

# Impact of IT Education on Organizational Performance in the Agricultural Sector<sup>†</sup>

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## <요 약>

This study aimed to clarify the effect of information technology (IT) education on the efficiency and effectiveness of working processes among agriculture corporations. Survey data on information levels from 222 agriculture corporations were collected from the Korean Agency of Education, Promotion, and Information Service in Food, Agriculture, Forestry, and Fisheries (EPIS) for a governmental white paper. Structural equation modeling was used for analysis. This study found that IT education increases the ratio of the use of information systems in working processes, especially given the use of data accumulated through information and communications technologies (ICT). The findings of this study suggest that the use of ICT data as an aspect of IT education is beneficial for the agricultural sector.

Key Words: IT education, Agriculture, Information System, Effectiveness

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## I. Introduction

In recent years, there have been many brilliant technological advances. One of the most notable has been the advent of information technology (IT), which has changed the face of society. IT has improved the efficiency of society by creating new industries and developing competitiveness in existing industries, all while changing the lifestyles and values of people at large. Among these changes, IT has had a particularly significant effect on the agricultural industry (Yu, 2003).

Agricultural informatization has rapidly developed in many countries since the 1970s. In Japan, IT has been used in various parts of the agricultural industry, such as for operating farms, crop fostering, and weather reporting. And in the United States, farmers can receive the latest data from government information centers, schools, and institutes, including information on agricultural production prices, seed amelioration, disease control, and insect pests, so as to make the most profit from their farms (Duan, 2011). In China, due to finite environmental resources and inefficient farming methods, the government realized the importance of IT education in the agricultural sector. In 1998, the government established the so-called “Digital China” plan, a strategy to support IT in the agriculture sector (Liang et al., 2003). This information can be used to express agricultural demands, which may result in positive growth of nation’s economy (Tshabalala, 2001).

There are certain obstacles, however, to

accepting IT in the agriculture industry. First, there are more agricultural corporations based in rural areas than in urban areas, and rural regions tend to have less access to IT than metropolitan areas (Cronin et al., 1995). Second, as many people move from rural areas to urban centers, rural regions have low population densities and typically lack the capacity for IT education. Extensive effort has been made at the national level to resolve such informatization problems in the agriculture industry. For example, the Ministry of Food, Agriculture, Forestry, and Fisheries (MFAFF; current name: Ministry of Agriculture, Food, and Rural Affairs) established the Center for Agriculture Forestry Fisheries Information Service (AFFIS; current name: Korea Agency of Education, Promotion and Information Service in Food, Agriculture, Forestry and Fisheries) for agricultural informatization. Since then, AFFIS and the Rural Development Administration has worked toward the informatization of rural areas. In 2015, the Korean government set a budget of 3.994 billion won to offer information services and knowledge to farmers, as well as disseminate field application software to agricultural corporations. Furthermore, the Korean government set a budget of 1.92 billion won for promoting the Internet of Things (IoT) within the agri-food industry.

Figures in the agricultural sector have begun to realize the importance of informatization, with many agricultural institutions developing programs for agricultural informatization. However, little research has been committed to

the influence of IT education on the agriculture sector. Therefore, this study aims to examine the impact of IT education on agricultural corporations. In particular, this study examines how IT education influences employees' work with information systems based on survey information from the Korean Agency of Education, Promotion, and Information Service in Food, Agriculture, Forestry, and Fisheries (EPIS). The study analyzes the effects of information system use on corporate work efficiency and effectiveness.

The following section details the present conditions of IT education in the agricultural sector in Korea. A theoretical background is then provided in relation to the study's research model and hypothesis. In following, a description of the study's methodology and data collected from agricultural corporation employees is presented, and the results of the statistical analysis are presented to showcase the effectiveness of IT education. The final section of this paper includes the results and conclusions of this study.

## II. Literature Review

DeLone and McLean discuss the measurement of information system success via an IS success model with six variable categories: system quality, information quality, IS use, user satisfaction, individual impact, and organization impact. However, they deemed this model too complicated to assess information system success. Therefore, DeLone and McLean

suggested a reformulated version of the success model in 2003, which added a service quality variable to measure information systems success. Using validated measures for IS success, Sedera used ease of use and ease of learning as measurements of service quality (Sedera and Gable, 2004). There are few studies that have analyzed the relationship between service quality and use. In Choe's study, training or education in information technology was found to have a positive effect on information system use in work processes. Various kinds of information systems have been used in work processes. Today, SNSs, such as blogs or Facebook, are some of the most useful marketing tools in many corporations. IT education has been disseminated via SNSs for marketing and communicating with customers (Lim and Syamimi, 2012), and teaching farmers how to operate an online shopping mall was found to have a positive effect on selling online agricultural products (Jeong et al., 2010). In addition, data on temperature, humidity, crop growth, and air volume can be accumulated by crop management systems. Crop management systems are a significant development of information and communications technologies (ICT). Also, agriculture education centers have management of ICT data in their IT education curricula (Yu et al., 2009). Use of information systems has had a positive impact on corporate productivity (DeLone and McLean, 2008). In Allen and McGee's model, productivity is measured by efficiency and effectiveness (Allen and McGee, 2004). Effectiveness refers

to how well a company meets its customers' demands, while efficiency refers to how well corporations use resources, such as capital, to meet customer requirements (Neely et al, 1995).

## 1. Hypothesis

According to Choe (1996), information technology education increases employee information system use while working. Along with the development of information technology, employees have been able to easily develop marketing strategies using SNSs. SNSs have become an indispensable part of business, and IT education has been shown to increase SNS use in work processes (Lim and Syamimi, 2012).

Compared to the past, people today can purchase things without visiting a store. Rather, they can go to an online shopping mall, choose the products they want, send payments online, and receive their purchases just a few days later from anywhere in the world. E-commerce is essential to business owners who seek to maximize their profit, and there are many classes on how to develop and operate an online shopping mall. E-commerce can be the new frontier for small business (Kim and Cha, 2000). IT education has been shown to have a positive effect on the sale of agricultural products online (Jeong et al., 2010).

ICT is an integral part of agriculture. World agricultural trends have moved toward "smart farming," which can prepare farmers for natural disasters and decreased yields so

as to provide stable agricultural products (Lee et al., 2014). Therefore, it is important to teach modern farmers about ICT. Luckily, many classes have been developed to cover the adoption of ICT on farms (Yu et al., 2009). The IoT is a new ICT technique that allows for the communication of data between different devices. In the agricultural sector, IoT-based production systems can collect crop data via IoT sensors, which facilitates better decision-making via crop statistics and yield predictions (Lee et al., 2013). In this study, the data accumulated by ICT is IoT data.

Based on the above information, the following hypotheses were established:

- H1: The frequency of IT education positively influences the usage of SNS in work processes.
- H2: The frequency of IT education positively influences e-commerce sales.
- H3: The frequency of IT education positively influences the use of IoT data in work processes.

One of the key functions of information system use within corporations is to enhance efficiency and effectiveness (Bakos and Treacy, 1986). Corporate information system use increases efficiency by curtailing costs, increasing the speed of business management, and facilitating swift communication and cooperation (Scott, 1998). Effectiveness and efficiency are two key components of performance measurement (Mentzer, 1991).

There were three kinds of information

system which widely used in agricultural sector. The first one is SNS. Time spent on SNS continue to rise among SNS users (Chun, 2011). SNS use is one of the most helpful marketing method in many corporations. Via SNSs, customers can receive information on products or services without visiting stores in person. SNSs have become one of the main tools in business marketing. SNS use has been found to increase work efficiency and effectiveness (Kim and Huarng, 2011).

The second one is online sales. With the development of the internet, people can now easily access and use internet networks, especially via smart phones. The development of the internet has allowed for rapid growth in e-commerce market (Lee et al, 2011). E-commerce has been shown to improve both the effectiveness and efficiency of corporations (Chang et al., 2003), as well as contributing to increased profits.

The last one is using ICT. ICT allows for the effective changing of information in agriculture (Kurtenbach and Thompson, 2000), and can increase the welfare of the agriculture industry (Goyal and González-Velosa, 2013). Furthermore, ICT use has been shown to improve the effectiveness of farm management (Adegbidi et al., 2012).

Based on the above information, this study also established the following hypotheses:

H4: SNS use positively influences the efficiency of work processes.

H5: SNS use positively influences the effectiveness of work processes.

H6: E-commerce sales positively influence the efficiency of work processes.

H7: E-commerce sales positively influence the effectiveness of work processes.

H8: IoT data use positively influences the efficiency of work processes.

H9: IoT data use positively influences the effectiveness of work processes.

Efficiency and effectiveness are the main factors of focus when evaluating the performance of a corporation. Effectiveness measures customer's satisfaction of products and client creation, while efficiency measures streamlined work processes (Neely et al, 1995). As work efficiency exerts a positive influence on work effectiveness, effectiveness increases along with efficiency (Price, 1972). Therefore, it is important to analyze the interaction between efficiency and effectiveness within a corporation to assess its overall performance. The summary of previous studies for the research variables is shown in Table 1.

H10: Efficiency rates positively influence effectiveness rates within a business.

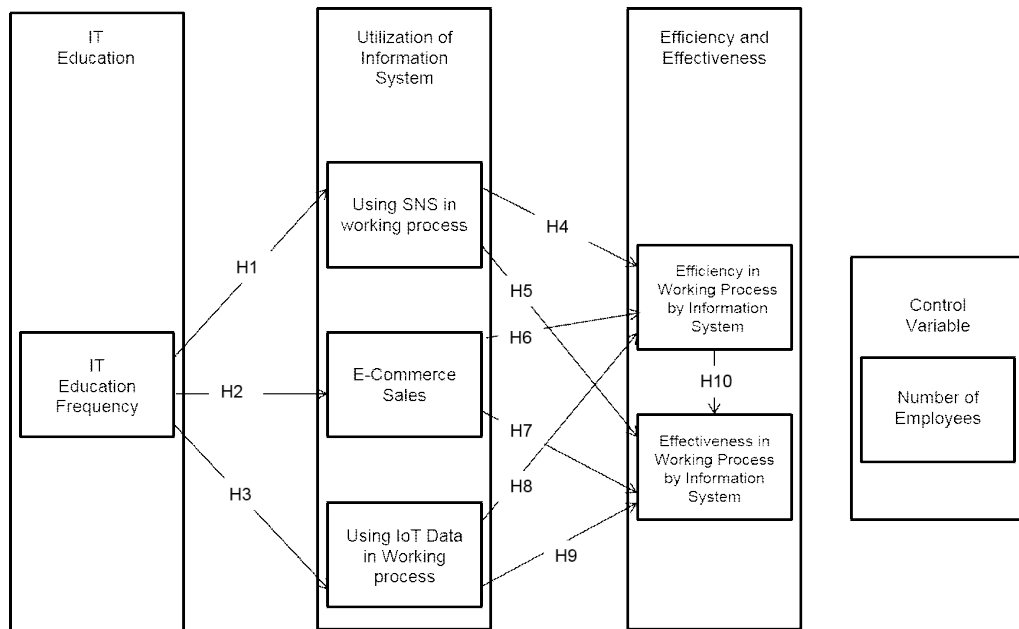
## 2. Research model

This study aims to clarify how IT education impacts information system use in work processes, as well as the impact of information systems on the efficiency and effectiveness of corporate agriculture work processes. In the following, it will be examined whether improved work efficiency improves the overall

work effectiveness of a corporation. The research model of this study is shown in Figure 1.

<Table 1> Summary of studies for the research variables

Research Variable	Related Study	Conclusion
IT education → SNS	Lim and Syamimi, 2012	IT education increase SNS use in work
IT education → e-commerce	Jeong et al., 2010	IT education has positive effect on the sale of agricultural products online
IT education → IoT	Yu et al., 2009	IT education has positive effect on the use of ICT in the agricultural sector
SNS → Efficiency	Kim and Huarng, 2011	using SNS increases work efficiency
SNS → Effectiveness	Kim and Huarng, 2011	using SNS increases work effectiveness
e-commerce → Efficiency	Chang et al., 2003	e-commerce improves the corporation's efficiency
e-commerce → Effectiveness	Chang et al., 2003	e-commerce improves the corporation's effectiveness
IoT → Efficiency	Goyal and González-Velosa, 2013	ICT improve efficiency of the agriculture industry
IoT → Effectiveness	Adegbidi et al., 2012	ICT improve effectiveness of farm management
Efficiency → Effectiveness	Price, 1972	work efficiency has positive influence on work effectiveness



<Figure 1> Research Model

### III. Data Collection and Method

#### 1. Data collection

The EPIS conducted a survey to understand the current state of agriculture in terms of its degree of informatization and use of information for practical purposes. This survey was distributed to managers of agriculture corporations in Korea. Respondents were required to state their corporate address, type of enterprise, size of capital, sales, and business profits in order to build a picture of the corporation's present condition.

With regard to informatization, the survey included questions about the plans of a corporation to promote informatization, the environment of informatization promotion, the set-up and practical usage of information systems, the effects of informatization, the current situation in terms of information infrastructure, and demand for informatization. With regards to IT education, the survey asked about specific numbers of annual average frequency of IT education per employees. Data from a total of 222 corporations was retrieved from the survey.

The survey also contained questions about the utilization of information systems in relation to work processes, including the ratio of SNSs use, the ratio of using e-commerce in total sales, and the degree of using data which

collected by ICT convergence technology. The answer options used were 5-point Likert-scales. The survey also inquired as to the efficiency and effectiveness of current work processes. There were 3 questions about the levels of contribution to efficiency in working process due to information system. There were 2 questions about the levels of contribution to effectiveness in working process due to information system.

The answer options used 5-point Likert-scales (No affect - Major affect). This study utilized the data of this survey to analyze the effect of IT education on the utilization of information systems on corporate work processes. Similarly, responses on the efficiency and effectiveness of work process were used to investigate the effect of information systems use on efficiency and effectiveness.

Of the corporations of the survey, 222 offered IT education. Of these, there were two types of organization: farming association corporations and agricultural company corporations. The majority of the corporations were located in Gyeongnam. Male representatives made up more than 80% of the workers. In these companies, employees received IT education less than five times a year. A sample of the demographic information is shown in Table 2.

&lt;Table 2&gt; Demographic profile of sample

Category		Mean	Count	%
Sample			222	100
Type of organization	Farming association corporation		158	71.17
	Agricultural company corporations		64	28.83
Office Address	Gyeongnam		34	15.32
	Jeonbuk		33	14.86
	Gyeongbuk		29	13.06
Full-time laborer		7		
Sex of representative	Male		194	87.39
	Female		28	12.61
Average invest cost of informatization		₩ 402,928		
Annual average IT education per employee		Less than 5		

## 2. Analysis method

This study employed a partial least squares (PLS) graph program for structural equation modeling (SEM). This program was used to analyze the gathered data so as to determine the effect of IT education on information system use and work processes, which in turn impacts an agricultural corporation's effectiveness and efficiency. PLS is useful for avoiding unwarrantable solutions and uncertainty (Fornell and Bookstein, 1982). For the reliability of the study's model, reliability coefficients were examined.

## IV. Results

This study utilized a PLS graph program for SEM to analyze the gathered data so as to determine the effect of IT education on

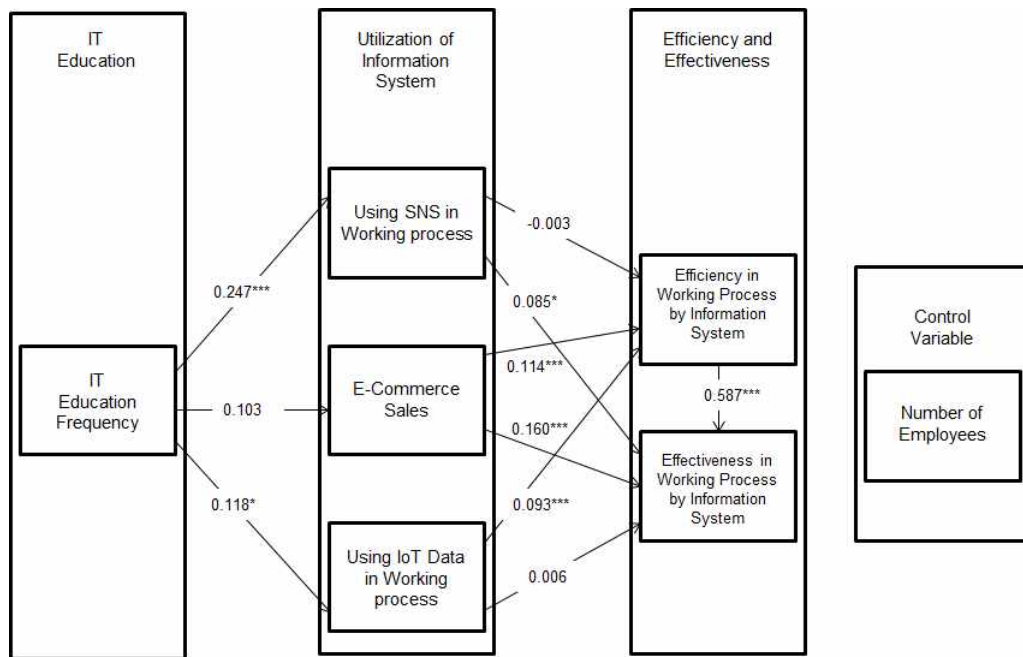
information system use, including SNSs, e-commerce, and IoT, as well as to determine the effect of information system usage on corporate efficiency and effectiveness. Table 3 shows the correlation between major constructs and it has discriminant validity of the research model.

Figure 2 shows the results of this study's model. Number of employees was used as a control variable. The results reveal that, with increased frequency of IT education, the proportion of work involving the usage of SNS ( $\beta=0.247$ ,  $p<0.001$ ) and IoT data ( $\beta=0.118$ ,  $p<0.05$ ) rises. Therefore, H1 and H3 were adopted. On the other hand, the ratio of e-commerce use for sales shows no significant effect on IT education ( $p=0.07$ ). Therefore, H2 was rejected. IT education was found to increase information system use for work processes in a selective manner, with a significant effect in terms of SNS and IoT data.



&lt;Table 3&gt; Correlation among major constructs

	IT EDU	SNS	EC	IoT	EFFI	EFFE
IT Education	1.000					
SNS Usage	0.247	1.000				
E-Commerce	0.038	0.641	1.000			
IoT Data	0.118	0.118	0.100	1.000		
Efficiency	0.071	0.053	0.107	0.106	1.000	
Effectiveness	0.051	0.138	0.166	0.082	0.671	1.000



&lt;Figure 2&gt; The results of structural equation modeling analysis

With the increase of SNS utilization in work processes, the overall effectiveness of work processes was found to increase ( $\beta=0.085$ ,  $p<0.05$ ). Therefore, H5 was adopted. However, SNS utilization was found to have no significant effect on the efficiency of work processes ( $p=0.92$ ). Therefore, H4 was rejected. The degree of IoT data usage was found to

have a significant impact on the efficiency of work processes ( $\beta=0.093$ ,  $p<0.001$ ). Thus, H8 was adopted. No significant relationship between the degree of IoT data usage and the effectiveness of work processes was found ( $p=0.96$ ). Therefore, H9 was rejected. While e-commerce sales were found to have both a significant effect on the efficiency ( $\beta=0.114$ ,

$p < 0.001$ ) and effectiveness ( $\beta = 0.160$ ,  $p < 0.001$ ) of work processes, no significant relationship was found between IT education and e-commerce sales. Therefore, H6 and H7 were rejected. Lastly, the efficiency of work processes was found to improve the effectiveness of work processes ( $\beta = 0.587$ ,  $p < 0.001$ ). Therefore, H10 was adopted.

The results are shown in Figure 2. According to these results, IT education can be said to increase information system use, such as SNS and IoT data, in work processes. Using SNSs for work processes was found to increase the effectiveness of corporations. IoT data use in work processes was found to increase efficiency in corporations. The results also show that efficiency has a positive effect on effectiveness in corporations. Consequently, the frequency of IT education was found to increase IoT data use in work processes. IoT data use was found to enhance efficiency in corporations, and work efficiency was found to have positive effects on work effectiveness in agricultural corporations.

## V. Conclusions

This study aimed to analyze the impact of IT education on agricultural corporations. The results of the study show that IT education increases IoT data use in work processes, and that IoT data use in work processes increases work efficiency in corporations. After all, efficiency increases work effectiveness in agricultural corporations. These results come

with certain important implications. Policy-makers in Korea have a tendency to focus on e-commerce when teaching information technology to agricultural industry workers. While it is unquestionable that online sales are one method to achieve additional revenue; however, the results of this study show that IT education does not affect e-commerce sales.

There are currently many machines for growing agricultural products on farms. These machines have database systems. Through such database systems, farmers have access to valuable data for the operation of their farms. For example, farmers can possess data on the proper pH concentration for summer days and nights, as well as the best temperature for growing quality rice. Based on this data, farmers can manage operations on their farms more effectively. Such data can be a main source for developing business at little expense. With little knowledge of how to use an information system, it is hard to fully utilize agricultural data, and rural farmers have fewer opportunities to receive education on information technology. Therefore, agricultural policy must be developed so as to encourage information technology education within the agricultural sector.

ICT makes it especially easier to maintain and utilize data, and thus, is in high demand for the production, management, and distribution processes of agricultural companies. Using this data, farmers can use their agricultural resources more efficiently. Farmers who own little infrastructure can get much more effort (Goyal and González-Velosa, 2013). For example,

farmers can adjust irrigation systems to prepare for drought. The adoption of information technology will not fix every issue a farmer has, but a balanced combination of experience an information technology can open up new possibilities for development in the agriculture industry. Nonetheless, farmers are still currently using ICT too infrequently, and have insufficient ICT knowledge. Therefore, promoting a positive view of ICT and giving farmers experience with using ICT is necessary (Adegbidi et al., 2012). Based on the results of this study, policy-makers should strive to incentivize farmers to educate themselves on ICT use.

This study has certain limitations. For one, the SEM method has to compare AVEs. However, in this study, there was only one factor of measurement, which was an inevitable consequence of the prefigured questionnaires that this study analyzed. Therefore, it was not necessary to compare AVEs. Second, acceptance technology takes a long time. It is hard to assess the impact of information technology on the agriculture industry over short periods of time. Therefore, future studies should analyze data over extended periods of time.

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## Appendix : Survey Questionnaire

Factor	Statements	Measurements
IT Education Frequency	Q: Annual average frequency of IT education per employee	Write specific numbers of IT education frequency
Using SNS in Working Process	Q: Ratio of using SNS in working process	1. Less than 20% 2. Less than 20~40% 3. Less than 40~60% 4. Less than 60~80% 5. More than 80%
E-Commerce Sales	Q: Ratio of using e-commerce in total sales	1. Less than 20% 2. Less than 20~40% 3. Less than 40~60% 4. Less than 60~80% 5. More than 80%
Using IoT Data in Working Process	Q: Degree of using data which collected by ICT convergence technology	1. Have never used 2. Rarely used 3. Often used 4. Usually used 5. Well used
Levels of Contribution to Efficiency in Working Process due to Information System	Q1: Simplify working procedure Q2: Improve efficiency in working process Q3: Improve professionalism in working Process	1. No effect 2. Minor effect 3. Neutral 4. Moderate effect 5. Major effect
Levels of Contribution to Effectiveness in working process due to Information System	Q1: Create new customer Q2: Definite progress in customer's satisfaction	1. No effect 2. Minor effect 3. Neutral 4. Moderate effect 5. Major effect

## 요약

## 정보화 교육이 농업 경영 조직에 미치는 영향†

유지혜\* · 문정훈\*\* · 이철\*\*\* · 이종태\*\*\*\*

본 연구는 정보화 교육이 농업법인회사에 미치는 영향을 밝히는데 목적을 두었다. 이를 위해, 본 연구는 농림수산물교육문화정보원에서 실시한 정보화수준 및 활용도 조사 보고서를 이용하여 구조방정식 모델 분석을 실시하였다. 연구결과, 정보화 교육은 소셜네트워크서비스(Social Network Services, SNS)를 활용하는 업무의 비율과 정보통신융합기술(Information and Communications Technologies, ICT)을 통해 축적된 데이터를 사용하는 업무의 비율에 긍정적인 영향을 주었다. 특히, ICT 정보시스템 활용은 조직 내 업무 효율성을 높이는 것으로 나타났다. 그리고 결국, 업무 효율성은 농업 경영 조직의 업무 효과성을 증대시키는 것을 확인하였다. 따라서 농업분야에 대한 정보화 교육은 ICT를 활용한 정보시스템 교육을 중점으로 하여 이뤄져야 할 것이다.

핵심주제어: 정보화 교육, 농업법인회사, 정보시스템, 효과성

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