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Crowdfunding as an Alternative Means for Funding Sustainable Appropriate Technology: Acceptance Determinants of Backers

Younghwan Moon and Junseok Hwang *

Technology Management, Economics and Policy Program, Seoul National University, Seoul 08826, Korea; ket17@snu.ac.kr

* Correspondence: junhwang@snu.ac.kr; Tel.: +82-2-880-8386

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Abstract: The research and development as well as the propagation of sustainable, appropriate technology requires the availability of stable funding. Crowdfunding is a form of funding whereby small sums of investments or contributions are collected from the general public and used to finance the development of goods or services. This method has been widely used in the arts and cultural fields and presents a useful alternative means by which to fund appropriate technology projects. The aim of this study is to identify the factors that influence backers who participate in appropriate technology projects through crowdfunding platforms, analyze the connections among these factors, and thereby establish the usefulness of crowdfunding as a viable new funding alternative. Results indicate that the key factors influencing user intention to crowdfund appropriate technology projects include social influence, effort expectancy, and perceived trust. In comparison to the findings of previous studies, performance expectancy was not found to have a significant effect. When compared to crowdfunding conducted in other fields, these results suggest that crowdfunding for appropriate technology is closer in nature to donations. Accordingly, for funding of these projects to be successful, aggressive online exposure using the social network service (SNS) of backers should be pursued from the earliest stages of funding.

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

1. Introduction

Appropriate technology refers to technology that is appropriate for local environmental, cultural, and economic circumstances at a specific time and place; such technology has a 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 inadequacies within then-current economic policies which 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 considerable attention in the 21st century as a framework for Official Development Assistance (ODA) in the fight against poverty and unemployment in developing nations [3].

Appropriate technology presents both various difficulties and 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 comprising one-off efforts in which the technology is abandoned once the project ends [4,5]. This is often a result of a lack of factors necessary for research and development as well as the 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; such technologies should create additional value via markets. Furthermore, additional diverse sources of funding beyond government assistance should be secured [4,7].

Crowdfunding refers to activities wherein donations or investments are collected from the public via such platforms as social networks to fund a 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 an automatic response system (ARS), crowdfunding is not constrained by geography. Additional advantages include the ability to utilize diverse interpersonal networks via social network service (SNS). Furthermore, it is relatively more efficient, in that the funding process requires low intermediary costs (e.g., wages or promotion costs). As a result of these strengths, crowdfunding has emerged as an alternative means of funding among projects for non-profit causes, cultural or artistic projects, experimental technologies, and startups that are unable to access traditional methods of financing, such as bank loans and stock issues [9].

Crowdfunding strengthens sustainable appropriate technology projects not only as a means of funding but also through the promotion of such projects through social networking services as well as advocate relevant technologies and knowledge exchanges through a funding platform. Although a variety of groups are currently attempting to find funding for appropriate technology projects via crowdfunding, structural approaches regarding such efforts are absent in the literature. In particular, because crowdfunding for appropriate technology is closer in nature to donations than to investments 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 study analyzes the factors that influence a prospective investor's intention to participate in appropriate technology crowdfunding projects, and to identify the possibility of crowdfunding as a means of self-financing. The paper is organized as follows. Section 2 presents a literature review in which the concepts of appropriate technology and crowdfunding are defined. In Section 3, we present the research model, define its variables, and propose our research hypotheses. In Section 4, we analyze our research model using survey response data, and, finally, we discuss the implications of our findings as well as the study's limitations in Section 5.

2. Theoretical Background

2.1. Appropriate Technology

Appropriate technology is broadly defined as technology that is appropriate for the local environmental, cultural, and economic circumstances within a certain time and place [1,2]. This approach emphasizes the appropriate use of existing technology and resources to strengthen the productive capacities of local communities and to 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, national governments, and the international community before declining during the 1980s. However, in the 2000s, it has received renewed attention as a useful means through which MDG objectives may be realized [3].

The 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. In his definition of appropriate technology, Bakker [10] included any technology that has a positive influence on basic human needs; in contrast, Abdullalli [11] viewed appropriate technology as that which guaranteed the appropriateness of technology for the welfare of 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 as well 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 part of ODA projects.

2.2. Challenges of Sustainable Appropriate Technology

The development and propagation of appropriate technology present various difficulties. In addition to the development-related issues encountered in pursuing appropriate technology, Zelenika and Pearce [5] have pointed to financial as well as organizational issues as additional sources of difficulty. Smillie [6] 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 to tackle certain social challenges. Several cases have been limited to low-grade technologies that were considered appropriate for local communities. Although such technologies are easy to develop and implement, they are less conducive to the development of follow-up technologies and are untested in terms of performance. For this reason, many appropriate technology projects become one-off affairs in practice and have failed to make new products and services available in the marketplace [4,5].

To secure the sustainability of appropriate technology movements, changes must be made in terms of both 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. Such technologies demand sufficient levels of funding [5]. Ultimately, appropriate technologies must not only be able to address challenges in local communities but they should be able to create additional value via markets and business models. This necessitates 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 the public via such platforms as social networks to fund a variety of projects [8]. Specifically, crowdfunding has been defined as online community activities conducted for the purpose of securing commitments from non-expert members of the general public for donations, sponsorships, and investment. This definition can be found in the proposed amendment to the enforcement decree of the Financial Investment Services and Capital Markets Act (2015), whose purpose it is to activate investment and protect investors in manufacturing, cultural content, and intellectual services [13,14].

Although crowdfunding traces its roots to donation activities in which contributions are collected from numerous individuals, it is different from general fundraising activities [15]. As implied by its etymology, a compound of "crowd" and "funding," the term derives from the active support of "crowds" via social network platforms [16,17]. In comparison 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 raise funds through the use of social networks [18,19]. Either implicitly or explicitly, backers make their contributions known via social networks, thereby informing their acquaintances about the causes or projects they are backing. This, in turn, encourages the participation and backing of members of their social networks. Because fundraising through interpersonal networks within SNS is based on trusted relationships among friends, colleagues, family members, and other acquaintances, it is more conducive for encouraging participation [18,20,21].

Reward-based crowdfunding is a specific form of crowdfunding, often used to sponsor cultural activities and public projects, through which backers or investors receive non-monetary rewards such as concert or art performance tickets or inclusion on a public list of contributors [22]. Reward-based 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 [9,23]. In the U.S. and Europe, reward-based crowdfunding has been propagated in the form of small investments by crowds for films and music recordings [17].

Reward-based crowdfunding has also been applied in public projects. The City of London has been actively utilizing crowdfunding in urban renewal projects since 2015. Citizens or community organizations propose business plans to funding platforms to improve spaces and local environments throughout the city. Citizens can contribute to the projects they want; if and when the target amount of funding is met, the project is started with financial input from the city. This method is useful not only for solving financial problems in public projects but also to encourage spontaneous participation from citizens [24]. In this study, we focus on reward-based crowdfunding rather than equity-based crowdfunding, which is mainly aimed at startups and small businesses.

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 appropriate technology projects currently in development in Korea receive government assistance as a part of ODA projects for developing countries. However, an increasing number of projects have realized that funding via government ODA provisions and non-profit organizations is 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; however, crowdfunding platforms specializing in appropriate technology, such as Kopernik, seek out the technological needs of local non-profit organizations, establish connections among them and suppliers of appropriate technology, and subsequently provide funding via crowdfunding. In a study of the School for Cultural Heritage through Map Exploitation project implemented in Albania, Dollani et al. [23] found that crowdfunding was effective in sourcing necessary funds, conducting promotional activities, and encouraging active participation. In addition, in a case study of Open Source Appropriate Technology (OSAT), Zelenika and Pearce [25] found that crowdfunding through platforms such as Indiegogo and Kickstarter could be used as a standalone means of funding distinct 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 research and development efforts of appropriate technologies.

However, the 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 significantly behind the overall funding success rate of crowdfunded projects of 52%, as surveyed by Korea's Financial Services Commission in 2017, and is even lower than the 27% success rate among cultural/arts projects, the most similar category of crowdfunding projects. Despite such low rates of success, there is a marked lack of research on the activation of investment in

crowdfunding for appropriate technology in comparison to other projects, such as financial, cultural, 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 issues and low-grade technology, not to mention the required diversity of knowledge and participation for the research and development process as well as a 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 it would also contribute to the more effective development of appropriate technology through the exchange of technology, knowledge, and the encouragement of wider participation via SNS.

Accordingly, we aim to analyze the factors that influence participation of and funding by 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 the identification of determinants which affect backing intention within the ecosystem comprising the crowdfunding platform, prospective backers, proponents of appropriate technology projects, and the projects' beneficiaries. Furthermore, we 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

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 to analyze the factors that influence backers of crowdfunded appropriate technology projects. The UTAUT model is derived from the theory of reasoned action (TRA) based on social psychology. Fishbein and Ajzen [26] suggest in TRA that attitudes toward behavior and subjective norms influence behavioral intention and often can lead to specific behaviors. TRA provides the rationale that certain behaviors, such as technology acceptance, can be predicted by understanding the factors that influence a user's behavioral intentions. On the basis of TRA, Davis and Bagozzi [27] suggest a technology acceptance model (TAM) which explains the reasons for adopting new technologies and information systems using two factors: perceived usefulness and perceived ease of use. However, the TAM model is limited in its application to specific details and it is difficult to analyze any correlation in an information technology context [28]. To overcome these limitations, Venkatesh and Morris [29] proposed the UTAUT model by integrating eight theories and models related to technology acceptance, such as TRA, TAM, the theory of planned behavior (TPB), and innovation diffusion theory (IDT). In the UTAUT model, individual behavior intention is influenced by several key factors: performance expectancy, effort expectancy, social influence, and facilitating conditions. It is also moderated by a user's gender, age, experience, and voluntariness of use [29,30]. The UTAUT model has been widely used in research on user acceptance of new information technology and new media. In this study, we analyze the factors affecting a backer's intention to contribute to appropriate technology crowdfunding projects based on the UTAUT model.

As shown in Figure 1, a crowdfunding project broadly comprises three components: a project proponent, a platform that provides information to backers and delivers the collected funds, and backers who make investment decisions related to the proposed project. Crowdfunded appropriate technology projects often have a different set of stakeholders than crowdfunded projects, particularly arts and cultural projects or those related to new technologies. Whereas backers in

general crowdfunding projects might look for 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 the increased availability of an appropriate technology to the residents of developing countries. This structural difference implies that the backing for an appropriate technology project may be closer in nature to a donation than an 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.

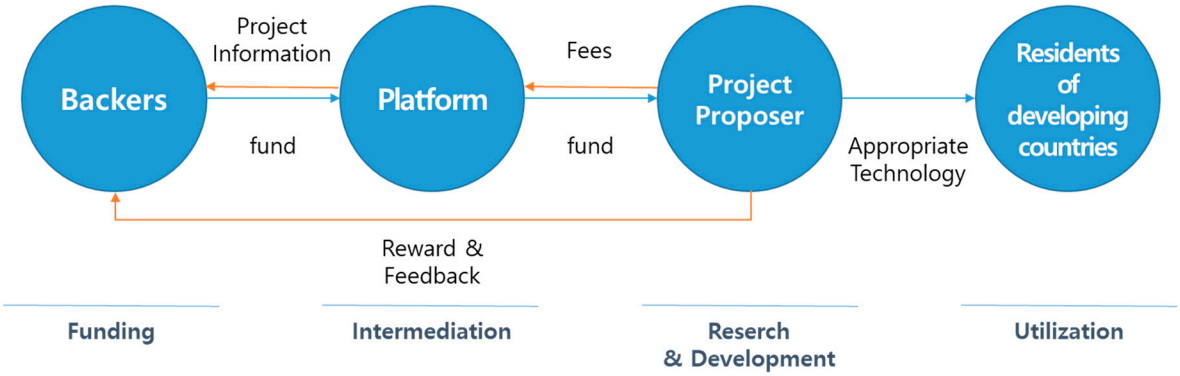

Figure 1. Stakeholders of a Crowdfunded Appropriate Technology Project.

3.2.2. Variable Definitions and Hypothesis Development

Performance expectancy (PE) refers to the extent of improvement in performance which one expects to observe as a result of the use of specific new information or technology [29]. 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 the project. A backer's expectations of the satisfaction that will be derived as a result of the crowdfunded project has a significant effect on their intention to participate and may also directly lead to their continued participation [31]. In addition to satisfaction, direct rewards have been found to directly influence participation intentions; concurrently, high performance expectancy has been found to influence participation intentions positively [32–34]. In view of this discussion, we propose the following hypothesis for the purposes of this study:

Hypothesis 1 (H1). *Users' performance expectancy has a positive effect on crowdfunding use intention.*

Effort expectancy (EE) refers to the perceived extent of convenience presented by the use of some new information or technology [29]. In this study, we define effort expectancy as the ease with which 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 [32,34]. Thus, we propose the following hypothesis:

Hypothesis 2 (H2). *Users' effort expectancy has a positive effect on crowdfunding use intention.*

Facilitating conditions (FC) refer to the extent to which users perceive that the infrastructure and organization are sufficiently in place to facilitate the use of information systems [29]. In this study, we define facilitating conditions as the perceived availability of organizational and technological infrastructure that supports the use of the crowdfunding platform, e.g., a customer center or payment systems. Earlier studies have stated that the official feedback channels of crowdfunding platforms contribute to facilitating user participation; however, inadequate information and statistical systems

regarding the funds raised often presents obstacles to the activation of crowdfunding efforts [35]. On this basis of this discussion, we propose the following hypothesis:

Hypothesis 3 (H3). *Users' facilitating conditions have a positive effect on crowdfunding use intention.*

Social influence (SI) refers to the extent to which the user believes that important people advocate the use of new information technology by individuals. This concept is similar to that of the subjective norm, which refers to the extent of influence that important persons have on an individual's behavior [29,30]. 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 [36]. In particular, during the early stages of funding, the social capital of the project proponent, which includes close friends, is considered an important positive factor on the successful implementation of projects [15,37]. In addition to the social capital available to the project proponent, a peer effect exists in which backers and their acquaintances mutually influence one another. The resulting social influence ultimately influences the investment behavior of crowdfunding users [32,38]. In view of these considerations, we set the following hypothesis:

Hypothesis 4 (H4). *Users' social influence has a positive effect on crowdfunding use intention.*

In this study, we examine how the perceived risk (RI) and perceived trust (TR) 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 ethics) 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 a similar significant effect on investment intention as well as a positive influence on participation intention as for other forms of e-commerce [33,39]. Gerber and Hui [40] identified a platform's transparency and level of trust, established through post-management systems, as key factors behind crowdfunding success; additionally, they found that lack of trust represents an obstacle to user participation. In view of these points, we propose the following hypotheses:

Hypothesis 5 (H5). *Users' perceived trust has a positive effect on the performance expectancy of crowdfunding.*

Hypothesis 6 (H6). *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 and/or indirect effect on participation intention [13,41], others have countered that perceived risk has no effect on user intention because most crowdfunding users who make investments in small sums perceive a lesser degree of risk [32]. To ascertain how perceived risk influences user intention, we set the following hypotheses in this study:

Hypothesis 7 (H7). *Users' perceived risk has a negative effect on performance expectancy.*

Hypothesis 8 (H8). *User's perceived risk has a negative effect on use intention.*

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

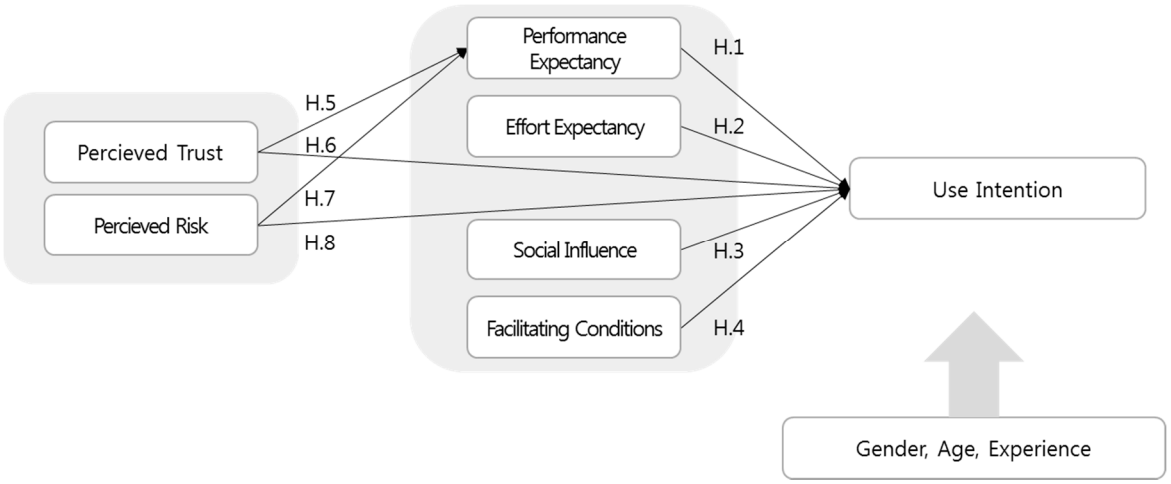

Figure 2. Research Model and Hypotheses.

4. Analysis Results

4.1. Data Description

An online survey was conducted for this study comprising for 425 people of the general public in Korea during 9–14 November 2017. The demographic characteristics of the respondents are summarized in Table 1. There were 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, individuals between 20 and 40 years old account for roughly 90% of all respondents. Only two respondents were between 60 and 69 years old; this low number is attributed to the e-mail format of the survey, a technology which may be unfamiliar to elderly people. Most respondents had educational backgrounds that included either a partial or completed college education (93.88%). The occupations of the respondents included 228 management and office workers, 60 students, 53 professionals, 35 full-time housewives, 24 production workers, 14 unemployed, 9 self-employed, and 2 others. About half (213) 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; 114 were willing to invest sums of 100,000 KRW or more.

Table 1. Demographic and social statistics of respondents.

Demographic and social variables	Features	Frequency	Percentage
Gender	Male	207	48.71%
	Female	218	51.29%
Age	10′s (10~19)	9	2.12%
	20′s (20~29)	149	35.06%
	30′s (30~39)	137	32.24%
	40′s (40~49)	93	21.88%
	50′s (50~59)	35	8.24%
	60′s (60~69)	2	0.47%
Education	Middle school graduation	1	0.24%
	High school graduate	25	5.88%
	College or graduation	44	10.35%
	University or graduation	292	68.71%
	Graduate school or graduation	63	14.82%
Occupation	Students	60	14.12%
	Management/office work	228	53.65%
	Professionals	53	12.47%
	Production work	24	5.65%
	Full-time housewife	35	8.24%
	Self-employed	9	2.12%
	Unemployed	14	3.29%
	Others	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. Survey Questionnaire and Descriptive Statistics

The independent variables of the UTAUT model employed in this study included performance expectancy, effort expectancy, social influence, facilitating conditions, perceived trust, and perceived risk. The dependent variable was use intention for a crowdfunded appropriate technology project. Performance expectancy was included both as an independent variable and as a mediating variable between perceived trust and perceived risk. The questionnaire for measuring each variable was constructed with reference to the variable definitions and hypothesis development described in Section 3.2.2 and as shown in Table 2. The questionnaire items were measured using a 5-point Likert scale (strongly disagree [1], disagree [2], neutral [3], agree [4], strongly agree [5]), and the descriptive statistics of the questionnaire measurements are shown in Table 3.

Table 2. Variables and Survey Questions.

The Variables Measurement		Survey Question	Reference
Performance Expectancy (PE)	PE1	The use of appropriate technology would be useful for improving the quality of life of people in developing countries.	[29,31–34]
	PE2	Using appropriate technology will increase productivity and income in developing countries.	
	PE3	Appropriate technology will make the lives of the people in developing countries more convenient.	
	PE4	Appropriate technologies will provide new educational and career opportunities for people in developing countries.	
Effort Expectancy (EE)	EE1	It is likely to be easy to invest and sponsor an appropriate technology project using crowdfunding.	[29,32,34]
	EE2	It is likely to be easy to learn to invest and sponsor an appropriate technology project using crowdfunding.	
	EE3	Investing and sponsoring appropriate technology projects through crowdfunding is likely to be straightforward and easy to understand.	
	EE4	It is likely to be easy to invest and sponsor proficient technology projects using crowdfunding	
Social Influence (SI)	SI1	People around me seem to be encouraging me to sponsor and invest in appropriate technology crowdfunding projects.	[15,29,30,32,36–38]
	SI2	Most of the people who are important to me will want to invest in and support the appropriate technology crowdfunding project.	
	SI3	My friends are likely to follow if they encourage investing in and sponsoring an appropriate technology crowdfunding project.	
	SI4	People around me are likely to give me advice and help in investing and sponsoring an appropriate technology crowdfunding project.	
Facilitating Conditions (FC)	FC1	The crowdfunding platform (Wadiz, Happy Bean, etc.) will be able to give me enough technical help to solve the problems that have arisen when I invest in and sponsor an appropriate technology project.	[29,35]
	FC2	The crowdfunding platform (Wadiz, Happy Bean, etc.) will have (or have) enough payment systems to invest in and sponsor appropriate technology projects.	
	FC3	Crowdfunding platforms (Wadiz, Happy Bean, etc.) will be building channels (mail, chat, bulletin boards) to communicate with the appropriate technical project manager.	
	FC4	The crowded funding platform (Wadiz, Happy Bean, etc.) will have sufficient knowledge and experience in sponsoring and investing in appropriate technology projects.	
Perceived Trust (TR)	TP1	I think the manager of appropriate technology-related crowdfunding platform will monitor and supervise well whether the proponents have been working as originally planned.	[33,39,40]
	TP2	I think that the manager of appropriate technology related crowdfunding platform has well evaluated the competence and reliability of proposers in advance.	
	TP3	I think the manager of appropriate technology related crowdfunding platform will do well post-management, including feedback, even after the proposed technology project is complete.	
Perceived Risk (RI)	RP1	I am doubtful that the technology and products that are developed through the investment and sponsorship of appropriate technology crowdfunding will function properly.	[32,41,42]
	RP2	I believe that investment and sponsorship of appropriate technology crowdfunding will result in poor quality of technology and products.	
	RP3	I am doubtful that the technology and products that are developed through investment and sponsorship of appropriate technology crowdfunding will increasing quality of life of people in the developing world.	
Use Intention (UI)	UI1	I will (or have a willingness to) invest and sponsor the appropriate technology crowdfunding.	[29,30,34]
	UI2	I would encourage (or would like to encourage) people around me to invest and sponsor the appropriate technology crowdfunding.	
	UI3	I will (or have a willingness to) invest and sponsor the appropriate technology crowdfunding regularly.	
	UI4	I will (or have a willingness to) invest and sponsor the appropriate technology crowdfunding within a year.	

Table 3. Descriptive Statistics of the Variables.

The Variables	Measurement Variable	N	Min	Max	Average	Standard Deviation
Performance Expectancy (PE)	PE1	425	1.0	5.0	4.278	0.6538
	PE2	425	1.0	5.0	4.120	0.6814
	PE3	425	1.0	5.0	4.132	0.6417
	PE4	425	1.0	5.0	4.195	0.6530
Effort Expectancy (EE)	EE1	425	1.0	5.0	3.616	0.7562
	EE2	425	1.0	5.0	3.671	0.7615
	EE3	425	1.0	5.0	3.725	0.7378
	EE4	425	1.0	5.0	3.612	0.7538
Social Influence (SI)	SI1	425	1.0	5.0	3.271	0.8631
	SI2	425	1.0	5.0	3.264	0.8362
	SI3	425	1.0	5.0	3.428	0.8214
	SI4	425	1.0	5.0	3.372	0.8650
Facilitating Conditions (FC)	FC1	425	1.0	5.0	3.605	0.7517
	FC2	425	1.0	5.0	3.680	0.7341
	FC3	425	1.0	5.0	3.496	0.7652
	FC4	425	1.0	5.0	3.546	0.7545
Perceived Trust (TR)	TP1	425	1.0	5.0	3.313	0.8431
	TP2	425	1.0	5.0	3.384	0.8133
	TP3	425	1.0	5.0	3.273	0.8773
Perceived Risk (RI)	RP1	425	1.0	5.0	3.452	0.8595
	RP2	425	1.0	5.0	2.861	0.8992
	RP3	425	1.0	5.0	2.993	0.9278
Use Intention (UI)	UI1	425	1.0	5.0	3.334	0.7080
	UI2	425	1.0	5.0	3.172	0.8016
	UI3	425	1.0	5.0	3.096	0.7995
	UI4	425	1.0	5.0	3.245	0.8363

4.3. Results of Factor Analysis

Prior to an analysis of the structural equation for the study model, we conducted a factor analysis to statistically confirm that the questionnaire items (measurement variables) explained each construct included in the research model. We conducted a confirmatory factor analysis to evaluate whether the variables defined and established through previous research were suitably clear through the questionnaire items. We used SPSS 23 and AMOS 18 to conduct a factor analysis on each of the measurement variables (questionnaire items) to construct the model's variables based on the survey responses. As summarized in Table 4, seven variables were extracted. The structure matrix in Table 5 shows how the measurement variables are grouped. Table 6 reports the correlation matrix of the variables that were extracted.

Table 4. Total Variance Explained by Factor Analysis.

Factor	Initial Eigenvalue			Extraction Sum of Squared Loading			Rotation Sum of Squared Loading
	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	0.632	2.431	74.601				
9	0.578	2.224	76.825				
10	0.539	2.072	78.897				

Table 5. Structure Matrix of Factor Analysis.

Measurement Variable	Factor						
	1	**2**	**3**	**4**	**5**	**6**	**7**
PE1	0.153	0.824	−0.194	0.075	−0.291	−0.281	0.086
PE2	0.244	0.830	−0.097	0.179	−0.344	−0.324	0.188
PE3	0.243	0.852	−0.121	0.172	−0.360	−0.213	0.178
PE4	0.308	0.811	−0.130	0.139	−0.350	−0.277	0.206
EE1	0.388	0.374	−0.105	0.156	−0.846	−0.274	0.343
EE2	0.315	0.303	−0.016	0.091	−0.852	−0.300	0.318
EE3	0.331	0.355	−0.023	0.109	−0.856	−0.310	0.270
EE4	0.368	0.333	−0.036	0.217	−0.877	−0.335	0.331
SI1	0.829	0.248	−0.076	0.227	−0.375	−0.296	0.528
SI2	0.874	0.178	−0.058	0.329	−0.298	−0.279	0.468
SI3	0.821	0.286	−0.116	0.247	−0.398	−0.287	0.551
SI4	0.821	0.252	0.006	0.356	−0.340	−0.243	0.493
FC1	0.422	0.341	−0.089	0.333	−0.429	−0.664	0.373
FC2	0.204	0.333	−0.086	0.055	−0.340	−0.768	0.115
FC3	0.281	0.203	−0.105	0.460	−0.235	−0.818	0.329
FC4	0.373	0.259	−0.148	0.441	−0.298	−0.781	0.326
TP1	0.353	0.199	−0.149	0.875	−0.197	−0.362	0.288
TP2	0.322	0.179	−0.263	0.868	−0.194	−0.326	0.362
TP3	0.419	0.259	−0.158	0.865	−0.256	−0.379	0.418
RP1	−0.066	0.000	0.815	−0.268	−0.026	0.061	−0.146
RP2	−0.083	−0.244	0.832	−0.078	0.124	0.079	−0.044
RP3	−0.044	−0.168	0.866	−0.145	0.039	0.180	−0.104
UI1	0.516	0.227	−0.134	0.230	−0.405	−0.258	0.872
UI2	0.595	0.185	−0.134	0.334	−0.311	−0.256	0.801
UI3	0.530	0.120	−0.030	0.411	−0.271	−0.219	0.868
UI4	0.496	0.184	−0.088	0.253	−0.336	−0.268	0.888

Table 6. Correlation Matrix of Factor Analysis.

Factor	**1**	**2**	**3**	**4**	**5**	**6**	**7**
SI	10.000	0.266	−0.063	0.330	−0.393	−0.304	0.575
PE	0.266	10.000	−0.155	0.137	−0.397	−0.311	0.173
RI	−0.063	−0.155	10.000	−0.165	0.048	0.113	−0.102
TR	0.330	0.137	−0.165	10.000	−0.140	−0.314	0.337
EE	−0.393	−0.397	0.048	−0.140	10.000	0.342	−0.349
FC	−0.304	−0.311	0.113	−0.314	0.342	10.000	−0.262
UI	0.575	0.173	−0.102	0.337	−0.349	−0.262	10.000

The internal reliability of the measurement variables (questionnaire items) used to construct the model variables are reported in Table 7. Cronbach's α for all variables exceeded 0.7, indicating that the questionnaire items consistently measured the variables. To establish the validity of the variables, we conducted a confirmatory factor analysis to assess the average variance extracted (AVE) and construct reliability (CR). Results showed all AVE values were greater than 0.5 and a CR exceeded 0.7, indicating a sufficient degree of convergent validity.

Table 7. 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
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

4.4. Analysis Results

4.4.1. Baseline Model

We conducted structural equation modeling to test the hypotheses. Structural equation modeling is a combination of path analysis and factor analysis, which makes it possible to infer causal relationships between variables in situations where experimental research is difficult or impossible [43]. In this study, the AMOS 18 program was used to analyze the research models in Figure 2.

As reported in Table 8, the goodness-of-fit for most models met the recommended standards, thereby indicating that the models were valid for analyzing the relationships between the measurement factors.

Table 8. Baseline Model Goodness of Fit.

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 = 0.000	0.042	0.053	0.893	0.898	0.932	0.941

The estimation results from SEM in this study are reported in Table 9 and can be seen in Figure 3. Of the seven measurement factors included in the research model, we found that the independent variables social influence (SI), effort expectancy (EE), and perceived trust (TR) each had significantly positive effects on the dependent variable, i.e., 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 9. Result of Baseline Model.

			Estimate	S.E.	C.R.	P	Standardize Estimate
PE	<—	TR	0.21	0.038	5.484	***	0.32
PE	<—	RI	−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	<—	TR	0.104	0.052	1.997	0.046 *	0.133
UI	<—	RI	−0.033	0.034	−0.964	0.335	−0.043

Table 10 summarizes the results of the test of each hypothesis based on the estimation results. H1 and H3, which predicted users' performance expectancy and facilitating conditions positively affecting use intention, were not supported. On the other hand, effort expectancy and social influence

were found to have significantly positive effects on use intention, thereby supporting H2 and H4. The perceived trust had a significantly positive influence on both performance expectancy and use intention, supporting H5 and H6. On the other hand, although perceived risk had a significantly negative effect on performance expectancy, it had no significant effect on use intention. Therefore, only H7 was supported.

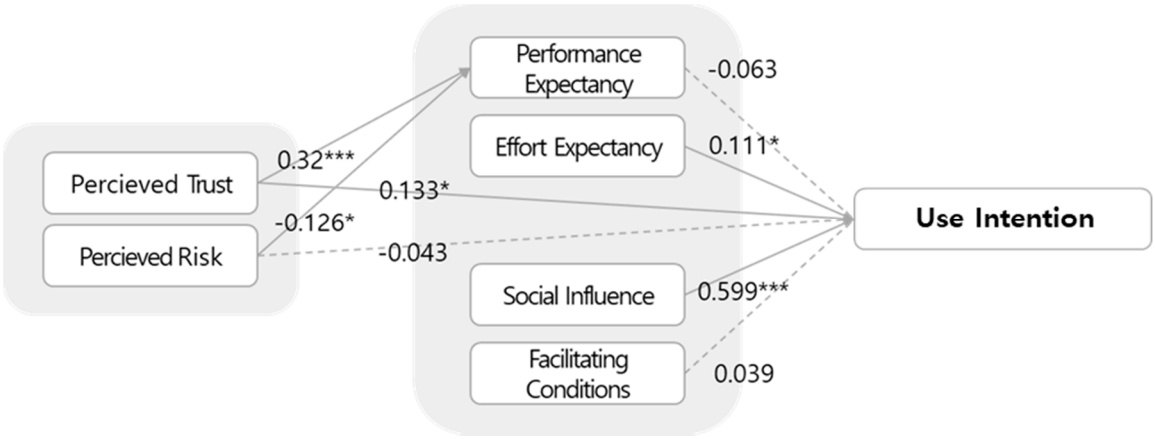

Figure 3. Results of Baseline Model Analysis.

Table 10. Results of the 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. Users' perceived trust has a positive effect on the performance expectancy of crowdfunding.	supported
H6. Users' perceived trust has a positive effect on crowdfunding use intention.	supported
H7. Users' perceived risk has a negative effect on performance expectancy.	supported
H8. User's perceived risk has a negative effect on use intention.	Not supported

4.4.2. Effects of Moderating Variables

The effects of the moderating variables in the model were examined through variables such as the respondent's gender, age, and prior experience with crowdfunding. The gender variable had possible values of male/female; the prior experience variable had possible values of yes/no. Males accounted for 207 of the respondents, with females accounting for 218. The age groups of the respondents comprised of those in their 20s (149 people) and 30s (137 people), with respondents in their 40s and 50s combined into a single group (128 people). Responses by people in their teens (nine people) and in their 60s (two people) were excluded from our analysis owing to insufficient sample size. On the basis of whether they had prior experience in backing a crowdfunded project, respondents were categorized as either "experienced" (213 people) or "not experienced" (212 people). Tables 11 and 12 reports the results of the analysis of 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 11. In contrast to the results of the baseline model, the only factor that had a direct influence on use intention was social influence (SI). In comparison to 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, although 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.

Table 11. Result of Moderating Effects (Gender).

Path			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 12. Although 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 in the inexperienced group. In terms of moderating effects, although 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 12. Result of Moderating Effects (Experience).

Path			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. Conclusions

On the basis of an analysis of an online survey, we 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, i.e., the degree of influence exerted by an individual's peer or reference group, was found to have the greatest effect on backing for crowdfunded appropriate technology projects. The decision to back a crowdfunded appropriate technology project was not only heavily influenced by an individual's reference groups, it also had the potential to induce the participation of further acquaintances via the funding platform and social networks. Because the interpersonal networks on SNS tended to be formed around closely related acquaintances, users observing the backing activities of their acquaintances were 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. Unlike general crowdfunding, backers of crowdfunded appropriate technology projects tend to participate on the basis of altruistic motives, such as sympathy, rather than result-oriented motives such as investment outcome [44]. Backers of crowdfunding efforts for similar types of projects, such

as arts and cultural projects, have been found to think 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.

With regard to how trust and risk associated with a crowdfunding platform directly influences use intention, only a user's perceived trust was found to have any significant effect in this study. This may be attributable to the monetary value of investments provided by individuals to crowdfunded appropriate technology projects is relatively small; accordingly, users are less sensitive to risk than in other crowdfunding projects [13,32]. This interpretation is supported by the survey results, where the median value of a respondent's 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 need; simultaneously, it 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/cultural projects and business startups [9,23]. Crowdfunding represents a promising alternative as 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 external technologies and diverse external talent necessary for successful implementation of sustainable appropriate technology [25].

In this study, we 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, 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, to spur 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. As a result of the online nature of the survey, this study was 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. Further and more representative studies are needed which include older respondents in the analysis. Prior to the survey, respondents were provided with explanations of the concepts of crowdfunding and appropriate technology; however, it was difficult to assess whether these explanations were sufficient for the respondents to comprehend. Therefore, future studies are needed which diversify data collection methods beyond online surveys. Finally, with regard to research on 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 when analyzing the more detailed internal motives of users. Because altruistic factors have a stronger influence on participation intention in the case of public projects, it is necessary to develop a research model that reflects these factors to analyze needs for public services and technologies.

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