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Article

Crowdfunding as an Alternative Means for Funding Sustainable Appropriate Technology—With a Focus on the Factors Determining the Acceptance of Backers

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Abstract: The R&D and propagation of sustainable appropriate technology requires the provision of stable funding. Crowdfunding is a form of funding whereby small sums of investments or contributions are collected from among the general public and used to finance the development of goods or services. This method has been in use widely in arts and culture fields, and presents a useful alternative means for funding appropriate technology projects. The aim of this study is to identify the factors influencing the backers who participate in appropriate technology projects through crowdfunding platforms, analyzing the relationships between these factors, and thereby establishing the usefulness of crowdfunding as a viable new alternative. The analysis results indicate that key factors influencing user intention to crowdfund appropriate technology projects include social influence, effort expectancy, and perceived trust. In contrast to the findings of previous studies, performance expectancy was not found to have a significant effect. This reflects the fact that, compared to the crowdfunding conducted for other purposes, crowdfunding for appropriate technology is closer in nature to donations. These findings indicate that for funding to be successful, aggressive online exposure using the SNS of backers should be pursued from the early stages of funding.

Keywords: appropriate technology, crowdfunding, UTAUT model, technology service acceptance factor

1. Introduction

Appropriate technology refers to technology that is appropriate for the local environmental, cultural, and economical circumstances within a certain place and time period, with the stated goal of realizing social innovation that is appropriate for a community's economic, social, and cultural environments[1, 2]. Appropriate technology emerged in the 1960s as an alternative in the face of the shortcomings of existing economic policies that focused on maximizing growth, such as the polarization of wealth and the depletion of resources. With the enactment of the UN's Millennium Development Goals (MDGs), appropriate technology has received attention well into the 2000s as a means of official development assistance (ODA) for combating poverty and unemployment in developing nations [3].

Appropriate technology presents various difficulties as well as possibilities. From a technological standpoint, appropriate technology is often limited to lower-grade technology that can be implemented on-site, with the majority of cases being one-off efforts in which the technology is abandoned once the project ends [4, 5]. This is due to the lack of factors necessary for R&D and propagation of appropriate technology, such as institutional support, diversity of participation, and provision of stable funding [6]. For appropriate technology to be sustainable, mid-to-high grade technologies should be used to address local issues, which should create additional value via markets; in addition, more diverse sources of funding beyond government assistance should be secured [4, 7].

Crowdfunding refers to activities wherein donations or investments are collected from among the masses via such platforms as social networks for the purpose of funding a wide variety of projects, ranging from the production of cultural or artistic content to the establishment of startups [8]. Unlike traditional fundraising methods, such as offline donations or using Automatic Response System (ARS), crowdfunding is not constrained by geography. It also has the advantage of being able to utilize diverse interpersonal networks via SNS. In addition, it is relatively more efficient in that it requires low intermediary costs (e.g., wages or promotion costs) in the funding process. Owing to these strengths, crowdfunding has emerged as an alternative means of funding among projects for non-profit causes, cultural or artistic projects, and experimental technologies and startups that are unable to access traditional methods of financing, such as bank loans and stock issues [9].

Although there is a wide variety of groups that are currently attempting to find funding for appropriate technology projects via crowdfunding, structural approaches regarding such efforts have been lacking in the literature. In particular, because crowdfunding for appropriate technology is closer in nature to donations than to investment when compared to general crowdfunding projects, a different perspective is needed to analyze the factors behind funding success and activation. In this study, we aim to present crowdfunding as a means of financing sustainable appropriate technology projects. For this purpose, we analyze the factors influencing the behavior of investors and backers who wish to participate in such projects.

This rest of this paper is organized as follows. In the literature review in Section 2, we define the concepts of appropriate technology and crowdfunding. Building on this, in Section 3, we present the research model, define its variables, and set our research hypotheses. Next, in Section 4, we analyze our research model using survey response data, and finally, we discuss the implications of our findings along with some of the study's limitations in Section 5.

2. Theoretical Background

2.1 Appropriate Technology

Generally, appropriate technology is defined as "technology that is appropriate for the local environmental, cultural, and economical circumstances within a certain place and time period." This approach emphasizes the appropriate use of existing technology and resources, so as to strengthen the productive capacities of local communities and create jobs. Appropriate technology first emerged during the 1960s as a countermovement in the face of the failures of growth-driven modes of development, such as wealth polarization and poverty[1, 2]. Appropriate technology was actively adopted during the 1970s by the private sector, states, and the international community before entering a slump during the 1980s, but in the 2000s, it has received newfound attention as a useful means through which the MDG objectives could be realized.

The fundamental goal of appropriate technology is to bring about social innovation through the use of technology that is appropriate for the economic, social, cultural, and political circumstances of a given community. Bakker [10] included any technology that has a positive influence on basic human needs in the concept of appropriate technology, while Abdullalli [11] viewed appropriate technology as that which guaranteed the appropriateness of technology for the welfare of the community members. Through such extensions in definition, recent research efforts in appropriate technology have sought to employ inexpensive and simple technologies that are appropriate for the society and environment of communities in developing nations, so as to improve the community members' quality of life. In particular, appropriate technology is now widely perceived as a means of providing assistance to developing countries as parts of ODA projects.

2.2 Challenges of Sustainable Appropriate Technology

The development and propagation of appropriate technology presents various difficulties. In addition to the development-related issues encountered in pursuing appropriate technology, Zelenika and Pearce [5] have pointed to financial issues and the organizational issues underpinning

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them as additional sources of difficulty. Smillie [6] has stated that the successful propagation of appropriate technology requires stable funding and participation, in addition to institutional support.

From a technological standpoint, appropriate technologies have focused on the use of locally available materials and technologies for tackling certain social challenges. In the course of using technologies that are appropriate for local communities, a substantial number of cases have been limited to the use of low-grade technologies. Such technologies, while easy to develop and implement, are less conducive to the development of follow-up technologies, and are untested in terms of performance. For this reason, many appropriate technology projects end up as one-off affairs in practice, and have failed to give rise to new products and services via markets [4, 5].

To secure the sustainability of appropriate technology movements, changes must be made in terms of technology and institutions from a business model perspective. In addition to the supplier-centered provision of technologies, a demand-centered approach is needed that focuses on local demand [12]. For this purpose, projects must move beyond the current use of simpler and lower-grade technologies and must be able to make use of mid and high-grade technologies, which calls for sufficient levels of funding [5]. Ultimately, appropriate technologies must not only be able to address challenges in local communities—they should be able to create additional value via markets and business models. This would necessitate not only government assistance, but also the diversification of funding sources [4, 7].

2.3 Crowdfunding with Appropriate Technology

2.3.1 Crowdfunding: Definitions and Applications

Crowdfunding refers to activities wherein donations or investments are collected from among the masses via such platforms as social networks for the purpose of funding a wide range of projects [8]. According to the proposed amendment to the enforcement decree of the Financial Investment Services and Capital Markets Act (2015), whose purpose is to activate investment and protect investors in manufacturing, cultural content, and intellectual services, crowdfunding refers to online community activities conducted for the purpose of securing commitments from non-expert members of the general public for donations, sponsorships, and investment [13, 14].

Although crowdfunding traces its roots to donation activities whereby contributions are collected from a multitude of individuals, it is different in nature to general fundraising activities [15]. As implied by its etymology, a compound of “crowd” and “funding,” crowdfunding differs from traditional methods of fundraising in that it is based on the active support of “crowds” via social network platforms [16, 17]. Compared to traditional fundraising methods (offline, ARS, etc.), crowdfunding is a more effective means of transcending geographical boundaries to raise awareness for non-profit causes and to raise funds through the use of social networks [18]. Either implicitly or explicitly, backers make their contributions known via social networks, thereby informing their acquaintances about the causes or projects they are backing, and in turn encouraging the participation and backing of members of their social networks. Because fundraising through interpersonal networks within SNS is based on trust between friends, colleagues, family members, and other acquaintances, it is more conducive to encouraging participation [18-20].

Crowdfunding has recently been touted as an alternative method of fundraising for causes that are less viable under the current system of competitive markets, such as non-profit projects, experimental technologies and ventures, and cultural/artistic projects [9, 21]. In the U.S. and Europe, crowdfunding has been propagated in the form of small investments by crowds for films and music records. In particular, it has driven the creation of startups and jobs through the Jumpstart Our Business Startups (JOBS) Act in the U.S., which allows startup firms to employ crowdfunding to secure funding in the form of investment shares [17].

2.3.2 Appropriate Technology and Crowdfunding

Crowdfunding has received attention as a means for pursuing external promotion, communication, and securing funds not only among cultural/artistic projects and business startups,

but also in the field of appropriate technology. A substantial number of the appropriate technology projects being pursued in Korea currently receive government assistance as a part of ODA projects for developing countries. However, an increasing number of projects now perceive that funding via government ODA provisions and non-profit organizations are insufficient for the development and propagation of sustainable appropriate technology efforts. In response, crowdfunding has been widely adopted by various appropriate technology projects as a means of inter-personal fundraising. Crowdfunding platforms, such as Kickstarter, currently support a variety of projects that lack funds, while crowdfunding platforms specializing in appropriate technology, such as Kopernik, seek out the technological needs of local non-profit organizations, establish connections between them and suppliers of appropriate technology, and then provide funding for them via crowdfunding. Studying the School for Cultural Heritage through Map Exploitation project implemented in Albania, Dollani et al. [21] found that crowdfunding was effective in sourcing the necessary funds, conducting promotional activities, and encouraging active participation. In addition, in a case study of Open Source Appropriate Technology (OSAT), Zelenika and Pearce [22] found that crowdfunding through platforms, such as Indiegogo and Kickstarter, could be used as a standalone means of funding apart from government assistance. The authors confirmed that, in addition to securing funding, crowdfunding platforms contributed to the exchange of information among participants, thereby further activating R&D efforts of appropriate technologies.

However, the actual activation of crowdfunding for appropriate technology will require further efforts. According to data compiled by the Korean organization, Global Network for Sharing Appropriate Technology (GNSAT) in 2016, a total of 35 appropriate technology projects in Korea had attempted to use crowdfunding as a funding method. Of these projects, which employed such crowdfunding platforms as Happy Bean and The Bridge, only seven projects (roughly 20%) succeeded in meeting their funding goals. Although the GNSAT study was not exhaustive, its findings are reflective of the realities of crowdfunded appropriate technology projects. The funding success rate of appropriate technology projects falls far behind the overall funding success rate of crowdfunded projects, 52%, as surveyed by Korea's Financial Services Commission in 2017, and is even lower than the 27% success rate among the most similar category of crowdfunding projects—cultural/arts projects. Despite such low rates of success, there is a marked lack of research on the activation of investment in crowdfunding for appropriate technology compared to those for other projects, such as financial, culture, or arts projects.

3. Research Model and Hypothesis

3.1 Research Objectives

Appropriate technology is associated with a variety of challenges, such as supplier-centric and low-grade technology, the diversity of knowledge and participation required for the R&D process, and the lack of institutional support and financial funding. In this study, we present the crowdfunding platform as an alternative means for realizing sustainable appropriate technology. The use of crowdfunding not only would enable a more independent mode of securing funds, but also would contribute to the more effective development of appropriate technology through the exchange of technology and knowledge and the encouragement of wider participation via SNS.

For this purpose, we aim to analyze the factors that influence participation and funding of backers in crowdfunded appropriate technology projects. Through this study, we establish the possibilities of crowdfunding as a self-sustaining means of funding, in addition to identifying which determinants affect backing intention within the ecosystem comprising the crowdfunding platform, backers, proponents of appropriate technology projects, and the projects' beneficiaries. Furthermore, we aim to propose that appropriate technology projects, which are currently focused around international ODA efforts, could transition to a new market-based business model via crowdfunding.

3.2 Research Model

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3.2.1 Unified Theory of Acceptance and Use of Technology Model

In this study, we employ the unified theory of acceptance and use of technology (UTAUT) model in order to analyze the factors influencing the backers of crowdfunded appropriate technology projects. The UTAUT is a theory that brings together previous theories of the acceptance and use of new technologies, such as the technology acceptance model (TAM), theory of reasoned action, and theory of planned behavior, to describe users' intentions to accept and use new technology. Some of the key variables proposed in this theory include performance expectancy, effort expectancy, facilitating conditions, and social influence. Users' gender, age, experience, and voluntariness of use have been proposed as moderating variables [23, 24].

In general, a crowdfunding project comprises a project proponent, a platform that provides information to backers and delivers the collected funds, and backers who make the investment decision. Crowdfunded projects for have a different set of stakeholders to crowdfunded projects in general, such as those for arts and culture or new technologies. Whereas backers in general crowdfunding projects might look to returns on their investments, backers of crowdfunded appropriate technology projects are rewarded vicariously through the benefits provided to a third party—usually in the form of appropriate technology being made available to the residents of developing countries. This difference in structure implies that the backing for an appropriate technology project may be closer in nature to donation rather than investment. Thus, in applying the UTAUT model in this study, we reflect on the characteristics of the stakeholder structure particular to appropriate technology projects in defining the model's variables.

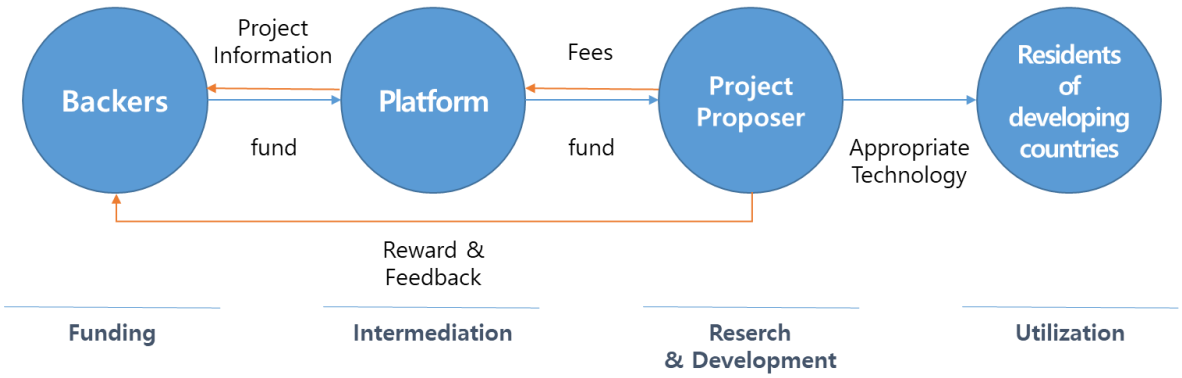

Figure 1 Stakeholders of a Crowdfunded Appropriate Technology Project

3.2.2 Variable Definitions and Hypothesis Setup

Performance expectancy refers to the extent of improvement in performance that one expects to result from the use of some new information/technology [23]. In this study, we define performance expectancy as the extent to which the challenges facing local communities are expected to be resolved through the crowdfunded appropriate technology. Earlier studies have stated that the expectations held by investors and backers regarding a project will influence their intention to participate in it. The backers' expectations of the satisfaction that will be derived as a result of the crowdfunded project have a significant effect on their participation intentions, and may lead to their continued participation [25]. In addition to satisfaction, direct rewards have been found to influence participation intentions directly, while high performance expectancy has been found to influence participation intentions positively [26-28]. In view of this discussion, in this study we propose the following hypothesis.

H1. Users' performance expectancy has a positive effect on crowdfunding use intention.

Effort expectancy refers to the perceived extent of convenience presented by the use of some new information/technology [23]. In this study, we define effort expectancy as the ease with which

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backers expect to be able to invest in appropriate technologies through crowdfunding. Earlier studies have stated that such ease of use has a positive effect on the participation intentions of backers [26, 28]. Thus, we propose the following hypothesis.

H2. Users' effort expectancy has a positive effect on crowdfunding use intention.

Facilitating conditions refer to the extent to which users perceive that the infrastructure and organization are sufficiently in place to facilitate the use of information systems [23]. In this study, we define facilitating conditions as the perceived availability of organizational and technological infrastructure that supports the use of the crowdfunding platform—such as a customer center and payment systems. Earlier studies have stated that the official feedback channels of crowdfunding platforms contribute to facilitating user participation, while inadequate information and statistical systems regarding the funds raised present obstacles to the activation of crowdfunding efforts [29]. Based on this discussion, we hypothesize as follows.

H3. Users' facilitating conditions have a positive effect on crowdfunding use intention.

Social influence refers to the extent to which the user believes that important people feel that individuals should use some new information/technology, making it a similar concept to that of the subjective norm, which refers to the extent of influence that important others have on an individual's behavior [23, 24]. In this study, social influence is defined as the extent of influence exerted by a user's surrounding reference group on the user's decision to invest in crowdfunding and appropriate technology.

Previous studies have stated that social influences, such as social networks and peer effects, play an important role in influencing users. Interpersonal networks, which encompass friends and acquaintances, are a key factor for the success of crowdfunding [30]. In particular, during the early stages of funding, the social capital of the project proponent—including close friends—is considered an important factor that exerts a positive effect on the successful implementation of projects [15, 31]. In addition to the social capital available to the project proponent, a peer effect exists wherein backers and their acquaintances mutually influence each other. The social influence that is formed in this way ultimately influences the investment behavior of crowdfunding users [26, 32]. In view of these considerations, we set the following hypothesis.

H4. Users' social influence has a positive effect on crowdfunding use intention.

In this study, we examine how the perceived risk and perceived trust associated with appropriate technology projects influence performance expectancy and user intention, in addition to the influence exerted by the key variables of the UTAUT model. Perceived risk refers to the investor's perception of functional risks that might arise owing to insufficient information with respect to crowdfunded appropriate technology projects. Functional risk refers to the possibility of project failure owing to the inadequacy of the appropriate technology itself or inadequate capacity for project implementation. Perceived trust refers to the user's subjective degree of belief in the expertise (knowledge and competency) and trustworthiness (public confidence and ethicality) of a crowdfunding platform, and points to a platform's capacity for monitoring and post-management.

Earlier studies on the effect of trust on crowdfunding users found that trust factors, such as the security and stability of a crowdfunding platform, had significant effects on investment intention, in addition to positive influences on participation intention, as for other forms of e-commerce [27, 33]. Gerber and Hui [34] identified a platform's transparency and level of trust, established through post-management systems, as key factors behind the success of crowdfunding, and found that lack of trust represents an obstacle to user participation. In view of these points, we propose the following hypotheses.

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H5-1 Users' perceived trust has a positive effect on the performance expectancy of crowdfunding.

H5-2 Users' perceived trust has a positive effect on crowdfunding use intention.

The findings of previous studies have varied regarding the effect of the perceived risk of appropriate technology projects on user behavior. While some studies have stated that perceived risk by investors/backers has a negative direct/indirect effect on participation intention [13, 35], others have countered that perceived risk has no effect on user intention, because most crowdfunding users, who make investments in small sums, perceive risk to a lesser degree [26]. To ascertain how perceived risk influences user intention, in this study, we set the following hypotheses.

H6-1 Users' perceived risk has a negative effect on performance expectancy.

H6-2 User's perceived risk has a negative effect on use intention.

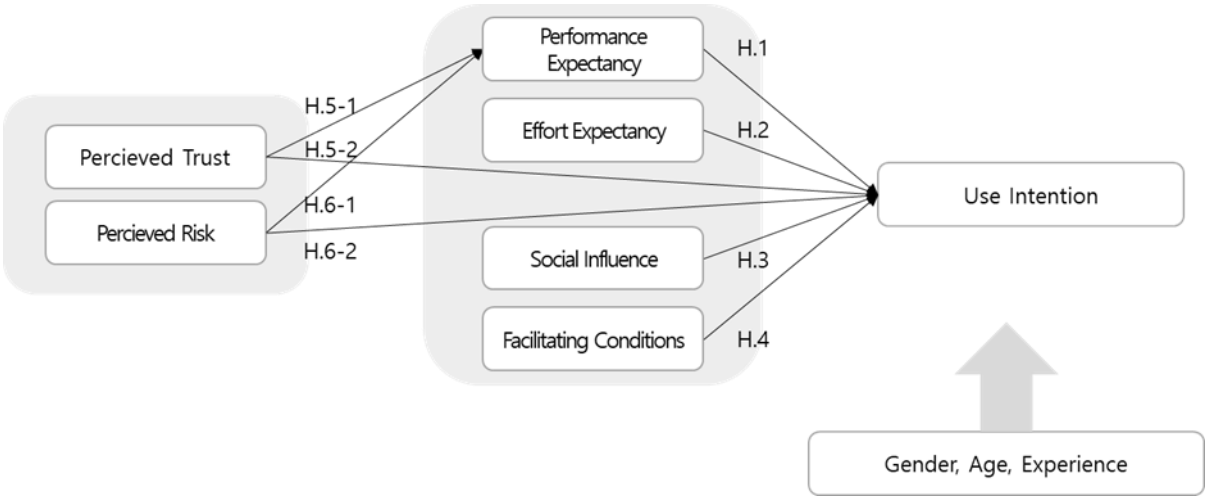

Figure 2 Research Model and Hypotheses

As described above, in this study we shall how the stakeholders of crowdfunded appropriate technology projects—the project proponent and the platform—influence investors/backers. In the case of the project proponent, we analyze the roles of performance expectancy and perceived risk. In the case of the platform, we shall analyze the roles of the effort expectancy and facilitating conditions supporting the funding project, in addition to that of perceived trust. Furthermore, we shall examine the factors influencing individual investors/backers via social influence and the moderating variables. For this purpose, in this study we shall consider moderating variables such as the user's gender, age, and previous experience in backing other crowdfunded projects. The model constructed based on the variables and hypotheses described earlier may be expressed as in Figure 2. We shall employ this model to identify the factors influencing the backers participating in appropriate technology projects via crowdfunding platforms, in addition to analyzing how these factors are interrelated.

4. Analysis Results

4.1 Data

An online survey was conducted comprising 425 members of the general public for this study. The demographic characteristics of the respondents are summarized in Table 1. There are show 207 male and 218 female respondents, with 9 respondents aged 10–19, 149 aged 20–29, 137 aged 30–39, 93 aged 40–49, 35 aged 50–59, and 2 aged 60–69 years. Thus, those in their 20s to 40s account for roughly 90% of all respondents. About half (213 people) of the respondents reported having previous experience backing crowdfunded projects. Regarding the size of investment they were willing to

make, 149 respondents replied that they were willing to invest sums of up to 10,000 KRW, while 114 were willing to invest sums of 100,000 KRW or more.

Table 1 Demographic and social statistics of respondents

	features	Frequency	Percentage
Gender	Male	207	48.71%
	Female	218	51.29%
Age	10's	9	2.12%
	20's	149	35.06%
	30's	137	32.24%
	40's	93	21.88%
	50's	35	8.24%
	60's	2	0.47%
Experience in using crowdfunding	Experienced	213	50.12%
	Not Experienced	212	49.88%
Willingness to pay for Appropriate Technology Crowd Funding project	Not more than 10,000 won	149	35.06%
	More than 10,000 won to less than 100,000 won	149	35.065
	Over 100,000 won	114	26.82%
	none	13	3.06%
	Total	425	100%

4.2 Research Variables

The independent variables of the UTAUT model employed in this study include performance expectancy, effort expectancy, social influence, facilitating conditions, perceived trust, and perceived risk. The dependent variable is use intention for a crowdfunded appropriate technology project. Here, performance expectancy is included both as an independent variable and as a mediating variable between perceived trust and perceived risk. The descriptive statistics of these variables are reported in Table 2.

Table 2 Descriptive statistics of the variables

The Variables	Measurement Variable	N	Min	Max	Average	Standard Deviation
Performance Expectancy	PE1	425	1.0	5.0	4.278	.6538
	PE2	425	1.0	5.0	4.120	.6814
	PE4	425	1.0	5.0	4.132	.6417
	PE5	425	1.0	5.0	4.195	.6530
Effort Expectancy	EE1	425	1.0	5.0	3.616	.7562
	EE2	425	1.0	5.0	3.671	.7615
	EE3	425	1.0	5.0	3.725	.7378
	EE4	425	1.0	5.0	3.612	.7538
Social Influence	SI1	425	1.0	5.0	3.271	.8631
	SI2	425	1.0	5.0	3.264	.8362
	SI3	425	1.0	5.0	3.428	.8214
	SI4	425	1.0	5.0	3.372	.8650

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Facilitating Conditions	FC1	425	1.0	5.0	3.605	.7517
	FC2	425	1.0	5.0	3.680	.7341
	FC3	425	1.0	5.0	3.496	.7652
	FC4	425	1.0	5.0	3.546	.7545
Perceived Trust	TP1	425	1.0	5.0	3.313	.8431
	TP2	425	1.0	5.0	3.384	.8133
	TP3	425	1.0	5.0	3.273	.8773
Perceived Risk	RP1	425	1.0	5.0	3.452	.8595
	RP2	425	1.0	5.0	2.861	.8992
	RP3	425	1.0	5.0	2.993	.9278
Use Intention	UI1	425	1.0	5.0	3.334	.7080
	UI2	425	1.0	5.0	3.172	.8016
	UI3	425	1.0	5.0	3.096	.7995
	UI4	425	1.0	5.0	3.245	.8363

We used the SPSS 23 package to conduct factor analysis on each of the measurement variables (questionnaire items) in order to construct the model's variables from survey responses. As summarized in Table 3, each of seven variables can be extracted, while the structure matrix in Table 4 shows how the measurement variables are grouped. Table 5 reports the correlation matrix of the variables that were extracted in this way.

Table 3 Total variance explained of factor analysis

	Initial Eigenvalue			Extraction Sum of Squared Loading			Rotation Sum of Squared Loading
Factor	Total	% of Variance	Cumulative %	Total	% of Variance	Cumulative %	Total
1	8.342	32.083	32.083	8.342	32.083	32.083	5.532
2	2.648	10.183	42.267	2.648	10.183	42.267	4.155
3	2.386	9.175	51.442	2.386	9.175	51.442	2.431
4	1.716	6.602	58.044	1.716	6.602	58.044	3.808
5	1.525	5.864	63.908	1.525	5.864	63.908	4.953
6	1.121	4.310	68.217	1.121	4.310	68.217	3.973
7	1.028	3.953	72.170	1.028	3.953	72.170	5.296
8	.632	2.431	74.601				
9	.578	2.224	76.825				
10	.539	2.072	78.897				

Table 4 Structure matrix of factor analysis

	Factor						
	1	2	3	4	5	6	7
PE1	.153	.824	-.194	.075	-.291	-.281	.086
PE2	.244	.830	-.097	.179	-.344	-.324	.188
PE4	.243	.852	-.121	.172	-.360	-.213	.178
PE5	.308	.811	-.130	.139	-.350	-.277	.206
EE1	.388	.374	-.105	.156	-.846	-.274	.343

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EE2	.315	.303	-.016	.091	-.852	-.300	.318
EE3	.331	.355	-.023	.109	-.856	-.310	.270
EE4	.368	.333	-.036	.217	-.877	-.335	.331
SI1	.829	.248	-.076	.227	-.375	-.296	.528
SI2	.874	.178	-.058	.329	-.298	-.279	.468
SI3	.821	.286	-.116	.247	-.398	-.287	.551
SI4	.821	.252	.006	.356	-.340	-.243	.493
FC1	.422	.341	-.089	.333	-.429	-.664	.373
FC2	.204	.333	-.086	.055	-.340	-.768	.115
FC3	.281	.203	-.105	.460	-.235	-.818	.329
FC4	.373	.259	-.148	.441	-.298	-.781	.326
TP1	.353	.199	-.149	.875	-.197	-.362	.288
TP2	.322	.179	-.263	.868	-.194	-.326	.362
TP3	.419	.259	-.158	.865	-.256	-.379	.418
RP1	-.066	.000	.815	-.268	-.026	.061	-.146
RP2	-.083	-.244	.832	-.078	.124	.079	-.044
RP3	-.044	-.168	.866	-.145	.039	.180	-.104
UI1	.516	.227	-.134	.230	-.405	-.258	.872
UI2	.595	.185	-.134	.334	-.311	-.256	.801
UI3	.530	.120	-.030	.411	-.271	-.219	.868
UI4	.496	.184	-.088	.253	-.336	-.268	.888

Table 5 Correlation matrix of factor analysis

Factor	1	2	3	4	5	6	7
SI	1.000	.266	-.063	.330	-.393	-.304	.575
PE	.266	1.000	-.155	.137	-.397	-.311	.173
RISK	-.063	-.155	1.000	-.165	.048	.113	-.102
TRUST	.330	.137	-.165	1.000	-.140	-.314	.337
EE	-.393	-.397	.048	-.140	1.000	.342	-.349
FC	-.304	-.311	.113	-.314	.342	1.000	-.262
UI	.575	.173	-.102	.337	-.349	-.262	1.000

The internal reliability of the measurement variables (questionnaire items) constructing the model variables are reported in Table 6. The Cronbach's α for all variables exceed 0.7, indicating that the questionnaire items consistently measure the variables. To establish the validity of the variables, we conducted confirmatory factor analysis to assess the average variance extracted (AVE) and construct reliability (CR). Results showed all AVE values in excess of 0.5 and a CR exceeding 0.7, indicating a sufficient degree of convergent validity.

Table 6 Cronbach's alpha, Average variance extracted, Construct reliability

Construct	Cronbach's alpha	AVE	C.R.	Number of items
PE	0.851	0.768	0.930	4
EE	0.882	0.769	0.930	4
SI	0.860	0.684	0.896	4

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FC	0.776	0.616	0.863	4
UI	0.883	0.758	0.926	4
TR	0.865	0.752	0.901	3
RI	0.792	0.622	0.830	3

4.3 Analysis Results

4.3.1 Baseline Model

We conducted structural model analysis to test the hypotheses. As reported in Table 7, the goodness-of-fit for most models met the recommended standards, thereby indicating that the models could validly be employed to analyze the relationships between the measurement factors.

Table 7 Baseline Model Goodness of Fit

	CMIN	RMR	RMSEA	GFI	NFI	TLI	CFI
Standard	>0.05	<0.05	<0.05	>0.9	>0.9	>0.9	>0.9
Result	CMIN=617.332 df=281 p=.000	0.042	0.053	0.893	0.898	0.932	0.941

The estimation results from the structural equation modeling (SEM) in this study are reported in Table 8, and can be visualized as in Figure 3. We found that, of the seven measurement factors making up the research model, the independent variables social influence (SI), effort expectancy (EE), and perceived trust (TR) each had significant positive effects on the dependent variable, use intention (UI). Meanwhile, perceived trust (TR) and perceived risk (RI) had direct and significant effects on performance expectancy (PE), but performance expectancy (PE) had no significant effect on use intention. Thus, we found no evidence of a mediation effect.

Table 8 Result of Baseline Model

			Estimate	S.E.	C.R.	P	Standardize Estimate
PE	<---	TRUST	0.21	0.038	5.484	***	0.32
PE	<---	RISK	-0.079	0.037	-2.149	0.032*	-0.126
UI	<---	PE	-0.075	0.054	-1.395	0.163	-0.063
UI	<---	EE	0.102	0.048	2.131	0.033*	0.111
UI	<---	SI	0.537	0.058	9.203	***	0.599
UI	<---	FC	0.039	0.072	0.543	0.587	0.039
UI	<---	TRUST	0.104	0.052	1.997	0.046*	0.133
UI	<---	RISK	-0.033	0.034	-0.964	0.335	-0.043

Table 9 summarizes the results of testing each hypothesis according to the estimation results. H1 and H3, which expected users' performance expectancy and facilitating conditions to positively affect use intention, were rejected. On the other hand, effort expectancy and social influence were found to have significant positive effects on use intention, thereby supporting H2 and H4. Perceived trust had a significant positive influence on both performance expectancy and use intention, thereby supporting H5-1 and H5-2. On the other hand, while perceived risk had a significant negative effect on performance expectancy, it had no significant effect on use intention. Therefore, only H6-1 was supported.

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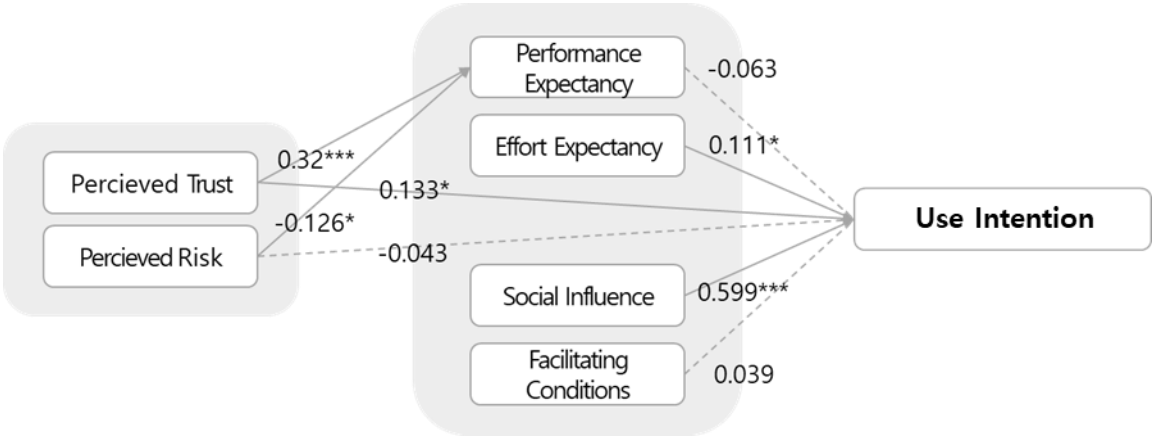

Figure 3 Results of Baseline Model analysis

Table 9 results of hypothesis test

Hypothesis	Results
H1. Users' performance expectancy has a positive effect on crowdfunding use intention.	Not supported
H2. Users' effort expectancy has a positive effect on crowdfunding use intention.	supported
H3. Users' facilitating conditions have a positive effect on crowdfunding use intention	Not supported
H4. Users' social influence has a positive effect on crowdfunding use intention.	supported
H5-1 Users' perceived trust has a positive effect on the performance expectancy of crowdfunding.	supported
H5-2 Users' perceived trust has a positive effect on crowdfunding use intention.	supported
H6-1 Users' perceived risk has a negative effect on performance expectancy.	supported
H6-2 User's perceived risk has a negative effect on use intention.	Not supported

4.3.2 Effects of Moderating Variables

The effects of the moderating variables in the model were examined through such variables as the respondent's gender, age, and prior experience with crowdfunding. The gender variable had possible values of male/female, while the prior experience variable had possible values of yes/no. Males accounted for 207 of the respondents, while females accounted for 218. The age groups of the respondents were made up of those in their 20s (149 people) and 30s (137 people), with respondents in their 40s and 50s merged into a single group (128 people). Responses by people in their teens (9 people) and in their 60s (2 people) were discarded from our analysis owing to insufficient sample size. Based on whether they had prior experience in backing a crowdfunded project, respondents were categorized as either "experienced" (213 people) or "not experienced" (212 people). Tables 10 and 11 report the results of analyzing the moderating effects of the SEM. The results for age were found to have no significant moderating effects.

The differences between male and female respondents are reported in Table 10. In contrast to the results of the baseline model, the only factor that had a direct influence on use intention was social influence (SI). When compared using standardized coefficients, this factor was found to have a stronger effect on the use intention of females than on that of males. In terms of moderating effects, while only perceived trust (TR) had a significant effect on performance expectancy (PE) in males, performance expectancy (PE) was found to be affected by both perceived trust (TR) and perceived risk (RI) among females. Meanwhile, as with the baseline model, performance expectancy (PE) was not found to have a significant effect on use intention (UI) in either group.

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Table 10 Result of Moderating effects (Gender)

			Male					Female				
			Estimate	S.E.	C.R.	P	Standardize Estimate	Estimate	S.E.	C.R.	P	Standardize Estimate
PE	<—	TR	0.257	0.058	4.437	***	0.369	0.15	0.048	3.1	0.002**	0.252
PE	<—	RI	-0.061	0.06	-1.027	0.305	-0.085	-0.089	0.045	-1.986	0.047*	-0.164
UI	<—	PE	-0.075	0.07	-1.074	0.283	-0.069	-0.094	0.084	-1.125	0.261	-0.069
UI	<—	EE	0.054	0.073	0.739	0.46	0.063	0.12	0.068	1.781	0.075	0.123
UI	<—	SI	0.512	0.099	5.202	***	0.533	0.544	0.071	7.637	***	0.645
UI	<—	FC	0.115	0.134	0.855	0.393	0.107	0.044	0.087	0.506	0.613	0.046
UI	<—	TR	0.148	0.079	1.872	0.061	0.196	0.048	0.071	0.675	0.5	0.058
UI	<—	RI	0.02	0.051	0.387	0.699	0.025	-0.089	0.048	-1.847	0.065	-0.12

The differences between respondents with and without prior crowdfunding experience are reported in Table 11. While only social influence (SI) had a direct effect on use intention (UI) in the experienced group, both social influence (SI) and effort expectancy (EE) had significant effects among the inexperienced group. In terms of moderating effects, while both perceived trust (TR) and perceived risk (RI) of a platform had significant effects in the experienced group, in the case of the inexperienced group, only perceived trust (TR) had an effect. In addition, performance expectancy (PE) was not found to have a significant effect in either group.

Table 11 Result of Moderating effects (Experience)

			Experienced					Not experienced				
			Estimate	S.E.	C.R.	P	Standardize Estimate	Estimate	S.E.	C.R.	P	Standardize Estimate
PE	<—	TR	0.196	0.052	3.75	***	0.308	0.224	0.058	3.876	***	0.33
PE	<—	RI	-0.105	0.043	-2.422	0.015*	-0.195	-0.019	0.067	-0.284	0.777	-0.025
UI	<—	PE	0.034	0.074	0.46	0.645	0.033	-0.119	0.069	-1.727	0.084	-0.104
UI	<—	EE	0.044	0.072	0.606	0.544	0.053	0.134	0.066	2.02	0.043*	0.151
UI	<—	SI	0.447	0.079	5.667	***	0.577	0.603	0.084	7.192	***	0.66
UI	<—	FC	0.024	0.106	0.228	0.819	0.029	-0.029	0.094	-0.312	0.755	-0.029
UI	<—	TR	0.104	0.078	1.33	0.184	0.157	0.054	0.068	0.789	0.43	0.07
UI	<—	RI	0.031	0.038	0.816	0.415	0.056	-0.152	0.064	-2.381	0.017*	-0.175

5. Conclusion

Based on the analysis results of an online survey, we have found that social influence, effort expectancy, and perceived trust had significant effects on the use intention of backers for crowdfunded appropriate technology projects. Of these factors, social influence—the degree of influence exerted by an individual's peer or reference group—was found to have the greatest effect on backing for the crowdfunded appropriate technology project. The decision to back a crowdfunded appropriate technology project is not only heavily influenced by an individual's reference groups, it also has the potential to induce the participation of further acquaintances via the funding platform and social networks. Because the interpersonal networks on SNS tend to be formed around closely related acquaintances, users observing the backing activities of their acquaintances are able to participate in crowdfunding with a higher degree of trust [18]. Therefore, encouraging more online exposure and promotion from the early stages of funding would enable more effective implementation of crowdfunding efforts.

In contrast to many previous studies, in this study, the performance expectancy of crowdfunded appropriate technology projects was not found to have a significant effect on use intention. This result is because, unlike in the case of general crowdfunding, backers of crowdfunded appropriate technology projects tend to participate out of altruistic motives, such as donation/sponsorship, rather than investment motives [36]. Backers of crowdfunding efforts for similar types of projects—such as arts and culture projects—have been found to conceive of their own participation along the lines of donation/sponsorship rather than the simple purchase/consumption of goods or contents [14]. Therefore, participation in crowdfunding for appropriate technology projects, which are characterized by their non-profit nature and focus on the public good, may rightly be understood as an extension of donation or sponsorship behavior. In addition to the nature of the project, the stakeholder structure of appropriate technology projects, wherein the investor/backer is separate from the beneficiary (i.e., user of the appropriate technology), may explain why performance expectancy has no significant effect.

Regarding how the trust and risk associated with a crowdfunding platform directly influence use intention, only the users' perceived trust was found to have a significant effect in this study. This may be attributable to the fact that the investment contributed by individuals to crowdfunded appropriate technology project are relatively small and thus, users are less sensitive to risk than other crowdfunding[13, 26]. This interpretation is supported by the actual survey results, where the median value of respondents' willingness to invest in a crowdfunded appropriate technology project was roughly 30,000 KRW.

For appropriate technology to be sustainable, it is necessary to utilize mid-to-high grade technology that reflects local needs, which must be adequately backed by the provision of stable sources of funding [4, 5, 7]. Crowdfunding has already seen active use as an alternative means of funding for arts/culture projects and business startups [9, 21]. Crowdfunding represents a very promising alternative in that it not only addresses the matter of funding, but also raises wider awareness about the need for appropriate technology through the interpersonal networks of the participating backers. Crowdfunding is also an advantageous tool in that it can play the role of an OSAT platform, which, through promotion activities, can attract the external technologies and diverse external talent necessary for successful implementation of sustainable appropriate technology [22].

In this study, we have analyzed the key influencing factors behind crowdfunding projects as a tool for realizing sustainable appropriate technology. We have found that crowdfunding for appropriate technology is closer in nature to donations than other crowdfunding is, and that user intentions were more heavily influenced by the participation of close acquaintances than the expected utility that might be realized through appropriate technology. Therefore, for the activation of crowdfunding for appropriate technology, there is a need to strategically encourage active online exposure among backers on social networks from the earliest stages of funding efforts. Furthermore, addressing effort expectancy issues, such as improving the convenience of the platform, would establish transparency regarding expenses and project implementation, making crowdfunding a useful alternative as a means of funding, promoting, and communicating appropriate technology.

This study was conducted using online survey responses. Due to the online nature of the survey, this study is limited in that the sample had a heavy concentration of relatively younger respondents in their 20s and 30s, with insufficient observations of older respondents over 60 years of age. There is a need for further studies to include older respondents in their analysis in order for the research results to be more representative. Prior to the survey, respondents were given explanations about the concepts of crowdfunding and appropriate technology—however, it was difficult to assess whether these explanations were sufficient for the comprehension of the respondents. Therefore, there is a need to consider diversifying the data collection methods beyond online surveys in future studies. Finally, in the case of research about crowdfunding for public projects whose beneficiaries and benefactors are not the same—such as appropriate technology—analyses based on the UTAUT and TAM are somewhat limited in analyzing the more detailed internal motives of users. Because altruistic factors have stronger influence on participation intention in the case of public projects, it is

necessary to develop a research model that reflects these factors in order to analyze needs for public services and technologies.

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