private hospitals and other areas of the KSA.

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Appendix A

Table A1. Responses of information security compliance behavior (ISCB) and domains after factor analysis.

		SD	D	N	A	SA	M	±SD
Religion and moral	1. My religious faith is extremely important to me	5 1.2	2 0.5	10 2.3	159 36.7	257 59.4	4.53	0.680
	2. I pray daily	2 0.5	0 0	19 4.4	164 37.9	248 57.3	4.52	0.628
	3. I look to my faith as a source of inspiration	4 0.9	3 0.7	21 4.8	167 38.6	238 55	4.46	0.706
	4. I look to my faith as providing meaning and purpose in my life	5 1.2	1 0.2	19 4.4	178 41.1	230 53.1	4.45	0.699
	5. My faith is an important part of who I am as a person	4 0.9	1 0.2	28 6.5	166 38.3	234 54	4.21	0.755
	6. I consider myself active in my faith or at mosque	3 0.7	8 1.8	45 10.4	215 49.7	162 37.4	4.44	0.709
	7. My relationship with God is extremely important to me.	4 0.9	0 0	11 2.5	145 33.5	273 63	4.58	0.638
	8. I look to my faith as a source of comfort	3 0.7	3 0.7	21 4.8	146 33.7	260 60	4.52	0.687
	9. My faith impacts many of my decisions	15 3.5	8 1.8	37 8.5	154 35.6	219 50.6	4.28	0.949
	Total no.	45	26	211	1494	2121		
Legal and punishment	%	1.15	0.67	5.41	38.34	54.43		
	1. My hospital has clear, written policies and procedures related to employee discipline.	14 3.2	19 4.4	108 24.9	200 46.2	92 21.2	3.78	0.939
	2. I believe that employee non-compliance can usually be corrected with punishment	14 3.2	26 6	98 22.6	206 47.6	89 20.6	3.76	0.953
	3. I believe that most non-compliant employees are eventually terminated	52 12	75 17.3	125 28.9	124 28.6	57 13.2	3.14	1.205
	4. I believe that trust between supervisors and "direct reports" is important in improving employee compliance	5 1.2	8 1.8	61 14.1	195 45	164 37.9	4.17	0.819

Table A1. Cont.

		SD	D	N	A	SA	M	±SD
Legal and punishment	5. I believe that most of our supervisors and managers utilize verbal warnings to improve the compliance of their employees	14 3.2	20 4.6	81 18.7	211 48.7	107 24.7	3.87	0.946
	6. I believe that most of our supervisors and managers use written behavior counseling with their non-compliant	19 4.4	28 6.5	118 27.3	178 41.1	90 20.8	3.67	1.015
	7. I believe that most of our supervisors and managers use written behavior contracts with their non-compliant employees	18 4.2	36 8.3	115 26.6	175 40.4	89 20.6	3.65	1.028
	8. Managers and supervisors are given latitude to apply hospital policies and procedures related to employee discipline	26 6	34 7.9	114 26.3	173 40	86 19.9	3.60	1.076
	Total no.	162	246	820	1462	774		
Personality traits	%	4.68	7.10	23.67	42.21	22.34		
	1. Am relaxed most of the time	8 1.8	28 6.5	88 20.3	229 52.9	80 18.5	3.80	0.879
	2. Get upset easily	58 13.4	96 22.2	97 22.4	135 31.2	47 10.9	3.04	1.227
	3. Talk to a lot of different people at parties	11 2.5	34 7.9	99 22.9	204 47.1	85 19.6	3.73	0.948
	4. Have a vivid imagination	10 2.3	30 6.9	101 23.3	194 44.8	98 22.6	3.79	0.949
	5. I Am not interested in abstract ideas	20 4.6 15.2	66 31.2	135 38.1	165 10.9	47	3.35	1.015
	6. I Have difficulty understanding abstract ideas	37 8.5	92 21.2	124 28.6	133 30.7	47 10.9	3.14	1.131
	7. A Sympathize with others' feelings	2 0.5	10 2.3	75 17.3	233 53.8	113 26.1	4.03	0.754
	8. Feel others' emotions	5 1.2	10 2.3	75 17.3	227 52.4	116 26.8	4.01	0.799
	9. Get chores done right away	3 0.7	8 1.8	60 13.9	224 51.7	138 31.9	4.12	0.762
	10. Like order	3 0.7	9 2.1	62 14.3	198 45.7	161 37.2	0.796	
	Total no.	157	383	916	1942	932		
	%	3.63	8.85	21.15	44.85	21.52		

Table A1. Cont.

		SD	D	N	A	SA	M	±SD
Information security compliance behavior	It is my intention to continue to comply with the organization's ISSP	5 1.2	7 1.6	85 19.6	221 51.0	115 26.6	4.00	0.795
	I am certain I will adhere to my organization's ISSP	4 0.9	10 2.3	57 13.2	228 52.7	134 30.9	4.10	0.779
	It is possible that I will comply with the organization's ISSP to protect the organization's information systems	12 2.8	11 2.5	61 14.1	222 51.3	127 29.3	4.02	0.887
	I am likely to follow the organization's ISSP in the future	5 1.2	6 1.4	64 14.8	231 53.3	127 29.3	4.08	0.771
	I would follow the organization's security policy whenever possible	8 1.8	6 1.4	57 13.2	224 51.7	138 31.9	4.10	0.814
	I intend to protect technology resources according to the requirements of the ISSP of my organization	10 2.3	4 0.9	59 13.6	222 51.3	138 31.9	4.09	0.832
	I intend to carry out my responsibilities prescribed in the ISSP of my organization when I use information resources	10 2.3	4 0.9	60 13.9	230 53.1	129 29.8	4.07	0.823
	I intend to carry out my responsibilities prescribed in the ISSP of my organization when I use technology resources	3 0.7	6 1.4	63 14.5	234 54.0	127 29.3	4.10	0.74
	I intend to recommend that others comply with ISSP	6 1.4	4 0.9	60 13.9	233 53.8	130 30.0	4.10	0.769
	Total no.	63	58	566	2045	1165		
Self-efficacy	%	1.62	1.49	14.52	52.48	29.89		
	1. I have the necessary skills to protect myself from information security violations	9 2.1	8 1.8	77 17.8	233 53.8	106 24.5	3.97	0.827
	2. I have the expertise to implement preventative measures to stop people from getting my confidential information	7 1.6	12 2.8	80 18.5	218 50.3	116 26.8	3.98	0.843
	3. I have the skills to implement preventative measures to stop people from damaging my work computer	12 2.8	20 4.6	94 21.7	196 45.3	111 25.6	3.86	0.944
	4. I can enable security measures on my work computer but only when I have manuals for reference	13 3	15 3.5	96 22.2	214 49.4	95 21.9	3.84	0.909
	5. I have the necessary skills to fulfill the requirements of the ISP	9 2.1	10 2.3	95 21.9	209 48.3	110 25.4	3.93	0.866
	6. I have the necessary knowledge to fulfill the requirements of the ISP	9 2.1	17 3.9	99 22.9	211 48.7	97 22.4	3.85	0.882

Table A1. Cont.

		SD	D	N	A	SA	M	±SD
Self-efficacy	7. I have the necessary competencies to fulfill the requirements of the ISP	4 0.9	19 4.4	99 22.9	211 48.7	100 23.1	3.89	0.841
	8. I would feel comfortable following my organization's ISSP on my own	3 0.7	11 2.5	71 16.4	224 51.7	124 28.6	4.05	0.783
	9. If I wanted to, I could easily comply with my organization's ISSP on my own	3 0.7	8 1.8	90 20.8	223 51.5	109 25.2	3.99	0.773
	10. I would be able to follow most of ISSP even if there was no one around to help me	5 1.2	17 3.9	96 22.2	202 46.7	113 26.1	3.93	0.860
	Total no.	74	137	897	2141	1081		
	%	1.71	3.16	20.72	49.45	24.97		
Subjective norms	1. My organization's IT department pressures me to follow the organization's ISSP	28 6.5	48 11.1	150 34.6	163 37.6	44 10.2	3.34	1.020
	2. My subordinates think I should follow the organization's ISSP	13 3	23 5.3	145 33.5	191 44.1	61 14.1	3.61	0.899
	3. Upper level management thinks I should comply with the requirements of my organization's ISPPs	14 3.2	23 5.3	134 30.9	189 43.6	73 16.9	3.66	0.930
	4. My colleagues think that I should comply with the requirements of my organization's ISPPs	14 3.2	22 5.1	146 33.7	186 43.0	65 15.0	3.61	0.914
	Total no.	69	116	575	729	243		
	%	3.98	6.70	33.20	42.09	14.03		
Cost of compliance/ noncompliance	1. My noncompliance with the requirements of the ISSP would impact me negatively	21 4.8	28 6.5	127 29.3	190 43.9	67 15.5	3.59	0.987
	2. Complying with the requirements of the ISSP is time consuming for me	25 5.8	68 15.7	145 33.5	152 35.1	43 9.9	3.28	1.030
	3. Complying with the requirements of the ISSP is burdensome for me	40 9.2	64 14.8	141 32.6	146 33.7	42 9.7	3.20	1.098
	Total no.	86	160	413	488	152		
	%	6.62	12.32	31.79	37.57	11.70		

Table A1. Cont.

		SD	D	N	A	SA	M	±SD
General information security	1. Overall, I am aware of the potential security threats and their negative consequences	8 1.8	14 3.2	79 18.2	216 49.9	116 26.8	3.97	0.864
	2. I have sufficient knowledge about the cost of potential security problems	6 1.4	15 3.5	95 21.9	215 49.7	102 23.6	3.91	0.843
	3. I understand the concerns regarding information security and the risks they pose in general	7 1.6	12 2.8	84 19.4	219 50.6	111 25.6	3.96	0.841
	Total no.	21	41	258	650	329		
	%	1.62	3.16	19.86	50.04	25.33		
Information security policy	1. I understand the rules and regulations prescribed by the ISSP of my organization	15 3.5	17 3.9	99 22.9	212 49.0	90 20.8	3.80	0.931
	2. I know my responsibilities as prescribed in the ISSP to enhance the IS security of my organization	11 2.5	22 5.1	94 21.7	210 48.5	96 22.2	3.83	0.918
	Total no.	26	39	193	422	186		
	%	3.00	4.50	22.29	48.73	21.48		
Technology awareness	1. I follow news and developments about the security related technologies	13 3	32 7.4	107 24.7	201 46.4	80 18.5	3.70	0.954
	2. I discuss Internet security issues or anecdotes with friends and people around me	12 2.8	17 3.9	115 26.6	210 48.5	79 18.2	3.76	0.892
	3. I read about the problems of malicious threats attacking users' computers	14 3.2 4.6	20 22.6	98 50.6	219 18.9	82	3.77	0.918
	4. I seek advice about security issues through online discussion forums, magazines, and other media sources	19 4.4	22 5.1	106 24.5	199 46	87 20.1	3.72	0.985
	Total no.	58	91	426	829	328		
	%	3.35	5.25	24.60	47.86	18.94		

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