International Journal of Innovative Research and Scientific Studies, 8(2) 2025, pages: 3212-3225

IJIRSS
International Journal of Innovative Research & Scientific Studies

ISSN: 2617-6548

URL: www.ijirss.com

The effect of basic psychological needs on employees' behavioral intention to protect industrial technology in high-tech firms

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Abstract

As high-tech companies become increasingly important globally, these companies dedicate greater resources to robust technology security and leakage-prevention measures. This study aims to define the factors influencing autonomy, competence, and relatedness which are the basic psychological needs that influence the information leakage-prevention behaviors of employees in high-tech industry enterprises based on self-determination theory (SDT). Additionally, this empirical study investigates the influence of these factors on the behavioral intentions related to industrial technology leakage prevention. It analyzes the relationship between basic psychological needs and intrinsic and extrinsic motivation based on SDT. Moreover, it verifies the mediating effect of motivation on the relationship between basic psychological needs and behavioral intentions. An online survey was conducted among employees of high-tech industries in Korea resulting in the collection of 200 questionnaires. The analysis demonstrated that autonomy, competence and relatedness had a significant positive effect on intrinsic motivation. It means that intrinsic motivation plays a more critical role than extrinsic motivation in shaping the behavioral intention of high-tech firms to prevent industrial-technology leakage. However, no effect was observed for relatedness on extrinsic motivation or for extrinsic motivation on behavioral intentions. The findings indicate that autonomy negatively impacted extrinsic motivation. This suggests that in the high-tech technology sector, employees' intrinsic motivation primarily drives their technology security behaviors based on personal professional judgment and ethics rather than extrinsic motivation.

Keywords: Basic psychological needs, Behavioral intention, High-tech firm, Industrial technique protection, Self-determined theory, Technology leakage.

DOI: 10.53894/ijirss.v8i2.5964
Funding: This paper is written with support for research funding from aSSIST University
History: Received: 28 February 2025 / **Revised:** 31 March 2025 / **Accepted:** 3 April 2025 / **Published:** 4 April 2025

Authors' Contributions: Conceptualization, S. Lee.; methodology, S. Lee.; software, S. Lee.; validation, S. Lee. and B. Kim.; formal analysis, B. Kim.; investigation, S. Lee. and U. V. Ivan.; resources, S. Lee. and U. V. Ivan.; data curation, B. Kim.; writing—original draft preparation, S. Lee. and B. Kim.; writing—review and editing, U. V. Ivan. and B. Kim.; visualization, B. Kim.; supervision, B. Kim. and U. V. Ivan.; project administration, U. V. Ivan. and B. Kim.; funding acquisition, S. Lee. and U. V. Ivan. All authors have read and agreed to the published version of the manuscript.
Competing Interests: The authors declare that they have no competing interests.
Transparency: The authors confirm that the manuscript is an honest, accurate, and transparent account of the study; that no vital features of the study have been omitted; and that any discrepancies from the study as planned have been explained.
Ethical: The Research Ethics Committee of aSSIST University, Republic of Korea has granted approval for this study on 25 Sep 2024 (Ref No.: The Statistics Act No. 33, 34).
Publisher: Innovative Research Publishing

1. Introduction

As global competition for technological hegemony intensifies, pursuing technological advantage has become a central objective for companies and countries. Consequently, the awareness of high-tech industrial technology leakage is growing [1]. Efforts to prevent the leakage of industrial technology is essential because such leakages are difficult to repair or recover from Wang et al. [2]. As a result, developed countries have recognized the seriousness of the problem and have established national legal and institutional frameworks to effectively address the resulting damage [3]. In 2018, the United States strengthened protections and investment regulations for advanced technologies through the Export Control Reform Act (ECRA) and the Foreign Investment Risk Review Modernization Act (FIRRMA) [4]. The United Kingdom's National Security Investment Act 2021 (NSIA) [5] regulates foreign investment in high-tech companies. Japan enacted the Economic Security Promotion Act of 2022 to strengthen the protection of high technology [6] and Canada regulates foreign capital investment through the Canadian Investment Act [7]. In 2022, South Korea enacted the "Special Act on the Protection and Promotion of National Advanced Strategic Industries" which introduces regulations to prevent the outflow of national advanced strategic technologies to foreign countries and establishes a system for systematically developing these technologies [8].

Nevertheless, 82% of industrial technology leaks in high-tech companies are perpetrated by current or former employees as opposed to external intelligence agents because individuals with authorized access to storage media can easily obtain this information. The severity of the threats posed by insiders continues to rise [9]. According to the 2022 Cost of Insider Threats Global Report, the mean cost associated with insider threats has increased by 44% over the past two years. Furthermore, the average cost per incident has increased by more than one-third to US $15.38 million [10]. Ultimately, preventing technology leakage requires heightened systematic leakage-prevention efforts and industrial security awareness among organizational members [11, 12].

Examining previous research in this field, Hwang and Lee [13] explained that the higher an internal employee's self-control and organizational attachment, the lower the likelihood of industrial-technology leakage behavior. In their respective works, Sherif [14]; Dhillon, et al. [15]; Reinheimer [16]; Taherdoost [17] and Stoykov [18] explained that regular training should be provided during the drafting of internal security policies and the fortification of information security within the company. This approach is instrumental in reinforcing employees' security awareness. Kreicberga [19] emphasized the necessity of employee engagement in technology security and ensuring that employees are adequately informed about the benefits of security which can mitigate the risk of information leakage. However, these studies are constrained theoretically and suggest significance only at the security policy level. Instead of examining the industry or organizational level and behavioral influences (e.g., needs and motivators) on individual employee behavior should be explored more comprehensively.

This study aims to empirically analyze how employees' psychological needs and motivations affect the intention to prevent industrial technology leakage. Autonomy, competence and relevance are defined as psychological motivation factors and the effect of these individual psychological factors on the prevention of leakage of employees of high-tech companies are analyzed. In particular, this study examined the relationship between intrinsic and extrinsic motives and the effect on the behavioral intention to prevent leakage based on the theory of self-determination (SDT). It reveals the factors that influence the employee's behavior to prevent industrial technology leakage and provides implications for how companies manage employees to prevent technology leakage.

This study holds significance as it explicitly highlights the role of psychological factors and motivational dynamics, which have been relatively underexplored in existing information security research. It offers strategic insights aimed at enhancing industrial technology prevention behaviors within high-tech firms' organizations. Furthermore, it will enhance the effectiveness of information security policies by proposing well-defined strategies for organizations to design management approaches that effectively fulfill employees' basic psychological needs. This study is anticipated to uncover critical factors influencing information leakage prevention behaviors, offering practical, systematic, and actionable insights into effective strategies for organizations to manage their employees and strengthen information security measures.

This thesis is structured as follows: relevant literature and the study's hypotheses are offered in section 2. The research methodology, including the study design and the methods are provided in section 3. The results of the quantitative analysis, focusing on the impact of autonomy, competence, and relatedness on SDT are presented in section 4. A detailed discussion of the study's findings is provided in section 5, while section 6 concludes with theoretical and practical implications, proposing actionable strategies to strengthen information security and promote compliance with security policies.

2. Literature Review and Hypothesis Development

2.1. Self-Determination Theory (SDT) and Basic Psychological Needs

SDT is a theory that identifies types of motivation and the process by which motivation is formed [20]. As agents of action, humans value autonomous effort and focus on extrinsically motivated behavior as well as the process of internalizing values in addition to intrinsic motivation [21]. Therefore, SDT emphasizes that the most powerful motivators influencing the triggering and sustaining of an individual's behavior reside within the actors . Specifically, SDT is a meta-theory comprising organismic integration theory (OIT) and cognitive evaluation theory (CET) which include six sub-theories [20, 22, 23]. Table 1 lists the six sub-theories which include causality orientations theory, cognitive evaluation theory, organismic integration theory, basic psychological needs theory, goal contents theory, and relationship motivation theory [24].

Table 1.
Components of self-determination theory.

Theories	Key concepts	Sources and representative scholars
Causality orientations theory	A theory that describes how individuals perceive and regulate their behavior. It is divided into autonomy orientation, control orientation, and impersonal orientation.	Deci and Ryan [20]
Cognitive evaluation theory	A theory that describes the cognitive appraisal process of motivation and addresses the effects of extrinsic rewards and feedback on an individual's intrinsic motivation.	Deci and Ryan [25]
Organismic integration theory	A theory that addresses how extrinsic motivation can become autonomously internalized. It divides extrinsic motivation into extrinsic regulation, internal regulation, identified regulation, and integrated regulation and proposes that it can gradually change into an autonomous form.	Deci and Ryan [23]
Basic psychological needs theory	According to this theory, intrinsic motivation increases when three fundamental psychological needs for autonomy, competence and relatedness are fulfilled.	Deci and Ryan [20]
Goal contents theory	Theories that explain the differential impact of intrinsic (i.e., growth and relationships) and extrinsic (i.e., financial and prestige) goals on motivation and well-being.	Kasser and Ryan [26]
Relationship motivation theory	A theory that describes the intrinsic motivation for humans to form positive relationships with others and argues that the fulfillment of relational needs has important implications for well-being, autonomy, and feelings of competence.	Deci and Ryan [23]

Self-determination refers to how individuals perceive that they are choosing to perform the work assigned to them [27]. The concept emphasizes the importance of initiative and autonomy in work-related behaviors and processes. Deci and Ryan [20] proposed autonomy, competence, and relatedness as the three basic psychological needs that must be fulfilled for self-determination to manifest.

First, autonomy is the desire to set goals, act as the primary coordinator of one's actions and determine the meaning and value of these actions assuming that the actor is the source of these actions. It relates to whether the source of the behavior is internal or external. High autonomy is the desire to be free to make decisions without being controlled by external pressures [20, 23]. Second, competence is defined as the desire to demonstrate one's abilities and act efficiently in social settings and interactions. Competence is a subjective perception of one's capabilities rather than an objective assessment of one's actual abilities. An individual experiences a sense of competence when they internalize a sense of autonomy [28]. Third, relatedness is the desire to form positive and meaningful relationships with others. It is underscored as an essential factor for being a member of society [23].

In examining extant studies on the relationship between basic psychological needs and security policy compliance behavior in the context of industrial technology security, Lee [29] analyzed the relationship between the basic psychological needs of autonomy, competence and relatedness and security policy compliance behavior. The findings indicated that these three needs significantly predicted security policy compliance behavior. Min et al. [30] studied the relationship between self-determination trait factors and security awareness and intention. Their findings revealed that the primary variables of SDT, namely autonomy, competence, and relatedness significantly influenced security awareness and intention. Menard et al. [31] stated that autonomy, competence, and relatedness are necessary for individuals to feel that they can make their choices within a group context. In the context of information security, autonomy is explained as the necessity for an organization to manage its information assets and it goes beyond complying with strict external requirements such as regulatory penalties. Autonomy is the belief that organization members can solve information risk management problems on their own. Wall et al. [32] discovered that higher autonomy increased employees' self-efficacy and response efficacy which positively influenced information security policy (ISP) compliance intention. In a cybersecurity motivation study, Romero-Masters [33] showed that autonomy-based motivation using SDT positively influenced cybersecurity compliance intention.

Additionally, Menard et al. [31] highlighted the significance of competence which involves individuals being acknowledged by their colleagues for their information security expertise. The idea is that when individuals are perceived as capable of performing information security behaviors, they experience an enhanced sense of responsibility. Johnston and Warkentin [34] found that higher levels of self-efficacy positively impacted security behavior. Menard et al. [31] emphasized relatedness explaining that information security behaviors are reinforced when individuals exchange information with their peers. Venkatesh et al. [35] determined that individuals with higher interpersonal interaction and social influence in information technology adoption had higher information awareness. Furthermore, Menard et al. [31] and Hwang [36] empirically demonstrated that self-determination increases individuals' intention and behavior to comply with information security regulations. Considering the preceding analysis, factors related to autonomy, competence and relatedness comprise self-determination and may influence the security behaviors of employees in high-tech companies.

2.2. Basic Psychological Needs and Motivations

According to Ryan and Deci [24] individuals are driven by intrinsic and extrinsic motivation with intrinsic value or self-regulatory factors influencing socio-environmental demands. Intrinsic motivation arises from within an individual in the form of interest, excitement, adventure, the need to engage and improve, the need to know, the need for novelty, the need for excellence and goal orientation [37, 38]. Intrinsic motivation refers to the drive to maintain behavior based on the satisfaction, interest and value derived from the behavior itself [39]. Conversely, extrinsic motivation refers to motivation external to the behavior's self-regulation where the outcome of the behavior rather than its meaning determines the behavior. It is driven by external rewards such as recognition, praise, grades, external attention and feedback [37]. In contrast, intrinsic motivation is not related to obtaining rewards from outside sources such as bonuses, money and performance pay.

Intrinsic and extrinsic motivations are influenced by the determinants of SDT which include autonomy, competence, and relatedness. Regarding intrinsic motivation, Manganelli et al. [40] proposed that fulfilling the needs for autonomy, competence, and relatedness in organizational work environments can foster intrinsic motivation such as organizational identification which can lead to positive behaviors at the psychological, behavioral, and organizational levels. Ryan and Deci [28] suggested that relatedness is a crucial component of intrinsic motivation with the desire for competence and autonomy. They further argued that relatedness is essential for maintaining intrinsic motivation Ryan and Deci [28].

Alzahrani [41] emphasized the importance of understanding security behavior as employees' intrinsic motivation to meet SDT and comply with ISP. Gangire et al. [42] explained that autonomy, competence and relatedness enhance intrinsic motivation, which can lead to information security behaviors. Furthermore, Slemp et al. [43] argued that promoting autonomy, competence and relatedness enhances employees' intrinsic motivation and consequently, fosters their psychological development in the context of information security.

As previous studies have shown, the basic psychological factors of autonomy, competence, and relatedness affect the intrinsic motivation of employees regarding industrial technology protection. Therefore, the following hypotheses were formulated for this study:

H_1: Autonomy in industrial technology protection will have a positive impact on the intrinsic motivation of employees in high-tech firms.

H_2: Competence in industrial technology protection will have a positive impact on the intrinsic motivation of employees in high-tech firms.

H_3: Relatedness in industrial technology protection will have a positive impact on the intrinsic motivation of employees in high-tech firms.

Ryan and Connell [44] explained that extrinsic motivation varies with the degree of autonomy and can be enhanced by categorizing motivation to increase levels of autonomy. According to Chang [45] a work environment that allows for autonomy triggers both intrinsic and extrinsic motivation leading to positive performance attitudes and high job engagement. Additionally, Luria [46] considered extrinsic motivation benefits as the highest form of motivation that fulfills the innate psychological needs for autonomy, competence, and relatedness. Makki and Abid [47] found that extrinsic motivation positively correlates with employees' job performance. Cerasoli et al. [48] and Ryan and Deci [49] argued that extrinsic motivation is enhanced by supporting basic psychological needs such as autonomy, competence, and relatedness. These factors may also influence extrinsic motivation in the security behaviors of employees in high-tech firms. We thus formulated the following hypotheses:

H_4: Autonomy in industrial technology protection will have a positive impact on the extrinsic motivation of employees in high-tech firms.

H_5: Competence in industrial technology protection will have a positive impact on the extrinsic motivation of employees in high-tech firms.

H_6: Relatedness in industrial technology protection will have a positive impact on the extrinsic motivation of employees in high-tech firms.

2.3. Behavioral Intention to Protect Industrial Technology

Behavioral intention can be defined as the likelihood of an individual performing a behavior based on their perception. Thus, an individual's internal intention to perform an external behavior that predicts their actual behavior [50]. According to Parish et al. [51] intention is a cognitive plan influenced by personal evaluations and social norms before a specific behavior is performed. Ajzen [52] defined behavioral intention as the subjective likelihood that a belief or attitude will be acted upon. It represents an individual's subjective state and is perceived as an intermediate variable between attitude and behavior. Ajzen [53] proposed that behavioral intention encompasses motivational factors influencing behavior and that the greater the behavioral intention, the more the likelihood of the behavior being performed by the individual. In other words, measuring an individual's willingness or belief to pursue a particular behavior can predict whether the behavior will occur. Thus, individuals with strong intentions are more likely to exert effort to achieve their goals and be better aligned to perform their behaviors [54, 55].

Behavioral intentions are influenced by intrinsic and extrinsic motivation. The severity and clarity of punishments and sanctions which are concepts of extrinsic motivation can drive employee engagement in information security Jaeger et al. [56]. Flaudias et al. [57] highlighted the importance of extrinsic motivation and behavioral regulation demonstrating that within the framework of SDT, certain forms of extrinsic motivation can enhance an individual's commitment to an activity if it includes self-determination. Herath and Rao [58] investigated the influence of incentives on the perceived effectiveness of punishment, pressure, and employee behavior in improving employees' understanding of ISP compliance. They found

that security behavior can be influenced by intrinsic and extrinsic motivation. Additionally, Son [59] observed that intrinsic motivation (e.g., self-esteem and achievement) and extrinsic motivation like appreciation and rewards are crucial for reinforcing employee compliance behavior.

Davis et al. [60] found that satisfying the psychological needs for autonomy, competence, and relatedness enhances employees' intrinsic commitment to information security performance strengthening their intention to engage in information security. Gangire et al. [61] explained that intrinsic motivation plays a critical role in employee compliance with security policies, enabling organizations to motivate employees to comply autonomously. Alzahrani and Johnson [62] found that intrinsic motivation, intention, and awareness influence security decisions and compliance with information security policies. Kranz and Haeussinger [63] reported that intrinsic motivation positively impacts the intention to comply with security policies. Padayachee [64] found that extrinsic motivation influences information security compliance behavior and that organizations can leverage it to increase security policy compliance. This extrinsic motivation can be internalized and evolve into autonomous compliance behavior. Therefore, extrinsic motivation has a substantial impact on the information-security behavior (ISB) of employees. We thus formulated the following hypotheses:

H_7: Intrinsic motivation in industrial technology protection will have a positive impact on the behavioral intention of employees in high-tech firms.

H_8: Extrinsic motivation in industrial technology protection will have a positive impact on the behavioral intention of employees in high-tech firms.

3. Materials and Methods

3.1. Research Model

A research model was designed as shown in Figure 1 based on the above hypothesis. First, autonomy, competency, and relevance variables were set as independent variables. Intrinsic and extrinsic motivation factors were set as parameters. The dependent variable was set as the intention of action to prevent industrial technology leakage. Accordingly, a structural equation analysis model for hypothesis verification was structured as a model that established a causal relationship between independent variables, parameters and dependent variables.

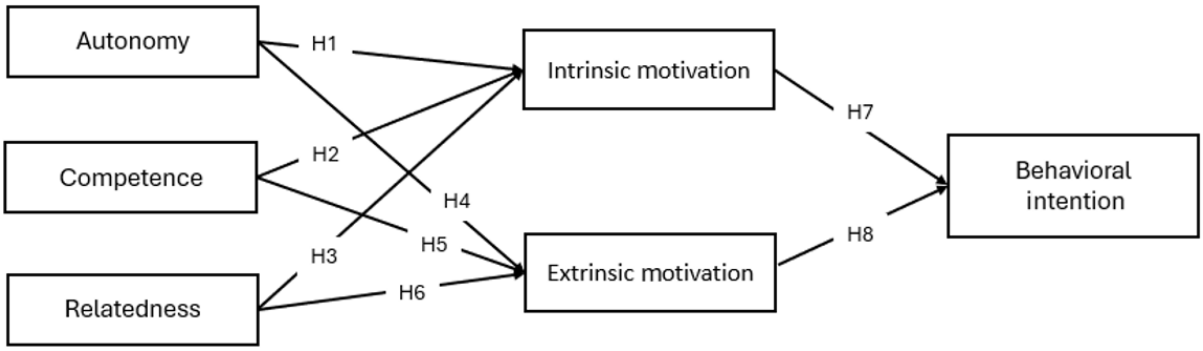

Figure 1.
Research model.

3.2. Measurement Variable and Data Collection

The questionnaire was organized as shown in Table 1 based on previous studies. In this study, industrial technology protection behavior is categorized for members in high-tech industries. This study is based on SDT, a theory of human behavior that identifies the roots of individuals' motivations and the processes by which these motivations are formed which are classified as "autonomy," "competence," and "relatedness" [20]. SDT posits that the external socio-environmental conditions in which an individual is placed will influence intrinsic motivation which is generated by satisfying the basic psychological needs of autonomy, competence, and relatedness [21].

SDT classifies motivation as intrinsic and extrinsic. Intrinsic motivation is derived from personal satisfaction and fulfillment, for example, by personal interest, joy, and pleasure [20]. It is driven by internally rewarding outcomes such as the joy of doing something special or satisfying one's curiosity rather than external factors, such as reward, avoidance of punishment or guilt, task performance, and social recognition [64]. Intrinsic motivation refers to the sense of reward from industrial technology protection activities, distinct from external rewards. Conversely, extrinsic motivation is driven by rewards or outcomes such as financial incentives, enhanced self-esteem, social approval or the avoidance of penalties [20]. The reason for engaging in an activity is to achieve a specific goal such as a tangible reward or public recognition [65]. In the context of industrial technology protection, as in other areas, extrinsic motivation includes monetary rewards, bonuses, and prestige.

In this study, "autonomy" is an individual's desire to act on their own will in protecting industrial technology. It is classified as a self-centered intrinsic need where the individual drives the behavior and seeks to act in alignment with personal volition [65]. Thus, the variable of autonomy is a factor influencing effective industrial-technology protection behavior. Competence is an individual's desire to efficiently protect industrial technology to the best of their ability. It encompasses feelings of confidence gained through continuous interaction with the social environment. The term denotes the ongoing attempts to enhance and maintain one's abilities and competencies through activities and the pursuit of

challenges in optimal situations. This competence is not merely a skill or proficiency acquired through such activities but rather confidence gained from the experience [66].

Thus, the variable of competence is a factor influencing effective industrial-technology protection behavior. “Relatedness” is an individual’s desire to strengthen interpersonal connections regarding industrial technology protection, fostering a sense of belonging and respect. It involves giving and receiving attention with feeling socially connected with others. It reflects the desire to form intimate emotional bonds with others [67]. Therefore, the variable of relatedness was defined as an influencing factor for effective protection behavior of industrial technology.

SDTs are not mutually exclusive and are classified into intrinsic and extrinsic motives according to the degree of individual autonomy [20]. Intrinsic motivation is created within an individual whereas extrinsic motivation is formed and expressed by the social environment [66, 68]. Essentially, both intrinsic and extrinsic motivations influence an individual's behavioral intention. Accordingly, the intrinsic and external motives of the members of the organization have an influence on the intention to protect industrial technology.

Table 2.
Variable definitions and measurement items.

Factors	Measurement items	References
Autonomy	• I feel confident in making my own decisions about how to live my life. • I generally feel free to express my thoughts and opinions. • I rarely have opportunities to independently decide on how to approach my work. • People who know me often say I am good at taking care of myself.	Deci and Ryan [20], Adie et al. [69] and Ryan and Deci [65]
Competence	• I gain a sense of accomplishment from most of the things I do. • I consider myself efficient. • I am good at teaching others what I know. • I believe I excel at many things compared to others.	
Relatedness	• I get along well with the people I meet. • I really like the people around me. • I usually give and receive help from those around me. • The people around me often share their feelings with me.	
Intrinsic motivation	• I think engaging in behavior that protects industrial technology is important. • Protecting industrial technology gives me a sense of satisfaction. • Protecting industrial technology aligns with my values. • I can develop myself by taking measures to protect industrial technology.	Deci and Ryan [20], Ryan and Deci [65], Guay, et al. [70] and Li, et al. [71]
Extrinsic motivation	• I think others will disregard me if I do not engage in industrial technology protection behavior. • I believe that protecting industrial technology will result in rewards (such as increased income and promotion). • People protect industrial technology owing to pressure from colleagues and others. • I believe that protecting industrial technology is the best way to gain recognition from colleagues at work.	
Behavioral intention	• I am dedicating my efforts to the protection of industrial technology. • I plan to take proactive measures for the protection of industrial technology. • I will do my best to ensure that industrial technology is protected.	Ajzen and Driver [72], Ajzen and Driver [72], Ajzen [53] and Quintal et al. [73]

3.3. Data Collection and Analysis Method

These variables were incorporated into the questionnaire which included 23 questions. The survey questionnaire was validated in seven days to improve its reliability and validity. In total, 220 responses were collected and analyzed with eight excluded owing to dishonesty, leaving 200 valid samples. Data were collected between April 29 and May 6, 2024. However, factor analysis led to excluding one autonomy, one competence, two relatedness, two intrinsic motivation, and two extrinsic motivation factors. SPSS 29.0 was utilized for the analysis of demographic characteristics, descriptive statistics, and exploratory factor analysis. AMOS 29.0 was employed to conduct confirmatory factor analysis (CFA) based on structural equation modeling, model validation, and path analysis for path analysis of the hypotheses. Additionally, a final CFA was completed using AMOS.

This study employed an online survey method to collect data from a randomly selected sample of office workers in high-tech industries. Table 3 shows a frequency analysis of the general characteristics of the participants. The gender breakdown shows that 65.0% of respondents identified as men and 35.0% identified as women. Regarding age, 7.5% of

respondents were aged between 20 and 29; 38.0% were aged between 30 and 39; 36.5% were aged between 40 and 49; 15% were aged between 50 and 59, and the final 3% were aged between 60 and 69. In terms of the industry sector, 22.5% were from electronics (e.g., semiconductors and displays), 46.5% from information technology (IT), 12.5% from genetics and biotechnology, 16.0% from new materials, and 2.5% from other sectors. A breakdown by job title reveals that 9.5% were executives and above; 17.0% were department managers or directors; 41.0% were managers or deputy general managers, and 32.5% were staff, associates, or assistant managers. In terms of company size, large companies accounted for 47%; small and medium-sized enterprises accounted for 52.5%, and others for 0.5%. In terms of work experience, 23.5% (n = 47) had less than five years of experience; 34.0% had 5–10 years; 27.5% had 10–20 years, and 15.0% had more than 20 years (see Table 3).

Table 3.
Demographic information of survey participants.

Classification		Frequency	Percentage (%)
Gender	Male	130	65.0
	Female	70	35.0
Age	20–29	15	7.5
	30–39	76	38.0
	40–49	73	36.5
	50–59	30	15.0
	60–69	6	3.0
Industry sector	Electronics (Semiconductors and displays)	45	22.5
	Information technology (IT)	93	46.5
	Genetics and biotechnology	25	12.5
	New materials	32	16.0
	Other	5	2.5
Job title	Executives and above	19	9.5
	Department managers or directors	34	17.0
	Managers or deputy general managers	82	41.0
	Staff, associates, or assistant managers	65	32.5
Corporation size	Large companies	94	47.0
	Small and medium-sized enterprises	105	52.5
	Other	1	0.5
Work experience	Less than five years	47	23.5
	5–10 years	68	34.0
	10–20 years	55	27.5
	More than 20 years	30	15.0

4. Results

4.1. Analysis Results of Reliability and Validity

The mean value and standard deviations were confirmed as shown in Table 4 as a result of descriptive statistical analysis. In addition, the skewness and kurtosis were confirmed not to violate the multivariate normality assumption, and the data appropriateness was presented.

Table 4.
Descriptive statistical analysis results.

Variables	N	Minimum	Maximum	Mean	Standard deviation	Skewness	Kurtosis
Autonomy	200	2	5	3.925	0.567	-0.387	1.229
Competence	200	1.67	5	3.683	0.615	-0.297	0.149
Relatedness	200	2	5	3.725	0.611	-0.066	0.011
Intrinsic motivation	200	1.5	5	3.872	0.661	-0.231	0.485
Extrinsic motivation	200	1	5	3.045	0.963	-0.316	-0.274
Behavioral intention	200	2	5	3.867	0.645	0.029	-0.369

We examined the observed variables' factor loadings to determine whether each observed variable accurately reflected the latent variable, as illustrated in Table 5. All path coefficients were statistically significant indicating that the observed variables effectively reflected the latent variable. Furthermore, the standardized path coefficient (β) exceeded 0.5 demonstrating satisfactory conceptual validity. Next, we assessed each variable's reliability and convergent validity. A conceptual reliability (CR) of 0.7 or higher and an average variance extracted (AVE) of 0.5 or higher indicate high validity. Additionally, Cronbach's alpha is considered to indicate high reliability if it exceeds 0.6. The autonomy construct's reliability was confirmed by a CR of 0.767, an AVE of 0.528, and a Cronbach's alpha of 0.761.

Table 5.
Results of reliability and convergent validity test.

Variables	Measurement question	Factor loading	S.E.	t-value	p-value	CR	AVE	Cronbach α
Autonomy	A1	0.837	-	-	-	0.767	0.528	0.761
	A2	0.731	0.220	7.688	***			
	A3	0.591	0.187	7.425	***			
Competence	C1	0.584	-	-	-	0.729	0.476	0.723
	C2	0.781	0.116	6.891	***			
	C3	0.690	0.149	8.339	***			
Relatedness	R1	0.701	-	-	-	0.654	0.486	0.649
	R2	0.693	0.145	5.953	***			
Intrinsic motivation	IM1	0.759	-	-	-	0.683	0.519	0.680
	IM2	0.680	0.157	7.093	***			
Extrinsic motivation	EM1	0.636	-	-	-	0.804	0.682	0.766
	EM2	0.980	0.193	3.701	***			
Behavioral intention	BI1	0.746	-	-	-	0.840	0.637	0.835
	BI2	0.822	0.089	10.860	***			
	BI3	0.823	0.084	11.955	***			

Note: *** $p < 0.001$ / S.E., Standard error; CR, Conceptual reliability; AVE, Average variance extracted.

According to the criteria set forth by Browne and Cudeck [74] the final model exhibited a superior fit compared to the original model. A closer examination of the final model revealed that the TLI was at the cutoff value of 0.9, and the CFI exceeded this cutoff. The RMSEA value was below the cutoff value of 0.10 indicating an overall good fit and confirming the appropriateness of the CFA model. The aforementioned criteria are generally considered reasonable benchmarks while no absolute threshold for goodness of fit has been established. Thus, the degree of goodness of fit is relative to the specific context of the study (see Table 6).

Table 6.
Analysis of the goodness of fit of measurement models.

Models	χ^2(df)	p	DF	χ^2/(df)	RMR	GFI	AGFI	NFI	TLI	CFI	RMSEA
Original model	543.499	0	278	1.948	0.070	0.825	0.779	0.770	0.848	0.870	0.069
Final model	155.011	0	75	2.067	0.044	0.910	0.856	0.865	0.892	0.923	0.073

Notes: DF, Degrees of freedom; RMR, Root-mean square residual; GFI, Goodness-of-fit index; AGFI, Adjusted goodness-of-fit index; NFI, Normal fit index; TLI, Tucker-Lewis index; CFI, Comparative fit index; RMSEA, Root-mean square error of approximation.

The square root of AVE showed a higher value than the correlation coefficient for all variables indicating that the discriminant validity was significant (see Table 7).

Table 7.
Correlation matrix and discriminant validity

Variables	Autonomy	Competence	Relatedness	Intrinsic motivation	Extrinsic motivation	Behavioral intention
Autonomy	**0.727**					
Competence	0.576	**0.690**				
Relatedness	0.390	0.585	**0.697**			
Intrinsic motivation	0.442	0.594	0.428	**0.720**		
Extrinsic motivation	-0.233	0.119	0.114	-0.017	**0.826**	
Behavioral intention	0.491	0.559	0.569	0.695	0.043	**0.798**

Note: The square root of AVE is shown in bold letters.

4.2. Analysis Results of Structural Model

The goodness of fit of the structural model was analyzed as illustrated in Table 8 and Figure 2. The model yielded a χ^2 (df) of 167.738, with a χ2/degrees of freedom of 2.123. The goodness-of-fit index (GFI) was 0.904. The normal fit index (NFI) was 0.854. The root-mean square residual (RMR) was 0.046; the adjusted goodness-of-fit index (AGFI) was 0.854, and RMSEA was 0.075 indicating a satisfactory model fit. The p-value for the structural equation model fit was statistically significant, and the TLI that assesses the model's explanatory power was close to but did not exceed the threshold of 0.9. In

contrast, the CFI which shows the model's explanatory power was 0.915 surpassing the threshold of 0.9 indicating that the model had a good overall fit.

Furthermore, extrinsic motivation had no effect on behavioral intention which led to rejecting the hypothesis (H8). The results indicated that autonomy positively influenced intrinsic motivation (2.058, $p < 0.05$) and negatively affected extrinsic motivation (-3.871, $p < 0.001$). Competence positively affected both intrinsic motivation (2.671, $p < 0.001$) and extrinsic motivation (2.078, $p < 0.05$). Relatedness positively affected intrinsic motivation (1.975, $p < 0.05$). Furthermore, intrinsic motivation positively affected behavioral intention (0.515, $p < 0.001$).

Table 8.
Results of the hypothesis tests.

Section	Path	B	CR (p)	Hypothesis	R^2
H1	Autonomy → Intrinsic motivation	0.298	2.058*	Accepted	0.517
H2	Competence → Intrinsic motivation	0.357	2.671**	Accepted	
H3	Relatedness → Intrinsic motivation	0.212	1.975*	Accepted	
H4	Autonomy → Extrinsic motivation	-1.233	-3.871***	Accepted	0.166
H5	Competence → Extrinsic motivation	0.559	2.078*	Accepted	
H6	Relatedness → Extrinsic motivation	0.242	1.128	Rejected	
H7	Intrinsic motivation → Behavioral intention	0.955	6.684***	Accepted	0.643
H8	Extrinsic motivation → Behavioral intention	0.020	0.515	Rejected	

Note: Structural model fit: χ^2(df) = 167.738, χ^2/degree of freedom = 2.123, RMR = 0.046, GFI = 0.904, AGFI = 0.854, NFI = 0.854, TLI = 0.887, CFI = 0.915, RMSEA = 0.075.
* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

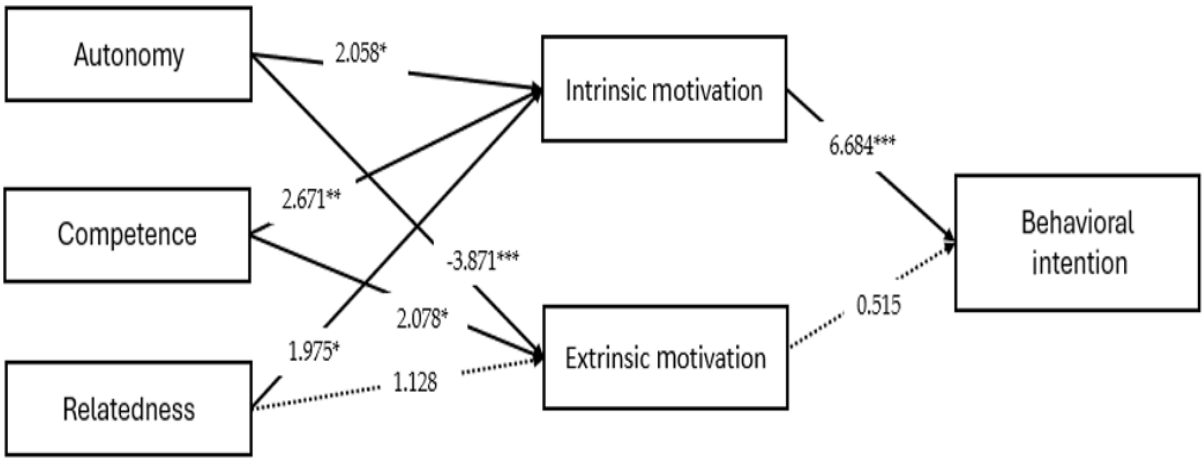

Figure 2.
Research result model.
Note: *p < 0.05, **p < 0.01, ***p <0.001.

4.3. Mediated Effect

As shown in Table 9, we employed a boosting method to assess the significance of the indirect effects and determined the direct, indirect, and total effects. The path analysis results indicated that the indirect effect of autonomy on intrinsic motivation was 0.285 and statistically significant; this confirmed that autonomy has an effect through the mediation of intrinsic motivation. The indirect effect through extrinsic motivation was -0.025 but this was not statistically significant. Thus, autonomy does not affect behavioral intention through extrinsic motivation and therefore, no mediation effect occurs. For competence, the indirect effect through intrinsic motivation was statistically significant at 0.341 confirming that competence has a mediating effect through intrinsic motivation. The indirect effect through extrinsic motivation was 0.011 but not statistically significant; therefore, competence does not affect extrinsic motivation through extrinsic motivation, and no mediation effect occurs. Regarding relatedness, extrinsic motivation did not mediate behavioral intention. Instead, autonomy and competence in industrial security were more effective in mediating intrinsic motivation toward behavioral intention.

Table 9.
Results of the mediated effect.

Dependent variables	Explanatory variables	Direct effect	Indirect effect	Total effect
Autonomy	Intrinsic motivation	0.298*	-	0.298
	Extrinsic motivation	-1.233***	-	0.516
	Intrinsic motivation -> Behavioral intention	-	0.285***	0.583
	Extrinsic motivation -> Behavioral intention	-	-0.025	-1.258
Competence	Intrinsic motivation	0.357**	-	0.218
	Extrinsic motivation	0.559*	-	0.548
	Intrinsic motivation -> Behavioral intention	-	0.341*	0.698
	Extrinsic motivation -> Behavioral intention	-	0.011	0.570
Relatedness	Intrinsic motivation	0.212*	-	0.367
	Extrinsic motivation	0.242	-	0.564
	Intrinsic motivation -> Behavioral intention	-	0.202	0.414
	Extrinsic motivation -> Behavioral intention	-	0.005	0.247

Note: *$p < 0.05$, **$p < 0.01$, ***$p < 0.001$.

5. Discussion

This study grounded in SDT provides empirical evidence on the impact of individual psychological needs on high-tech company employees' behavioral intentions to prevent industrial-technology leakage. The study found that these effects are mediated by intrinsic and extrinsic motivation factors. The analysis yielded the following primary research findings.

First, intrinsic motivation plays a more critical role than extrinsic motivation in shaping the behavioral intention of high-tech firms to prevent industrial-technology leakage. These results align with those of previous studies. Kohn [75] and Hagger and Chatzisarantis [76] argued that compared to extrinsic motivation, intrinsic motivation is a more powerful predictor of behavioral intentions in organizational settings. Gagné and Deci [77] demonstrated that extrinsic motivation, such as monetary rewards, influenced employees' short-term job performance but had no significant effect on long-term behavioral intentions such as the intention to remain in the organization and voluntarily take on additional work. According to SDT, humans naturally tend to seek psychological growth and integration which includes connecting with others and personal development [23]. When needs for autonomy, competence and relatedness are fulfilled, individuals experience enhanced psychological growth reducing their intention to leak knowledge. Thus, a heightened awareness of information protection behavior serves as an intrinsic motivator, encouraging organizational members to voluntarily engage in behaviors that protect industrial technology. In the high-tech industries, it can be concluded that behavioral intentions to prevent industrial technology leakage are more strongly influenced by intrinsic motivational factors than by extrinsic motivational factors.

Second, relatedness does not have a substantial impact on extrinsic motivation. Extrinsic motivation is primarily driven by external factors such as rewards, incentives and promotions. Relatedness, as a psychological need does not directly stimulate extrinsic motivation. Suen et al. [78] argued that relatedness is less associated with extrinsic motivation compared to intrinsic motivators such as autonomy and competence. Wilkesmann and Vorberg [79] also found that while relatedness enhances intrinsic motivation, it does not significantly affect extrinsic motivation. Thus, this study's results align with previous research indicating that employee involvement in high-tech company security initiatives does not directly influence extrinsic motivation. It is important for high-tech companies to stimulate external motivation factors related to the autonomy and competence of their members to stimulate external motives to build the effect of protecting industrial outflows. Therefore, when considering systems and policies such as compensation and promotion systems for industrial technology security, companies can consider designing programs that can stimulate autonomy and competence.

Third, autonomy negatively impacts extrinsic motivation which is intrinsically linked with intrinsic motivation. High levels of autonomy allow individuals to feel in control of their actions, thereby enhancing intrinsic motivation. However, this sense of autonomy can conflict with extrinsic motivation which relies on external rewards or incentives. As shown by Ryan and Deci [65], while autonomy promotes intrinsic motivation, it can diminish the importance of external factors and weaken extrinsic motivation. Extrinsic motivation is stimulated by external factors such as rewards and punishments. Therefore, an emphasis on autonomy may result in a decrease in the importance of external factors and weakening of extrinsic motivation. Thus, the study supports previous findings that intrinsic motivation is a key driver of employees' intentions to prevent industrial-technology leakage with extrinsic motivation also playing a role. In particular, employees in the high-tech industry may have stronger intrinsic needs such as professional-based pride and self-efficacy. In addition, when a positive psychological desire for autonomy and innovation is expressed, it can affect organizational commitment or satisfaction. In the end, it can be seen that in order to strengthen organizational citizenship awareness of industrial technology leakage prevention behavior, it is necessary to strengthen internal motivation based on autonomy.

6. Conclusion

6.1. Research Implications

The rapid acceleration of technological innovation and the dynamic shifts in the global marketplace have significantly heightened the critical importance of industrial security, particularly in high-tech sectors that are increasingly vulnerable to

risks such as intellectual property theft, data breaches and advanced cyberattacks. Traditional security measures are insufficient to address these challenges, necessitating an integrated approach that combines the psychological and behavioral dimensions of employees with advanced technical solutions. Grounded in SDT, this study examines the impact of intrinsic and extrinsic motivation on industrial technology prevention behaviors. By bridging theoretical insights with practical applications, it seeks to offer a meaningful academic contribution to the field of industrial security management and propose actionable strategies to enhance security compliance behaviors within organizations facing growing technological complexity and evolving security threats.

Based on the findings, we propose three key implications for how high-tech industrial companies should address industrial technology security issues. First, enhancing intrinsic motivation positively impacts behavioral intention to prevent technology leakage. Intrinsic motivation boosts an individual's autonomy and self-determination leading them to engage in activities that are inherently enjoyable and satisfying. Companies should empower employees with autonomy and involve them in work-related decisions.

This approach enhances intrinsic motivation. Additionally, companies should help employees understand how their work contributes to the company's vision and goals. Such practices foster a sense of value and importance; this in turn strengthens intrinsic motivation. Employees should also be given opportunities for personal development and growth through ongoing technology security training programs and education. Organizations should offer customized security training tailored to the organization's specific needs and employees' individual roles and responsibilities to reinforce behavioral intentions aimed at preventing technological leaks. This training should clarify the connection between employees' work and the organization's technology security goals. Furthermore, organizations should provide opportunities for direct participation in security-related decision-making processes and reinforce intrinsic motivation by ensuring employees experience continuous growth and development through regular feedback.

Second, relatedness does not impact extrinsic motivation. Since workplace interactions and a sense of belonging do not directly influence extrinsic rewards such as salary and promotions, employers may benefit more from providing direct rewards rather than trying to foster relatedness to enhance extrinsic motivation. The following two distinct strategies must be considered when motivating employees: stimulating intrinsic motivation through relatedness and using clear reward schemes for extrinsic motivation. This approach can help organizations design more effective motivational programs. To motivate employees, organizations should highlight the intrinsic value of their work through programs that promote team interaction and reinforce a sense of belonging, while also establishing clear performance-based reward systems that directly link extrinsic rewards, such as pay and promotions, to employee performance. This dual approach will enable organizations to create a balanced motivational environment and build an effective culture and team climate.

Third, autonomy can negatively affect extrinsic motivation and needs to be carefully managed. The findings indicate that an increase in autonomy does not always lead to positive outcomes. Specifically, increased autonomy in tasks linked to extrinsic motivation can create confusion in situations that require clear guidance and rewards. This confusion can diminish motivation among employees and hinder their goal achievement; therefore, clear guidance and rewards are often more effective than autonomy alone. We recommend adjusting the level of autonomy based on the situation, providing regular feedback and support, and helping employees understand the meaning and value of their work.

This approach can be effective in high-autonomy environments where clear goals and extrinsic rewards can enhance motivation and facilitate achievement. Discussing a goal-oriented environment is crucial for reinforcing security behavior within an organization. Such discussions should set clear expectations, increase accountability, strengthen motivation, and ensure consistency. In cases where increased autonomy might reduce extrinsic motivation, establishing transparent goals and implementing appropriate rewards can serve as effective alternatives. This environment ensures that employees understand the organization's security goals and their roles, minimizing confusion and encouraging compliance with security regulations. Regular feedback and support also play a vital role in mitigating the negative effects of autonomy in a goal-oriented context and fostering a sense of responsibility among employees.

6.2. Research Limitations and Future Plans

The following limitations are inherent to this study: First, the study sample is not unique and lacks generalizability. Since this study was conducted on high-tech industrial firms in Korea, the results may not be generalizable to other industries and countries. The different cultural, social, economic, and legal environments in each country can lead to variations in organizational culture regarding technology leakage. Additionally, the risks associated with and responses to technology leakage can vary depending on the type of organization such as small versus large businesses or manufacturing versus services. Future studies should address these differences by conducting comparative research across various countries, industries, and types of companies.

Second, this study used intrinsic and extrinsic motivation based on SDT as well as the basic psychological needs of autonomy, competence, and relatedness as the main variables. However, the model does not fully account for other significant variables that might influence the prevention of technology leakage. Therefore, future research should use qualitative methods such as case studies or in-depth interviews to capture and analyze a broader range of variables. This approach would help construct a more comprehensive research model and enable a deeper examination of interactions between variables.

Third, this study is limited by its inability to provide insights into how the constructs of intrinsic motivation, extrinsic motivation, autonomy, competence, and relatedness vary over time. Behavioral intentions for technology leakage prevention may change over time; it is therefore imperative to adopt a long-term perspective. Future research could include

longitudinal studies to analyze the long-term impact of these constructs and observe changes over time through follow-up studies.

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