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ABSTRACT

Crowdsourcing marketplace as a new platform for companies or individuals to source ideas or works from the public has become popular in the contemporary world. A key issue about the sustainability of this type of marketplace relies on the effort that problem solvers expend on the online tasks. However, the predictors of effort investment in the crowdsourcing context is rarely investigated. In this study, based on the expectancy theory which suggests the roles of reward valence, trust and self efficacy, we develop a research model to study the factors influencing effort. Further, the non-linear relationships between self efficacy and effort is proposed. Based on a field survey, we found that: (1) reward valence and trust positively influence effort; (2) when task complexity is high, there will be a convex relationship between self efficacy and effort; and (3) when task complexity is low, there will be a concave relationship between self efficacy and effort. Theoretical and practical implications are also discussed.

Keywords

Crowdsourcing, expectancy theory, non-linear relationship, self efficacy, effort

INTRODUCTION

Crowdsourcing is a new outsourcing approach that takes tasks as an open call to an undefined, large group of people (Howe 2006). This approach has become more and more popular nowadays for advancing innovation, global IT outsourcing (Agerfalk and Fitzgerald 2008; Gefen and Pavlou 2006), idea competition or open innovation (e.g., where companies collect innovative ideas from customers) (Ebner, Leimeister, Bretschneider and Krcmar 2008; Leimeister, Huber, Bretschneider and Krcmar 2009), and knowledge contribution, such as Wikipedia and online question and answer sites (e.g., Yahoo! Answers) (Dutta, Roy and Seetharaman 2010).

One special crowdsourcing marketplace, which we focus on in this study, is a virtual community in which people who needs others' help to complete a task (e.g., namely seekers) can broadcast their task requirements and provide certain monetary rewards, whereas other members of the community participate in these tasks and compete for the rewards (e.g., namely solvers). Examples of this type of crowdsourcing marketplace include Amazon's Mechanical Turk and myTino.com in the USA as well as Taskcn.com and Witkey.com in China.

As the sustainability of virtual communities (e.g., Open Source Software Community, OSS) heavily relies on the persistent effort of participants (Fang and Neufeld 2009; Ke and Zhang 2009), it is important to understand the motivators and/or inhibitors determining solvers' participation effort (Sun et al. 2011; Sun et al. 2012). Specifically, three barriers inhibiting solvers' participation can be identified as follows. First, the monetary rewards provided are relatively low. For instance, in

Amazon's Mechanical Turk, the payments are around 0.1$ for most of tasks. Thus whether participants can be adequately motivated by the low payments should be concerned. Second, reward providers' opportunistic behavior is also a barrier blocking participants' continuous participation. It is reported that when some reward providers attain a satisfying solution from participants, they do not pay this participant. Instead, they register another new client as participant, submit a similar solution, and finally title themselves as winners. Thus, trust is also an important issue that needs to be addressed. Third, the competition between participants is very intensive in the crowdsourcing marketplace (Yang, Adamic and Ackerman 2008a). The participants for the tasks in Mechanical Turk are counted by thousands. This requires participants to have adequate ability to well complete the tasks. Therefore, ability concerns may influence solvers' effort investment too.

The expectancy theory (Vroom 1964) is addressed to understand the roles of these three barriers. The expectancy theory is also called as the valence-instrumentality-expectancy (VIE) model, where valence refers to the extent to which people consider the reward to be important to them, corresponding to the first barrier; instrumentality refers to the probability that high performance can lead to high reward, corresponding to the second barrier; expectancy refers to the probability that high effort can lead to high performance, corresponding to the third barrier. Therefore, expectancy theory is appropriate to explain solvers' task participation behavior.

In this study, beyond the original expectancy theory which postulates the linear relationship between VIE factors and effort, we attempt to understand the non-linear relationships in the expectancy theory, and our research interest focuses on the role of self efficacy which is found to have a more complex relationship with effort (Bandura 1982). To clearly state, our research objective is to *understand the non-linear relationship between self efficacy and effort.*

THEORETICAL DEVELOPMENT

Expectancy Theory Hypotheses

Expectancy theory is widely used to investigate working motivation (Vroom 1964). The theory proposes that when a person makes decision on whether or not to behave in a certain way, s/he goes through a whole cognitive process to consider three key motivational elements: valence, instrumentality and expectancy. These three motivational elements are embedded in three sub-processes of decision making (as shown in Figure 1).

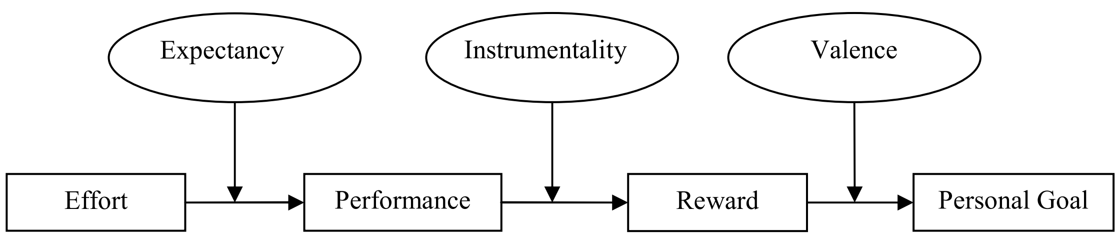

Figure 1. Expectancy Theory

The first stage is about the relationship between effort and performance: "what is the probability that I can achieve high performance if I spend much effort?" People's perception about this probability is defined as expectancy. Self efficacy is considered as the most important factor relevant to expectancy and is always used as the proxy of expectancy (Gist and Mitchell 1992).

At the second stage, people evaluate the relationship between performance and rewards: "If I achieve high performance, what is the probability that I can attain the rewards?" This probability is defined as instrumentality. In our research context, one key factor relevant to instrumentality is solvers' trust beliefs on reward providers. If solvers consider that reward providers can keep their promise, the instrumentality is high. Thus, in this study, we use trust as the proxy of instrumentality.

At the last stage, people should make judgment on the relationship between rewards and personal goals: "If I obtain the rewards, will my personal goals be satisfied?" In this study, we directly measure reward valence as the importance of gaining the monetary reward.

Based on the expectancy theory, the research model can be depicted as Figure 2. According to the expectancy theory, we propose the direct effects of reward valence and trust on effort by arguing that when reward valence and trust are high, solvers are more likely to be motivated to spend effort on the online tasks (Vroom 1964). As to the role of self efficacy, we will further discuss its non-linear effects on effort later (Bandura 1982). Thus, we propose the following hypotheses first:

H1: Reward valence is positively associated with effort.

H2: Trust is positively associated with effort.

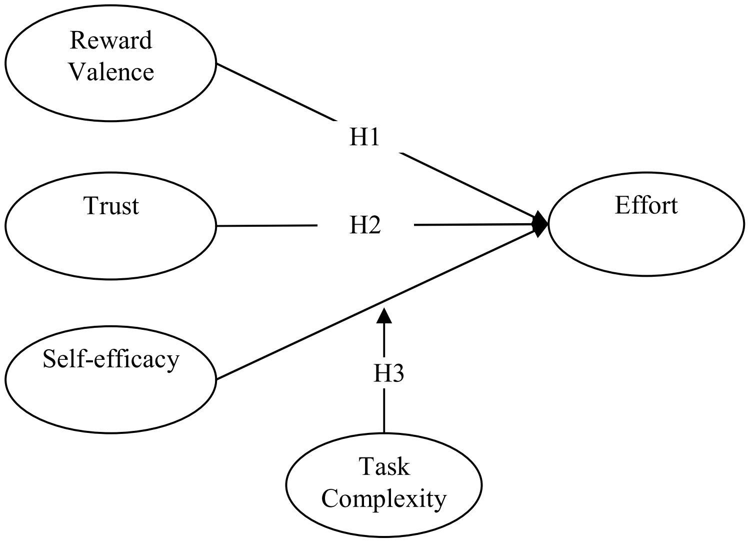

Figure 2. Research Model

Non-linear Relationship between Self Efficacy and Effort

To better understand the relationship between self efficacy and effort, we reconceptualize the role of self-efficacy by proposing an *activation-deactivation model*. In this reconceptualization, we postulate that self efficacy plays two roles according to two different mechanisms. The first role is called activation role through which people will expend more effort on the task when they feel the probability to complete the task is high due to their high ability. The second role is called deactivation role through which people will expend less effort on the task when they feel that they are so efficacious that investing much effort is not needed. According to these two mechanisms, a three-stage non-linear model of self-efficacy can be expected (see Figure 3).

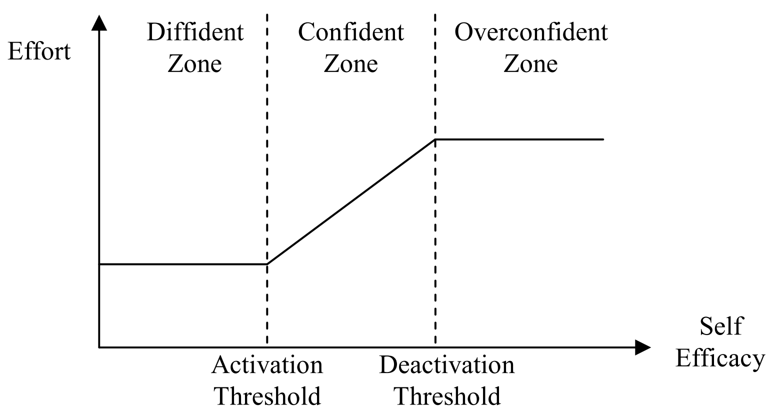

Figure 3. An Activation-Deactivation Model of Self-Efficacy

We propose that there are two thresholds setting the boundary of the linear relationship between self-efficacy and effort. The first threshold (e.g., activation threshold) determines when self-efficacy begins to exert its activation role. Before the activation threshold, people's self-efficacy is too low, limiting their effort at a very low level. The zone before the activation threshold is called as *diffident zone*.

The second threshold deactivation threshold determines when self-efficacy starts to lose its effect on effort (e.g., deactivation role). After the deactivation threshold, people will not spend more effort on the task since they believe it is not needed. The zone after the deactivation threshold is called as *overconfident zone*.

The zone between the activation and deactivation threshold is *confident zone* where following the increase of self-efficacy the expectancy to complete the task and the motivation to participate in the task increase, leading to more effort expended on the task.

Based on the activation-deactivation model of self efficacy, we further theorize that the activation and deactivation thresholds are determined by the task complexity. Specifically, when task complexity is high, people will be motivated only when a high level of self-efficacy is achieved (e.g., high activation threshold); meanwhile, when task complexity is high, completing the task requires more effort, therefore, even at a relatively high level of self-efficacy, people may still would like to spend more effort (e.g., high deactivation threshold) (Bandura 1982). In this case, the activation-deactivation model can be illustrated in different ways under different levels of task complexity (see Figure 4).

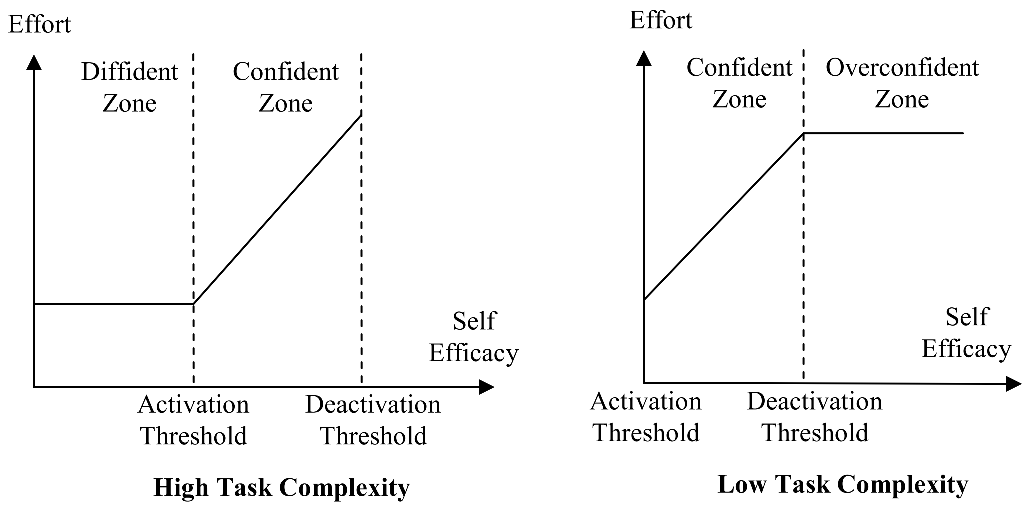

Figure 4. The Activation-Deactivation Model under Different Levels of Task Complexity

When task complexity is high, both activation and deactivation thresholds are high. An extreme situation is that the deactivation threshold is so high that the overconfident zone disappears. When task complexity is low, both activation and deactivation thresholds are low. An extreme situation is that the activation threshold is so low that the diffident zone disappears. Therefore, when task complexity is high, the relationship between self efficacy and effort can be depicted as a *convex curve* while when task complexity is low, the relationship between self efficacy and effort is illustrated as a *concave curve*.

Thus, we propose that,

H3: The nonlinear relationship between self efficacy and effort is moderated by task complexity.

H3a: A convex relationship between self efficacy and effort appears when task complexity is high.

H3b: A concave relationship between self efficacy and effort appears when task complexity is low.

METHODOLOGY

Research Setting and Participants

Data was collected through a field survey in a crowdsourcing marketplace in China where it called Witkey website. China has occupied a leading position worldwide in developing crowdsourcing marketplace due to its huge amount of labors and small and medium enterprises (SME). Taskcn.com, which is one of the most popular Witkey website in China, is believed to be a suitable research setting for examining solvers' online task participation behavior.

Although there are many types of tasks posted on Taskcn.com, such as design, programming, strategic planning, and writing (Yang, Adamic and Ackerman 2008b), we only focus on the IT-relevant tasks, i.e., the final product should be an IT artifact (e.g., an website, a program, or a computer-aided Logo design). IT-relevant tasks occupy the majority of online tasks (over 60% for Taskcn.com), and needs to be paid more attention. Thus, only solvers who have experience in the IT-related tasks are eligible for participating in the survey.

Measures

Instruments for most of constructs were adapted from prior relevant studies. Slight wording modifications were applied to fit the research context, and all measures used seven-point Likert scale. Effort is measured by three dimensions: attention, effort intensity and goal commitment (Kanfer 1991; Locke, Latham and Smith 1990). For each dimension, three items are adapted from Barrick et al. (2002). Reward valence is adapted from Sanchez et al. (Sanchez, Truxillo and Bauer 2000). The integrity dimension of trust is used to measure trust in this study. It is measured by four items adapted from McKnight et al. (2002). Self efficacy is measured by three items adapted from Kankanhalli et al. (2005).

Procedure

Taskcn.com in China was selected as the research site. Subjects were recruited by two means. First, the survey was open to voluntary participants. Interested subjects with IT design task experience could participate in the survey without invitation. Second, we sent invitation letters to 700 randomly selected participants with experience in IT design tasks. We obtained a total of 140 and 146 responses through these two channels, respectively. Among these responses, 205 usable responses were gathered. About 75% of subjects were male; 90% were around 21-35 (age); 80% with a bachelor degree; and 60% with over 4 years of computer experience.

DATA ANALYSIS

Data analysis was conducted through two stages. At the first stage, the reliability and validity of constructs were assessed to ensure the appropriateness of the measurement model. At the second stage, the hypotheses were tested using moderated multiple regression analysis (Kankanhalli et al. 2005).

Reliability and Validity

Reliability can be assessed using Cronbach's Alpha (Kankanhalli et al. 2005). A value of Alpha greater than .7 suggests a good reliability of the construct (Fornell and Larcker 1981). As shown in Table 1, alpha values for all the constructs were greater than .7, satisfying the suggested criteria.

	Mean	SD	Alpha	EFRT	RWDV	TRST	SEFC	TSKX
EFRT	5.392	1.103	.907	1.000				
RWDV	6.091	0.916	.680	.465	1.000			
TRST	4.798	1.429	.918	.352	.249	1.000		
SEFC	5.540	1.145	.864	.310	.314	.204	1.000	
TSKX	4.423	1.279	.745	.108	.026	.030	-.109	1.000

Table 1. Reliability and Correlations

Note: EFRT=Effort; RWDV=Reward valence; TRST=Trust; SEFC=Self efficacy; TSKX=Task complexity.

	1	2	3	4	5
EFTI1	**.697**	.306	.025	-.044	.228
EFTI2	**.725**	.189	.153	-.092	.152
EFTI3	**.723**	.114	.056	-.134	.197
ATEN1	**.724**	.211	.253	-.017	.197
ATEN2	**.728**	.160	.040	.037	.172
ATEN3	**.710**	-.048	.111	.236	.110
GLCM1	**.766**	.032	.184	.170	-.009
GLCM2	**.765**	.064	.059	.161	.017
GLCM3	**.728**	.087	-.039	.168	.103
TRST1	.198	**.836**	.107	.146	.059
TRST2	.191	**.823**	.009	.036	.109
TRST3	.122	**.901**	.094	.081	.081
TRST4	.111	**.905**	.108	.137	.025
SEFC1	.195	.116	**.830**	-.059	.143
SEFC2	.045	.062	**.840**	-.097	.150
SEFC3	.215	.111	**.848**	-.089	.011
TSKX1	.126	.139	-.186	**.819**	.077
TSKX2	.350	.310	-.023	**.575**	.034
TSKX3	.000	.070	-.039	**.860**	.057
RWDV1	.163	.023	.312	.138	**.677**
RWDV2	.281	.126	.183	.013	**.715**
RWDV3	.224	.098	-.090	.040	**.783**
Eigenvalue	7.320	2.953	2.400	1.644	1.301
% of variance	30.501	12.306	10.001	6.851	5.421
Cumulative %	30.501	42.807	52.808	59.659	65.081

Table 2. Loadings and Cross-Loadings

Note: EFTI=Effort intensity; ATEN=Attention; GLCM=Goal commitment; they are three dimensions of Effort.

Both the convergent and discriminant validity can be assessed using the exploratory factor analysis (EFA). When item loadings on the expected constructs are high enough, the convergent validity is achieved. When the cross-loadings are smaller than the item loadings, the discriminant validity is achieved. All the items loaded high on the expected constructs, suggesting good convergent validity. As item loadings were higher than the cross-loadings, the good discriminant validity was identified too (see Table 2).

A self-report survey, where the same subject responds to the items in a single questionnaire at the same point in time, is likely to be susceptible to the common method variance (CMV) or common method bias (CMB), which may compromise the credibility of the data analysis results (Malhotra, Kim and Patil 2006). Harman's one-factor test, a widely used method in assessing CMV/B, was performed address this issue (Podsakoff, MacKenzie, Lee and Podsakoff 2003). As shown in Table 2, the most covariance explained by one factor was 30.5%, indicating that CMV/B is not a likely contaminant of the results.

Hypotheses Tests

A hierarchical regression analysis was performed to test the hypotheses (Kankanhalli et al. 2005; Sharma, Durand and Gur Arie 1981). As shown in Table 3, three regression models were executed to test the moderated nonlinear effect of self efficacy on effort. In the first model, the main effects of the control variable task complexity and three factors (e.g., reward valence, trust, and self efficacy) were entered into the regression. The results showed that reward valence (β=.328, t=5.178) and trust (β=.170, t=2.673) had positive effects on effort, lending supports to H1 and H2. The nonlinear effects of self efficacy (e.g., the quadratic component) were considered in Model 2. The results showed that no significant nonlinear effect of self efficacy was found (β=-.019, t=-.268). In model 3, the moderating effect of task complexity was considered. The results showed that the moderated nonlinear effect of self efficacy on effort was significant (β=.187, t=2.515). Including this moderating effect made the R-square increase from .327 to .348 with the significant level of F-change p=.013.

	Model I		Model II		Model III	
	β	t	β	t	β	t
Task Complexity	.192**	3.045	.195**	3.037	.098	1.323
Reward Valence	.328**	5.178	.327**	5.162	.281***	4.308
Trust	.170**	2.673	.170**	2.659	.180**	2.847
Self Efficacy	.193**	3.054	.205**	2.690	.230**	3.032
Self Efficacy^2			.019	0.268	.049	.691
Self Efficacy^2 x Task Complexity					.187*	2.515
R^2	.326		.327		.348	
R^2 Change			.001		.021	
F Change			.072		6.327*	
*p<.05, **p<.01, ***p<.001.						

Table 3. Regression Results

To further investigate the moderated nonlinear relationship, we compared the mean value of effort under different levels of self efficacy and task complexity. As shown in Table 4, each case had two labels: one label to indicate the level of self efficacy (low vs. moderate vs. high) and one label to indicate the level of task complexity (low vs. high). Median values were used to separate these cases. According to these two labels, the whole sample was separated into six sub-groups. Then, we compared the mean value of effort under different situations. The results showed that when task complexity was high, there was a significant difference in effort between the high and moderate level of self efficacy (Δ=0.483, t=1.947) but an insignificant difference between the high and moderate level of self efficacy (Δ=0.335, t=1.541), suggesting a convex curve and supporting H3a. In contrast, when task complexity was low, there was a significant difference in effort between the low and moderate level of self efficacy (Δ=0.850, t=3.287) but an insignificant difference between the high and moderate level of self efficacy (Δ=0.049, t=.201), suggesting a concave curve and supporting H3b. The results were also illustrated in Figure 5.

	Low TSKX			High TSKX		
	Low SEFC	Moderate SEFC	High SEFC	Low SEFC	Moderate SEFC	High SEFC
Frequency	31	36	33	39	44	22
Percent (%)	15.1	17.6	16.1	19.0	21.5	10.7
Mean of Effort	4.613	5.463	5.512	5.248	5.583	6.066
Low vs. Moderate	Δ=0.850, t=3.287***			Δ=0.335, t=1.541		
High vs. Moderate		Δ=0.049, t=0.201			Δ=0.483, t=1.947*	
TSKX=Task Complexity; SEFC=Self Efficacy; One-tailed t-test: *p<.05, **p<.01, ***p<.001.						

Table 4. The Moderated Non-Linear Effect Test

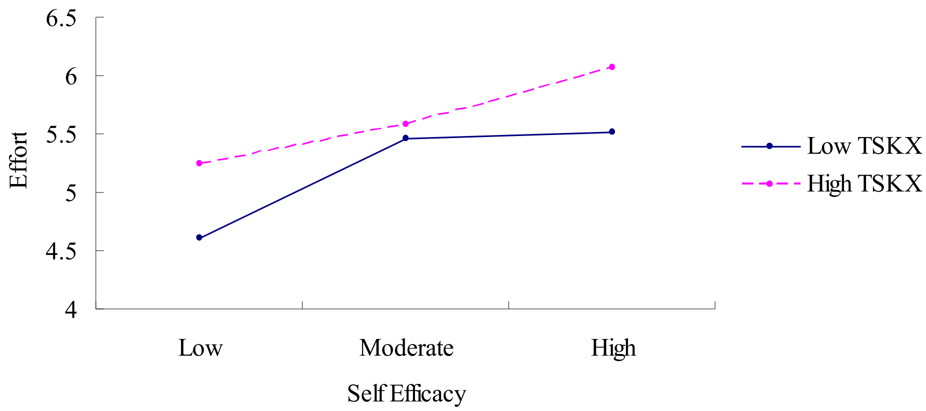

Figure 5. The Moderated Non-Linear Effect

Note: TSKX=Task Complexity

DISCUSSIONS, IMPLICATIONS AND LIMITATIONS

Discussions of the Results

This study attempts to understand the non-linear relationships in the expectancy theory, specifically, the moderated nonlinear effect of task complexity on the relationship between self efficacy and effort. The key findings can be summarized as follows.

First, the results show the significant positive effects of reward valence and trust. The positive relationship between reward valence and effort indicates that when people perceive gaining reward in the online task participation process as important, they will be more likely to be motivated to actively participate in the online tasks and to expend more effort. The positive relationship between trust and effort suggests that when solvers trust that reward providers will keep their promise, they need not to worry about reward providers' opportunistic behavior and would like to invest more effort.

Second, the moderated nonlinear effect of task complexity on the relationship between self efficacy and effort indicates that under different levels of task complexity, the non-linear relationships between self efficacy and effort are different. Specifically, the results show that when task complexity is high, self efficacy works only when self efficacy is moderate and high. As to the low level of self efficacy, solvers may still feel the task is too difficult to be completed. In contrast, when task complexity is low, self efficacy works only when self efficacy is low and moderate. As to the high level of self efficacy, solvers may feel the task is too easy to invest much effort.

Theoretical Implications

Theoretical implications of this study can be discussed from several aspects. First, as to our knowledge, this is the first study that attempts to understand the predictors of effort in the crowdsourcing marketplace by addressing the expectancy theory. Although there have been several studies researching on why people would like to expend effort in the open source software (OSS) communities (Ke et al. 2009), the predictors of solvers' effort investment in the crowdsourcing context is rarely examined. In particular, previous studies on crowdsourcing have not recognized the similarity between crowdsourcing marketplace (a new working mode) and conventional working. Therefore, utilizing the expectancy theory which is the most famous theory in working motivation as a new theoretical perspective to understand the phenomenon in crowdsourcing marketplace appropriately captures this feature. This study confirms the applicability of expectancy theory in the crowdsourcing context and encourage future researchers to consider it as an important theoretical underpinning when studying solver behavior in crowdsourcing marketplaces.

Second, this study challenges the linear relationship between self efficacy and effort and proposes an activation-deactivation model to describe the non-linear relationship between self efficacy and effort (i.e., moderated nonlinear relationship). Our findings suggest researchers to deeply think about this relationship by considering both the non-linear nature and the moderating role of task complexity. This study can extend the expectancy theory by deeply exploiting the comprehensive relationship between self efficacy and effort. Future researchers using expectancy theory as the theoretical basis could further investigate how the non-linear relationship between self efficacy and effort changes along with task complexity.

Practical Implications

According to the theoretical implications, several practical implications also could be derived from the study. First, both crowdsourcing marketplaces and reward providers should engage in the development of incentive mechanisms and trust mechanisms. For the crowdsourcing marketplaces, they should provide certain benchmark criteria for reward providers to set the reward and for solvers to select the task. They also should pay attention to the strategies to avoid the opportunistic behavior of reward providers, such as warranty policy, identity confirmation, and reputation systems. For the reward providers, they should learn how to appropriately set the reward to leverage solvers motivation and to keep their promise if they want to use the crowdsourcing marketplaces to facilitate their business in a long-run. Second, task complexity should be appropriately set according to solver's ability. Crowdsourcing marketplaces can design a recommendation system to help solvers select the task. Through the recommendation system, solvers can easily know which task is with the complexity that can fully leverage their self efficacy.

Limitations

Despite valuable implications obtained from the results, there are some limitations of this study. First, the study focuses on IT-relevant tasks, such as website design, programming, and Logo design and so on. However, there are various task types on crowdsourcing marketplaces. Besides IT-relevant tasks, tasks relevant to business strategic plan, translation, and writing are also available on the website. It still calls for future investigation to examine the generalizability of the results. Second, the study was conducted in a specific crowdsourcing marketplace in China. However, prior studies on culture postulate that individuals with different cultural background have different behavioral motivations (Hofstede 1980). Future studies should pay attention to the cross-culture issue and compare the results in different cultural contexts based on our proposed research model.

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APPENDIX - MEASURES

Reward Valence (RWDV): Adapted from Sanchez et al. (2000)
RWDV1: I would like to get the monetary rewards for the online tasks.
RWDV2: To me, whether gaining the rewards or not is very important.
RWDV3: It would be good to get the monetary rewards.

Trust: Adapted from McKnight et al. (2002)
TRST1: The reward providers on the Taskcn.com are trustworthy
TRST2: The reward providers on Taskcn.com will keep their promises to give awards to those who complete the task best.
TRST3: I would characterize reward providers on Taskcn.com as honest.
TRST4: Reward providers on Taskcn.com are sincere and genuine.

Self-efficacy (SEFC): Adapted from Kankanhalli et al. (2005)
SEFC1: I am competent at completing the tasks on the Taskcn.com.
SEFC2: I have the expertise needed to complete the tasks on the Taskcn.com.
SEFC3: I have confidence in my ability to complete the tasks on the Taskcn.com.

Task Complexity (TSKX): Adapted from Yeo et al. (2004), Taylor (1981), and Seijts et al. (2004)
TSKX1: I find that completing the tasks on the Taskcn.com is: 1=not difficult at all, 7=extremely difficult.
TSKX2: Completing the tasks on the Taskcn.com is a challenge to me.
TSKX3: I find the tasks on the Taskcn.com are very complex.

Effort – Effort Intensity: Adapted from Barrick et al. (2002)
EFTI1: I work at my full capacity to finish the tasks on the Taskcn.com.
EFTI2: I try hard to finish the tasks on the Taskcn.com.
EFTI3: I put a lot of effort into completing tasks on the Taskcn.com.

Effort – Attention: Adapted from Barrick et al. (2002)
ATEN1: I frequently think about getting the tasks on the Taskcn.com done.
ATEN2: I focus my attention on completing tasks on the Taskcn.com.
ATEN3: I often consider how I can get more tasks on the Taskcn.com done.

Effort – Goal Commitment: Adapted from Barrick et al. (2002)
GLCM1: I persist in overcoming obstacles to complete tasks.
GLCM2: I never give up trying to finish the tasks.
GLCM3: I am strongly committed to pursuing the goal of finishing the tasks.