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Determinants of Adoption of Desktop 3D Printer
: Perceived Risks and Personal Motivation

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Abstract

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As an alternative to traditional manufacturing methods, three-dimensional printer (3DP) has attracted considerable attention from the consumer. Despite improving technology and dropping price, however, certain aspects of 3DP remains sparse, and general use of the technology remain under-studied. In addition, current regulations and laws are insufficient and limited in handling arising problems, such as liability problems and intellectual property (IP) issues. To implement proper strategies and promote the industry, a deeper understanding of consumer behaviors is needed. Using an extended version of the technology acceptance model (TAM) with perceived risk and motivations, this paper aims to investigate the factors affecting users' intention to use desktop 3DP. Performance, financial, legal, physical, and psychological risk are selected as dimensions of risk. Marketplace and identity motivations are selected as dimensions of social influence. Because 3DP meets the needs of consumers at different stages, we compare the analyzed results of two stages of 3DP use (namely, usage of 3D printers and usage of 3D

printed products). A total of 407 sample questionnaires were collected through an online survey system and analyzed with a structural equation model. The results show that each facet of risk contributed to users' perceived overall risk in 3DP, which in turn negatively impacted their intention to use 3DP in the stage of "use of desktop 3D printers" as well as users' perceived usefulness of 3DP in the stage of "printed product use." Furthermore, the results suggest that paths showing how overall risk affects consumers' intention to use desktop 3DP differ depending on users' do-it-yourself experience and users' motivation of identity. Overall risk has indirect effects in the low-motivation group and in the non-experience group, while overall risk shows no effects in the high-motivation group and experienced group herein. Our research concludes with a discussion of managerial and political implications based on findings.

Keywords: Desktop 3D printer, User acceptance, Technology acceptance model, Perceived overall risk, Structural equation model, Prosumer, Prosumption

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1. Introduction

Increasingly, consumers want products that reflect their individual needs from initial stages of product design. It is anticipated that consumer trends will change from mass production to personalized production, and, accordingly, additive manufacturing (AM) or three-dimensional printing technology is attracting consumer attention as a technology to realize personalized production methods (Hu, 2013). Three-dimensional printing technology enables consumers who, up to this point, have been able only “to choose” and “to buy” the products that they require now “to participate in design” or “to direct production” of products. With this has come the discovery of new value through collaboration with consumers or experts (Guk-Hee & Jaekyung, 2016; Lee Jong Seok, 2015). Three-dimensional printing (3DP) technology was developed in the 1980s by Charles Hull with a stereolithography (STL) method of making liquid polymers using ultraviolet light. Subsequently, Crump developed the fused deposition modeling (FDM) approach that is commonly used today. Because the price of three-dimensional printers was prohibitively expensive for individual consumers until the early 2000s, three-dimensional printing was mainly used to create industrial prototypes. However, as related patents have expired since 2004, low-priced desktop three-dimensional printers have been produced for consumers interested in do-it-yourself (DIY) products (Savini & Savini, 2015; Sheng Yi & Chang Sup, 2014). In past research, mainly the effects of three-dimensional printers on existing industries have been studied (Angrish, 2014; Leukers et al., 2005; Sivashankar et al., 2016), An increasing amount of research on aspects of

desktop three-dimensional printers, such as modeling and service directions for user convenience (Campbell & Bernabei, 2017; Guk-Hee & Jaekyung, 2016; Jang, Nam, & Kim, 2017; Sugimoto, Maeda, Maekawa, & Maruo, 2017), technology of desktop three-dimensional printers (Alimanova, Zholdygarayev, Tursynbekova, & Kozhamzharova, 2017; Elibiary et al., 2017; Moscato et al., 2015; Rajamanickam & Mulla, 2017; Sanz-Izquierdo & Jun, 2014), security vulnerability (Do, Martini, & Choo, 2016; Moore, Armstrong, McDonald, & Yampolskiy, 2016), and expected problems (Niess & Wende, 2017; Yampolskiy et al., 2016) has been performed. In these advanced studies, however, consumer behavior analysis related to three-dimensional printers relies on the existing TAM model or the extended TAM model without accounting for specific characteristics of desktop three-dimensional printers or consumer tendencies in terms of the prosumer. Therefore, the current study proposes a "consumer acceptance model of desktop three-dimensional printer technology" that explains which elements of the technology resonate with consumers and who intends to use desktop three-dimensional printer technology. In order to achieve this, both negative and positive factors are included and compared in two stages of use including consumer use of three-dimensional printers and use of printed products. In addition, the study attempts to investigate differences between the consumer motivation of identity (Wolf & McQuitty, 2011) and DIY experience in consumers as moderator variables. Our findings can be used by companies to devise risk reduction strategies for end-user acceptance of desktop three-dimensional printers.

The object of this paper is to investigate factors affecting consumers' intention to use

desktop 3DP. The following questions are the main angles of this study.

① Does perceived risk by consumers negatively affect their intention to use desktop 3D printing in both stages of use?

② What types of risks are salient for consumer use of 3D printing in both stages of use?

③ Do marketplace motivations positively affect consumers' perceived usefulness and intention to use 3D printing in both stages of use?

This paper is organized as follows. In Section 2, this paper reviews existing studies related to desktop 3DP and describes the existing TAM and TAM 2 models. Section 3 covers conceptual models and hypotheses, and Sections 4 and 5 cover corresponding results and discussions. The final section describes the main implications of this paper and directions for future research.

2. Literature Review

2.1 Three-dimensional Printer

2.1.1 General Concept

Since the Industrial Revolution, conventional manufacturing techniques, such as cutting and forming, have used injection molding machines and milling machines for precision cutting. These machines have disadvantages including they are expensive and they make it difficult to repeat the same operation for various products (Wang, Sun, Cobb, Lawson, & Sharples, 2016). In contrast, three-dimensional printing (3DP) is a method of creating a three-dimensional (3D) drawing using computer software—that is, computer-aided design (CAD) software—and transmitting the drawing to a three-dimensional printer to output (or print) a desired type of product (Hyeon-Chang, 2015). In terms of product flexibility in comparison to existing manufacturing, it is possible to customize order production without having to reserve stock in advance, so that products can evolve in pre-order and post-production methods (Noorani, 2006).

Types of 3D printers are predominantly liquid-based stereo lithography (SLA), solid-based fused deposition modeling (FDM), and powder-based selective laser sintering (SLS) machines. Liquid-based SLAs were first commercialized by Charles Hull in 1984. The process involves a liquid in which solidification occurs in response to a specific light used in a tank, and photopolymer is the main material. In the case of solid-based FDM developed in 1988, filament-type thermoplastics are injected through a nozzle to form a thin film, and the thin film is subsequently stacked to produce a product. Finally, the

principle of SLS involves formation of a thin film by emission of a laser beam to a tank containing powders such as plastic powder, metal powder, and ceramic powder. By spraying the powder after film formation, a desired object is formed via layers similar to FDM. Three-dimensional printers are available for industrial, professional, and personal use depending on the application, with respective price ranges between 1-2 billion, 10-100 million, and 1-10 million Korean won (Sheng Yi & Chang Sup, 2014).

According to a report by Wohlers (2016), a global market research firm, the 3DP market grew 25.9% to 5,165 billion US dollars in 2015. It also shows an annual average growth rate of 33.8% over three years (Wohlers, 2016). Another research firm, Gartner, reports that 10% of global manufacturing companies in 2018 have the ability to integrate 3D printing technology into the manufacturing process, thereby reducing the time it takes to introduce products (Gartner, 2016). In addition, the McKinsey (2013) estimates the impact of three-dimensional printing technology at $2,350-550 billion by 2025. In the case of Korea, the value of the 3DP market increased to 223 billion won in 2015 and to 297.1 billion won in 2016, further growing to 346.9 billion won in 2017. The number of related workers increased from 980 to 1,893 in Korea in the same time span (KAIT, 2017).

Considering the technological innovation and the size of the market, the US government and the European government are actively supporting research and development (R&D) projects related to three-dimensional printing. In the United States, the government has established the National Additive Manufacturing Innovation Institute (NAMII) to oversee the development of 3DP technology and plans to establish a

specialized agency benchmarking the NAMII. Through this initiative, the United States is trying to promote development of the technology and practical application with companies in the fields of design, materials, and systems. In the case of the United Kingdom (UK), 3D printing is recognized as a key technology, and plans are set to teach the use of 3D printing directly and the creation of 3DP products. In China, central and local governments are working to create industries and industrial complexes related to 3D printing. In Korea, too, an official "3D printing industry development strategy" was launched in April 2014 to establish a demand-linked growth base in order to support business activation and secure technological competitiveness (KEIT, 2015).

In fact, corporate giant Nike utilized 3D printing in 2013 to produce the shoe sole in demand by customers, and aircraft manufacturer Boeing has been using some thermoplastic parts from SLS technology in its 737, 747, and 777 jet planes (Mellor, 2014).

With high utilization on a global scale, 3D printing is expected to cause various problems. According to Hyeon-Chang (2015) who has studied the effects of three-dimensional printing on society and economy, crimes such as chemical production, the production of criminal tools, and theft of fingerprints by others have been found to be possible. Yampolskiy et al. (2016) describes a scenario in which a third party can operate or attack in the manufacturing process using 3D printing. In fact, the United States became a setting of controversy on August 1, 2018, when "Defense Distributed," a nonprofit organization, released three-dimensional drawings of Liberator and AR-15

semi-automatic rifles (David, 2018).

Another problem is the infringement of intellectual property rights due to the use of 3DP. There are many cases of infringement, but instances can be roughly divided into cases of replicating products and of sharing 3D drawings of potential products. Additional issues that may arise in connection with these shared drawings are product liability and ethics issues. There may be stakeholders, such as those who have designed a product, who have posted the design on the Internet, together with those who have downloaded product designs, printed products, or who have used printed products. Around these cycles of design, production, and use, there are many questions about who has responsibility in areas of 3DP (Hyeon-Chang, 2015; Niess & Wende, 2017).

2.1.2 Desktop 3DP

Until the early 2000s, 3DP was used primarily for prototyping purposes in the industrial sector due to its exorbitant costs. This changed with the launch of the 3D Reproduction Rapid (Rep Rap) prototyping project, initiated by A. Bowyer in 2005. Similar projects, such as Fab @ Home, have been launched following Rep Rap, and low-cost desktop 3D printers and personal 3DP have become popular as existing 3DP has created new 3DP opportunities and has increased the availability of 3D printer parts (Savini & Savini, 2015). In the first two decades of the 21st century, the price of desktop 3D printers has dropped to less than $5,000 per unit (T. Wohlers & Caffrey, 2014). For convenience, this paper integrates concepts and trends in desktop 3DP and personal 3DP

into the term “desktop 3DP” (T. Wohlers & Caffrey, 2014).

As the popularity of desktop 3DP increases, new research is being conducted in the field of desktop 3DP. For example, Li et al. (2017) described how production costs, environmental sustainability, and surface roughness differ among types of desktop 3DP products. Wittbrodt et al. (2013) explained that 3DP products via the Rep Rap project stand to provide economic benefits to US consumers. Similarly, Petersen and Pearce (2017) have shown that it is economically effective to use desktop 3D printers and 3D drawings, which are widely available online and free to consumers.

In contrast, some researchers have identified potential problems with the use of 3DP. As with MPEG audio layer 3 (MP3) or media files that are easily shared and therefore difficult to protect, similar intellectual property (IP) problems can occur in desktop 3DP (Bradshaw, Bowyer, & Haufe, 2010). In products created via desktop 3DP, the inclusion of harmful substances such as ultrafine particles is possible (Stephens, Azimi, El Orch, & Ramos, 2013; Zhou, Kong, Chen, & Cao, 2015); thus, the use of home products such as dishes and cups could result in potential toxicity, carcinogenic substances, or bacterial contamination (Sharma, 2018).

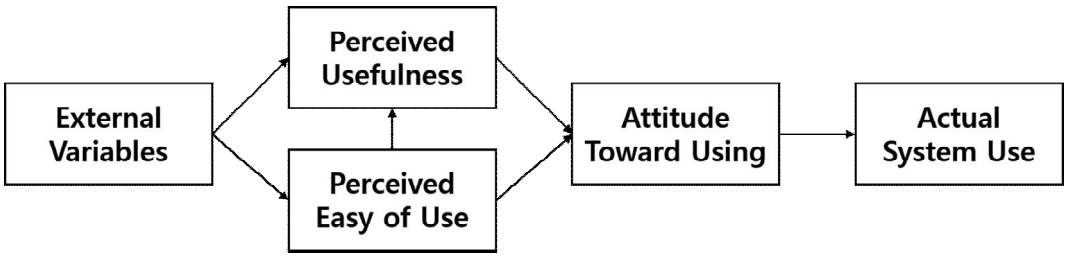
According to Article 17 of Korea’s Three-Dimensional Printing Promotion Act, the use of desktop 3DP means that responsibility for the product is, as a prerequisite, subsumed by the consumer from the enterprise. These clear risks of desktop 3DP, however, are not taken into consideration in existing research on consumer acceptance of technology. Positioning desktop 3DP as a form of innovative production technology using computers,

this paper discusses the perceived risks to consumers in Section 2.4.

2.2 Technology Acceptance Model(TAM)

2.2.1 General Concept

Of seminal importance, the technology acceptance model (TAM) from the work of Davis (1989) is based on the Theory of Reasoned Action (TRA) in the work of Fishbein and Ajzen (1975). The TAM is a model to implicitly explain consumers' innovative use of new technology. The basic content of the TAM describes how an individual's intention to use a technology (acceptance intention) is influenced by the individual's attitude toward the technology, demonstrating that attitude is influenced by the perceived usefulness of the technology and the perceived ease of use. Perceived usefulness refers to the subjective probability of a potential user to improve his or her work performance by using a particular system. Perceived ease of use means the degree to which a potential user expects to exert no considerable effort to use the system (Davis, 1989; Davis, Bagozzi, & Warshaw, 1989). Figure 1 shows the basic TAM structure.



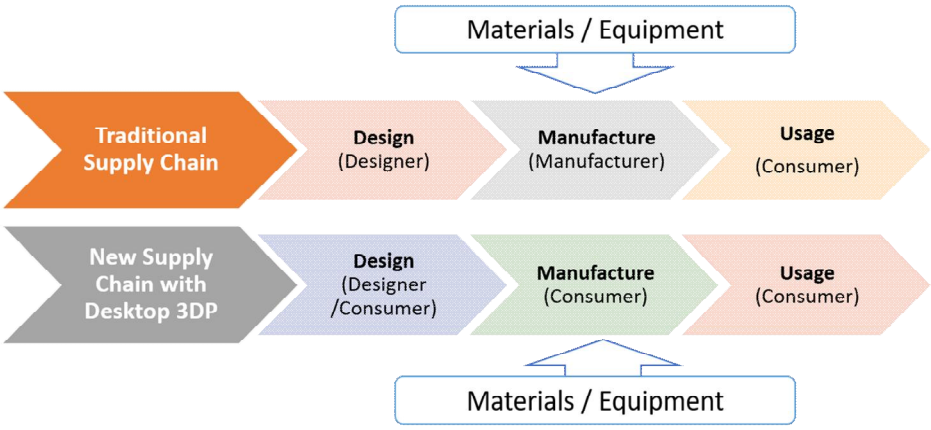
[Figure 1] Technology Acceptance Model (TAM)

The TAM, originally proposed by Davis in 1989, was used as a model for predicting user attitude and intention to use new technology in the context of involuntary technology use by members of an organization. Since then, the TAM has proven that the perceived usefulness and ease of use of new technology for general consumers influence consumers' intentions and attitudes toward technology use in voluntary and involuntary environments (An, 2011; Featherman & Pavlou, 2003; Gwang-Suk, Hyo-Jin, & Jaewook, 2010; M.-C. Lee, 2009).

As the Internet rose in popularity, TAM was applied to the study of users' intention to use the technologies that sellers (in this case, service providers) and consumers performed on the Internet and the attitude of consumers' acceptance toward these novel developments. Featherman and Pavlou (2003) found that consumers' perceived usefulness in the intentions of electronic services (e-services) had a significant effect on acceptance intention. Likewise, the work of M.-C. Lee (2009) demonstrates that user intentions and attitudes toward the use of Internet banking were significantly influenced by two factors of TAM. In addition, product characteristics (efficiency, security, quality) and consumer characteristics (social influence, consumer innovation) have a significant impact on perceived usefulness and perceived ease of use, as well as on consumer acceptance of Smart Grid systems and Internet-based Protocol Television (IPTV) advertisement technology (An, 2011; Gwang-Suk et al., 2010). Specifically, Gwang-Suk et al. (2010) showed that there is a difference between users categorized in an expert group and a non-expert group of users in accepting technology.

2.2.2 TAM in Different Stage

The use of 3DP by the public due to technological advances and price declines will change the form of existing consumer-maker supply chains. In the existing production system, the designer at the planning stage, the manufacturer at the production stage, the seller at the sales stage, and the consumer at the product use stage form the supply chain by playing discrete roles at each stage. In contrast, desktop 3DP allows consumers to have a comprehensive role from planning to use. However, the elements of equipment and materials come from the outside as well as existing production systems (Harris, 2015). The steps described above are shown in Figure 2, with the exception of the product sales phase.



[Figure 2] Comparison of Traditional and New Supply Chain with Desktop 3DP

Turbovich, Avital, Mazor, Das, and Kalita (2017) re-classified the consumer into the "producer" (to describe a consumer who owns desktop 3DP and participates in the design stage) and into "manufacturer" (to describe a consumer who owns desktop 3DP and uses

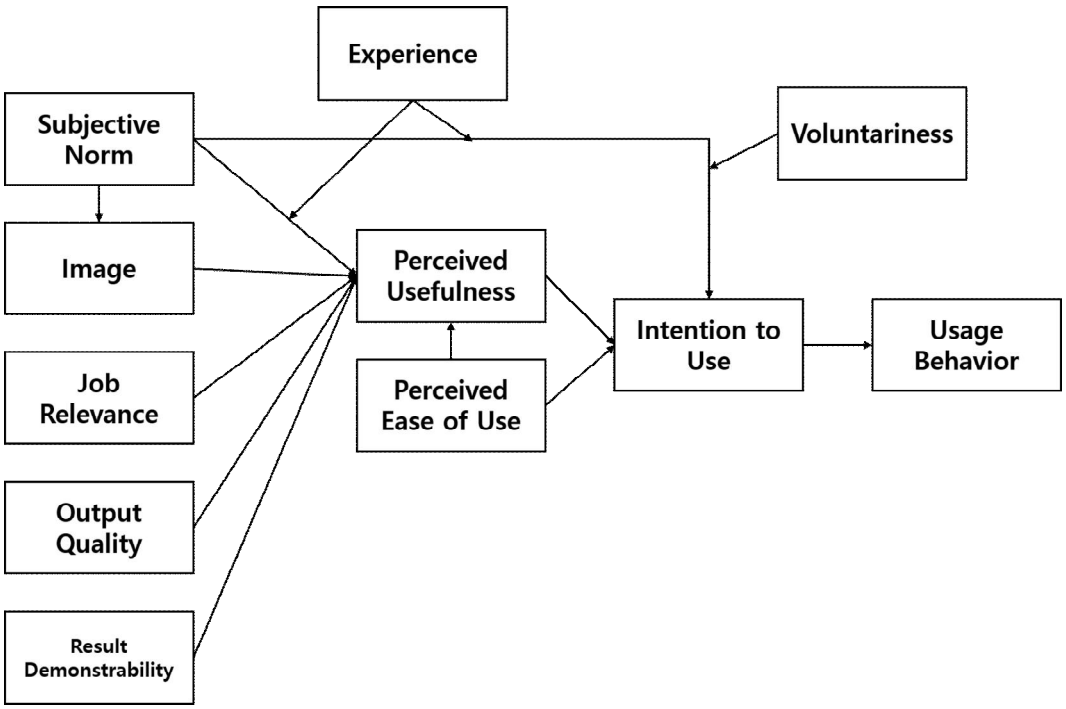
modified designs or one who does not participate in the design stage). This study, however, does not distinguish between the two sets of consumer behaviors, and thus uses the term “consumers”.

Based on the traditional supply chain system in Figure 2, application of the TAM is useful at the moment of product purchase or service usage decisions between the manufacture and usage stages. In the case of desktop 3DP, however, TAM is a factor between the design and manufacture stages. In other words, the consumer is aware of the usefulness, ease of use, and risks in using desktop 3DP at two stages, including the producing of products with 3DP and the using of products produced via 3DP. Departing from existing TAM models, it is important for consumers who accept desktop 3DP to understand differences in how they feel about the usefulness, ease of use, and risks of the technology at the stage of using desktop 3DP and at the stage of using the printed products.

2.2.3 TAM 2

Since its original proposal by Davis (1989), the TAM has been used as a key model for predicting and explaining system use and has been further developed, modified, and extended by other researchers (Marangunić & Granić, 2015). Venkatesh and Davis (2000) pointed out that, in the TAM, perceived usefulness is a major determinant of intention to use, and thus it is important to identify factors that affect perceived usefulness. Thus, an extended technology acceptance model (TAM 2) has been described by adding

dimensions of social influence processes (subjective norms, voluntariness, image) and cognitive instrumental processes (job relevance, output quality, result demonstrability) based on the original TAM (Fig. 2).



[Figure 3] Extended Technology Acceptance Model (TAM 2)

Social influence refers to the interrelated social influences that affect consumers in a situation that will accommodate a new system. Cognitive tool processes refer to what is possible by accepting a new system. Table 1 defines the dimensions of social impact and cognitive instrumentation (Venkatesh & Davis, 2000).

Through this TAM 2, “the degree of external stimuli felt in a society or its group as usual” and “the degree of psychological expression that connects the consumer’s goals

with the means to achieve them" can affect technology acceptance and perceived usefulness.

[Table 1] Definition of Variables in TAM 2 (Venkatesh & Davis, 2000)

Process	Constructs	Definition
Social Influence	Subjective norm	Person's perception that most people who are important to him think he should or should not perform the behavior in question
	Voluntariness	The extent to which consumers perceive their acceptance decisions voluntarily
	Image	The degree to which consumers perceive themselves as improving their position within the community by using innovative technologies
Cognitive Instrumental Determinants	Job relevance	The degree to which the technology applicable to work
	output quality	The extent to perceive that consumers perform the desired job performance adequately
	result demonstrability	The degree to which consumer can see the result of using technology

2.3 Prosumption

2.3.1 General Concept

The concept of prosumption, first introduced by Toffler (1980), describes people who play the role of producers and consumers at the same time. The definition of prosumption is to engage in the making of products for users to consume on their own. Desktop 3DP can be seen as an aspect of this prosumption behavior insofar as individuals create products that they want to use for themselves.

Increasingly, consumers are drawn to prosumption, and it is important for marketers to find ways to facilitate prosumption activities (Kotler, 1986). In addition, people who participate in prosumption, including physical behaviors, mental endeavors, and socio-psychological behaviors, are called “prosumers”. Prosumers are likely to experience various difficulties due to economic and technological constraints in the process of creating desired products by means of various resources (Xie, Bagozzi, & Troye, 2008).

2.3.2 DIY(Do-It-Yourself) Behavior

Popular DIY behaviors are a facet of prosumption insofar as mental and physical participation are required on the part of consumers to produce, transform, or reconfigure products using raw materials and other components (Wolf & McQuitty, 2011). Wolf and McQuitty (2011) argue that consumer acceptance of DIY activities involves not only material factors such as economic conservation, but also motivations that enable consumers to accept new value beyond material value. These motivations, the authors explain, come from the marketplace and are manifest in motivations of consumer identity. They describe marketplace motivations as arising from evaluation of economic benefits for consumers, a lack of quality, a lack of product availability, and the need for customization in products. Identity motivations are described as satisfying the needs of craftsmanship, personal capacity building, belonging to the local community, and originality. Table 2 describes each of the evaluation factors.

[Table 2] Definition of evaluations (Wolf and McQuitty, 2011)

Motivation		Definition
Market place	**Relative economic benefits**	Compare the economic value of existing markets for similar goods and services with the economic value of DIY activities
	Lack of product quality in the professional sector	Recognizing that services cannot achieve sufficient quality
	Lack of product availability	If the consumer does not have the desired level of available product, the desire to change to another product
	Need for customization	If there is no product available at the level desired by the consumer, the desire to produce the product satisfying the demand by itself
Identity	**Sense of empowerment**	Empowered by prior DIY behavior and motivated to undertake further DIY project
	Constructing an identity as a craftsman	Personal fulfillment and viewed their completed DIY project as a reflection of their ability as craftsmanship
	Being part of a DIY community	Connecting with others by doing DIY project
	Need for uniqueness	Trying to reduce the threat of being similar to others by creating unique items

Marketplace motivations are similar to the social influence dimension of TAM 2, and identity motivations are similar to experience in that past satisfaction with products affects the future behavior of consumers.

2.4 Perceived Risk

2.4.1 General Concept

Perceived risk was first described in the work of Bauer Bauer (1960), with the statement that, “Consumer behavior involves risk in the sense that any action of a

consumer will produce consequences which he cannot anticipate with anything approximating certainty, and some of which at least are likely to be unpleasant." Cox and Rich (1964) define perceived risk as "the nature and amount of risk perceived by a consumer in contemplating a particular purchase decision." The research of Cox and Rich explains that the degree of risk perceived by the consumer is a function of the amount of money to be spent and the amount of money to spend and the subjective feeling of being able to lose that amount of money. The work of Bettman (1973) describes factors that determine perceived risk as inherent risk, which is a common risk in the product group, and "handled risk," which can occur when a brand is selected in the product group. Featherman and Pavlou (2003) who have studied e-service adoption, have defined perceived risk (PR) as "the probability of loss when pursuing desired results using e-service[s]."

This paper defines perceived risk as "the probability of loss when pursuing a desired result using desktop 3DP or printed products," similar to the definition put forward by Featherman and Pavlou in their study.

Such perceived risk occurs when consumers feel uncertain due to a lack of contextual information, and results from differences in costs, benefits, risks, and utilities in accepting different technologies or services (Featherman & Pavlou, 2003). Because of uncertainty in information, it is important for consumers to find strategies to understand and reduce perceived risks in dealing with "faceless" sellers, as in sight-unseen shopping (Cox & Rich, 1964) or e-service (Featherman & Pavlou, 2003) , which are areas wherein

perceived risks are greater than the perceived risks of in-store selling (Zhang, Tan, Xu, & Tan, 2012).

2.4.2 Dimensions of Perceived Risk

For consumers, product risks have increased as in-store to non-store methods and sales methods have evolved from door-to-door sales to sales methods involving e-mail, phones, and the Internet. Many scholars have recognized that consumers perceive various forms of risk, and that perceived risk affects the purchasing decisions of consumers (Akaah, 1988).

Roselius (1971) found that brand loyalty and brand image play a major role for consumers in their feelings of relatively low perceived risk (PR) in comparison to levels of feelings induced by store images, free samples, rumors, and credible tests.

In addition, the work of Soltanpanah, Shafe, and Mirani (2012) on PR related to e-commerce shows that various types of risks including security, financial, social, time, and performance risks are important. The types and definitions of various risks described in previous studies are shown in Table 3 below.

[Table 3] Dimensions of PR and Definitions

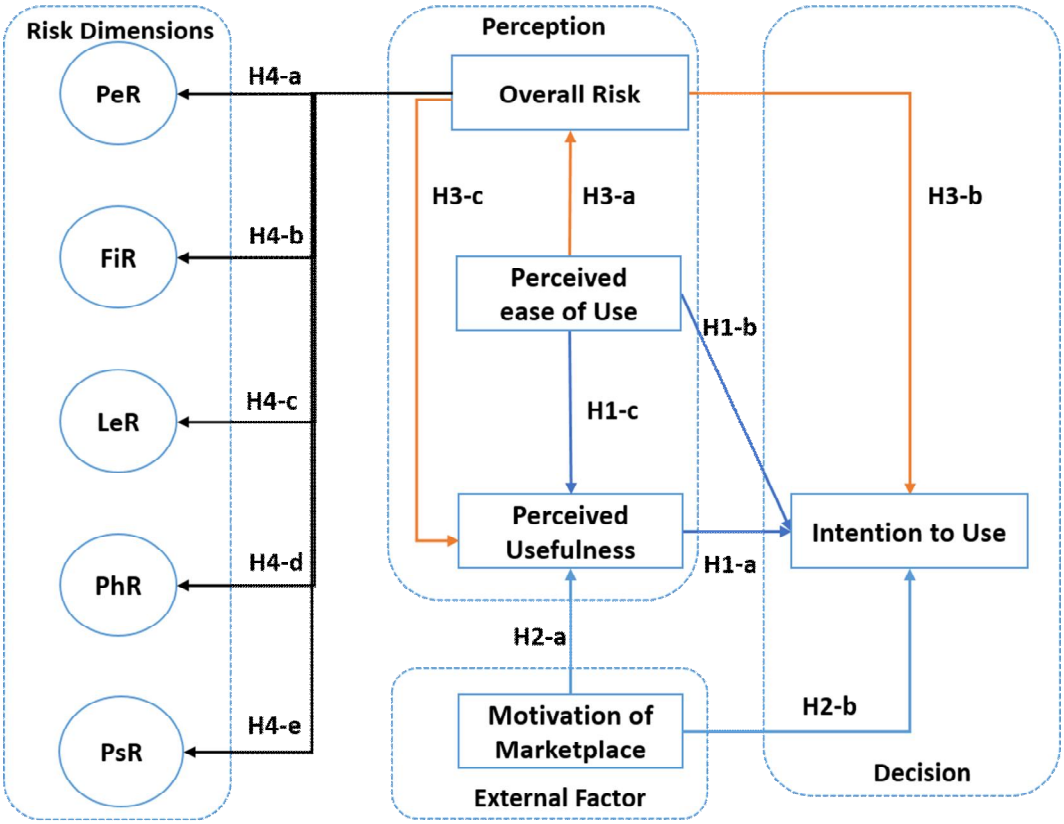
Dimension	Definition	Related Literature
Overall Risk	"the degree to which individuals believe that if they purchase products or services through the Internet, they will suffer losses."	Lim (2003)

Performance Risk	"potential or imposed damages which are caused by technical deficiencies or improper functioning of the system"	Soltanpanah et al. (2012)
Social Risk	"Potential or imposed damage that causes the loss of social status of people because of using the system among other authority groups."	Soltanpanah et al. (2012)
Time-loss Risk	"Potential or imposed damage which is caused by wasting time and brining about problems because of the delay in the leading of system operations and spending time on learning how to use the system tools and devices."	Soltanpanah et al. (2012)
Financial Risk	"Potential or imposed financial risk which is caused by errors in the system operations."	Soltanpanah et al. (2012)
Physical Risk	"Products are dangerous to our health or safety when they fail."	Roselius (1971)
Psychological Risk	"Suffering from the mental anxiety which is caused by their purchasing behavior or using system."	Lim (2003); Soltanpanah et al. (2012)
Legal Risk	"Potential or imposed damage which is the result of lack of any complied law for electronic crime or lack of knowledge in this area."	Soltanpanah et al. (2012)

3. Conceptual Model and Hypotheses

3.1 Conceptual Model

The models in this paper were created by taking into account perceived risks consistently described in the findings of existing literature together with marketplace motivations similar to the social influence dimension presented in the TAM 2. Using this model, this paper verifies a technology acceptance model that can explain the acceptance of desktop 3DP by general users. The research model for consumer acceptance of desktop 3DP is shown in Figure 4.



[Figure 4] Conceptual Model

As described above, both “consumer uses desktop 3DP” and “consumers use products made with desktop 3DP” are discrete stages of use in the sense that consumers accept desktop 3DP as a tool to create the products they desire (rather than only accepting 3DP for the sake of using the technology itself). Nevertheless, consumers’ motivation is the same in the two stages insofar as consumers perceive motivation prior to technology adoption. Following the description in Section 3.2 of the discrete stages of using desktop 3DP, Section 3.3 summarizes the two-stage hypothesis.

3.2 Variables and Hypotheses

This study constructs an acceptance model of desktop 3DP considering the technology acceptance model, perceived risk, and marketplace motivations, thereby forming the following hypotheses.

3.2.1 TAM

The TAM is central in this study. The original model explains that consumer intentions are determined by perceived usefulness and perceived ease of use. Accordingly, the definitions in the existing model by Davis (1989) have been modified to fit desktop 3DP.

[Table 4] definition of TAM variables

Variables	Definition	Related Literature
Intention to Use	Individual’s intention to use a Desktop 3DP	Davis (1989)
Perceived	The extent to which a person believes that using the	Davis (1989); Venkatesh and

Usefulness	Desktop 3DP will bring positive influence	Davis (2000)
Perceived Ease of Use	The extent to which a person believes that using Desktop 3DP will be free of effort	Davis (1989); Venkatesh and Davis (2000)

The following hypotheses are presented through previous research with the existing TAM on desktop 3DP.

H1-a: The perceived usefulness of desktop 3DP has a positive influence on consumers' intention to use desktop 3DP.

H1-b: The perceived ease of use of desktop 3DP has a positive influence on consumers' intention to use desktop 3DP.

H1-c: The perceived ease of use of desktop 3DP has a positive influence on consumers' perceived usefulness of desktop 3DP.

3.2.2 Revision of TAM 2

As technology acceptance models have proven to be valid in evolving contexts, many researchers have been trying to extend the basic TAM and improve its impact (Chow, Herold, Choo, & Chan, 2012; Gefen & Straub, 1997; Taylor & Todd, 1995; Venkatesh & Davis, 2000). These studies are mostly about external factors or control variables that impact factors that affect perceived usefulness and perceived ease of use. Alternatively, some studies have shown that adding variables to the model affects consumer intention to use new technology (Marangunić & Granić, 2015).

The TAM 2 explains the significance of social influence (subjective norms, voluntariness, and image) in determining whether an individual uses a new system Venkatesh and Davis (2000). Unlike technologies that are the focus of the TAM or TAM 2, which are aimed at group activities, desktop 3DP differs in that it creates products for personal activities. Given that the social impact of TAM 2 is in measuring the extent to which individuals respond to external stimuli, our designated marketplace motivations are similar in the sense that the social impact of external products is to inspire prosumption behavior.

Because the use of desktop 3DP is similar to the concept of prosumption described above, direct production and use, or the motivation of the marketplace, which affects the behavior of the prosumer as described by Wolf and McQuitty (2011), is considered to be a factor affecting perceived usefulness, similar to the dimension of social influence in TAM 2. Thus the following hypotheses are drawn.

H2-a: The motivation of marketplace has a positive influence on consumers' perceived usefulness of desktop 3DP.

H2-b: The motivation of marketplace has a positive influence on consumers' intention to use desktop 3DP.

The term "motivation of identity" refers to a person's motivation to pursue additional activities through past positive experiences of prosumption. This is similar to the concept

of self-efficacy insofar as past personal behavior history influences a person's choice of future behavior and environment (Ajzen, 2002; Bandura, 1993). The concept of self-efficacy is a voluntary personal ability assessment factor for past experiences that affect an individual's use of services or products. In the case of motivation of identity, the improvement of personal abilities from past experiences is a motivating factor for future actions.

Kim and Kim (2005) explained that self-efficacy negatively affects perceived risk in environments of electronic commerce transaction. This study investigates how motivation of identity affects perceived risks between groups with high and low levels of motivation as moderator variables.

3.2.3 Perceived Overall Risk

This study defines overall risk based on the definition of Lim (2003) as the "degree of people's beliefs and the extent to which they have incurred a loss by using 3DP."

Featherman and Pavlou (2003) found that consumers with perceived high acceptance of specific e-service technologies have lower uncertainty in using products or services. The following hypothesis is presented through the relationship between ease of use and overall risk factors in the existing TAM.

H3-a: The perceived ease of use of desktop 3DP has a negative influence on overall risk of desktop 3DP for consumers.

In addition, several previous studies of perceived risk have shown that perceived risk negatively affects intention to use and perceived usefulness (Featherman & Pavlou, 2003; Im, Kim, & Han, 2008; Khan & Ahmad, 2016; M.-C. Lee, 2009). Thus, the following hypothesis is formed.

H3-b: Overall risk for desktop 3DP has a negative influence on consumers' intention to use desktop 3DP.

H3-c: Overall risk for desktop 3DP has a negative influence on consumers' perceived usefulness of desktop 3DP.

3.2.4 Dimension of Overall Risk

It is important to define the different kinds of risks included in overall risk and to see how overall risk affects consumer behavior, specifically in terms of perceived risk (Lim, 2003). Cunningham (1967) identified types of perceived risks as performance, financial, opportunity/time, safety, and psychological loss—and these risks all come from an umbrella of performance risk. Featherman (2003) added privacy risk to emerging e-services-related research. Privacy risk and social risk are not considered herein because there is little correlation between 3DP use and privacy risk based on previous studies.

However, this paper does consider the physical risks of 3DP associated with skin or respiratory illnesses that may be caused by chemicals or particles generated during printing (Huang, Liu, Mokasdar, & Hou, 2013; Jang et al., 2017). This paper also

considers legal risks related to infringement of intellectual property rights that may arise during design phases of 3DP (Hyeon-Chang, 2015; Niess & Wende, 2017; Sangani, 2013). Herein, legal risk is redefined based on the work of Soltanpanah et al. (2012). Table 5 lists our definitions and hypotheses of risks.

[Table 5] Definition and Hypotheses of Risks

Dimension	Definition and Hypothesis	Related Literature
Overall Risk (OvR)	Degree in people's belief and to how much extent they feel they have incurred a loss by using Desktop 3DP	Lim (2003)
Performance Risk (PeR)	- Potential or imposed damages which are caused by technical deficiencies or improper function of Desktop 3DP - *H4-a: The overall risk for Desktop 3DP is determined by the performance risk related with it.*	Soltanpanah et al. (2012)
Financial Risk (FiR)	- Potential or imposed financial risk which is caused by errors in operations or misuse of the Desktop 3DP - *H4-b: The overall risk for Desktop 3DP is determined by the financial risk related with it*	Soltanpanah et al. (2012)
Legal Risk (LeR)	- Potential or imposed damage which is the result of lack of any complied law or lack of knowledge in Desktop 3DP - *H4-c: The overall risk for Desktop 3DP is determined by the legal risk related with it*	Soltanpanah et al. (2012)
Physical Risk (PhR)	- Refers to the fact that using desktop 3DP is harmful to people's health - *H4-d: The overall risk for Desktop 3DP is determined by the physical risk related with it*	Soltanpanah et al. (2012)

Psychological Risk (PsR)	- Fact that people might be suffering from the mental anxiety which is caused by using desktop 3DP - *H4-e: The overall risk for Desktop 3DP is determined by the Psychological risk related with it*	Lim (2003); Soltanpanah et al. (2012)

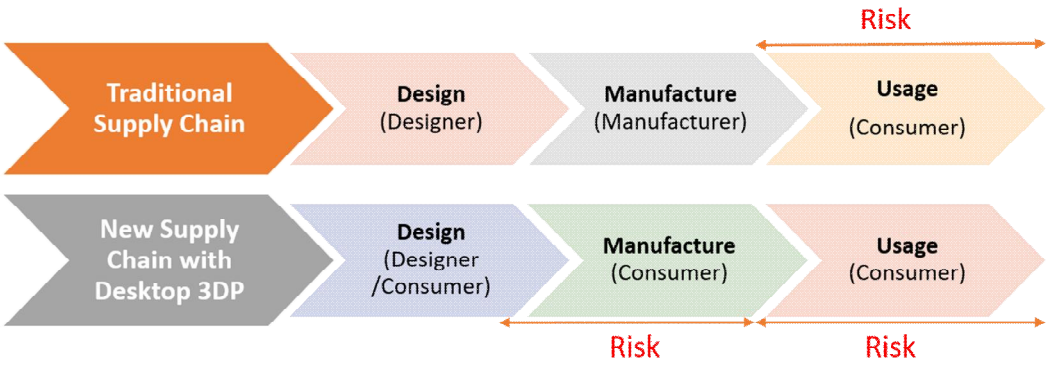
Table 6 summarizes the hypotheses and paths related to all variables in this study.

[Table 6] Summary of Proposed Hypotheses

Hypothesis	Path and influence	Result
H1-a	Perceived Usefulness → Intention to Use	
H1-b	Perceived Ease of Use → Intention to Use	
H1-c	Perceived Ease of Use → Perceived Usefulness	**Positive**
H2-a	Motivation of Marketplace → Perceived Usefulness	
H2-b	Motivation of Marketplace → Intention to Use	
H3-a	Perceived Ease of Use → Overall Risk	
H3-b	Overall Risk → Intention to Use	**Negative**
H3-c	Overall Risk → Perceived Usefulness	
H4-a	Overall Risk → Performance Risk	
H4-b	Overall Risk → Financial Risk	
H4-b	Overall Risk → Legal Risk	**Positive**
H4-b	Overall Risk → Physical Risk	
H4-b	Overall Risk → Psychological Risk	

3.3 Stage Comparison

Consumers who purchase desktop 3D printers must consider their purchase with the aim of using the products printed by 3DP (as opposed to purchasing desktop 3D printers for the sake of using the technology of desktop 3DP itself). For this reason, departing from the existing TAM, overall risk can be perceived in two stages including 1) using desktop 3DP and 2) using the printed products of 3DP (see Figure 5).



[Figure 5] Stage Comparison

This study examines how overall risk affects the entire process at each stage. The first-stage hypotheses described above are modified as shown in Table 7 below, using the second-step printed product.

[Table 7] Definition of Risk at Second Stage

Dimension	Definition and Hypothesis	Related Literature
Overall Risk	Degree in people's belief and to how much extent they feel	Lim (2003)

(S_OvR)	they have incurred a loss by using printed product	
Performance Risk (S_PeR)	- Potential or imposed damages which are caused by technical deficiencies or improper function of using printed product - *H4-a: The overall risk for printed product is determined by the performance risk related with it.*	Soltanpanah et al. (2012)
Financial Risk (S_FiR)	- Potential or imposed financial risk which is caused by errors in operations or misuse of the printed product - *H4-b: The overall risk for printed product is determined by the financial risk related with it*	Soltanpanah et al. (2012)
Legal Risk (S_LeR)	- Potential or imposed damage which is the result of lack of any complied law or lack of knowledge in printed product - *H4-c: The overall risk for printed product is determined by the legal risk related with it*	Soltanpanah et al. (2012)
Physical Risk (S_PhR)	- Refers to the fact that using printed product is harmful to people's health - *H4-d: The overall risk for printed product is determined by the physical risk related with it*	Soltanpanah et al. (2012)
Psychological Risk (S_PsR)	- Fact that people might be suffering from the mental anxiety which is caused by using printed product - *H4-e: The overall risk for printed product is determined by the Psychological risk related with it*	Lim (2003); Soltanpanah et al. (2012)

4. Research Methodology

The models used in this study consisted of ten latent variables (intention to use, overall risk, perceived use, perceived ease of use, motivation of marketplace, performance risk, financial risk, legal risk, physical risk, and psychological risk).

The fitness of the model for path weights and data was analyzed via structural equation modeling (SEM) using maximum likelihood robust estimation with statistical software SPSS 25 and AMOS 24.

Finally, this study compared the results of both stages of use—1) using desktop 3DP and 2) the use of printed products—and compared the differences with the motivation of identity and DIY experience as moderator variables.

4.1 Data Collection

From November 1–9, 2018, this paper conducted online survey questionnaires of 307 ordinary people. The following table summarizes the characteristics of those who responded to the online surveys. Out of the total 307 subjects, 304 were included in the data analysis, except for three who one answer to 77 questionnaires. Of these, 151 (49.7%) were male respondents and 153 (50.5%) were female respondents. Regarding the age range of respondents, 72 (23.7%) people were in their 20s, 79 (26.0%) people were in their 30s, 78 (25.7%) people were in their 40s, and 75 (24.7%) people were in their 50s. Most of the respondents had graduated from college (198, 65.1%), and the highest reported income was between 20,000 won and 40 million won. Among the 304

respondents, 167 consumers reported having had produced and used their own DIY projects, and 137 consumers reported never having had experienced it before.

[Table 8] Summary of demographic characteristic of respondents

Variables	Overall Sample (n=304)	Percent(%)
Sex		
Male	151	49.7
Female	153	50.3
Age (Years)		
20s	72	23.7
30s	79	26.0
40s	78	25.7
50s	75	24.7
Education Level		
Less than Junior-High	3	1.0
High School	28	9.2
Junior College graduated	44	14.5
University graduated	198	65.1
Graduate School graduated	30	9.9
Others	1	0.3
Earn (1 USD : 1100KRW)		
Less than $18,182	64	21.1
$18,182 ~ $36,364	126	41.4
$36,364 ~ $54,545	66	21.7
$54,545 ~ $72,727	30	9.9
More than $72,727	18	5.9

4.2 Survey Development

The items of observable variables corresponding to each latent variable were designed based on existing research or variable definition. Perceived usefulness, perceived ease of use, and intention to use, which correspond to the existing TAM structure, are referred to in the work of Im et al. (2008). Overall risk and dimensions are referred to in the works of Lim (2003) and Soltanpanah et al. (2012). Legal risk items were designed based on the definitions given by Soltanpanah et al. (2012). In the case of marketplace and identity motivations, the questionnaire items were designed based on the definition of each of the four factors identified by Wolf and McQuitty (2011). Each questionnaire item used a 5-point Likert scale (with scores ranging from 1 for strongly disagree to 5 for strongly agree). Questionnaire content (and prior knowledge provided to participants) is shown in Appendix 1. Descriptive statistics of each observation variable are shown in Appendix 2.

5. Result

5.1 Result of Factor Analysis

5.1.1 Desktop 3DP usage stage

Before SEM analysis, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were performed to confirm whether the latent variables in the study model were explained by observable variables and whether the observable variables were correctly established. To do EFA and CFA, statistical software SPSS 25 and AMOS 24 were used. The values of total variance explained by factor analysis and structure matrix of factor analysis are shown below in Tables 9 and 10. As shown in Table 9, ten variables were extracted. Table 10 shows how each variable was grouped.

[Table 9] Total Variance Explained by Factor Analysis (Stage 1)

Factor	Initial Eigenvalue			Extraction Sum of Squared Loading			Rotation Sum of Squared Loading
	Total	% of Variance	Cumulative %	Total	%of variance	Cumulative %	Total
1	8.268	23.624	23.624	2.820	8.057	8.057	4.513
2	5.667	16.191	39.815	3.467	9.907	17.963	4.242
3	2.605	7.442	47.257	6.289	17.968	35.932	5.325
4	2.101	6.004	53.261	2.692	7.692	43.624	5.551
5	1.995	5.700	58.960	2.098	5.995	49.619	3.931
6	1.484	4.240	63.200	1.658	4.736	54.355	5.897
7	1.265	3.614	66.814	1.603	4.581	58.936	4.030
8	1.061	3.032	69.846	1.113	3.180	62.116	3.545
9	0.899	2.567	72.414	0.746	2.131	64.246	2.444

10	0.855	2.444	74.858	0.506	1.447	65.693	3.844
11	0.682	1.947	76.805				
34	0.147	0.419	99.617				
35	0.134	0.383	100.000				

[Table 10] Structure Matrix of Factor Analysis (Stage 1)

Constructs/Items		**Factor**									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
PeR	**PeR1**	.120	-.004	-.062	.005	.050	.022	.140	.571	.035	-.140
CR:.768	**PeR2**	.022	-.050	-.050	.045	.016	-.004	-.072	.932	-.034	.042
AVE:.526											
Alpha:.764	**PeR3**	-.138	.116	.125	-.105	-.133	.012	.238	.470	.084	.077
FiR	**FiR1**	.049	-.075	-.136	.030	-.018	.128	.808	-.025	-.015	.016
CR:.771	**FiR2**	-.041	.013	.088	-.022	-.076	-.083	.793	.006	-.017	-.018
AVE:.532											
Alpha:.764	**FiR3**	.037	.040	.028	.038	.171	-.060	.549	.022	.058	-.046
LeR	**LeR1**	.001	-.036	-.020	.016	.889	-.004	-.111	.016	.017	.003
CR:.848	**LeR2**	-.053	.089	-.063	-.044	.820	.083	.053	-.063	-.005	-.022
AVE:.588	**LeR3**	-.044	.005	.072	.004	.467	-.022	.086	.197	.045	.071
Alpha:.842	**LeR4**	.027	-.048	.061	-.046	.819	-.008	.011	-.035	-.036	.033
PhR	**PhR1**	-.005	-.004	.907	-.093	-.004	.094	.005	.026	-.073	.041
CR:.882	**PhR2**	.027	.000	.860	-.046	-.072	.102	-.016	-.006	.008	-.029
AVE:.654	**PhR3**	.038	-.044	.581	.095	.053	.021	.109	-.165	.057	-.071
Alpha:.881	**PhR4**	.007	.009	.809	.104	.047	-.161	-.065	.035	.012	-.002
PsR	**PsR1**	-.026	-.023	.201	.577	.086	.012	-.042	.049	-.004	.009
CR:.866	**PsR2**	.007	-.082	-.036	.684	-.058	-.021	.185	.049	-.072	.093
AVE:.619	**PsR3**	-.023	.005	-.033	.941	-.037	.029	-.025	-.044	.031	.031
Alpha:.859	**PsR4**	.027	.077	-.001	.807	-.032	.054	-.085	-.006	.058	-.107
OvR	**OvR1**	-.075	.081	.076	.183	.073	.495	.081	.030	-.018	.051

CR:.895	**OvR2**	.034	-.035	.056	.000	.007	.814	-.052	.016	.020	-.050
AVE:.681	**OvR3**	-.048	.054	-.007	.064	-.014	.844	.018	.006	-.028	.016
Alpha:.892	**OvR4**	.065	-.058	-.018	.008	.035	.847	.000	-.019	-.011	.014
PEOU CR:.701 AVE:.547 Alpha:.680	**PEOU1**	.002	.001	-.021	.081	.032	-.134	.061	.080	.498	-.009
	PEOU2	.004	-.023	-.001	-.038	-.027	.079	-.031	-.043	1.015	.021
PU	**PU1**	.040	.755	-.007	-.059	.033	.001	-.022	-.005	-.003	.033
CR:.902	**PU2**	.045	.905	-.055	.051	.049	.015	-.021	.054	-.040	-.119
AVE:.696	**PU3**	-.035	.898	-.006	.010	-.042	.021	.059	-.066	-.005	-.044
Alpha:.901	**PU4**	.005	.787	.048	-.006	-.031	-.048	-.045	.020	.027	.069
IU CR:.842 AVE:.640 Alpha:.838	**IU1**	.081	-.065	-.022	.005	.028	.013	-.025	.027	.011	.992
	IU2	.212	.160	-.050	.043	-.030	.046	-.002	-.087	-.042	.452
	IU3	.197	.169	.043	-.011	.051	-.120	.039	-.063	.043	.427
MoM	**MoM1**	.868	-.030	.069	.017	-.053	.003	-.025	.007	-.049	.018
CR:.899	**MoM2**	.886	.009	.044	-.031	.051	-.060	.063	-.008	-.028	-.072
AVE:.691	**MoM3**	.844	.014	-.055	.016	.033	-.042	.017	-.029	.066	-.022
Alpha:.898	**MoM4**	.741	.030	-.005	-.024	-.087	.148	-.049	.111	.021	.076

Note 1: PeR – Performance Risk; FiR – Finance Risk; LeR – Legal Risk; PhR – Physical Risk ; PsR – Psychological Risk; OvR – Overall Risk; PEOU – Perceived Ease of USE; PU – Perceived Usefulness; IU – Intention to Use; MoM – Motivation of Marketplace

Note 2: KMO(Kaiser-Meyer-Olkin) : 0.865

Note 3: Using Maximum likelihood for extraction method

As shown in Table 10, Cronbach's α value, which confirms the possibility of achieving the same value when iterative measurement is assumed, has a value of more than 0.7 or has a similar value. The average variance extracted (AVE) and construct reliability values

to check convergent validity are both over 0.5 and 0.7.

5.1.2 Printed product usage stage

As in Section 5.1.1, before SEM analysis at the printed product usage stage, exploratory factor analysis (EFA) and confirmatory factor analysis (CFA) were performed to determine whether latent variables in the study model were explained by observable variables and whether observable variables were correctly established. See Tables 11 and 12 below.

[Table 11] Total Variance Explained by Factor Analysis (Stage 2)

Factor	Initial Eigenvalue			Extraction Sum of Squared Loading			Rotation Sum of Squared Loading
	Total	% of Variance	Cumulative %	Total	%of variance	Cumulative %	Total
1	10.043	28.695	28.695	9.650	27.571	27.571	7.493
2	5.152	14.720	43.415	4.826	13.788	41.359	4.046
3	2.485	7.100	50.514	2.172	6.205	47.564	5.391
4	1.677	4.791	55.305	1.315	3.758	51.322	4.226
5	1.591	4.545	59.851	1.211	3.460	54.782	6.185
6	1.546	4.418	64.269	1.170	3.344	58.126	5.222
7	1.268	3.622	67.890	1.056	3.016	61.142	3.053
8	1.025	2.928	70.818	0.641	1.832	62.974	5.286
9	0.908	2.594	73.412	0.576	1.646	64.620	3.969
10	0.774	2.211	75.623	0.530	1.515	66.135	6.038
11	0.677	1.935	77.558				

34	0.155	0.444	99.616
35	0.134	0.384	100.000

[Table 12] Structure Matrix of Factor Analysis(Stage 2)

Constructs/Items		**Factor**									
		1	**2**	**3**	**4**	**5**	**6**	**7**	**8**	**9**	**10**
PeR	**PeR1**	.026	-.031	.715	-.004	-.018	-.079	-.010	.115	.010	-.001
CR:.866	**PeR2**	.077	.040	.771	-.141	.036	-.085	.050	-.089	.082	.003
AVE:.618	**PeR3**	-.035	-.043	.887	.072	.040	.009	-.010	-.009	-.045	-.065
Alpha:.865	**PeR4**	-.009	.015	.805	.029	-.057	.077	-.003	-.018	-.031	.002
FiR	**FiR1**	.006	.038	.242	.060	-.023	.167	-.009	.344	-.118	.074
CR:.773	**FiR2**	.042	.037	-.020	.010	-.005	.047	.072	.706	-.039	-.067
AVE:.532	**FiR3**	.018	-.073	.047	-.090	.039	-.105	-.034	.869	.086	-.008
Alpha:.770											
LeR	**LeR1**	.041	-.059	-.048	-.042	-.002	.798	.015	-.057	-.006	-.055
CR:.813	**LeR2**	-.126	-.012	.074	.059	.008	.783	-.036	.077	.026	.044
AVE:.592	**LeR3**	.070	.009	-.061	-.079	.029	.823	.029	-.074	.065	-.081
Alpha:.810											
PhR	**PhR1**	.035	-.001	.016	.060	.829	.045	-.017	.000	-.106	-.054
CR:.889	**PhR2**	.074	-.039	-.020	-.003	.825	.036	.018	-.009	-.040	-.045
AVE:.668	**PhR3**	.195	.047	-.024	-.105	.513	.022	.038	-.005	.117	.096
Alpha:.886	**PhR4**	-.031	.017	.012	-.001	.817	-.052	-.010	.042	-.011	.068
PsR	**PsR1**	.298	.003	-.005	.027	.015	.191	-.030	-.064	-.104	.471
CR:.889	**PsR2**	.244	.090	.103	-.079	-.075	.156	-.063	.072	.015	.439
AVE:.669	**PsR3**	.305	-.074	-.052	.098	.041	-.131	-.001	.060	.019	.715
Alpha:.888	**PsR4**	.311	-.015	-.017	-.062	.013	-.056	.063	-.118	.081	.758
OvR	**OvR1**	.599	.091	.017	.018	.048	-.010	-.060	.088	-.049	.128

CR:.899	**OvR2**	.796	-.014	.032	-.061	.035	-.077	.007	.039	.086	-.020
AVE:.691	**OvR3**	.929	-.063	.005	.052	-.050	.014	-.026	-.005	-.035	-.011
Alpha:.897	**OvR4**	.892	.009	.005	.034	.019	.044	.025	-.027	-.011	-.039
PEOU	**PEOU1**	.092	.059	.009	.149	.021	.120	.436	.099	-.026	.015
CR:.766	**PEOU2**	-.016	-.017	.023	-.024	.001	.005	.837	-.129	-.005	.004
AVE:.527	**PEOU3**	-.055	-.007	-.006	-.025	-.001	-.038	.786	.148	.035	.027
Alpha:.754											
PU	**PU1**	-.015	.023	-.074	.880	-.053	-.025	.030	.093	-.065	.014
CR:.879	**PU2**	.029	-.014	-.069	.789	.048	-.043	-.014	-.009	.069	.014
AVE:709	**PU3**	.032	.002	.129	.823	-.005	-.028	.007	-.207	.050	-.005
Alpha:.879											
IU	**IU1**	-.133	.077	.057	.252	.091	.039	-.043	.015	.550	.023
CR:.831	**IU2**	.047	-.016	-.018	.096	-.114	.014	.053	-.015	.780	.087
AVE:.621	**IU3**	.047	.042	-.030	.296	.005	.077	-.056	.112	.565	-.096
Alpha:.829											
MoM	**MoM1**	.021	.866	-.091	.038	.025	-.038	-.056	.049	-.053	-.012
CR:.897	**MoM2**	-.004	.880	-.002	-.086	-.029	.047	.009	.007	.033	-.041
AVE:.685	**MoM3**	.016	.861	.001	.008	-.080	-.041	.051	-.020	-.021	-.019
Alpha:.895	**MoM4**	-.034	.701	.086	.078	.099	-.038	-.005	-.093	.037	.021

Note 1: PeR – Performance Risk; FiR – Finance Risk; LeR – Legal Risk; PhR – Physical Risk ; PsR – Psychological Risk; OvR – Overall Risk; PEOU – Perceived Ease of USE; PU – Perceived Usefulness; IU – Intention to Use; MoM – Motivation of Marketplace

Note 2: KMO(Kaiser-Meyer-Olkin) : 0.891

Note 3: Using Maximum likelihood for extraction method

As shown in Table 11, all Cronbach's α values, which confirm the possibility of achieving the same value when iterative measurement is assumed, are over 0.7. The average variance extracted (AVE) and construct reliability values for confirming convergent validity to ensure high correlation between the measured values are both over 0.5 and 0.7.

5.2 Analysis Result

The structural equation model is a model for identifying and explaining mutual causal relationships among variables that affect dependent variables. Here, SEM was performed using statistical software AMOS 24.

5.2.1 Desktop 3DP usage stage

Table 13, below, shows the reference values required for most SEMs together with their values in the model to illustrate goodness of fit in the use stage of desktop 3DP. These values ensure that the model is appropriate for analyzing the relationship between latent variables. However, the goodness of fit index (GFI) does not show suitability at the optimum level, but it shows acceptable results.

[Table 13] Model – Fit – Value (stage 1)

Measure	CMin(DF)	CMin/DF	CFI	SRMR	RMSEA	PClose	TLI	GIF
Threshold	-	1~3	> 0.95	< 0.08	< 0.06	> 0.05	> 0.9	> 0.9
Estimate	901.513(515)	1.751	0.936	0.051	0.050	0.521	0.926	0.855

Estimate values obtained from SEM analysis are shown in Figure 6 and in Table 14 below. Overall risk, perceived usefulness, and motivation of marketplace have a direct impact on intention to use.

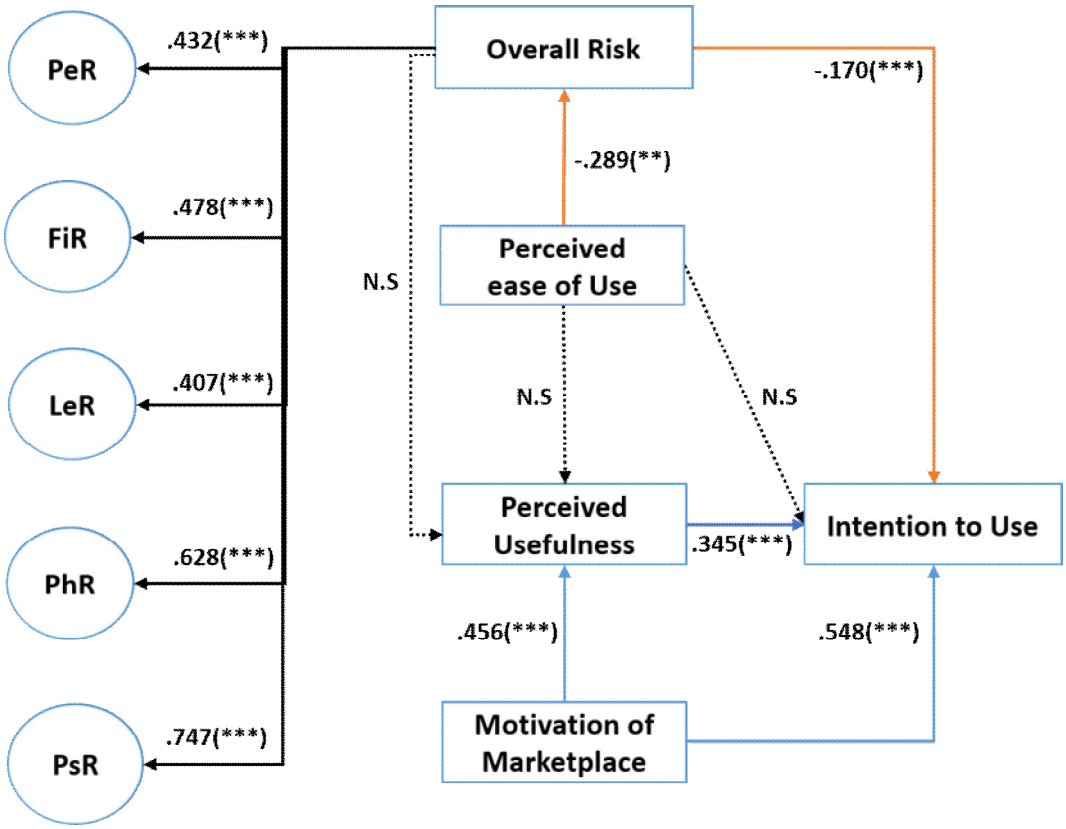
Also, motivation of marketplace has positive effects on perceived usefulness, while

perceived ease of use has negative effects on overall risk. Overall risk was explained by performance risk, financial risk, legal risk, physical risk, and psychological risk.

[Table 14] Testing Result (stage 1)

Hypothesis	Relationship	Estimate	P	Standardized Estimate	Result
H1-a	**PEOU(+)→IU**	-0.112	0.225	-0.057	N.S.
H1-b	**PEOU(+)→PU**	0.011	0.900	0.007	N.S.
H1-c	**PU(+)→IU**	0.437	***	0.345	Support
H2-a	**MoM(+)PU**	0.365	***	0.456	Support
H2-b	**MoM(+)→IU**	0.554	***	0.548	Support
H3-a	**OvR(-)→IU**	-0.248	***	-0.170	Support
H3-b	**PEOU(+)→OvR**	-0.391	***	-0.289	Support
H3-c	**OvR(-)→PU**	-0.041	0.553	-0.036	N.S.
H4-a	**OvR(+)→PeR**	0.454	***	0.432	Support
H4-b	**OvR(+)→FiR**	0.577	***	0.478	Support
H4-c	**OvR(+)→LeR**	0.565	***	0.407	Support
H4-d	**OvR(+)→PhR**	0.970	***	0.628	Support
H4-e	**OvR(+)→PsR**	0.902	***	0.747	Support

Note; *p<0.05, **p<0.01, ***p<0.001



[Figure 6] SEM Result (Stage 1)

5.2.2 Printed product usage stage

In order to explain goodness of fit in the stage of use of printed products in Table 15, as above, the reference values required for most SEMs and the values in the corresponding model are shown. This comparison ensures that the model is appropriate for analyzing the relationship between latent variables. While the GFI and PClose values do not show suitability of our model at the optimum level, the values show acceptable results.

[Table 15] Model – Fit - Value (stage 2)

Measure	CMin(DF)	CMin/DF	CFI	SRMR	RMSEA	PClose	TLI	GIF
Threshold	-	1~3	>0.95	<0.08	<0.06	>0.05	>0.9	>0.9
Estimate	899.483(515)	1.747	0.940	0.050	0.050	0.537	0.931	0.853

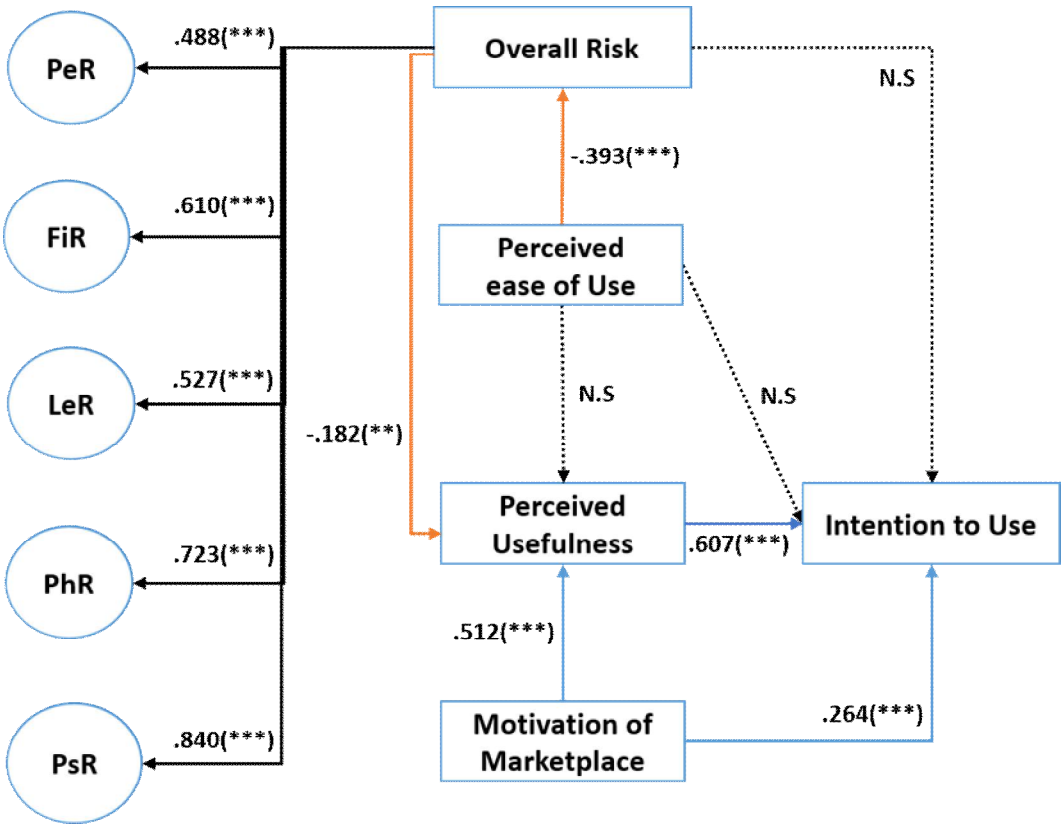
Estimate values obtained from SEM analysis are shown in Figure 7 and in Table 16 below. In contrast to stage 1, stage 2 findings show that overall risk did not have a direct impact on intention to use. As in stage 1, motivation of marketplace has positive effects on perceived usefulness, and perceived ease of use has negative effects on overall risk. Overall risk was explained by performance risk, financial risk, legal risk, physical risk, and psychological risk.

[Table 16] Testing Result (stage 2)

Hypothesis	Relationship	Estimate	P	Standardize Estimate	Result
H1-a	**PEOU(+)→IU**	0.115	0.237	0.069	N.S.
H1-b	**PEOU(+)→PU**	-0.120	0.242	-0.079	N.S.
H1-c	**PU(+)→IU**	0.671	***	0.607	Support
H2-a	**MoM(+)PU**	0.412	***	0.512	Support
H2-b	**MoM(+)→IU**	0.554	***	0.264	Support
H3-a	**OvR(-)→IU**	-0.058	0.380	-0.048	N.S.
H3-b	**PEOU(+)→OvR**	-0.550	***	-0.393	Support
H3-c	**OvR(-)→PU**	-0.198	**(0.004)	-0.182	Support
H4-a	**OvR(+)→PeR**	0.495	***	0.488	Support

H4-b	**OvR(+)→FiR**	0.500	***	0.610	Support
H4-c	**OvR(+)→LeR**	0.583	***	0.527	Support
H4-d	**OvR(+)→PhR**	0.875	***	0.723	Support
H4-e	**OvR(+)→PsR**	0.969	***	0.840	Support

Note; *p<0.05, **p<0.01, ***p<0.001



[Figure 7] SEM Result (Stage 2)

5.3 Effects of Moderating Variables

In the stage of desktop 3DP usage, respective p values are 0.133 for DIY experience and 0.109 for motivation of identity. Accordingly, this paper confirms that past DIY experience and motivation of identity do not work as control variables. However, both variables were significant at the stage of the usage of printed products. Content is shown in Tables 17 and 18.

Table 17 shows differences in groups of consumers according to DIY experience. In the case of consumers with DIY experience, it is shown that motivation of marketplace did not directly influence the intention to use (unlike in findings from the basic model). Also, the effects of overall risk on perceived usefulness (PU) were found to be none, thus differing from findings in the group of consumers non-experienced with DIY.

[Table 17] Result of Moderating Effects (DIY experience)

	experienced N=167			**Non-experienced N=137**		
Relationship	Estimate	P	Standardize Estimate	Estimate	P	Standardized Estimate
PEOU(+)→IU	0.113	N.S.	0.055	0.088	N.S.	0.082
PEOU(+)→PU	-0.074	N.S.	-0.043	-0.268	N.S.	-0.223
PU(+)→IU	0.847	***	0.707	0.458	***	0.517
MoM(+)→PU	0.511	***	0.621	0.253	***	0.302
MoM(+)→IU	0.159	N.S.	0.161	0.240	***	0.325
OvR(-)→IU	-0.078	N.S.	-0.054	-0.035	N.S.	-0.041
PEOU(+)→OvR	-0.422	**(0.002)	-0.295	-0.689	***	-0.542
OvR(-)→PU	-0.078	N.S.	-0.065	-0.426	***	-0.451

OvR(+)→PeR	0.448	***	0.396	0.570	***	0.628
OvR(+)→FiR	0.423	***	0.507	0.595	***	0.732
OvR(+)→LeR	0.609	***	0.494	0.525	***	0.546
OvR(+)→PhR	1.016	***	0.702	0.732	***	0.761
OvR(+)→PsR	0.954	***	0.798	0.977	***	0.880

Note; *p<0.05, **p<0.01, ***p<0.001

Differences according to propensity of motivation of identity are shown in Table 18 below. Unlike findings in the baseline model, perceived ease of use has direct effects on intention to use. As in the case of DIY experience, motivation of marketplace has a direct impact on intention to use, and perceived usefulness has been found to be directly affected by overall risk.

[Table 18] Result of Moderating Effects (MoI)

	High Motivation of Identity (>3) N=161			**Low Motivation of Identity (<=3) N=143**		
Relationship	**Estimate**	**P**	**Standardized Estimate**	**Estimate**	**P**	**Standardize Estimate**
PEOU(+)→IU	-0.159	N.S.	-0.098	0.404	**(0.006)	0.265
PEOU(+)→PU	0.052	N.S.	0.035	-0.261	N.S.	-0.196
PU(+)→IU	0.735	***	0.673	0.668	***	0.582
MoM(+)→PU	0.495	***	0.519	0.320	***	0.321
MoM(+)→IU	0.174	N.S.	0.168	0.338	***	0.296
OvR(-)→IU	-0.118	N.S.	-0.105	-0.015	N.S.	-0.013
PEOU(+)→OvR	-0.649	***	-0.449	-0.424	**(0.002)	0.322
OvR(-)→PU	-0.015	N.S.	-0.015	-0.364	***	-0.361
OvR(+)→PeR	0.591	***	0.551	0.383	***	0.406
OvR(+)→FiR	0.513	***	0.588	0.479	***	0.637

OvR(+)→LeR	0.654	***	0.500	0.494	***	0.548
OvR(+)→PhR	0.860	***	0.716	0.887	***	0.727
OvR(+)→PsR	0.921	***	0.834	1.004	***	0.833

Note; *p<0.05, **p<0.01, ***p<0.001

5.4 Summary and Discussion

5.4.1 Comparison between Stages

The purpose of this study was to investigate consumers' intention to use desktop 3DP. Although the TAM, including dimensions of perceived risk and social influence, has been used as a model for verifying different aspects of consumer intentions in various contexts, previous research is rare in terms of prosumers performing prosumption. Accordingly, this study models a combination of different risks associated with using desktop 3DP and prosumer characteristics.

The premise is that desktop 3DP turns users into producers and consumers who equally utilize a production tool and the printed products of the tool. This structure is in contrast to other structures in which one person provides a finished product and another person purchases and uses the product. Thus an online questionnaire was conducted for each step to determine whether the factors influencing consumers' acceptance of 3DP technology were the same in both usage stages of 3DP (i.e., the use of 3DP and the use of printed products).

In order to obtain more detailed results, this study examined the personal characteristics of respondents (motivation of identity) and their past experience with DIY, variables which have been frequently used in previous research as moderators. First, this

study compares the results of using desktop 3DP (stage 1) and using the printed products of 3DP (stage 2). Differences between the stages of use are shown in Table 19.

[Table 19] Comparison of results of two stages of 3DP use

		Stage 1		Stage2		
Hypothesis	**Relationship**	**P**	**Standardize Estimate**	**P**	**Standardized Estimate**	**Result**
H1-a	**PEOU(+)→IU**	0.225	-0.057	0.237	0.069	N.S
H1-b	**PEOU(+)→PU**	0.900	0.007	0.242	-0.079	N.S
H1-c	**PU(+)→IU**	***	0.345	***	0.607	Support
H2-a	**MoM(+)PU**	***	0.456	***	0.512	Support
H2-b	**MoM(+)→IU**	***	0.548	***	0.264	Support
H3-a	**OvR(-)→IU**	***	-0.170	0.380	-0.048	Different
H3-b	**PEOU(+)→OvR**	***	-0.289	***	-0.393	Support
H3-c	**OvR(-)→PU**	0.553	-0.036	**(0.004)	-0.182	Different
H4-a	**OvR(+)→PeR**	***	0.432	***	0.488	Support
H4-b	**OvR(+)→FiR**	***	0.478	***	0.610	Support
H4-c	**OvR(+)→LeR**	***	0.407	***	0.527	Support
H4-d	**OvR(+)→PhR**	***	0.628	***	0.723	Support
H4-e	**OvR(+)→PsR**	***	0.747	***	0.840	Support

Note; *p<0.05, **p<0.01, ***p<0.001

As shown in Table 19, H1-a and H1-b hypotheses (related to the existing TAM wherein perceived ease of use affects perceived usefulness and intention to use) were not supported. The results of this study are similar to findings in the mass customization study of H.-H. Lee and Chang (2011) in which perceived ease of use does not directly impact intention to use, but rather shows indirect effects through perceived usefulness. In

the current study, perceived ease of use indirectly affects intention to use and perceived usefulness through overall risk.

As with social effects in the existing TAM 2, motivation of marketplace has positive effects on intention to use and perceived usefulness. Furthermore, in the stage of desktop 3DP usage, overall risk was shown to directly affect intention to use, but in the second stage (i.e., the use of printed products), overall risk indirectly affected consumers' intention to use via perceived usefulness.

5.4.2 Group Comparison

Comparative group analysis showed no meaningful comparison ($p = 0.378$) between consumer groups in the first step. In contrast, significant differences were shown between groups in the second step. Differences between motivation of identity and DIY experience are that motivation of marketplace positively affects intention to use, and that overall risk negatively affects perceived usefulness, as shown in Tables 17 and 18. In comparing the two groups, the group with no DIY experience or motivation of identity had significant effects on intention to use and perceived usefulness. Also, it was confirmed that perceived ease of use affected intention to use only in the comparison of motivation of identity.

6. Conclusion

6.1 Academic Implication

Several academic implications are identified herein. First, this study considers both positive and negative factors in consumer acceptance of desktop 3DP. In the case of existing desktop 3DP research, most studies attempt to identify positive factors (Wang et al., 2016). This study considers negative aspects based on identification of problems caused by desktop 3DP, and also considers the characteristics of consumers using desktop 3DP—namely, prosumers—by adding motivation of marketplace as an external variable. This improves our understanding of consumer behaviors in a more comprehensive way.

Second, designations of product/service providers in the existing TAM provide the consumer with a finished product. Thus, in that model, consumers perceive product risks at one initial point. In the case of desktop 3DP, however, consumers must be aware of risks twice—once during the use of desktop 3DP and again during the use of printed products. Therefore, unlike in the survey method of the existing TAM, it is meaningful that our modified TAM considers two stages of use, and that consumers are shown to perceive risk differently at each stage.

Third, in many previous studies, consumer experience has been used as a moderator variable. By comparing DIY experience and the personal tendencies of prosumers, this study finds similarity to prosumers in the context of 3DP.

Finally, this study constructs PR dimensions based on the results of previous studies on the risks of desktop 3DP, further confirming that legal and physical risks are important for

3DP (unlike pertinent risks identified in existing research on e-services, another current area of study in technology acceptance today).

6.2 Practical Implications

Practical implications can be confirmed through the results of this study. First, unlike existing TAM findings, in this study, perceived ease of use was not shown to affect perceived usefulness or consumer intention to use 3DP. The findings of this study show that perceived ease of use was a direct determinant of overall risk and had indirect effects on intention to use (in stage 1) and perceived usefulness (in stage 2).

Indirect effects of perceived ease of use on consumer intention to use have been shown in online mass customization research (H.-H. Lee & Chang, 2011). Previous research has shown mixed results of the influence of perceived ease of use on consumer intention to use new technology (Moon & Kim, 2001; Van der Heijden & Verhagen, 2004; Vijayasarathy, 2004). Similar to findings in the work of Featherman and Pavlou (2003) related to e-services, intrinsic risks in the usage of desktop 3DP are partially formed by the ease of use of software.

Also, because overall risk differently affects different stages of 3DP usage, marketers need to come up with different risk relief strategies for different stages of use. For example, certification bodies may certify conformity and reliability testing of desktop 3DP. In another aspect, raw materials and 3DP manufacturers can operate online galleries of free 3D drawing files with pictures of final outcomes.

Second, because these control variables have meaningful results only in the second stage of use (and not in the first stage), personal identity of consumers or consumer experiences related to new 3DP technology show significant differences in consumer perceptions of 3DP printed products (and not in acceptance of the new technology itself).

Finally, given that perceived ease of use does not directly affect perceived usefulness or consumer intention to use 3DP, strategies of focus on the development of platforms or development of 3D scanners for easier use may not be important for technology adaptation in the context of 3DP.

6.3 Limitation and Future Research Directions

This paper contributes to our understanding of consumer intention to use desktop 3DP. However, in the case of motivation of identity or motivation of marketplace (which affect prosumer propensity), these motivations were used only as one observable variable and could not be used as external variables. Therefore, this study cannot confirm which factor more greatly influenced outcomes between marketplace or identity motivations. Future research will need to examine additional variables that affect marketplace and identity motivations.

In addition, this study is restricted to cases in which individuals directly purchase desktop 3D printers to manufacture and use 3D printed products on their own. This is different from a model in which service companies such as the growing startup Shapeways print and ship 3D printed products on behalf of consumers who design and

upload 3D printable files over the Internet. Indeed, a necessity of future research will be to concentrate on the diversity of these services.

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Appendix 1: Survey Sheet

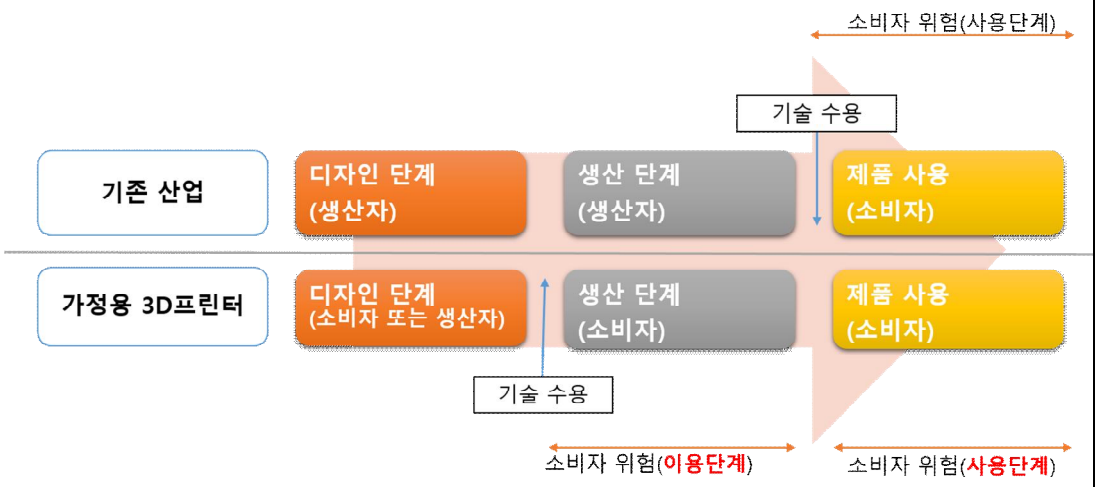
안녕하십니까?

본 설문은 가정용 삼차원프린터에 대해 사용자의 수용요인을 연구하기 위하여 실시하는 설문조사입니다. 본 설문에서는 실제 완성품을 직접 사용하는 것을 목표로 하는 사용자를 대상으로 합니다. 따라서 완성품을 판매 또는 공유하여 금전적으로 이득이 되는 경우는 해당되지 않습니다.

귀하의 답변은 연구 목적 외에는 사용되지 않을 것이며 **통계법 33조**에 의거하여 비밀은 철저하게 보장될 것입니다. 덧붙여, 추후 가정용 삼차원프린터 대중화 등에 유용하게 사용될 수 있사오니 한 문항도 빠짐없이 충실하게 답변해 주실 것을 부탁 드립니다. 시간을 할애하여 설문 작성에 협조해 주셔서 감사합니다.

Part 1. 설문은 크게 가정용 "3D프린터 이용단계"와 3D프린터를 이용하여 만든 제품의 "사용단계"로 나누어 설문할 예정입니다. 다음은 설문에 응답하기 위하여 필요한 사전 지식 입니다. 설문을 위한 응답에 앞서 아래 내용을 읽어 주십시오

1. 기존 산업과의 공정 과정 비교



2. 삼차원(3D)프린터의 개념

3D프린터는 CAD(Computer Aided Design) 등의 프로그램을 활용하여 만든 3D 도면에 따라 액체·파우더 형태의 폴리머(수지), 금속 등의 재료를 가공·적층 방식으로 쌓아 올려 입체물을 제조하는 장비입니다. 이런 3D프린터를 활용하게 되는 경우, 기존의 절삭가공과는 달리 조립할 필요가 없으며, 필요할 때마다 주문생산 할 수 있으며, 디자인영역이 제한되지 않습니다.

주로 산업분야에서 직접부품생산, 기능성 모델, 시제품생산을 위해 사용되어 왔으나, 최근 주요 기술의 특허 만료로 인한 가격하락으로 가정용 3D프린터(Desktop 3D printer)가 보급되기 시작했습니다.

이러한 가정용 3D프린터를 활용하여 개인이 원하는 모형, 장난감, 액세서리, 수리용 부품, 가정용품 그리고 최근에 와서는 음식까지도 직접 만들 수 있습니다.

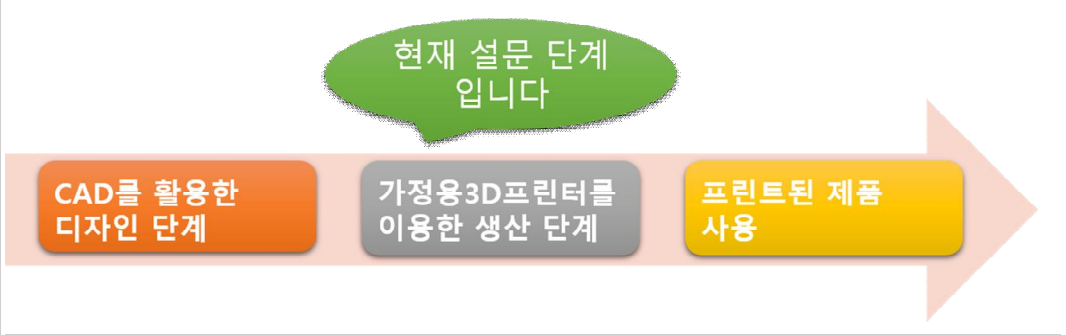
3D프린터 제작 단계는 크게 모델링, 프린팅, 피니싱으로 이루어집니다. 모델링이란, CAD나 3D 스캐너와 같은 프로그램 또는 도구를 활용하여 3D 도면을 제작하는 것을 말합니다. 프린팅은 제작한 3D 도면을 이용하여 물체를 만드는 것을 말하고 피니싱은 표면을 연마하거나 색을 칠하는 등의 작업을 말합니다. 이때 필요한 시간은 제품이 복잡한 정도에 따라 다릅니다.

3. 가정용 3D 프린터 예시

다음은 가정용으로 나온 3D 프린터의 예시입니다. 왼쪽부터 Davinci(29.9만원), Ender-3(25만원), MMUSE(102만원). MMUSE의 경우 가정에서 음식을 만들 때 사용할 수 있는 3D 프린터입니다.

4. 가정용 3D 프린터의 장/단점	
장점	– 맞춤형 제작이 가능 – 복잡한 형상 제작이 용이함 – 조립된 형태의 제품 제작이 가능 – 복수의 상이한 재료를 사용한 일체 조형도 가능 – 복수의 모델을 동 시간에 제작하는 것도 가능
단점	– 아직까지는 조형 속도가 느리고, 규모가 큰 물체의 프린팅에 한계 – 표면 해상도가 아직 높지 않음 – 단층 방향의 충격에 약함 – 가정용 3D프린터는 아직 사용 가능한 재료에 한계가 있음 – 높은 퀄리티를 원할수록 높은 가격대의 3D프린터 필요 – 높은 디자인 해상도를 원할수록 높은 컴퓨터 능력을 요구함 – 공유된 도안 또는 제작품에 대해서 지적재산권분쟁 및 책임소재가 불분명함

Part 2. 지금부터 가정용 3D프린터 "이용단계"에서의 사용자 인식과 관련된 질문이 제시됩니다. 본 설문의 문항은 '전혀 그렇지 않다' 부터 '매우 그렇다' 사이의 5점 척도에 근거하여 구성되어 있습니다. 다음의 각 문항에 대하여 귀하의 견해와 일치하는 번호에 체크하여 주십시오.



가. 다음은 귀하가 느끼는 가정용 3D 프린터 "이용단계"에서의 기능적 위험요소에 관한 질문입니다.

기능적 위험요소란? 가정용 3D프린터의 기술적 결함 또는 부적절한 기능으로 인해

발생하는 잠재적 또는 부가되는 손해를 말합니다.
1. 가정용 3D프린터가 제대로 된 기능을 수행할지 의심스럽다 ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
2. 나는 가정용 3D프린터의 품질이 떨어질 것 같다 ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
3. 나는 가정용 3D프린터가 내가 원하는 원료를 사용할 수 있을지 의심스럽다 ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
4. 나는 가정용 3D프린터가 내가 제작/다운받은 도면을 제작할 수 있을지 의심스럽다 ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

나. 다음은 귀하가 느끼는 가정용 3D 프린터 "이용단계"에서의 경제적 위험요소에 관한 질문입니다. 경제적 위험요소란? 가정용 3D프린터의 작업 오류 또는 오용으로 인한 잠재적으로 부가될 수 있는 재정적 위험
5. 나는 가정용 3D프린터가 제 기능을 하지 못하는 경우, 금전적 손실을 입을까 걱정된다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
6. 나는 내 가정용 3D프린터가 구매한 도면/원료의 가치를 표현하지 못할까봐 걱정된다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
7. 구매한 3D프린터가 내가 기대한 수준으로 제품을 만들지 못할 때, 제대로 환불을 받지 못할까봐 염려된다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
8. 나는 가정용 3D프린터를 사용하는 도중에 취소를 눌렀을때 발생할 수 있는 금전적 손실이 걱정된다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

다. 다음은 귀하가 느끼는 가정용 3D 프린터 "이용단계"에서의 위법성 위험요소에 관한 질문입니다. 위법성 위험요소란? 가정용 3D프린터 및 관련분야와 연관된 법 또는 규정에 대한 정보 부족으로 인하여 잠재적으로 부가될 수 있는 손해
9. 나는 가정용 3D프린터를 이용하여 제품을 만드는 경우, 해당 제품이 타인의 저작권을 침해할 것이 걱정된다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
10. 나는 가정용 3D프린터를 이용하여 원하는 제품을 만들 때, 해당 제품을 만드는 것이 법을 어기는 것일까 두렵다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
11. 나는 가정용 3D프린터를 이용하는 과정에서 발생한 피해에 대해 내가 아닌 다른 3자(프린터 제작자/판매자/도면판매자/원료판매자 등)에게 잘못이 있는지 확인하기 어렵다고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
12. 나는 가정용 3D프린터를 이용하기 위해 도면을 작성하는 경우, 해당 도면이 타인의 저작권을 침해할 것이 걱정된다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

라. 다음은 귀하가 느끼는 가정용 3D 프린터 "이용단계"에서의 신체적 위험요소에 관한 질문 입니다. 신체적 위험요소란? 가정용 3D프린터를 이용함으로써 잠재적으로 발생할 수 있는 건강상 피해
13. 가정용 3D프린터를 이용하는 환경이 내 피부에 악영향을 미칠까 걱정된다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
14. 나는 가정용 3D프린터를 이용하는 환경이 만성질환의 원인이 될까 염려된다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
15. 나는 가정용 3D프린터를 이용하는 과정에서 찰과상 또는 화상을 입을까 걱정된다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
16. 나는 가정용 3D프린터를 이용하는 과정에서 호흡기에 악영향을 미칠까 걱정된

다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

마. 다음은 귀하가 느끼는 가정용 3D 프린터 "이용단계"에서의 심리적 위험요소에 관한 질문 입니다. 심리적 위험요소란? 가정용 3D프린터를 이용함으로써 잠재적으로 발생할수 있는 정신적/심리적 고통 또는 피해
17. 나는 가정용 3D프린터를 이용하는 경우, 불필요한 걱정거리가 생길 것 같다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
18. 나는 가정용 3D프린터를 이용하는 경우, 내가 예상했던 완성도와 달라 심리적 손해를 받을 것 같다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
19. 나는 가정용 3D프린터를 이용하는 과정에서 불필요한 불안감을 느낄 것 같다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
20. 나는 가정용 3D프린터를 이용하는 과정에서 불필요한 긴장감을 느낄 것 같다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

바. 다음은 귀하가 느끼는 가정용 3D 프린터 "이용단계"에서의 전반적으로 느끼는 위험요소에 관한 질문 입니다.
21. 나는 전반적으로 가정용 3D프린터를 이용하면 다음 수준의 위험성이 있다고 생각한다. ① 전혀 위험하지 않다 ② 약간 위험하다 ③ 보통이다 ④ 위험한 편이다 ⑤ 매우 위험하다
22. 나는 가정용 3D프린터를 이용하는 것은 위험하다고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
23. 가정용 3D프린터를 이용하여 제품을 만드는 것은 나를 불확실한 위험에 노출할 가능성을 높게 한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
24. 가정용 3D프린터를 이용하는 환경은 나를 알 수 없는 위험에 스스로 노출하는 것과 같다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

사. 다음은 귀하가 느끼는 가정용 3D 프린터 "이용단계"에서의 사용 용이성에 관한 질문 입니다.
25. 나는 가정용 3D프린터를 이용하여 제품을 제작하기 위해 많은 노력이 필요하다고 생각한다. ① 전혀 위험하지 않다 ② 약간 위험하다 ③ 보통이다 ④ 위험한 편이다 ⑤ 매우 위험하다
26. 나는 가정용 3D프린터가 용이하다고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
27. 나는 가정용 3D프린터를 이용하는 과정이 복잡하다고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
28. 나는 가정용 3D프린터를 이용하기 위한 정보를 얻는 것이 어렵다고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

아. 다음은 귀하가 느끼는 가정용 3D 프린터 “이용단계” 에서의 유용성에 관한 질문 입니다.
29. 나는 가정용 3D프린터를 이용하는 것이 나에게 유용하다고 생각한다. ① 전혀 위험하지 않다 ② 약간 위험하다 ③ 보통이다 ④ 위험한 편이다 ⑤ 매우 위험하다
30. 나는 가정용 3D프린터를 이용하여 혜택을 얻을 수 있을 것이라고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
31. 나는 가정용 3D프린터를 이용함으로써 유용한 제품을 얻을 수 있을 것이라고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
32. 가정용 3D프린터를 이용하면 나에게 도움이 된다고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

자. 다음은 귀하가 느끼는 가정용 3D 프린터 이용의도에 관한 질문 입니다.
33. 나는 가정용 3D프린터를 구매하여 원하는 모형(액세서리, 장난감 등)을 만들 의사가 있다.

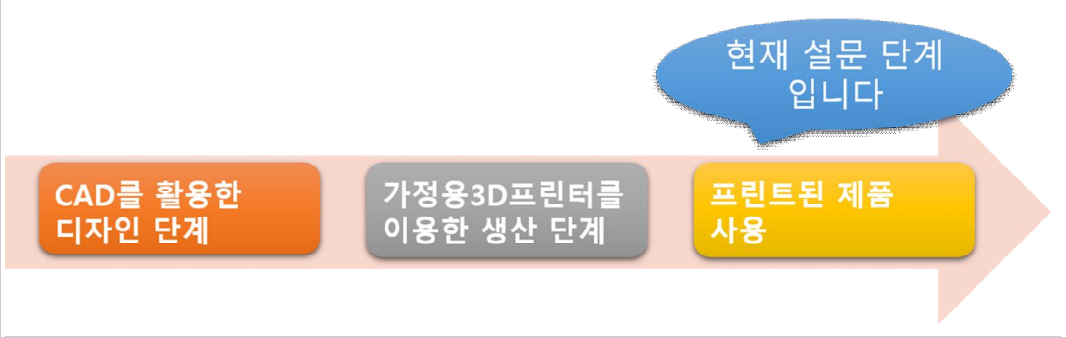
① 전혀 위험하지 않다 ② 약간 위험하다 ③ 보통이다 ④ 위험한 편이다 ⑤ 매우 위험하다
34. 나는 가정용 3D프린터를 구매하여 가정용품(접시, 젓가락, 포크 등)을 만들 의사가 있다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
35. 나는 집에서 사용하는 서랍장, 청소기, 도구 함 등에 파손이 발생하였을 때, 해당 부분을 가정용 3D프린터를 구매하여 만들 의사가 있다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
36. 나는 가정용 3D프린터를 구매하여 음식을 만들 의사가 있다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

차. 다음은 귀하가 시장으로부터 느끼는 가정용 3D프린터의 이용 동기부여 요소에 관한 질문입니다. 시장으로부터의 동기부여란? 시장으로부터 제품의 품질 , 제품의 가용성 부족 및 맞춤형 제품의 필요성을 느끼는 정도
37. 나는 평소에 제품을 구매하고자 할 때, 내가 원하는 제품이 없어 스스로 만들고자 하는 욕구를 느낀다. ① 전혀 위험하지 않다 ② 약간 위험하다 ③ 보통이다 ④ 위험한 편이다 ⑤ 매우 위험하다
38. 나는 평소에 제품을 구매하고자 할 때, 내가 원하는 품질수준의 제품을 만들고 싶은 욕구를 느낀다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
39. 나는 평소에 구매하고자 하는 제품이 충분한 가용성을 가지지 못하기 때문에 제품을 만들어 제작하고 싶어 하는 욕구를 느낀다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
40. 나는 평소에 이 가격이면 내가 직접 만들어야겠다는 욕구를 느낀다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

카. 다음은 귀하가 개인적으로 느끼는 가정용 3D프린터의 이용 동기부여 요소에 관한 질문 입니다. 개인적 동기부여란? 평소 역량강화 , 장인정신의 실현, 공동체 추구, 독창성의 필요성

을 느끼는 정도
41. 나는 평소에 스스로 제품을 제작하는 능력을 키우고자 하는 성격이다. ① 전혀 위험하지 않다 ② 약간 위험하다 ③ 보통이다 ④ 위험한 편이다 ⑤ 매우 위험하다
42. 나는 평소 작업 시 세밀한 작업까지 완벽하게 하고자 하는 성격이다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
43. 나는 평소 비슷한 취미를 가진 사람들끼리 모이는 동호회, 모임을 찾아서 나가고자 하는 성격이다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
44. 나는 평소 나만의 취향의 활동을 하거나 제품을 구매하고자 하는 성격이다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

Part 2. 지금부터 가정용 3D프린터 이용하여 만든 제품의 "사용단계" 에서의 사용자 인식과 관련된 질문이 제시됩니다. 본 설문의 문항은 '전혀 그렇지 않다' 부터 '매우 그렇다' 사이의 5점 척도에 근거하여 구성되어 있습니다. 다음의 각 문항에 대하여 귀하의 견해와 일치하는 번호에 체크하여 주십시오



가정용 3D프린터를 이용하여 만든 제품 예시

가. 다음은 가정용 3D프린터로 제작한 제품을 사용할 때, 느끼는 기능적 위험요소에 관한 질문 입니다. 기능적 위험요소란? 가정용 3D프린터로 제작한 제품을 사용할 때, 기술적 결함 또는 부적절한 기능으로 인해 발생하는 잠재적 또는 부가되는 손해를 말합니다.
1. 가정용 3D프린터로 만든 제품이 제대로 된 기능을 수행할지 의심스럽다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
2. 가정용 3D프린터로 만든 제품은 품질이 떨어질 것 같다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
3. 가정용 3D프린터로 만든 제품은 내가 원하는 견고함을 가지고 있을지 의심스럽다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
4. 가정용 3D프린터로 만든 제품은 내가 생각했던 것과 같은 성능을 가지고 있을지 걱정된다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

나. 다음은 가정용 3D프린터로 제작한 제품을 사용할 때, 느끼는 경제적 위험요소에 관한 질문 입니다. 경제적 위험요소란? 가정용 3D프린터로 만든 제품을 사용할 때, 작동 오류 또는 잘못된 사용으로 인한 잠재적으로 부가될 수 있는 재정적 위험

5. 가정용 3D프린터로 만든 제품이 제 기능을 하지 못하는 경우, 금전적 손실을 입을 것 같다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
6. 가정용 3D프린터로 만든 제품이 기존 시장에서 판매하는 제품을 구매하는 것에 비해 가격이 비쌀 것 같다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
7. 가정용 3D프린터를 이용하여 제작한 부품으로 기존 공산품을 수리하는 경우, 나중에 해당 업체에서 AS시 추가 비용을 발생할 것 같다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
8. 가정용 3D프린터를 이용하여 제작한 부품으로 기존 공산품을 수리하는 경우, 작동이 정상적으로 되지 않아 새 제품을 사야 할 것 같다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

다. 다음은 가정용 3D프린터로 제작한 제품을 사용할 때, 느끼는 위법성 위험요소에 관한 질문 입니다. 위법성 위험요소란? 가정용 3D프린터로 만든 제품 및 제품사용관련 법 또는 규정에 대한 정보 부족으로 인하여 잠재적으로 부가될 수 있는 손해
9. 가정용 3D프린터로 특정 제품을 만들어 사용하는 것이 불법행위가 될 수 있다고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
10. 가정용 3D프린터로 만든 제품을 사용하는 과정에서 발생한 피해에 대해, 내가 아닌 다른 3자(프린터 제작자/판매자/도면판매자/원료판매자 등)에게 잘못이 있는지 확인하기 어렵다고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
11. 어떤 제품이 가정용 3D프린터로 만들어 사용할 수 있는지 알지 못해 법을 어길까 두렵다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

라. 다음은 가정용 3D프린터로 제작한 제품을 사용할 때, 느끼는 신체적 위험요소에 관한 질문 입니다. 신체적 위험요소란? 가정용 3D프린터로 만든 제품을 사용함으로써 잠재적으로 발생

할 수 있는 건강상 피해
12. 가정용 3D프린터로 만든 제품을 사용하는 것이 피부에 악영향을 미칠까 걱정된다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
13. 가정용 3D프린터로 만든 제품을 사용하는 것이 만성질환의 원인이 될까봐 염려된다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
14. 가정용 3D프린터로 만든 제품을 사용하는 과정에서 찰과상 입을까봐 걱정된다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
15. 가정용 3D프린터로 만든 제품을 사용하는 과정에서 호흡기 질환을 얻을 까봐 걱정된다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

마. 다음은 가정용 3D프린터로 제작한 제품을 사용할 때, 느끼는 심리적 위험요소에 관한 질문 입니다. 심리적 위험요소란? 가정용 3D프린터로 만든 제품을 사용함으로써 잠재적으로 발생할 수 있는 정신적/심리적 고통 또는 피해
16. 가정용 3D프린터로 만든 제품을 사용하는 경우, 불필요한 걱정거리가 생길 것 같다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
17. 가정용 3D프린터로 만든 제품을 사용하는 경우, 내가 예상했던 기능/성능과 달라 심리적 손해를 받을 것 같다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
18. 가정용 3D프린터로 만든 제품을 사용하는 과정에서 불필요한 불안감을 느낄 것 같다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
19. 가정용 3D프린터로 만든 제품을 사용하는 과정에서 불필요한 긴장감을 느낄 것 같다 ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

바. 다음은 가정용 3D프린터로 제작한 제품을 사용할 때, 전체적으로 느끼는 위험요소에 관한 질문 입니다.
20. 가정용 3D프린터로 만든 제품은 다음 정도의 위험 수준이 있다고 생각한다. ① 전혀 위험하지 않다 ② 약간 위험하다 ③ 보통이다 ④ 위험한 편이다 ⑤ 매우 위험하다
21. 나는 가정용 3D프린터로 만든 제품을 사용하는 것은 위험하다고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
22. 가정용 3D프린터로 만든 제품을 사용하는 것은 나를 불필요한 위험에 노출할 가능성이 높다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
23. 가정용 3D프린터로 만든 제품을 사용하는 환경은 나를 알 수 없는 위험에 스스로 노출시키는 것과 같다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

사. 다음은 가정용 3D프린터로 제작한 제품을 사용할 때, 느끼는 사용 용이성에 관한 질문 입니다.
24. 나는 가정용 3D프린터로 만든 제품을 사용하기 위해 많은 노력이 필요하다고 생각한다. ① 전혀 위험하지 않다 ② 약간 위험하다 ③ 보통이다 ④ 위험한 편이다 ⑤ 매우 위험하다
25. 나는 가정용 3D프린터로 만든 제품의 사용이 용이하다고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
26. 나는 가정용 3D프린터로 만든 제품을 사용하는 과정이 복잡하다고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
27. 나는 가정용 3D프린터로 만든 제품을 사용하기 위한 정보를 얻는 것이 어렵다고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

아. 다음은 가정용 3D프린터로 제작한 제품을 사용할 때, 느끼는 유용성에 관한 질문 입니다.
28. 나는 가정용 3D프린터로 만든 제품을 사용하는 것이 나에게 유용하다고 생각한

다. ① 전혀 위험하지 않다 ② 약간 위험하다 ③ 보통이다 ④ 위험한 편이다 ⑤ 매우 위험하다
29. 나는 가정용 3D프린터로 만든 제품을 사용하여 혜택을 얻을 수 있을 것이라고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
30. 나는 가정용 3D프린터로 만든 제품을 사용하면 나에게 도움이 된다고 생각한다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

자. 다음은 귀하가 느끼는 가정용 3D프린터로 제작한 제품의 사용의도에 관한 질문입니다.
31. 나는 가정용 3D프린터로 만든 모형(액세서리, 장난감 등)을 사용할 의사가 있다. ① 전혀 위험하지 않다 ② 약간 위험하다 ③ 보통이다 ④ 위험한 편이다 ⑤ 매우 위험하다
32. 나는 가정용 3D프린터로 만든 가정용품(접시, 젓가락, 포크 등)을 사용할 의사가 있다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다
33. 나는 가정용 3D프린터로 만든 서랍장, 청소기, 도구 함 등의 부품을 사용하여 수리할 의사가 있다. ① 전혀 그렇지 않다 ② 그렇지 않다 ③ 보통이다 ④ 그렇다 ⑤ 매우 그렇다

Part 4. 다음은 귀하의 기본적인 정보에 관한 질문입니다.
1. 귀하의 성별은 어떻게 되십니까? ① 남성 ② 여성
2. 귀하의 연령은 어떻게 되십니까? ① 20세 미만 ② 20~39세 ③ 30~39세 ④ 40~49세 ⑤ 50세 이상
3. 귀하의 최종 학력은 어떻게 되십니까? ① 중졸이하 ② 고졸 이하 ③ 전문대 재학 또는 졸업 ④ 대학교 재학 또는 졸업 ⑤ 대학원 재학 또는 졸업 ⑥ 기타
4. 귀하는 과거 본인에게 필요한 제품을 만들어 사용해보신 경험이 있습니까?

(DIY 제작, 가죽공방, 향수 공방, 등) ① 있음 ② 없음
5. 귀하는 과거에 3D프린터를 사용해 보신 적이 있습니까? ① 있음 ② 없음
6. 귀하의 과거 1년 간 3D프린터 실제 사용 횟수는 어떻게 되십니까? ① 0회 ② 1회 ③ 2~5회 ④ 6~10회 ⑤ 10회 이상
7. 3D프린터 이용 시, 제작한 제품은 무엇이었습니까? ① 경험 없음 ② 액세서리, 장난감 ③ 수리용 부품 ④ 가정용품(접시, 포크 등) ⑤ 기타
8. 귀하의 연 수입은 어떻게 되십니까? ① 2,000만 원 이하 ② 2,000~4,000만 원 ③ 4,000~6,000만 원 ④ 6,000~ 8000만 원 ⑤ 8,000만 원 이상

Appendix 2. Descriptive Statistics of the Variables

[Table 20] Descriptive Statistics of the Variables(Stage1)

Latent variables	Observable variables	N	Average	Standard Deviation
Performance Risk	PeR1	304	3.57	0.780
	PeR2	304	3.50	0.867
	PeR3	304	3.74	0.821
Financial Rick	FiR1	304	3.69	0.773
	FiR2	304	3.89	0.799
	FiR3	304	3.70	0.809
Legal Risk	LeR1	304	3.42	0.879
	LeR2	304	3.33	0.899
	LeR3	304	3.70	0.741
	LeR4	304	3.49	0.804
Physical Risk	PhR1	304	3.34	0.929
	PhR2	304	3.31	0.957
	PhR3	304	3.25	0.914
	PhR4	304	3.45	0.885
Psychological Risk	PsR1	304	3.11	0.893
	PsR2	304	3.28	0.871
	PsR3	304	2.99	0.860
	PsR4	304	3.04	0.911
Overall Risk	OvR1	304	3.14	0.704
	OvR2	304	2.86	0.805
	OvR3	304	3.05	0.859
	OvR4	304	2.95	0.841
Perceived Ease of Use	PEOU1	304	3.45	0.778
	PEOU2	304	3.34	0.762

Perceived Usefulness	PU1	304	3.23	0.770
	PU2	304	3.34	0.800
	PU3	304	3.37	0.756
	PU4	304	3.32	0.788
Intention to Use	IU1	304	3.35	0.920
	IU2	304	3.15	0.999
	IU3	304	3.31	0.924
Motivation of Marketplace	MoM1	304	3.10	0.898
	MoM2	304	3.26	0.891
	MoM3	304	3.11	0.890
	MoM4	304	3.18	0.916

[Table 21] Descriptive Statistics of the Variables(Stage2)

Latent variables	Observable variables	N	Average	Standard Deviation
Performance Risk	PeR1	304	3.41	0.774
	PeR2	304	3.34	0.797
	PeR3	304	3.60	0.786
	PeR4	304	3.58	0.763
Financial Rick	FiR1	304	3.62	0.726
	FiR2	304	3.69	0.774
	FiR3	304	3.54	0.748
Legal Risk	LeR1	304	3.34	0.861
	LeR2	304	3.57	0.751
	LeR3	304	3.37	0.777
Physical Risk	PhR1	304	3.36	0.816
	PhR2	304	3.28	0.867
	PhR3	304	3.14	0.855

	PhR4	304	3.38	0.851
Psychological Risk	PsR1	304	3.18	0.836
	PsR2	304	3.26	0.794
	PsR3	304	3.09	0.823
	PsR4	304	3.10	0.827
Overall Risk	OvR1	304	3.21	0.759
	OvR2	304	3.02	0.768
	OvR3	304	3.05	0.847
	OvR4	304	3.06	0.862
Perceived Ease of Use	PEOU1	304	3.59	0.712
	PEOU2	304	3.35	0.814
	PEOU3	304	3.37	0.781
Perceived Usefulness	PU1	304	3.31	0.747
	PU2	304	3.29	0.785
	PU3	304	3.31	0.742
Intention to Use	IU1	304	3.34	0.873
	IU2	304	3.17	0.972
	IU3	304	3.35	0.935
Motivation of Marketplace (Same as stage 1)	MoM1	304	3.10	0.898
	MoM2	304	3.26	0.891
	MoM3	304	3.11	0.890
	MoM4	304	3.18	0.916

Abstract (Korean)

전통적인 제조 방법에 대한 대안으로 삼차원 프린터는 최근 대중으로부터 많은 주목을 받고 있다. 그러나 기술의 발전과 가격 하락에도 불구하고 3차원 프린터는 여전히 학술 연구가 부족하고 일반적인 사용에 대한 연구가 이루어지지 않고 있다. 또한 현재의 법규 및 규제가 불충분하여 책임 문제 및 지적 재산권 문제와 같은 문제의 처리에 제한이 있다. 적절한 전략을 수립하고 업계를 홍보하기 위해서는 소비자 행동에 대한보다 깊은 이해가 필요하다. 이 논문은 인지된 위험성 및 동기 부여와 함께 확대된 기술수용모델(TAM)을 사용하여 사용자의 사용 의도에 영향을 미치는 요인을 조사하는 것을 목표로 한다. 기능적, 금전적, 법적, 물리적, 심리적 리스크가 주요 위험의 차원으로 선택되었고 시장의 동기 부여가 사회적 영향으로써 선택되었다. 가정용 삼차원 프린터 사용에 있어 소비자의 역할이 기존의 생산방식과 다르기 때문에 2단계(가정용프린터 사용 및 프린팅한 제품 사용)의 분석 결과를 비교했다. 총 304개의 샘플을 온라인 설문 시스템을 통해 수집하고 구조 방정식 모델을 통해 분석하였다. 결과는 각각의 위험들이 소비자가 인식하는 전반적인 위험에 기여한다는 것을 보여 주며 지각된 위험은 '가정용 삼차원프린터 사용' 단계에서 사용 의도에 부정적인 영향을 주고 '인쇄 된 제품 사용'단계에서 지각된 유용성에 부정적인 영향을 준다. 또한 전반적인 위험이 소비자의 가정용 삼차원프린터 사용에 영향을 주는 경로는 사용자의 DIY 경험과 Identity 동기에 따라

다르다. 인쇄된 제품을 사용하는 단계에서 전반적인 위험은 낮은 동기 부여 그룹과 경험이 없는 그룹에서 사용 의도에 간접적인 영향을 미치는 반면, 높은 동기 부여 그룹과 경험 있는 그룹은 영향을 주지 않는 것으로 나타났다.

주요어: Desktop 3D printer, User acceptance, Technology acceptance model, Perceived overall risk, Structural equation model, Prosumer, Prosumption

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