

# An Exploratory Study on Determinants Affecting R Programming Acceptance<sup>†</sup>

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## <요 약>

R programming is free and open source system associated with a rich and ever-growing set of libraries of functions developed and submitted by independent end-users. It is recognized as a popular tool for handling big data sets and analyzing them. Reflecting these characteristics, R has been gaining popularity from data analysts. However, the antecedents of R technology acceptance has not been studied yet. In this study we identify and investigates cognitive factors contributing to build user acceptance toward R in education environment. We extend the existing technology acceptance model by incorporating social norms and software capability. It was found that the factors of subjective norm, perceived usefulness, ease of use affect positively on the intention of acceptance R programming. In addition, perceived usefulness is related to subjective norms, perceived ease of use, and software capability. The main difference of this research from the previous ones is that the target system is not a stand-alone. In addition, the system is not static in the sense that the system is not a final version. Instead, R system is evolving and open source system. We applied the Technology Acceptance Model (TAM) to the target system which is a platform where diverse applications such as statistical, big data analyses, and visual rendering can be performed. The model presented in this work can be useful for both colleges that plan to invest in new statistical software and for companies that need to pursue future installations of new technologies. In addition, we identified a modified version of the TAM model which is extended by the constructs such as subjective norm and software capability to the original TAM model. However one of the weak aspects that might inhibit the reliability and validity of the model is that small number of sample size.

Key Words: R programming, Technology acceptance, Subjective norm, Perceived usefulness, Ease of use, Software capability, Intention to use, Open source system

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## I. Introduction

In our current computing age, big data becomes one of the most important assets. Big data is the massive data accumulation and procedures used to identify recurring patterns. Big data analysis is now being used to manipulate large data sets and activities involved in this manipulation include being able to capture, store, search, compare, analyze and visualize. Once this vast amount of material is readable it allows users to create new possibilities, such as: business analysis, advertising, predicting customer buying habits, espionage, fraud, follow-up to the population, etc. (Oracle, 2016).

Companies who normally create data analysis reports in order to get a complete profile of their current data are obligated to make investments in analytic software technology. For example, according to Economist (2000), software giants like Oracle, IBM, Microsoft and SAP have spent more than \$15 billion for purchasing software companies which are specialized in managing data and analyzing data. We are entering a new data age and companies are aware of the importance of investment in data technology which is what has led to the birth of new professionals specialized in data management: the data scientist (New, 2015). These kinds of specialists are in charge of extraction of knowledge, dealing and digging deep down the vast data and finding what no one else has ever found. They establish new relations never detected before, combining the skills of

software programmer, statistician and storyteller (New, 2015).

Big data analysis requires multidisciplinary expertise and diverse tools. Cooperation among computer engineers, data scientists, and business analysts is essential for defining and executing business analytics. Since data manipulation and management requirements are not structured and definite, collective intelligence based development of tools and applications is appropriate, compared to the traditional proprietary development which is suitable for static data manipulation. Thus, the proliferation of open and free source software movement supports the popularity of R programming system.

The programming language R is similar to other programming languages, like C, Java and Perl, that at the same time is a platform to perform analyses and visualization. It involves a number of mechanisms like statistical linear and nonlinear modeling, clustering, classical statistical tests, different types of analysis, classification, graphical techniques among others. Additionally, R is an open source programming environment, permitting users to add as much functionality as they need for the analysis. Users have access to a variety of objects in R, from codes developed directly by S as well as access to a wide database of programming languages as Perl and Python, from libraries designed to facilitate user interface.

It is generally known that once the basics of how to utilize R have been learned, it is a powerful and easy tool to use that possesses

many strengths, helping to calculate, create and develop simple descriptions of statistics and creating graphs. In a comparison made by Scavetta (2012) between R and excel, he found that R is capable of storing large data tables in an easily accessible format and a data frame, for data management.

According to the definition by Wikipedia (2018), open source software is a “software with its source code made available with a license in which the copyright holder provides the rights to study, change, and distribute the software to anyone and for any purpose.” Its advantages are offering the potential for a more flexible technology and rapid innovation. It is also more reliable since the software has gone through rigorous process for testing and fixing bugs. Unlike proprietary software, it is free of dependency on the developing company.

R is also open source, so it can be extended through packages developed by its community of users. R can be integrated with different databases and libraries which facilitate its use from interpreter programming languages. Another feature of R is its graphics capability, which allows you to generate graphs with high quality.

Like any technology, R is not perfect and it does have some disadvantages. The software is not yet as popular as some others on the market such as SPSS or Excel, causing unfamiliarity among users which could cause them to view it less positively. In R, the learning curve is more challenging than in others packages which use well designed GUI for better visualization and graphical interface.

The main reason for that is due to the command line driven rather than a point and click application. Obviously this type of interface will dissuade except the dedicated users.

The main objective of this study is to identify what are the antecedents for affecting the intention to use R programming language in a studying environment like universities. For the identification this study will mostly employ the famous technology acceptance model (TAM) with some modifications.

The main difference of this research from the previous ones is that the target system is not a stand-alone. In addition, the system is not static in the sense that the system is not a final version. Instead, R system is evolving and open source system. We applied TAM model to the target system which is a platform where diverse applications such as statistical, big data analyses, and visual rendering can be performed.

In Section II, we briefly provide related literature on the technology acceptance models for both individual level and social level, especially for e-commerce environment. We also provide a technology acceptance model in an organizational settings, where demand and supply sides of technology need to be considered at the same time to determine the level of organizational need for the technology. In Section III our research model, which is a modified version of TAM reflecting R programming environment and hypotheses are specified. Research methods for testing the hypotheses along with the measurements are

provided in Section IV, followed by the analysis and the results in Section V. Limitations of this study and conclusions are finally stated in Section VI.

## II. Related Literature on R and Technology Acceptance Theories

In this section we discuss about R programming language and related models explaining technology acceptance. Those models are 1) traditional technology acceptance model (TAM), 2) modified TAM, reflecting e-commerce environment, and 3) model accommodating supply and demand side of technology, or technology push and technology pull.

### 1. R

According to the news release by the New York Times (Vance, 2009), R becomes rapidly accepted by the data analyst community for the following reasons: First, big data analysis requires cooperation among statisticians, engineers, and scientists. But their computer programming and analytical skill levels are quite different. The interactive nature of programming interface ease of use for the on demand packages or functions is intuitive and ease of use. Its editing software called R Studio makes the programmer-system interface even more interactive. Second, it is open source software, and thus free. It is like

Apache based web server, MySQL for database engine, and the Firefox for web browsers. Third, the most important accelerating factor for fast acceptance is that statisticians, engineers, and scientists can improve and modify the open source programs for their specific purposes. Since R packages contributed by the community grow exponentially, its usefulness for specific data manipulation, data analysis and mining, and graphical display becomes higher and higher. In summary, it is shown that the rapid acceptance of R lies in the ease of use for the users across disciplines and ever sophisticated and diverse capability of R due to the contribution of devoted users.

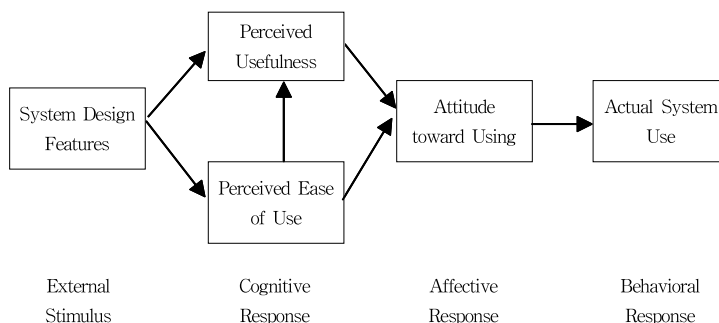
### 2. Traditional TAM model

According to the influential article by Davis (1989), perceived usefulness and perceived ease of use are the most significant determinants toward the attitude and system usage as in <Figure 1> from Davis (1993). That is, the two antecedents determining the attitude toward usage and actual usage are individual person's beliefs toward information systems, which are represented by perceived usefulness and perceived ease of use.

It is noted that the utility of the model is limited to simple and stand-alone systems such as word processors, e-mail system, text editors, and so on. It is noted that the recent application of TAM to new technology can be found in Yoon et al. (2017). Yoon et al. extended TAM model to test the Internet of

Things systems. The model include the exogenous variables such as IoT system quality, explanatory power, and normative norm along with the popular endogenous variables such as usefulness, ease of use. However,

networked systems, where many sub systems or participants are involved, require trust issues to provide security and reliability of the transactions. This type of technology systems needs different technology acceptance model.

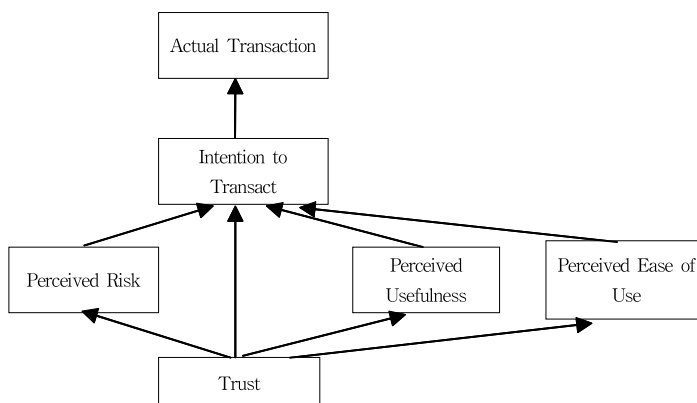


<Figure 1> Original TAM

### 3. Modified TAM for e-commerce systems

The original TAM model did not specify any risks involved for using information technology. However, the Internet induced technology is client-server architecture, separating

the user from the system, which raises issues of risks from malicious hacking and data security. To integrate these issues in the technology acceptance, Pavlou (2003) and Folkinshteyn et al. (2016) included trust as the enabling factor for perceived usefulness and perceived ease of use as in <Figure 2>.



<Figure 2> TAM under e-commerce systems

Since the decisions of shoppers or users of e-commerce systems are dependent on the information provided by the system, the trustworthiness of the information and fulfillment of the information is crucial for e-commerce system acceptance. Thus, the major difference between the original TAM and the TAM of e-commerce system is that trust is the prerequisite to usefulness and ease of use. For the reference of importance of trust issue, see Han et al. (2016).

#### 4. Modified TAM for Organizational Perspective

Note that the psychological concepts such as perceived usefulness and perceived ease of use are based on the beliefs of individuals. That is, the previous two versions of TAM are assumed to be individual level's acceptance.

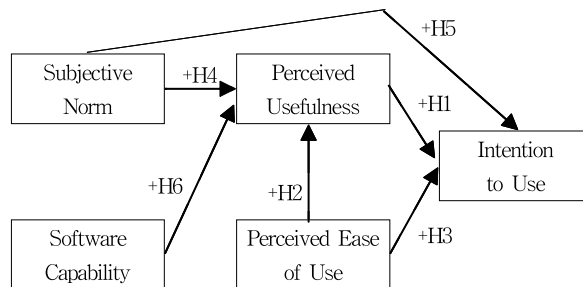
On the other hand, suppose that a new information system or technology is out there. Some organizations might accept the system and the others will not. Then the question is what are the factors determining the acceptance of the technology into the organization.

Unlike the previous TAM, for an organization to make decision to adopt a new technology or not, the organization needs to consider the supply side and demand side factors simultaneously (See for example, Zmud, 1984). The supply side of a technology may include the effectiveness or the attractiveness of the new system and the efficiency or costs for adopting. The demand side may include the level of satisfaction with the current systems and social norms to accept it (see Chau et al (2000).

### III. Research model and hypotheses

R programming system is not only providing programming environments such as editor, interpreter, and output screens but also a rich set of functions and libraries so that users perform different tasks of big data analysis. In addition, its help facilities promote the effective usage of R environment.

Based on the classical TAM model by Davis, we predicted that individuals would be more willing to use R programming language



<Figure 3> Research Framework

when perceived usefulness and perceived ease of use are high. In addition, subjective norm (Davis et al., 1989, Hartwick et al., 1994) and software capability (DeLone et al., 2003) are the constructs added to the original TAM model. Here we propose a model that comprise important features of technology acceptance as in <Figure 3> where the research hypotheses and the direction of associations are described.

### ***Intentions to use***

Intention of use of certain system is described as person's motivation to exert effort to adopt a system. Intention is the mediator connecting motivational factors affecting the use of determinate technology (Ajzen, 1991).

### ***Perceived usefulness***

Perceived usefulness is defined by Davis as "the degree to which a user's beliefs that using a specific application system would enhance his or her job performance" (Davis, 1989). As is shown in TAM, exist a relationship between perceived usefulness and intention to use. It is possible then to say then that perceived usefulness positively influence the intention to adopt R.

*H1: An individual's perceived usefulness is positively related to their intention to use R programming language.*

### ***Perceived ease of use***

Perceived easy of use can be defined as "the degree to which the prospective user expects the target system to be free of effort"

(Davis, 1989). According to the suggestion by Davis on the technology acceptance model, perceived ease of use is positively related to the perceived usefulness. It is hypothesized that perceived ease of use positively influences the intention to adopt R.

*H2: An individual's perceived easy of use is positively related to the perceived usefulness of R programming language.*

*H3: An individual's perceived easy of use is positively related to their intention to use R programming language.*

### ***Subjective norm***

Subjective norm is defined as an individual's perception of whether people important to the individual think the behavior should be performed. The contribution of the opinion of a significant person is weighted by the motivation that an individual has to comply with the wishes of that referent (Davis et al., 1989). In TAM2, Venkatesh & Davis (2000) found a positive relationship between subjective norm and perceived usefulness. Besides, internalization is the experts power, where the target individuals attributes expertise and credibility to the influencing agent. TAM2 suggests that internalization will occur whether the context of system use is voluntary or mandatory.

Subjective norm is especially prevalent in student attitudes towards a technology adoption in the future. This phenomenon dictates the outcome in people's behavior as

they compare themselves to others and accommodate their behavior with people close to them rather than those who are dissimilar (Miller & Grush (1988) and that is because this variable represents a normative belief coming from the social pressure, from professors, from classmates, or from similar people to use and be proficient in the use of R programming. Korean culture highlights the group-oriented attitudes and has an immediate impact on the subjective norm (Hofstede, 1986) Subjective norm, can be suggested as a variable in the Korean university environment, which may influence behavioral intentions to use R programming language.

It is then possible to say that:

*H4: Subjective norm will have a positive effect on perceived usefulness.*

Even when a system is mandatory to use in certain institutions, user's perception about usefulness may increase in response to persuasive social information. It was found by Hartwick & Barki (1994), that subjective norm has a significant effect on intention in mandatory settings, but not in voluntary settings. Later TAM2 (Venkatesh et al., 2000) describes that the direct compliance based effect of this construct on intention over and above perceived usefulness will happen only if the system is mandatory and not voluntary. Voluntariness is described as the extent to which potential adopters perceived to adoption decision to be non-mandatory (Hartwick et al.

1994). Determining if certain technology is used because it is compulsory by the universities or has been elected to use it, is an important determinant of whether users would continue using certain technology.

*H5: Subjective norm will have a positive effect on the intention of using R programming language when system use is perceived as mandatory.*

### **Software capability**

Users are more satisfied with the use of technology if they believe that it will improve their performance and productivity (Mawhinney & Lederer, 1990). Then, system capability is the confidence that software users can obtain the desired results in the amount of time required and with reliability. According to R programming descriptions, R is a software that has all the functions necessary to accomplish successful statistical analyses and graphical visualizations (Smith, 2015). For that reason, it is possible to suggest that people would use R in the future, if they believe R has the proper functions to develop statistics in different fields. According to Smith (2015), users can get access to everything they need within R, which might not come true for five or 10 years through commercial software.

In addition, R programming language is a software in continuous advance and evolution, and the continued and rapid growth in add-on packages which make use of latest analytic algorithms and methods (Muenchen, 2011). In particular, making R software more attractive



and trustable comes from the fact that when someone develops a new predictive model or a new visualization technique, he does not only publish their research results along with the R code in open source so that anybody can access and use it (Smith, 2015). Being accessible to the new capability of R for users is a bigger determinant on people satisfaction and user's future acceptance.

This leads us to the following hypothesis

*H6: The software capability and quality of R programming language is positively related to the perceived usefulness.*

#### IV. Research methods

The questionnaire utilizes a Likert Scale and implements a seven-point scale to examine how strongly individuals agree or disagree with statements. The statements of the scale will go from strongly disagree to strongly agree. A seven point scale will allow the test to explore different participant's experiences and clarify preferences about R.

In order to test the constructs, instruments were drawn from the literature and modified to reflect our research domain using measurement constructs used in past studies as described in <Table 1>.

<Table 1> Items used in the study

Construct	Measure	Source
Perceived usefulness (PU)	-R will be useful in my job -R has enabled me to accomplish tasks more quickly -Using R will increase my productivity -Using R will give me more control of my work. -R will enable my effectiveness on my studies	Adapted and modified from Davis (1989]
Perceived ease of use (EU)	-Learning R is easy. -I find using R is easy. -My interaction with R has been clear and understandable. -Interacting with R has been flexible.	Adapted and modified from Davis (1989]
Intention to use (IU)	-I expect to use R in the future -I am very likely to continue to use R -In the future if I have to use a statistical software I would choose R -In the future I am willing to invest time and effort using R	Adapted and modified from Davis (1989]
Subjective norm (SN)	-The people who are important to me adopted R -The people whose opinions I value adopted R -R is very visible in my referent group -People around me who use R have more prestige than those who do not -Using R is considered a status symbol among my friend	Adapted and modified from Venkatesh & Davis (2000]

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Software capability (SC)	<ul style="list-style-type: none"> <li>-I believe R programming language is efficient</li> <li>-R has a vast number of functions</li> <li>-R is a reliable programming language</li> <li>-R is a continuous upgradable programming language.</li> <li>-R as an open source program is available anywhere (accessible)</li> <li>-Accessibility to help function provided by R and R community is high</li> </ul>	Adapted and modified from the construct, "system quality" by Delone, Mclean (2003)
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The study was carried out in a group of users of R programming language. The study of the implementation of R programming language was of particular interest because it is important software and has been adopted by many colleges and by big companies. A survey questionnaires on online was given to a group of 86 undergraduate students at universities in the central region of South Korea. They were chosen because they are not yet familiar with or constantly dealing with R and in the case of adoption, they will determine whether to use the program in the future or not. The ages of the students range from 18 years to 25 years.

An online questionnaire survey was conducted to universities student of R programming users in who have used or are currently using such system. Students were sent the online surveys through the Internet or the professors currently teaching such program at that time in local Korean universities.

The survey was conducted in September 2015 to students who had contact with R for at least 6 months. 60% of the surveyed students said they used the software because it was compulsory and 81% used it for study purposes.

## V. Analysis and Results

The indicators proposed in <Table 1> were used to measure the constructs. For measurement and structural model testing, we used the partial least squares (PLS) analysis running the PLS-SEM algorithm. Reasons for using PLS are: The sample size is not big enough, and the normality of the data is not guaranteed. Moreover, this study is rather explanatory, not confirmatory. We performed measurement model tests for the constructs of perceived usefulness, perceived ease of use, intention of use, subjective norm, and software capability. We also perform the significance tests for the paths specified in <Figure 3> for university students.

Model assessment focuses on the measurement models. Examination of PLS-SEM estimates enables the researcher to evaluate the reality and validity of the constructs measures (Hair et al, 2013) For the analysis, we used a cloud version of PLS-SEM available at <http://ssra.or.kr/>.

### 1. Reliability

The reliability of the variables measurement

was tested using Cronbach's alpha and composite reliability index as in <Table 2>. The Chronbach's alpha ranges from 0.916 for perceived ease of use to 0.843 for subjective

norm, while the composite reliability index lies between 0.941 and 0.889. These two sets of indices indicate that the reliability of the constructs are acceptable. (Henseler et al. 2009).

<Table 2> Reliability of constructs

Construct	Cronbach's Alpha	Composite Reliability Value
SN	0.843	0.889
SC	0.868	0.902
EU	0.916	0.941
PU	0.903	0.929
IU	0.873	0.915

### 2. Convergent Validity

Convergent validity defined by Hair as “the extent to which a measure correlates positively with alternative measures of the same construct. Using the domain sampling model, indicators of a reflective contract are treated as different approaches to measure the same construct. Therefore, the items that are indicators

of a specific construct should converge or share high proportion of variance (Hair et al., 2013). As is suggested by Fornell and Lacker (1981), all factor loadings and values of average variance extracted (AVE) should be greater than 0.50 for convergent validity.

The diagonal values of the correlation matrix in <Table 3> are the square root of AVE values which are greater that 0.7.

<Table 3> Fornell-Larcker Criterion

	SN	SC	EU	PU	IU
SN	0.829				
SC	0.614	0.803			
EU	0.579	0.434	0.881		
PU	0.637	0.546	0.619	0.840	
IU	0.734	0.473	0.671	0.733	0.886

### 3. Discriminant Validity

Discrimination validity is described by Hair as “the extent to which a construct is truly

distant from other constructs by empirical standards. Discriminant validity is required to guarantee that a construct is unique and captures phenomena not represented by other

constructs in the model (Hair et al., 2013). Discriminant validity was established since all the constructs satisfy the Fornell-Larcker criteria.

#### 4. Hypotheses test

The results of the path analysis and hypotheses test are shown in <Table 4>.

<Table 4> Results of Path Analysis

Hypothesis	Path Coefficient	t-value	p-value	Decision
H1. PU -> IU	0.347	3.415	0.000	Accept
H2. EU -> PU	0.352	3.242	0.001	Accept
H3. EU -> IU	0.240	2.772	0.003	Accept
H4. SN -> PU	0.308	2.521	0.007	Accept
H5. SN -> IU	0.374	4.184	0.000	Accept
H6. SC -> PU	0.204	2.059	0.021	Accept

We predicted that individuals would be more willing to use R programming language when perceived usefulness and perceived ease of use are relatively high (H1, H2, H3), subjective norm and software capability (H4, H5) are constructs added to the original TAM model. All six hypotheses were supported.

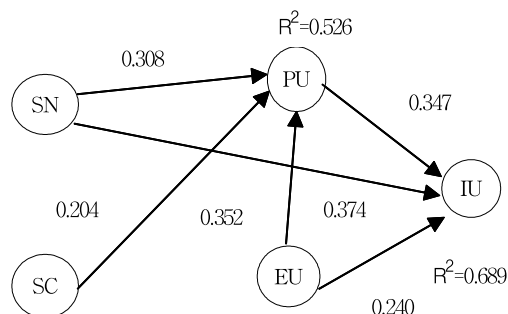
There is a strong significant effect of perceived usefulness on intention to use (H1=0.347), that lead us to think that students believe that R programming would be a helpful tool in their future research or professional life, and that they will choose to adopt it.

According to the previous assumption that individuals will be more likely to adopt a certain technology due to social pressure, Hypothesis 5 says that: "Subjective norm will have a significant direct effect on intention of use R programming language, when system use is perceived as mandatory."The results support the hypothesis strongly (H5, b=0.374). Social norm also has a direct significant effect

on perceived usefulness (H4, b=0.308).This implies that means that there is significant social pressure from classmates and professors for the future adoption of R programming.

There is a significant effect from perceived ease of use on perceived usefulness (H2, b=0.352, p<0.05), Therefore, Hypothesis 2 was also supported. In addition, Hypothesis 3 had a significant effect on ease of use as well. As Davis mentioned, this means that if a program is effortless to use (ease of learning, flexible, clear, and understandable, etc.), people will have a higher willingness to adopt this technology (Davis [3]).

Path diagram along with the standardized path coefficients and R2 is given in <Figure 4>. Note that the explaining power of Subjective Norm, Software Capability, and Perceived Ease of Use on Perceived Usefulness is 52.6%, while that of Perceived Usefulness and Subjective Norm on Intention to Use is 68.9%.



<Figure 4> Path diagram along with coefficients and R2

## VI. Limitations and conclusion

The main difference of this research from the previous ones is that we applied TAM model to the target system which is a platform where diverse applications such as statistical, big data analyses, and visual rendering can be performed.

The model presented in this work can be useful for both colleges that plan to invest in new statistical software and for companies that need to pursue future installations of new technologies. One of the weak aspects that might inhibit the reliability and validity of the model is that small number of sample size.

In this paper a modified version of the TAM model was proposed by including constructs such as subjective norm and software capability to the original TAM model. The model is to explain the factors that influence the level of adoption of data analysis programming R. The six hypotheses suggested are all confirmed by the empirical data. In particular, the perceived ease of use of R programming influences in a positive way on

the perceived usefulness. This relationship can be explained by the interpreter mode of R programming execution so that users get immediate feedback from the system, which makes users' perception of ease of use high. In addition, the users can obtain the appropriate function and associated parameters from the help system, which does not require to memorize the function calls, but facilitates the user's know-where capability to find appropriate functions. Another important conclusion is that the higher the perceived usefulness is, the more likely that individuals will have the intention to use R. However, if the perceived usefulness of the software is low, then the individual will not consider R as a tool to achieve tasks, which would result in a low intention of use as well. On the other hand, if there is high social pressure from professors, classmates, coworkers or superiors, then the usefulness and intention of use will be high too.

One of the weak aspects that might inhibit the reliability and validity of the model is that small number of sample size.

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## Abstract

R 프로그래밍 수용 결정 요인에 대한 탐색 연구<sup>†</sup>

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R 프로그래밍 시스템은 인터넷을 통해 개방적이고 무료로 제공이 된다. R 환경은 혁신적이고 독자적인 사용자 그룹이 제공하는 다양한 함수가 포함되는 라이브러리에 의해 그 기능이 지속적으로 풍부해지고 다양해지고 있다. R의 사용은 조직에서의 빅데이터 분석이 점차 도입되면서 다양한 데이터 형태의 데이터 조작과 데이터 분석처리가 요구되면서 점차 채택되기 시작하였다. 그러나 R 수용에 대한 연구는 아직까지 존재하지 않고 있다. 본 연구는 교육환경의 사용자가 R을 수용하는데 미치는 인지변수를 식별하고, 그들간의 관계를 규명하고자 한다. 기존의 기술수용모형에 주관적 규범과 소프트웨어 역량을 추가한 확장된 R 수용모형을 제안하고, 경로분석을 통하여 가설을 검증하였다. 사용의도에 정의 영향을 미치는 변수는 주관적 규범, 지각된 편리성, 지각된 유용성으로 밝혀졌고, 지각된 유용성은 주관적 규범, 소프트웨어 역량, 그리고 지각된 편리성으로부터 영향을 받는 것으로 나타났다. 본 연구가 이전 연구와의 주요 차이점은 대상 시스템이 독립적인 시스템이 아니고, 또한 시스템은 정적이고 개발이 확정된 상태가 아닌 진화하고 오픈소스 시스템을 대상으로 했다는 것이다. 또한 R 환경은 플랫폼으로서, 다양한 통계분석, 빅데이터분석, 그리고 시각화가 가능한 시스템이다. 우리는 TAM (Technology Acceptance Model)을 적용하여 R플랫폼에 대한 사용자의 수용에 영향을 주는 변수를 식별하고 인과관계를 처음으로 시도하였다. 또 다른 기여도는 기존의 TAM모형에 주관적 규범과 소프트웨어 역량 개념을 추가한 확장된 모형을 식별한 것이다. 본 연구결과는 통계나 빅데이터 분석 패키지 도입 계획이 있는 대학이나 기업체에 시사점을 제공할 수 있을 것이다. 그러나 분석에 사용된 표본의 수가 적고, 표본이 모집단을 대표할 수 있다는 근거가 약해 제안된 모델의 신뢰성 및 타당성이 상대적으로 미흡하다고 할 수 있을 것이다. 따라서, 향후 연구에서는 확정적 연구를 위해서는 이와 같은 문제점에 대한 보완이 필요하다고 판단된다.

핵심주제어: R 프로그래밍, 기술수용, 주관적 규범, 지각된 유용성, 지각된 편리성, 소프트웨어 역량, 사용 의도, 공개 소프트웨어

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