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ADMINISTRATIVE AND TECHNOLOGICAL INNOVATION: THE INDIRECT EFFECTS OF ORGANIZATIONAL CULTURE AND LEADERSHIP

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Abstract

Administrative innovation is defined as changes to the rules and structures that characterize the communication methods and work of employees within an organization, and technological innovation refers to the implementation of programs and services. This study examines the relationship between administrative and technological innovation using two environmental factors, namely leadership and organizational culture, as indirect variables.

Using structural equation modeling on a 2015 Korea Institute of Public Administration survey, this study finds that there are no direct effects between administrative innovation and technological innovation. However, results indicate that a strong organizational culture positively affects the relationship between administrative and technological innovation, and leadership in an organization plays a similar role to that of organizational culture. These findings suggest that changing the rules of are organization alone is not enough to lead to technological innovation, which must be supported by a strong culture and leadership.

Keywords: administrative innovation, technological innovation, culture, leadership, public sector innovation.

1. Introduction

The topic of innovation has received considerable attention from various sectors, particularly the business sector, because it is considered a core value that enables organizations to improve their competitive advantage, efficiency, and growth potential (Borins, 2002; Demircioglu, 2017; Ekval and Aroven, 1994; Howell and Higgins, 1990; Tushman and O'Reilly, 2002). Nonetheless, relatively little attention has been given to innovation in the public sector due to the distinctive characteristics of public organizations, such as high level of regulations, rigid conformity to formal rules, and the complex relationship between innovative activities and performance management (Demircioglu, 2017; Jaskyte, 2011; Salge and Vera, 2012). This recent change in research trends has been noted because many studies on public sector innovation have simultaneously been conducted in diverse areas. For example, many studies on public sector innovation have been conducted in the US and the UK. Public sector innovation research has also been receiving considerable attention in European countries and the Australian public sector (Bugge and Bloch, 2016; Demircioglu, 2021; Demircioglu and Audretsch, 2020; Torugsa and Arundel, 2016) where a wide variety of topics, including the conditions for innovation, job satisfaction, innovation factors, and the effects of innovation, have been discussed. This is very encouraging because most public sector innovations are heterogeneous (Demircioglu and Audretsch, 2020), which justifies the need for research on innovation in other areas.

Additionally, both practitioner and academic communities have now recognized that public sector organizations should be innovative and maintain high standards of service. Many studies about public sector innovation have covered the subject of increasing pressure for central and local governments to be more effective, efficient, and responsive to resident demands to address the changing external environment, such as service provision and demographic pressures (Cinar, Trott and Simms, 2021; Meijer and Thaens, 2021; OECD, 2015; Ruijer and Meijer, 2020). This trend indicates the need for more innovation within public organizations, and more studies on innovation in public organizations should therefore be conducted. Innovation is not only essential for the competitive advantage and successful operation of public organizations but also for addressing various internal organizational issues. For instance, innovation plays an important role in economic development and competition in both the public and private sectors (Cefis and Marsili, 2006; Lee, Li and Jung, 2019; Park, Lee and Lee, 2003). Consequently, researchers and public officials need to understand both how public organizations can innovate and the processes that should be followed for public organizations to become innovative.

In this sense, this research focuses specifically on the relationship between administrative and technological innovation. One of the main reasons for focusing on the relationship between administrative and technological innovation is that the adoption of innovation in public organizations is complex and diverse, depending on the type of innovation, such as technological, administrative, and process (Jaskyte, 2011). Specifically, many researchers have found that different types of innovation are not equally related to or affected by the same variables (Damanpour, 1988; Jaskyte and Kisieliene, 2006; Subramanian

and Nilananta, 1996). In other words, the factors relating to innovation are driven at the personal, environmental, and organizational levels and have different impacts on the adoption of innovations. The main trend in innovation studies is that many researchers have analyzed the relationship between various organizational processes and structural characteristics (Damanpour, 1987; Kimberly and Evanisko, 1981; Wolfe, 1994). For instance, many studies have used centralization, specialization, complexity, administrative intensity, external and internal communication, and resources as variables for innovation. Structural factors relating to technological innovation are different from those of administrative innovation, and few studies have analyzed the relationship between administrative and technological innovation. In this sense, more research is needed to examine innovations from various angles in terms of organizational processes. Here, technological innovation is exemplified by the South Korean smart work project, which utilizes Smart Work Centers, video conferencing, teleworking, mobile working, and exclusive messengers (The Seoul Development Institute, 2012), whereas administrative innovation is defined as 'the implementation of a structure, procedure system, or process in the administrative core of an organization that is new to the prevailing organization practices' (Jaskyte, 2011, p. 78). Additionally, although many innovation studies have predominantly focused on structural factors (Jaskyte, 2011), adding to this, the current study also explores two environmental factors, namely leadership and organizational culture, as indirect variables of technological innovation.

Accordingly, this study aims to contribute to the field of innovation by posing the following research questions: (1) How does administrative innovation affect technological innovation (smart work)? (2) How does administrative innovation affect organizational culture and leadership? (3) How do organizational culture and leadership influence technological innovation? In this study, the argument is that public organizations, by adopting administrative innovation, allow organizational culture and leadership to influence technological innovation.

2. Literature review

2.1. Innovation in public organizations

The topic of innovation has received substantial academic attention because it is of paramount importance to private organizations, governments, leaders, and communities. The importance of the topic cannot be overemphasized (Moussa, McMurray and Muenjohn, 2018). Over the past several decades, interest in innovation in the public sector has increased for the quality of government services and improvements in the efficiency of organizations (Hartley, 2005; Osborne and Brown, 2013). Specifically, the trend of the main theme of innovation research has moved from private sector innovation to public sector innovation (Salge and Vera, 2012). Concurrently, the topic of public sector innovation has increasingly become a prominent issue in administrative and political fields because the topic of innovation is widely recognized as a sound driver of public sector competitive

power (Damanpour and Schneider, 2009; Walker, 2006). Indeed, innovation such as reform and change are essential for all organizations (Moussa, McMurray and Muenjohn, 2018). For example, innovation in an organization is crucial because it is closely related to economic growth, employment growth, development entrepreneurship, and competitive advantage. Innovation has an impact on other fields (Audretsch and Link, 2019; Link and Siegel, 2007; Suzuki and Demirciolgu, 2019). Despite the considerable attention given to the topic of innovation, it is difficult to find consensus on the definition of innovation (Damanpour, 1991). The reason is that, as with most important notions in the social sciences, there are diverse paradigms and interpretations (Moussa, McMurray and Muenjohn, 2018). These issues are not unique to the private sector, but there is less of a common understanding of innovation and management theories that deal with the innovation process in relation to public organizations (Salge and Vera, 2012). Further, previous studies have not helped improve our understanding of the concept of innovation. Specifically, the results of research on the subject are unclear and inconclusive because there is neither widespread acceptance of a definition of innovation nor an accepted method of its measurement. This provides the main rationale for selecting this topic: the theoretical framework and analysis of this study could contribute to the available theoretical evidence and enable researchers to better understand the concept of innovation.

To better understand the concept of innovation, it is necessary to compare innovation with the adoption of innovation because there is a tendency for some researchers to confuse the terms and to use them interchangeably (Mohr, 1969). Nevertheless, the two concepts have undeniable similarities (Damanpour, 1991). Through the adoption of innovation, organizations aim to improve their performance and effectiveness (Damanpour, 1991). The adoption of innovation is thus the process that leads to an organization's assimilation of a practice, product, or process (Walker, 2008). According to Rogers (1995), two steps are involved in adopting innovation. The first step is the decision to adopt, which is called initiation. The second step comprises implementation and includes the innovation process. From this perspective, it is clear that the adoption of innovation does not guarantee organizational innovation. Based on this logical structure, studies divided organization innovation into two parts: administrative innovation and technological innovation. This is because administrative innovation indicates a decision for efficient government through the adoption of new rules, and technological innovation means the implementation of an innovative process for the ultimate objective.

Innovation, on the other hand, can be defined as the means to change an organization (Hage, 1980). For example, Mohr (1969, p. 112) defined innovation as 'the successful introduction into an applied situation of means or ends that are new to that situation', while Walker (2008) described it as the development or use of innovative ideas or behaviors. Damanpour (1991) also tried to establish the concept of innovation. In his research, innovation means a change that breaks with the current mindset and includes the practices undertaken by an organization to create a new one. Many other scholars have also tried to clarify the meaning of innovation. Overall, considering the previous literature, this study advocates that 'innovation not only involves the generation, but also the practical

realization of new, creative ideas' (Hartley, Sørensen and Torfing, 2013, p. 822). Thus, administrative and technological innovation can fall within a wide range of innovations.

Most previous studies have mainly focused on factors associated with overall organizational innovativeness (Jaskyte, 2011). This trend indicates that there are fewer studies on the various predictors that have an impact on diverse innovations in public organizations. Past research on innovation has been evaluated as being ambiguous and fragmented (Subramanian and Nilakanta, 1996), and no great progress has been made by recent studies. In this regard, this study could contribute to a better understanding of administrative and technological innovations with the ultimate goal of overall innovativeness.

2.2. The effect of administrative innovation on technological innovation

While there are several innovation typologies, including incremental/radical, original/borrowed, and developmental/evolutionary (Jaskyte, 2011), the distinction between administrative and technological innovation is one of the most important dichotomies (Han, Kim and Srivastav, 1998). Administrative innovation includes changes to the rules and structures that characterize the communication methods and work of employees within an organization (Jaskyte, 2011). This means that administrative innovation is not directly related to work activities (Damanpour, 1991). By way of contrast, technological innovation alludes to the implementation of programs and services that offer a break from established practices (Jaskyte, 2011) and is directly related to products and processes (Damanpour, 1991). In this study, technological innovation indicates the degree of use of video conferencing, Smart Work centers, telecommuting, and mobile working. As such, administrative innovation is more likely related to organizational management whereas technological innovation tends to involve work activities.

The literature shows that structural factors and formalization, which form part of administrative innovation, have an impact on technological innovation by making the introduction of new practices easier and, further, becoming a powerful force for behavioral change among employees (Daft, 1982; Lee and Pan, 2014). Additionally, Ke and Huang (2014) argued that information and knowledge regarding new policies could be powerful when advocating in favor of innovation. Based on the previous discussion, we regard the direct outcomes and outputs of administrative innovation as the adoption of new laws, operational grounds, guidelines, reward systems, and appraisal systems for Smart Work. The following hypothesis was developed based on this premise:

- *Hypothesis 1a: Administrative innovation has a positive effect on technological innovation.*

2.3. The role of organizational culture

This study hypothesizes that organizational culture may have an indirect effect on technological innovation. An indirect effect indicates that it has an impact on the strength or direction of the relationship between an independent variable and a dependent variable (Baron and Kenny, 1986). While administrative innovation may be positively related to technological innovation, that is not the only link. Based on contingency theory,

administrative innovation is highly likely to influence the organizational culture, and technological innovation is also likely to be determined by organizational culture. Contingency theory explains that organizations not only tend to satisfy organizational members' needs but also balance this with environmental circumstances (Morgan, 2006). We assumed that the adoption of smart work projects by the Korean government represents a significant change. This administrative innovation, which is related to smart work project, would have an impact on organizational subsystems, such as human-cultural and strategic subsystems. In other words, the introduction of procedures and rules about the smart work project would logically have an influence on organizational culture and leadership because organizations tend to adapt to changes in the environment. Some people could raise objections about this logic because previous studies indicate that organization culture and leadership have an impact on innovation (Damanpour and Schneider, 2006; Howell and Higgins, 1990; Nemeth, 1997; Peters and Waterman, 1982). However, if we limit the subject of study to a smart work project by the Korean government, administrative innovation is required prior to changing organization culture and leadership. The reason for this is that Korean public officials should obey organizational discipline and laws. This means that Korean government agencies are able to accept smart work projects after administrative innovation has occurred. In this sense, the smart work project case is preceded by administrative innovation. By expanding this theory, we can anticipate the influence of organizational culture on innovations.

Organizational culture has received substantial attention from academics and is one of the human variables in innovation (Jaskyte, 2011). In this sense, it makes sense to include the variable of culture in this study. Although there are many definitions of organizational culture, it generally refers to an organization's values (Schein, 2010). These values provide the members of an organization with a set of criteria that they can use to discern right from wrong. An organization's values are communicated with artifacts, norms, and observable behaviors (Schein, 2010). In other words, the specific organizational culture that persists over the long run can be observed. Organizational culture also comprises the organizational beliefs that provide the members of an organization with the organization's norms (Schein, 2010), and it is these norms that lead to changes in individual behavior. Sometimes, the influence of the organizational culture goes beyond the existing organizational control systems, authority, and procedures (O'Reilly, Chatman and Caldwell, 1991). In such instances, the organizational culture is perceived to be powerful within the organization.

Nonetheless, the effects of culture on innovation are not straightforward. While a few researchers have argued that there is no relationship between organizational culture and innovation (Jaskyte and Kisieliene, 2006), some studies have shown that there is a substantial relationship between organizational culture and innovation, and it has been suggested that the characteristics of an organization's culture can support innovation (Hogan and Coote, 2014; Lee and Pan, 2014). For example, Jaskyte and Dressler (2005) advocated that innovation is less likely to happen in an organization with a predictable and strong culture because employees working within such a culture are not allowed to depart from the standard, established patterns. As Nemeth (1997) noted, a strong culture could be a barrier to

the implementation of a new program or the response to a changing environment. However, other studies have contended that a strong organizational culture leads to technological innovation by forcing employees to behave in similar ways (Peters and Waterman, 1982). This is particularly true in public organizations where high value is placed on the strict adherence to unwritten social norms or formal rules of behavior. Accordingly, this study suggests the following hypotheses:

- *Hypothesis 1b: Administrative innovation has a positive effect on organizational culture.*
- *Hypothesis 2a: A strong organizational culture has a positive effect on technological innovation.*
- *Hypothesis 2b: A strong organizational culture positively mediates the relationship between administrative and technological innovation.*

2.4. The role of leadership

This research advocates that organizational leadership plays a similar indirect role to that of organizational culture. While organizational culture pertains to the beliefs and values of an organization's members, organizational leadership relates to the attitudes and work ethic that empower the individuals working across all levels of the organization. Accordingly, leadership can facilitate organizational innovation to improve organizational efficiency and the pursuit of novel change (Damanpour and Schneider, 2006). This suggests that the leaders in an organization can create and support a favorable environment that leads to organizational innovation.

Previous research has shown that leadership can change organizations in various ways. First, an organization's leader can change members' behaviors through the official power and authority given to him or her (Vroom and Jaago, 2007). Even though some employees may resist being forced to participate in the innovation process by only complying with its minimum requirements, this suggests that individuals in organizations will accept innovation regardless of their personal preferences or intentions. Second, an organization's leaders can choose the organization's priorities. This decision-making ability not only impacts their subordinates, but also changes the entire organization (Khalili, Muenjohn and McMurray, 2015). These two conditions make those in leadership roles important for innovation.

Some studies have also demonstrated how leadership style influences organizational innovation. According to Muenjohn and McMurray (2014), design leadership, which frames a concept in an organization, is an important factor in innovation, but it is nevertheless argued that the concept of design leadership is itself very vague (Moussa, McMurray, and Muenjohn, 2018). Contrarily, a servant leadership style undeniably has a positive impact on organizational innovation (Yoshida *et al*., 2014) whereas evaluations of transformational leadership have been mixed. For example, Osborn and Marion (2009) claimed that transformational leadership leads to lower levels of innovation. On the other hand, it has been suggested that transformational leadership can promote innovative activities (Eisenbeiß and Boerner, 2013).

As mentioned, leadership can lead to innovation and is thus one of the most important influencing factors for innovation (King, 1992; Shin and McClomb, 1998). Some researchers have maintained that the function of leadership is to create an environment that promotes innovation (Hage and Dewar, 1973). Notwithstanding, empirical studies have shown that the effects of leadership on innovation are mixed. For example, Jaskyte (2004) contended that there is no specific relationship between leadership and innovation. Conversely, Howell and Higgins (1990) noted that leaders can achieve innovation through the introduction of innovative projects and the pursuit of untraditional plans. Accordingly, the following hypotheses are proposed:

- *Hypothesis 1c: Administrative innovation has a positive effect on leadership.*
- *Hypothesis 3a: Leadership has a positive effect on technological innovation.*
- *Hypothesis 3b: Leadership positively mediates the relationship between administrative and technological innovation.*

2.5. The Context of Smart Work in Korea

Smartness is an essential issue for government reform strategies (Eom, Choi and Sung, 2016). Since the concept of smart government became a key trend for government reform, smart work has received much attention because it is a key initiative for smart governments. Smart work was originally a common work practice in not only the private sector but also the public sector in many countries. Governments in the UK established a 'Smarter Working' initiative in 2012 that emphasized flexible working for public workers. In public organizations, smart work is considered an important technological innovation. First, the purpose of smart work is to provide workers with future-oriented workplaces (The Seoul Development Institute, 2012). Smart work therefore advocates allowing workers to perform their jobs anytime and within a comfortable environment. Furthermore, workers can maximize their labor efficiency and easily integrate diverse information due to the rapid developments in information technology (The Seoul Development Institute, 2012). In the past, the terms 'teleworking' and 'ubiquitous' were merged to indicate smart work. More recently, smart work has come to generally denote a task performance method that allows workers to work outside their designated workspace (Lee and Yang, 2011). This suggests that workers can work freely in any place.

Initiated in 2011, the South Korean smart work project has received considerable attention because the previous South Korean government had established smart work as a national agenda (Kim, 2011). Several researchers have sought to determine why smart work emerged. First, organizations adopted the smart work system to maximize their efficiency in the era of limitless competition (The Seoul Development Institute, 2012). Additionally, smart work enables workers to find the right work-life balance and thus offers them the opportunity to improve the quality of their lives (Kim, 2011). As a political reason, the recent relocation of public institutions from Seoul to local districts has led to increased attention to smart work projects. Specifically, the exclusion of the main public agencies, such as the Blue House and the National Assembly, from the relocation of public institutions project provides important momentum to the smart work project in Korea. This has occurred

because public officials should overcome the physical distance from Seoul, the capital of Korea, to Sejong, the new administrative hub. Considering the Korean situation there is a strong likelihood that leadership plays an important role in the innovation process, although there is conflicting evaluation of the role of leadership. Specifically, the case of Seoul analyzed in this study suggests that top leadership plays an important role in shaping public sector innovation (Berman and Kim, 2010). Notably, compared to other countries, South Korea has a strong organizational culture centered around the relationship between subordinates and superiors.

The smart work project has both advantages and disadvantages, and its effects and limitations depend on certain social, organizational, and personal aspects (Jeong and Kang, 2007). Within the social context, the project not only provides underprivileged people with opportunities to access public services, which can be provided in various venues throughout the nation, but it also reduces traffic congestion and air pollution. A negative effect is that people tend to have less human interaction. Within the organizational context, smart work leads to challenges in managing human resources and equipment costs, even though there may be greater job satisfaction among employees. Lastly, from a personal perspective, individuals can reduce their commute times and increase their work autonomy. On the other hand, there is a strong likelihood that workers who utilize smart work may be at a disadvantage for promotion (Jeong and Kang, 2007).

3. Methodology

3.1. Data source

The Korea Institute of Public Administration (KIPA), an organization affiliated with the prime minister's secretariat, led the data collection process, which was conducted from December 10 to December 18, 2015. The survey respondents were all public service workers from central government (450 employees), local governments (100 employees), and public corporations (250 employees). One of the major agencies for public opinion collaborated with KIPA on this research. This study was based on a stratified random sampling method, and online and postal methods were used to collect the data. Each concept in the conceptual model of this study was measured using the KIPA survey data.

The average response rate from the participating organizations was 40% and ranged from 24% to 74%. It is true that there is a trend in the last two decades of low response rates automatically indicating lower study validity (Morton *et al*., 2012). However, recent studies have shown that there is no direct relationship between validity and response rates. Specifically, a study with a response rate below 20% could produce more exact results than studies with a 70% response rate (Visser *et al*., 1996). Additionally, the results of a study with a 5% response rate are only marginally less accurate than those of a study with about a 50% response rate (Holbrook, Krosnick and Pfent, 2007).

Another justification of this survey is that it was conducted by a major public opinion agency using a stratified random sampling method. In other words, this survey was conducted by an organization that has the public's trust. The stratified random sampling

method also improved the validity of this survey because it provided us with an appropriate representation of each stratum. Hence, there is less likelihood that one population group would be omitted in the investigation. Indeed, a stratified random sampling method could give us more accurate estimates compared to simple random sampling. Accordingly, we believe that the 40% response rate is acceptable.

Among the respondents, as shown in Table 1, the proportion of males (62%) was higher than that of females (38%). In terms of age, 16% of the respondents were in their 20s, 46% were in their 30s, 30% were in their 40s, and 8% were in their 50s or over. For marital status, 64% of the respondents were married. In terms of level of education, the majority of the respondents had at least a bachelor's degree. Those who worked in central government accounted for 56% of the respondents, followed by affiliated government, mainly government-sponsored research institutes (31%) and local government (13%). About two-thirds of the respondents were employees with less than 10 years of public service, whereas those who had at least 30 years or more experience in the public service accounted for only 2%. Overall, according to the 2015 Smart Work Survey, 93% of public sectors responded that they were well aware of what smart work is and that they used smart work centers to reduce commuting costs and improve work-life balance and work efficiency. However, they indicated that organizational culture, particularly face-to-face communication, was a barrier to this.

Table 1: Demographic characteristics of respondents

		Number of respondents	Percentage (%)
Gender	Male	494	61.75
	Female	306	38.25
Age	Less than 29	128	16.00
	30-39	367	45.88
	40-49	238	29.75
	50 and over	67	8.38
Marital Status	Married	509	63.63
	Unmarried	291	36.38
Education	High school graduates	10	1.25
	College graduates	469	58.63
	Graduate/Professional	321	40.13
Types of Organization	Central governments	450	56.25
	Local governments	100	12.50
	Public Corporations	250	31.25
Years of Service	Below 10	463	57.88
	10-19	212	26.50
	20-29	108	13.50
	30 and over	17	2.13
Position	Employee	494	61.25
	Manager	299	37.38
	Executive	7	0.88
Total Respondents		800	100.00

Source: The authors

3.2. Measures

This study used structural equation modeling (SEM) with confirmatory factor analysis (CFA). SEM can minimize measurement errors and is suitable for analyzing series relationships (Eom, Choi and Sung, 2016). In other words, SEM can be used to analyze the relationships between latent variables measured via several questionnaires (Lei and Wu, 2007). SEM has been used in recent studies in this field because of these strengths (DeHart-Davis, Davis and Mohr, 2015; Demircioglu, 2018; Favero and Bullock, 2015).

SEM with CFA is based on observed and latent constructs (Clausen, Demircioglu and Alsos, 2020). The latent constructs in this study, namely, administrative innovation, organizational culture, leadership, and technological innovation, are not directly measurable. We therefore used several survey items that are closely related to the concept of each variable to capture them. In this regard, Currivan (1999) indicated that 'the measurement model specifies a confirmatory factor analysis (CFA) of the proposed relationship between observed indicators and latent constructs, while SEM specifies hypothesized relationships among latent constructs' (p. 507). With respect to the latent variables, 18 items in the questionnaire were used to operationalize the concept. For instance, the abstract concepts of organizational culture and leadership are relevant to the Smart Work project and are specified via the survey items. Table 2 presents the survey questions that were constructed for each variable in the hypotheses as well as the factor loadings with Cronbach's alpha. The results of the CFA model are presented in Table 2. The purpose of this analysis was to determine the quality of the measurement model (Kim and Shim, 2020).

3.3. Technological innovation

We define technological innovation as a set of new practices that public employees use in their work after the implementation of Smart Work policy. To measure technological innovation, we rely on four survey items asking, 'how often do you use the following activities: video conference, Smart Work center, telecommuting, and mobile working'. Each item was measured on a five-point Likert scale with responses ranging from 'very low' to 'very high'. Four items in the KIPA survey were used to assess technological innovation: video conferencing, Smart Work Centers, telecommuting, and mobile working. These indicators could represent the introduction of the new program/activity to employees or customers, significant changes in the organization, and the extension of services to new areas.

3.4. Administrative innovation

Five items from the survey were used to measure administrative innovation: clarifying the legal definition of smart work, updating the guidelines of the smart work budget and management, establishing detailed standards for smart work, and setting up a reward system that was associated with performance evaluations.

Table 2: Results of confirmatory factor analysis and scale reliability

Construct	Mean	Std. Dev	Standardized Loadings	Cronbach's alpha
Administrative Innovation (Scale: 1=strongly disagree; 5=strongly agree)				
My organization has an official legal definition and operational grounds for Smart Work	2.82	1.08	.927	.961
My organization periodically updates the guidelines of the Smart Work budget and management	2.81	1.02	.931	
My organization has detailed standards for Smart Work	2.75	1.01	.938	
My organization has a reward system to encourage Smart Work	2.79	1.07	.925	
The performance appraisal system of my organization is linked to the usage of Smart Work	2.72	1.02	.927	
Organizational Culture (Scale: 1=strongly disagree; 5=strongly agree)				
There is an appropriate organizational culture for Smart Work	2.76	1.12	.909	.953
My organization offers enough Smart Work experience opportunities	2.77	1.07	.945	
My organization offers education for Smart Work	2.76	1.05	.952	
My organization is proactive in promoting awareness of Smart work	2.78	1.05	.938	
Leadership (Scale: 1=strongly disagree; 5=strongly agree)				
My manager shows his/her support for Smart Work	2.82	1.08	.901	.952
Securing budget for Smart Work is one of his/her priorities	2.81	1.02	.924	
My manager finds and shares success stories about Smart Work	2.75	1.01	.922	
My manager enjoys discussing Smart Work experiences	2.79	1.07	.928	
My manager is effective at obtaining private resources to support Smart Work	2.72	1.02	.908	
Technological Innovation How often do you use the following activities? (Scale: 1=very low; 5=very high)				
Video conference	2.77	1.12	.787	.821
Smart Work center	3.20	1.08	.764	
Telecommuting	2.48	1.25	.832	
Mobile working	2.55	1.20	.843	

Source: The authors

3.5. Organizational culture

The definition of organizational culture in this study is based on that of Deshpande and Webster (1989). Organizational culture thus means a set of common values that allow employees to understand the organization's mission and guide their behaviors and ways of thinking (Deshpande and Webster, 1989). To measure this concept, we used SEM

as a research method. SEM has more strengths than OLS because it can effectively address mediators and efficiently and simultaneously analyze observed and latent variables (Demircioglu, 2021).

We measured the concept of culture and leadership using survey items from the Korea Institute of Public Administration. For example, four items from this survey were used to measure organizational culture: building an appropriate organizational culture for smart work, the assignment of smart work experience opportunities, education for smart work, and information to enhance awareness of smart work. The survey items are closely related to the abstract concepts of organizational culture. The most important criterion when selecting the survey items was whether there is a connection between survey items and the latent variables. Accordingly, the abstract concepts of organizational culture and leadership are related to the Smart Work project and are specified by the survey items. The SEM method allowed us to establish latent variables and analyze the relationships between them.

3.6. Leadership

In this study, leadership is defined as a set of methods used to develop employee and leader relationships (Jaskyte, 2011). Five items from the KIPA survey data were used to assess leadership: the awareness and will of the head of an organization, budget security for smart work, locating and disseminating information about smart work success stories, describing users' intentions, and the utilization of private resources. These survey items had many similarities with the Leadership Practices Inventory (LPI), which is designed to measure organizational leadership (Posner and Kouzes, 1993). In this sense, the survey items are acceptable. Table 3 presents the correlation matrix for the four key constructs.

Table 3: Correlation matrix for the four key constructs

Construct	Mean	Standard deviation	Correlation matrix			
			1	2	3	4
Administrative Innovation	2.87	0.91	1			
Organizational culture	2.77	1.00	0.74	1		
Leadership	2.78	0.95	0.78	0.80	1	
Technological Innovation	2.74	0.92	0.41	0.45	0.44	1

Source: The authors

3.7. Control variables

Some previous studies have argued that demographic, social, group, and organizational factors have a significant impact on smart work (Eom, Choi and Sung, 2016; Yousafzai, Foxall and Pallister, 2007; Bailey and Kurland, 2002; Kowalski and Swanson, 2005). For example, female workers tend to be more sensitive than male workers to smart work projects (Pérez, Sánchez and De Luis Carnicer, 2002). This indicates that female workers react more sensitively to both the benefits of and barriers to smart work than male workers.

Additionally, personal characteristics, such as gender and age, and organizational type have a significant impact on related technological innovation (Yousafzai, Foxall and Pallister, 2007). Therefore, based on previous studies, the current study includes several control variables: gender, age, education, type of organization, years of public service, and position. This is because, given the Korean context, these control variables are more likely to be significant than other variables.

After the central government formulated a policy for the implementation of technological innovation, various local governments and public corporations followed its guidance. Consequently, this study controls for the type of organization. Figure 1 specifies the relationships among the study variables.

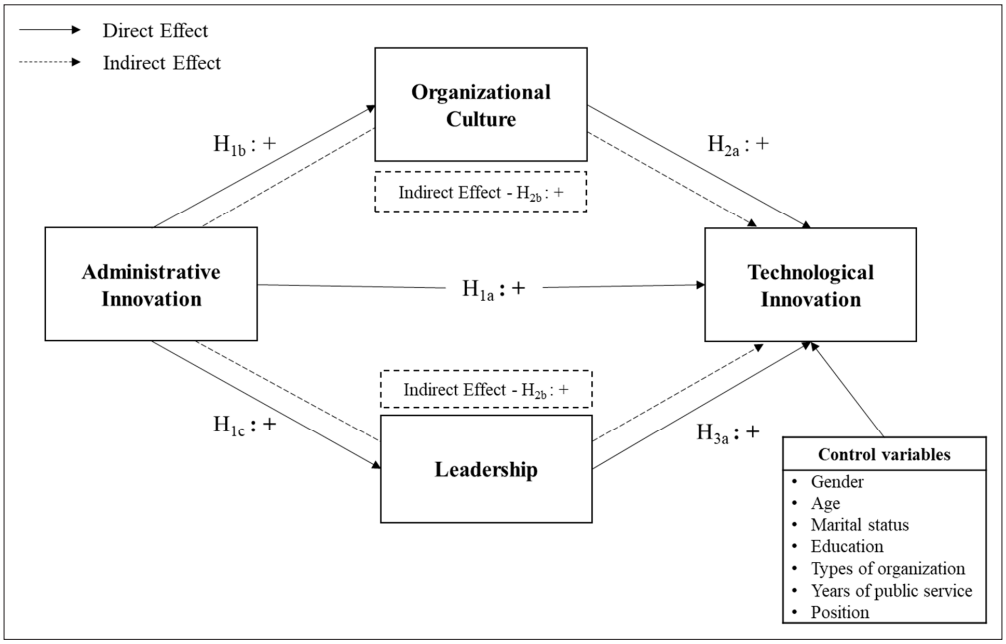

Figure 1: A conceptual model of the relationship between administrative innovation, culture, leadership, and technological innovation

Source: The authors

4. Analysis and results

This study used structural equation modeling (SEM) to test the hypotheses. Table 2 represents a structural model of the relationships between administrative innovation, culture, leadership, and technological innovation. Conventional maximum likelihood estimation (MLE) with normally distributed factors was used to test the model (Jöreskog and Sörbom, 1996). The fit of the model was found to be satisfactory ($\chi 2 = 1165.65$, df = 248; RMSEA = 0.068; CFI = 0.942; TLI = 0.935). In general, an RMSEA value below 0.08 indicates a good model fit (MacCallum, Browne and Sugawara, 1996). The CFI and TLI

had higher values than the recommended threshold value of 0.90 (Jiménez and Sanz-Valle, 2011). This SEM method provided the parameter estimates for each construct (Table 4), and the estimates reflect the standardized effects of technological innovation.

In terms of the hypotheses and as shown in Table 4, the results for H_{1a} (administrative innovation → technological innovation) indicate no significant effect of administrative innovation on technological innovation. On the other hand, the findings support H_{1b} (administrative innovation → organizational culture) and H_{1c} (administrative innovation → leadership), showing that administrative innovation has a statistically positive effect on both organizational culture and leadership. The results also provided support for H_{2a} (organizational culture → technological innovation) and H_{3a} (leadership → technological innovation), indicating that organizational culture and leadership have positive effects on technological innovation.

Table 4: The results of the structural equation modeling estimation

Hypothesis	Standardized Estimates	Std. Err	Hypothesis Test
H_{1a}: Administrative Innovation → Technological Innovation (+)	.013	.054	Not supported
H_{1b}: Administrative Innovation → Organizational Culture (+)	.847***	.035	Supported
H_{1c}: Administrative Innovation → Leadership (+)	.871***	.033	Supported
H_{2a}: Organizational Culture → Technological Innovation (+)	.179***	.052	Supported
H_{3a}: Leadership → Technological Innovation (+)	.180***	.060	Supported
Control Variables			
Gender → Technological Innovation	.096*	.053	
Age → Technological Innovation	.001	.006	
Marriage → Technological Innovation	-.118*	.061	
Education → Technological Innovation	-.075	.053	
Years of Service → Technological Innovation	.057*	.033	
Position → Technological Innovation	-.179***	.053	
Types of Organization → Technological Innovation	-.051	.032	

Note: The fit statistics for the measurement model of 18 indicators for the four constructs: $\chi^2_{(248)} = 1165.65$; RMSEA = 0.068; CFI = 0.942; TLI = 0.935; * p < .05; ** p < .01; *** p < .001.

Source: The authors

Finally, H_{2b} and H_{3b} state that organizational culture and leadership affect the relationship between administrative innovation and technological innovation. To test these indirect effects, direct and indirect tests were used. Table 5 shows that, although administrative innovation has a direct effect on organizational culture and leadership, administrative innovation does not directly affect technological innovation. The indirect effects analysis shows that administrative innovation has a positive effect on technological innovation through organizational culture and leadership. This suggests that organizational culture and leadership affect the relationship between administrative innovation and technological innovation.

Table 5: Decomposition of Direct, Indirect, and Total Effects of Administrative Innovation on Technological Innovation

	Standardized Estimates	Std. Err
Direct Effect	.013	.054
Indirect Effect	.308***	.047
Total Effect	.320***	.034

Note: * significant at p < .1; ** significant at p < .05; *** significant at p < .01.

Source: The authors

5. Discussion and implications for practice

The purpose of this research was to analyze the relationship between administrative innovation and technological innovation and to assess the effect of organizational culture and leadership on technological innovation. The results show that there are no direct effects between administrative innovation and technological innovation. There are two possible explanations for this finding. First, the establishment of new rules and structures in relation to technological innovation does not guarantee technological innovation within an organization. Second, the outputs and outcomes of policy could be different depending on the particular organizational context even though the central government provides strong impetus for the use of consistent policies.

Nonetheless, organizational culture and leadership have a direct and positive effect on technological innovation. This finding supports the argument that both organizational culture and leadership lead to technological innovation and are thus among the most important influencing factors. The findings of this study provide additional evidence to the field of innovation by showing the guidelines for driving ultimate organizational innovation. A significant contribution of this research is that it contributes to improving the understanding of the relationships between innovations. Based on contingency theory, we found that administrative innovation could act as an input that energizes public sector organizations. As a next step, this input has an influence on the human-cultural and strategic subsystems. In the final stage, technological innovation results in organizational output. In this regard, this study elaborates the process of innovation in the public sector. This study's

findings go beyond previous studies' findings because they mainly focused on structural factors. Additionally, the findings of this research suggest that administrative innovation is also an important source of technological innovation because it has an indirect effect on technological innovation through organizational culture and leadership.

Although the findings of this study have critical implications in practice, the findings should be used with caution because this study did not measure the real effectiveness of the technological innovation indicators. While this study obtained interesting results about the relationship between administrative innovation and technological innovation, it has some limitations. First, the model in this study did not include all the critical factors needed to explain the relationships between the variables even though the design of the study model was based on extensive research. Second, our study did not demonstrate what types of leadership or culture better support technological innovation in public organizations due to a lack of available data. The third limitation is that the study was based on a cross-sectional design that assessed the prevalence of the Smart Work project at a point in time in a random sample of public sector workers. In other words, it provides a 'snapshot' of the relationships between the variables. It is important to note that this study did not include a follow-up with the same respondents on the same issue, so it is difficult to establish causal relationships over a period of time.

Our research also allows to provide recommendations for future studies. First, the use of a more sophisticated method and larger sample size is necessary to test the theoretical hypotheses and confirm the direction of the relationships. For example, a longitudinal study design would achieve a more objective research result. Second, this study relies on the South Korean context only. Future research is needed to determine whether the current results are consistent with the findings of similar studies in other countries. Third, case studies of public sector innovations could be another option for future studies. One of the strengths of case studies is that they provide more detailed information about specific innovations and the process driving these innovations (He and Ma, 2020). The likelihood of obtaining accurate information about public sector innovation would be higher using the case study method.

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Appendix 1: Demographic Survey

(1) Name of affiliated organization		_____
(2) Institutional type		1. Central governments 2. Local governments 3. Public institutions
(3) Working Area		1. Seoul 2. Gyeonggi-do 3. Sejeong city 4. Etc.
(4) Gender		1. Male 2. Female
(5) Age		_____
(6) Marital Status		1. Married 2. Unmarried
(7) Education		1. High school graduates 2. College graduates 3. Graduate/Professional
(8) Year of Service		_____
(9) Position	Public Official	1. Grade 8-9 2. Grade 6-7 3. Grade 5 4. Grade 4 5. Grade 3 or higher
	Public institution	1. Senior Researcher or higher 2. Junior Researcher 3. Research worker 4. General administrative official 5. Etc.

Appendix 2: Survey items for operationalization of variables

Survey Items					
Administrative Innovation					
(Scale: 1=strongly disagree; 5=strongly agree)					
My organization has an official legal definition and operational grounds for Smart Work	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
My organization periodically updates the guidelines of the Smart Work budget and management	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
My organization has detailed standards for Smart Work	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
My organization has a reward system to encourage Smart Work	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
The performance appraisal system of my organization is linked to the usage of Smart Work	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
Organizational Culture					
(Scale: 1=strongly disagree; 5=strongly agree)					
There is an appropriate organizational culture for Smart Work	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
My organization offers enough Smart Work experience opportunities	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
My organization offers education for Smart Work	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
My organization is proactive in promoting awareness of Smart work	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
Leadership					
(Scale: 1=strongly disagree; 5=strongly agree)					
My manager shows his/her support for Smart Work	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
Securing budget for Smart Work is one of his/her priorities	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
My manager finds and shares success stories about Smart Work	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
My manager enjoys discussing Smart Work experiences	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
My manager is effective at obtaining private resources to support Smart Work	Strong disagree	Disagree	Neutral	Agree	Strongly Agree
Technological Innovation					
How often do you use the following activities?					
(Scale: 1=very low; 5=very high)					
Video conference	Never	Rarely	Sometime	Often	Extremely Often
Smart Work center	Never	Rarely	Sometime	Often	Extremely Often
Telecommuting	Never	Rarely	Sometime	Often	Extremely Often
Mobile working	Never	Rarely	Sometime	Often	Extremely Often