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Conceptualizing task affordance in online crowdsourcing context

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Abstract

Purpose – The purpose of this paper is to present a new concept – task affordance in crowdsourcing context, and build it as a theoretical lens to help the authors reconfigure the artifacts and process in task-oriented crowdsourcing projects. The paper differs from previous studies by focusing on the relationships between the task artifacts, systems and goal-directed actors in crowdsourcing process rather than on the pure examination of task properties.

Design/methodology/approach – An operational definition of task affordance was proposed and a pseudo-entity-relationship model based approach was employed to portray the task affordance in online crowdsourcing context. Furthermore, the authors developed a typology of task affordance and decomposed the concept into five dimensions, namely, design affordance, presentation affordance, assignment affordance, task-platform fit affordance, and task-worker fit affordance. A preliminary analysis of task affordances across various crowdsourcing categories was also conducted to validate the proposed typological framework.

Findings – The findings show that the task affordances have varying degree and extend among the diverse crowdsourcing categories. For instance, task design affordances seem to be low in the crowd processing and crowd rating cases compared with that in the crowd solving and crowd creation cases. For another example, in terms of the task presentation affordance, crowd rating cases need the lowest affordance while the crowd creation cases need the highest affordance. Therefore, the authors would like to emphasize that the successful adoption, implementation, and design of the task-oriented crowdsourcing owes to the careful examination of the relationships among the actors, artifacts, and environment of the crowdsourcing projects.

Originality/value – To the authors' best knowledge, this paper is the first study on conceptualizing the task affordance in online crowdsourcing context. The study contributes to the academic literature on a comprehensive overview of task-related studies in crowdsourcing, which are scattered in several information related fields. Furthermore, this research contributes directly to the area of information science and technology due to a common interest in studying the environments and contexts in which people, information and technology interact and interplay. Practically, this study may yield some implications for the requester and platform operator when designing the relevant tasks or developing the specific crowdsourcing platform.

Keywords Crowdsourcing, IT artifact, Affordance theory, Crowdsourcing platform, Online task properties, Task affordance

Paper type Conceptual paper

Introduction

Crowdsourcing can be defined as the act of taking a task once performed by the employees inside of an organization and outsourcing it to a large, undefined group of people in an open call (Howe, 2009). The previous literature has indicated that crowdsourcing can be

interpreted from two different perspectives, i.e., a business domain perspective and a technique domain perspective (Luz *et al.*, 2014; Quinn and Bederson, 2011). Although the focus and emphasis may be different due to the specific needs and viewpoints from these two perspectives, yet the common ground of crowdsourcing is task oriented (Luz *et al.*, 2014).

To date, many existing studies on crowdsourcing tend to treat the task as a parameter or influence factor (Baba *et al.*, 2014; Yang *et al.*, 2008; Zheng *et al.*, 2011), and various research methods have been employed to explore the task-related issues in crowdsourcing context (Nakatsu *et al.*, 2014; Singla and Krause, 2013; Zhao and Zhu, 2014a). Therefore, there are many task-related concepts, constructs, and variables, such as task complexity (Nakatsu *et al.*, 2014), task property (Schulze *et al.*, 2011), task granularity (Zhao and Zhu, 2014a), task decomposition (Jiang and Matsubara,2014), task matching (Yuen *et al.*, 2011), to name just a few. However, these concepts and ideas scattered across various studies are to some extent related or blended, and even some of the concepts are tightly interwoven (e.g. task match and task alignment). We believe that by channeling the separate research efforts into a comprehensive perspective can help develop a better blueprint of the existing practices in crowdsourcing projects. Moreover, when exploring the task-related issues in crowdsourcing research, many studies, let alone practice, do not use any theory (at least, not explicitly). Although some researchers absorb or borrow theories from other disciplines, there is still a great necessity to frame the task constructs within an integrated theoretical landscape. As Hardesty (2010) suggests, researchers need to develop a better theoretical understanding of the relationship between task design and the performance of crowdsourcing case. We believe that the reconceptualization of task-related issues in crowdsourcing has an important place in theorizing an alternative vision to the research theme.

In order to untangle the complicated relationship among the actors, artifacts, and environment, a new approach that is based on the concept of affordance in ecological psychology has been suggested as a suitable approach (Markus and Silver, 2008). Consistent with Markus and Silver's idea, we conceptualize crowdsourcing task as real things, whether they are material things like designing a product or abstract things like providing a consulting plan. As real things, crowdsourcing tasks have various properties, and the task properties in crowdsourcing context have been extensively explored in the previous studies (Schulze *et al.*, 2011). However, ecological psychologists believe that animals and people perceive, not the properties of objects, but rather the affordances of objects. In this view, affordances include both the inherent properties of objects and the emergent properties of the actor-network system (Markus and Silver, 2008).

The traditional conceptualization of task-related constructs in crowdsourcing mainly focused on the task properties or characteristics, because they can help explain the performance and outcomes observed when crowdsourcing is adopted or employed. On their own, however, they make for unsatisfactory explanations of crowdsourcing uses and consequences. Not only is there the problem of how crowdsourcing tasks can be theorized as acting on people (both the requesters and participants), but, because tasks can be decomposed into smaller sub-tasks, there is no effective way to limit their analysis, reflecting the repeating decomposition problem (RDP) highlighted by DeSanctis and Poole (1994). Therefore, motivated by a need to further examine and incorporate holistic experiences with affordance in our understanding of people and technology in crowdsourcing context, in this paper we describe a new concept-task affordance.

We posit that task affordance, a direct design research related variable, is important to the study of adoption, participation, and implementation behavior in crowdsourcing because it serves as a key antecedent to salient beliefs about the interaction between the IT artifact, people, and technology. Furthermore, task affordance makes a task measureable and controllable, so the participants can clearly anticipate and employ resources and methods they will need for completing it.

The remainder of this paper is organized as follows. First, we discuss prior work on task-related crowdsourcing studies and affordance theory. An operational definition of task affordance in crowdsourcing context is then developed and illustrated by a pseudo-entity-relationship (ER) model based approach. This is followed by a detailed description of the five dimensions of task affordance, and a preliminary analysis is conducted to validate our proposed concepts and typological framework. Finally, we present the theoretical and practical contributions of this study, and the limitations and directions for future research.

Literature review
Task-related studies in crowdsourcing context
Task-related studies have a long research tradition in many disciplines, such as information science (Vakkari, 2003), information systems (Goodhue and Thompson, 1995), management science (Campbell, 1988), and organization science (Wood, 1986). In the crowdsourcing context, some studies explicitly investigated the task components (Nakatsu et al., 2014; Schulze et al., 2011) while others incorporated the task-related constructs into their research design (Zhao and Zhu, 2014a; Zheng et al., 2011). In particular, some studies treated the task construct as a single variable, such as task complexity (Nakatsu et al., 2014; Ye and Kankanhalli, 2013), while others regarded it as a composite variable, such as task properties (Schulze et al., 2011; Yang et al., 2008). According to Vakkari (2003), task can be either defined as the abstract description of job content or the illustration of working process that can be divided and combined. Therefore, in crowdsourcing context, some researchers focused on the features or functions of task itself, such as task characteristics (Nevo et al., 2012; Ye and Kankanhalli, 2013) and task attributes (Shao et al., 2012), while some other researchers focused on the behaviors or actions upon the tasks in order to complete a defined job, such as task design (Alagarai Sampath et al., 2014), task decomposition (Jiang and Matsubara, 2014; Kulkarni et al., 2012), task assignment (Ho et al., 2013), and task performance evaluation (Rogstadius et al., 2011). Furthermore, there are some classifications or typologies of crowdsourcing based on the task types (Luz et al., 2014; Zhao and Zhu, 2014b) or task characteristics (Nakatsu et al., 2014; Ye and Kankanhalli, 2013). In addition, some researchers attempt to categorize the crowdsourcing projects or cases by adopting a multi-dimensional perspective combining task attributes with other prosperities (Geiger et al., 2012; Kaufmann et al., 2011). Table I summarizes the relevant task-related concepts in crowdsourcing context.

Affordance theory
The concept of affordance was first introduced by Gibson from the ecology psychological perspective (Gibson, 1979). Gibson claimed that "affordance of an object refers to both the attributes of the object and the actor" (Gaver, 1991, p. 79), which means an object's affordances cannot be the same for all actors as they "exist relative to the action capabilities of a particular actor" (Markus and Silver, 2008; McGrenere and Ho, 2000).

Concept (key references)	Description	Disciplines
Task complexity (Nakatsu et al., 2014; Rogstadius et al., 2011)	Task complexity refers to the extent to which the task is difficult to perform (Wood, 1986). Three dimensions of task complexity are considered, i.e., task structure, task interdependence, and task commitment (Nakatsu et al., 2014)	Information systems, information science, computer science
Task specificity (Leimeister et al., 2009; Martinez and Walton, 2014; Richter and Raban, 2012; Ye and Kankanhalli, 2013)	Task specificity addresses the scope of theme. If task specificity is high, organizers search for ideas concerning a specific scope. If task specificity is low, no specific scope is addressed (Leimeister et al., 2009)	Information systems; HCI, technological economics
Task autonomy (Kaufmann et al., 2011; Lee et al.,2013)	Task autonomy refers to the degree of freedom that is allowed to the worker during task execution (Kaufmann et al., 2011)	Information systems; computer science
Task decomposition (Jiang and Matsubara, 2014; Kulkarni et al., 2012; Minder and Bernstein, 2011; Zhang et al., 2011)	Task decomposition refers to the identification of required coordination mechanisms, and the possibility to recombine identified emergent patterns flexibly rather than only breaking a solution into its parts (Minder and Bernstein, 2011)	Computer science, HCI
Task granularity (Brambilla et al.,2014; Kulkarni et al., 2012; Zhao and Zhu, 2014a)	Task granularity is defined as the smallest individual investment necessary in order to make a contribution (Zhao and Zhu, 2014a)	Information science, HCI, computer science
Task enjoyment Antin and Shaw (2012), Füller et al. (2011), Harris (2015), Schuurman et al. (2013)	Task enjoyment is one of the main drivers for engagement in creative activities. It helps to further explain why individuals find various tasks inherently interesting (Füller et al., 2011)	Management science; information science; HCI
Task presentation (Alagarai Sampath et al., 2014; Schulze et al., 2011; Vukovic, 2009)	Task presentation is defined as the quality perception of a task's esthetic features and description (Schulze, 2011)	Information science, HCI, information systems
Task identity (Alam and Campbell, 2012; Goncalves et al., 2013; Kaufmann et al., 2011; Kobayashi et al., 2015)	Task identity refers to the extent a worker perceives the completeness of the task he has to do. The more tangible the result of his work is, the higher will be his motivation (Kaufmann et al., 2011)	Information systems, information science, HCI
Task assignment/recommendation/routing (Boutsis and Kalogeraki, 2014; Feldman and Bernstein, 2014; Geiger and Schader, 2014; Ho and Vaughan, 2012; Yuen et al., 2014)	The series of concepts or ideas can be defined as the capabilities that are required to predicting or detecting the appropriate users or communities for the purpose of crowdsourcing	Information systems, computer science

Table I.
Task-related concepts in crowdsourcing context

In other words, affordances reflect the reciprocity of an acting organism and specified features of an environment, and can guide behaviors (Zhao *et al.*, 2013). Furthermore, according to Gibson (1979), affordances can be perceived directly, without prior synthesis or analysis. Direct perception is possible when there is an affordance and there is information in the environment that uniquely specifies that affordance (Zhao *et al.*, 2013). Thus an affordance exists at what ecological psychologists refer to as the domain of the real (Markus and Silver, 2008). In addition, multiple affordances may arise from a single structure-actor relationship (Volkoff and Strong, 2013). For example, a person may view an iPad as offering a hedonic affordance (e.g. playing games and enjoying the music), but might also view it as offering a utilitarian affordance to help the person process the documents and receive office e-mails in a working context. To date, the consensus emerged among ecological psychologists that an affordance refers to relations between the capabilities of organisms and features of the environment, and was defined as an opportunity for action (Chemero, 2003; Stoffregen, 2003).

The concept of affordance was popularized by Norman's (1988) book *The Psychology of Everyday Things*. In his later work, Norman also stated that the perceived affordances should be used to convey the design properties to the users or on the basis of user-centered philosophy, which focusing on specifying an affordance and indicating the ease of undertaking (Norman, 1999, 2008). Recently, Markus and Silver (2008) suggested a new approach for conceptualizing the IT artifact via three concepts: technical objects, functional affordances, and symbolic expressions. They claimed that the concept of affordance "approaches the study of IT effects from a broader social or behavioral standpoint, inquiring about second-order effects or why system effects may differ across contexts" (Markus and Silver, 2008, p. 627). Volkoff and Strong (2013) argue that affordances are generative mechanisms and can be actualized over time by organizational actors. So far, affordance-based studies have largely focused on how different visual cues support perception of affordances (Volkoff and Strong, 2013), and many of the information-related affordance concepts have been proposed to investigating the IT design, use and evaluate, such as motivational affordance (Zhang, 2008), functional affordance (Markus and Silver, 2008), emergent affordance (Van Osch and Mendelson, 2011), perceived affordance (Zhao *et al.*, 2013), and organizational affordance (Volkoff and Strong, 2013), etc.

Conceptual development
Defining the task affordance
Naturally, a crowdsourcing project may involve multiple actors and artifacts, such as requesters, designers, workers, communities (a set of works), platforms, and workflows (Luz *et al.*, 2014; Zhao and Zhu, 2014b). It is important to note that each of these actors or artifacts may have a relationship with task. For example, the requesters initialize and plan a task; the designers specify and present a task; the workers or communities participate in the task-solving activities; the platforms schedule and manipulate a task; the workflow delegate and control a task-solving process. From the perspective of artifact, task may act as the most crucial appendant embedded in it. Also, from the perspective of actor, task is the key element driving the goal-directed behavior of either requesters or participants. However, so far there are few, if any suitable existing theories that explore the different aspects of task-related issues in crowdsourcing context (Schulze *et al.*, 2011), thus we will introduce the affordance lens into the conceptualization of crowdsourcing task. Since the affordance theory has a realist root

and can be viewed as a generative mechanism (Markus and Sliver, 2008; Volkoff and Strong, 2013), it is appropriate to adopt it as a useful approach to illustrate the primary issues existing in crowdsourcing task.

Recent IS literature described that affordances arise specifically from the relation between objects such as IT artifacts and goal-oriented actors (Leonardi, 2011; Volkoff and Strong, 2013). In this view, the real properties of artifacts are necessary conditions for affordances, not the affordances themselves (Markus and Sliver, 2008). Although many prior studies have explored the task properties in crowdsourcing, it is still insufficient for explaining the potentially necessary relations between actors (e.g. requester, designer, and worker) and artifacts (e.g. system, platform, and workflow). Because task is goal-oriented, affordances of tasks are understood to be perfectly real and perceivable from the actors' perspectives (Chemero, 2003). Furthermore, the relevant task properties in crowdsourcing may differ depending on the type of actors and artifacts and the interactions between them in light of the requesters' goals, workers' capabilities, and the performance of the crowdsourcing systems or platforms. Therefore, we propose the concept of task affordance to illuminate the entangled relations between organization, people, and technology, which advance the view that there is an inherent inseparability between actors, artifacts, and environment advocated by Orlikowski (2007). More formally, task affordances are defined as the attributes of the artifacts associated with the structural features and the potential possibilities for goal-oriented action afforded to complete crowdsourcing tasks by workers with general or specific capabilities. We assume that the actors and artifacts in crowdsourcing are not self-contained, independent entities, but rather they enact each other in practice and come in contact. Thus, identifying and examining the task affordances that arise from the relation between artifacts and goal-directed actors, and understanding building blocks and key issues in terms of task affordances, will provide valuable implications and insights for researchers, managers, and designers in crowdsourcing context.

ER model based approach to portray the task affordance in crowdsourcing context
According to the definition of task affordance, it is clear that affordances are emergent properties of the actor-environment system rather than the inherent properties of artifacts (Stoffregen, 2003). In a given task-oriented crowdsourcing process, three categories of components are usually involved, i.e., requester who initiates the crowdsourcing project and has a task as the main appendant; workers who respond to the tasks and attempt to provide their solutions; and an intermediation platform or system who serves as an enabler to deliver the task to the crowd and manage the whole process of crowdsourcing (Zhao and Zhu, 2014b). Meanwhile, in terms of the connections among the three components, there are some necessary operations that may activate the process, such as task releasing, task recommending, worker participating, task validation, and rewarding, etc. We argue that the various connections among the three components may imply the potential task affordances that need to be perceived by actors before they can be acted on. As indicated by Volkoff and Strong (2013), multiple affordances are present at the same time, so in addition to uncovering these affordances, we must understand the nature of their relationships. We contend that the task affordances root in the relationships and may have different structural levels from which they emerged. In that case, task affordance should be regarded as a multi-dimensional concept and may be reflected in the whole process of the crowdsourcing project, from the design of a task to the completion. In order to

illustrate the main artifacts, actors, and relationships in crowdsourcing context, this paper applies the ER model approach to propose a methodology for extracting and classifying the task affordances of a given crowdsourcing process.

In essence, an ER model is a theoretical and conceptual way of abstracting the real world and representing it in an understandable manner (Chen, 1976). Generally, the ER model defines the conceptual view of database and is considered a good option for designing information systems. The ER model focuses on working around real-world entities and the associations among them. Thus, the building blocks of an ER model are entities, relationships, and attributes. An entity can be a real-world object, either animate or inanimate, that can be easily identifiable. In addition, entities are represented by means of their properties, called attributes. Furthermore, the association among entities is called a relationship, and relationship is also the property that links the entities together. In this case, we contend that the ER model can be employed as an effective approach to conceptualize the task affordance since it highlights both the inherent properties of objects and the emergent properties of the actor-environment system (Stoffregen, 2003).

In crowdsourcing context, there are three main entities, i.e., requester, worker, and platform. Requester refers to the actors (either an individual or an organization) who initiate the crowdsourcing project and can evaluate the final outcome of the project, and thus may benefit from the crowdsourcing. They have some attributes such as objective, needs, and mental models. Worker refers the actors (either an individual or a community consists of a group of people) who participate in the crowdsourcing project and can submit their feedback competitively, collectively, or collaboratively, and thus may have a potential to win awards from the requesters. They have some attributes such as capabilities, personal traits, and preferences. Platform refers to the artifacts (either self-developed or a third-party social information systems) that implement the crowdsourcing project and control the process with a set of rules and requirements. They have some attributes such as system feature, function, and business domain. Moreover, since the crowdsourcing is task oriented (Luz *et al.*, 2014), and each of the three entities will have relations with tasks, thus it is important to set the task as an independent entity. Originally, task is an appendant put forward by the requester and should be viewed as one of the attributes of the requester. However, if so, task can also be viewed as the appendant of platform or workers, since the platform aims to manage the task and the workers attempt to solve the task. One way to overcome this problem may refer to the theory proposed by Orlikowski (2000) that indicating a dual concept of technology, namely, technological artifact and technology-in-practice. The first emphasized a specific machine, technique, appliance, or device, while the latter highlighted a repeatedly experienced, personally ordered, and edited version of the technological artifact, being perceived and experienced differently by different actors depending on the contexts (Orlikowski, 2000). In light of this idea, we argue that the task can also be viewed as a dual concept, namely, task artifact and task-in-practice. We accept Grint and Woolgar's (1995, p. 289) claim that "technology exists only in and through our descriptions and practices, and hence it is never available in a raw, untainted state". We believe that it is the same story for the task artifact explored in this study. The task can either be regarded as an independent artifact extracted from the other related entities or emerged from the structural features and the potential possibilities for goal-oriented action afforded by the interaction among the main entities. Therefore, we treat the task as a weak entity which cannot be uniquely identified by its attributes alone (i.e. task properties), but should associate with other

main entities to show its full meaning. The classification will help us understand the task artifact as an associate entity with its own attributes which have been explored extensively before, at the same time, provide the potential space for task affordances emerging from the properties of relations and enacted as the various actors coping with tasks in a given crowdsourcing project.

Regarding the relationship among the entities, we consider the general life cycle of a crowdsourcing project, which may consist of task design, task presentation, task assignment, and task evaluation (Luz *et al.*, 2014; Zhao and Zhu, 2014b). Task design aims at specifying the task properties based on the requester's objectives, needs, and designer's mental model. For example, task complexity may differ due to the various task granularities, namely, routine task, complicated task, and innovative task (Zhao and Zhu, 2014b). Task design may also consider the cognitive and affective aspects of task, for instance, the degree of challenge (Zheng *et al.*, 2011) and perceived enjoyment (Füller *et al.*, 2011). Task presentation aims at representing the task via the platform in a way understandable and interpretable. The platform may provide multiple features and functions to meet the needs of task presentation, especially on the task content and format. For example, some tasks should be presented in a more fascinating way to evoke the empathy of participants rather than presenting a narrative script. In addition, some complicated tasks should incorporate the domain knowledge to facilitate the storytelling. Task assignment focuses on decomposing the complex and tedious task into smaller pieces of subtasks (if necessary), and conducting the push and pull strategy based on workers' capabilities, personal traits, and preferences. For example, some collaborative tasks, such as the open source software development, need to be effectively decomposed into subtasks that are more easily handled with, and these subtasks should be recommended to the appropriate group of people or community with domain knowledge and interests. Task evaluation refers to the assessment of the crowdsourcing performance of task-solving and the extent of task fit. In particular, task evaluation places great emphasis on the completion and final result of those submitted human intelligence work, which means a well-designed rating or review mechanism is of a great necessity, especially for the summative evaluation. However, task evaluation as an action, is too general to define any specific affordance since the crowdsourcing performance is a subjective or objective concrete outcome by requesters' or peers' judgments. Thus, it is important to decompose the task evaluation into some workable and direct concepts. Previous work has highlighted the fit among task, technology, and people (Finneran and Zhang, 2005; Goodhue and Thompson, 1995) and we believe that compared with task evaluation, task fit draws more attention upon the relationship between actors and artifacts, which may lead to a detailed explanation on the entangled relations emerging from the multiple actors and platforms. In other words, the extent of task fit plays a fundamental role in building a desired task evaluation mechanism. In this paper, two kinds of task fit will be discussed, including task-platform fit and task-worker fit. The former highlights the match between the task artifact and platform, while the latter pays great attention to the alignment between the task artifact and participants. According to the definition of task affordance, it is the relation that may provide the space for the affordance to support the interaction between artifacts and goal-oriented actors, and multiple task affordances may exist and act on each possible stage in the crowdsourcing process. Thus in our case, the task affordances will have a potential to appear in each stage of the life cycle of a given crowdsourcing project, and positively act as the attributes of the relationships. Figure 1 shows the ER framework in crowdsourcing context. All of the three main entities have

Figure 1.
Pseudo-ER model
based approach to
illustrate the
crowdsourcing
process
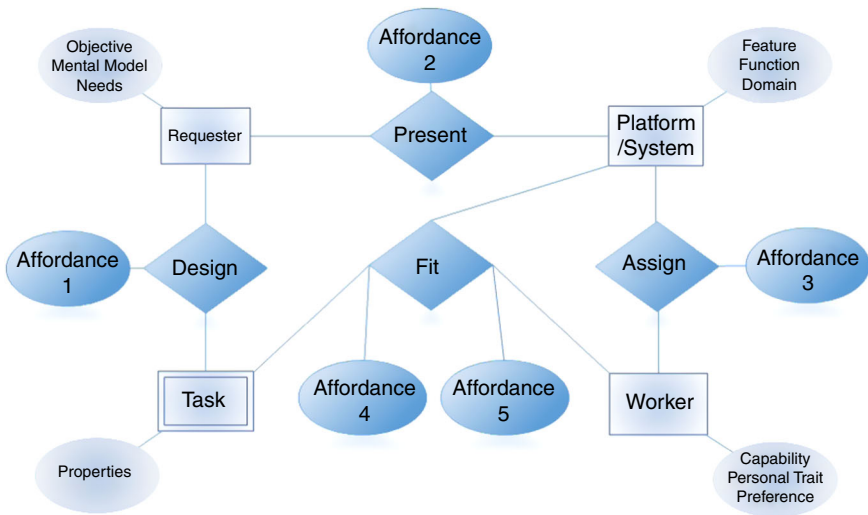
the relationships with the weak entity-task (double-lined rectangle), indicating that the crowdsourcing process is task-oriented. Lastly, it is worth noting that we do not define the key, cardinality, and degree of relationship of ER model from a rigorous perspective in this study, yet our overarching objective of building this pseudo-ER model is to conceptualize the artifacts, actors, relationships, and the potential task affordances (as the attributes of relationships) in crowdsourcing context.

Classifying the task affordances in crowdsourcing context

As shown in Figure 1, the various task affordances illuminate the major foci when initializing, implementing, and evaluating a crowdsourcing project. The task affordance typology below is presented to provide a vocabulary for subsequent discussion within the paper. Terms within the different categories of task affordances are defined as supporting abilities, thus emphasizing the potential actions they may offer the actors and artifacts in crowdsourcing context.

Affordance 1: task design affordance

A good and appropriate design facilitates the overall understanding of the task and therefore increases the chance of correct results (Khanna *et al.*, 2010). Task design affordance refers to the ability that can support the specification of the inherent task properties and affect the worker's perception of the task, thus affecting the quality of results. Some researchers advocate that exploring cognitively inspired task designs to improve the performance of crowd workers is a promising topic for both cognitive psychology and human computation (Alagarai Sampath *et al.*, 2014). Some researchers suggest employing ergonomic theories as the theoretical lens to improve the positive design in crowdsourcing context (Finnerty *et al.*, 2013). We believe that certain properties of the design, for instance, enjoyment, fun, and flow state, etc., may influence not only the overall attractiveness of the task but also the interest of workers. Task design affordance focuses on externalizing the characteristics and attributes of the task artifacts, and thus increasing workers' perceived physical affordance,

perceived cognitive affordance, and perceived affective affordance when interacting with the crowdsourcing tasks. For example, task design affordance should help to provide a good description of the task by explaining its nature, characteristics, time limitations, qualification requirements, etc. In addition, task design affordance should be considered on the basis of the task granularity for a given crowdsourcing project. For those simple tasks, basic affordances are enough for explicating the objectives and requirements. While for those complicated tasks, superior affordances are needed to enhance the analyzability and variability of the problems and scopes.

Affordance 2: task presentation affordance
Previous studies have shown that task presentation may have a direct effect on worker intention (Schulze *et al.*, 2012) and crowd performance (Alagarai Sampath *et al.*, 2014) in crowdsourcing context. Task presentation is usually defined as the quality perception of a task's esthetic features and description (Schulze *et al.*, 2012), for example, whether the task is easy to read or with a good representation of language and symbol (Lyons and Marler, 2011). Although there are some cognitive overlapping between task design and task presentation (Alagarai Sampath *et al.*, 2014), we articulate that the task presentation should focus on rendering of task contents and formats according to the platform with its own feature, function, and domain. Thus, task presentation affordance refers to the ability supported by the platform that can facilitate the representation of the designed task either in a standard or in a personalized way. For instance, the crowdsourcing platform should provide alternative templates for the requesters to select when they post their tasks. Also, the platform should support the autonomy of requesters when they submit their tasks in various content types and formats. Furthermore, the platform may offer some tutorials and FAQs on how to present the tasks in an effective and popular way. In addition, some gamification elements can be incorporated into the design of crowdsourcing platform to facilitate the storytelling of the task in an engrossing way. Bower (2008) proposed some detailed affordances in e-learning context that could be classified as the task presentation affordance, such as media affordances, spatial affordances, temporal affordances, navigation affordances, emphasis affordance, and synthesis affordances. We contend that more cognitive psychological theories can be employed to further investigate the task presentation affordance.

Affordance 3: task assignment affordance
Task assignment is a key step in the implementation of crowdsourcing process. Various crowdsourcing platforms may have different strategies when assigning the tasks. For example, the traditional crowdsourcing systems, such as Amazon Mechanical Turk (AMT), do not provide enough flexibility as they depend on the willingness of the crowd to process the tasks (Boutsis and Kalogeraki, 2014). However, some particular crowdsourcing platforms, such as Threadless, do have very strict time limitation and a relatively defined participants or communities. In addition, some complex tasks are needed to decompose into smaller subtasks that can be executed either sequentially or in parallel by workers (Jiang and Matsubara, 2014). Thus, in this paper, we define the task assignment affordance as the ability supported by the platform that can facilitate the decomposing (if necessary) and delivering of the presented tasks considering the time limitation, budget constraint, task properties, and workers' characteristics. On the one hand, some researchers have indicated that due to

the task dependencies, it is important to decompose the task into smaller pieces, especially for those complicated tasks, which consist of many interacting elements that workers need to process simultaneously and will lead to a higher cognitive load (Markus and Silver, 2008). Meanwhile, we notice that the RDP, which refers to a situation where a phenomenon is decomposable into ever-smaller units with no obvious way to limit the analysis (DeSanctis and Poole, 1994), is also very common in crowdsourcing context. Thus, we advocate employing the activity theory as an approach to illustrate that the task can be decomposed into lower levels and/or a component of a higher level affordance (Kaptelinin and Nardi, 2009). Actually, some researchers have indicated that activity theory and affordance theory exhibit several conceptual similarities (Bærentsen and Trettvik, 2002; Kaptelinin and Nardi, 2009), suggesting that they can be viewed as complementary theories. On the other hand, crowdsourcing platform should effectively and efficiently support the task delivery to the workers. For example, some researchers have paid great attention to several dominant aspects of task assigning, such as achieving real-time response demands (Boutsis and Kalogeraki, 2014), finding the truthful workers (Xu et al., 2013), enhancing the accuracy of the results (Khazankin et al., 2011), and balancing between the project budget and reliability of results (Ho and Vaughan, 2012). Furthermore, besides the supporting at the algorithm level, we suggest applying the motivational affordance theory (Zhang, 2008) as a theoretical basis to explore the incentive design of the crowdsourcing platform to optimize the task assignment process.

Affordance 4: task-platform fit affordance
Most of the crowdsourcing publications have stressed the task type, namely, routine tasks, complex tasks, and creative tasks (Zhao and Zhu, 2014b). Meanwhile, some researchers indicated that the crowdsourcing platforms may also have diverse typologies based on their business model, system architecture, and functions or targets (Kazman and Chen, 2009). Hence, there are some conceptual and logic mapping between the task artifacts and platforms/systems. Task-platform fit affordance refers to the cognitive ability that can facilitate the understanding and assessment on the interaction between the task and platform, and thus help the requesters making an appropriate decision on the platform selection. It is worth noting that this kind of task affordance mainly focuses on the interplay of the task-platform relationship rather than depending on either side. For instance, if the task is to collect a large amount of data in a citizen science project, the crowdsourcing platform should be self-developed (e.g. Galaxy Zoo), or the requester could post their task on a general crowdsourcing platform with a massive users (e.g. AMT). Another case is that if the task is to solve a complex technical problem, it would be better to select a specific crowdsourcing platform with a relevant troubleshooting history. So far, few if any studies, have investigated this kind of task affordance in crowdsourcing context. We believe that some theoretical lens, such as task-technology fit (Goodhue and Thompson, 1995), task-media fit (McGrath and Hollingshead, 1993), and media richness theory (Daft and Lengel, 1986), can be used as the foundations to further examine the task-platform fit affordance in crowdsourcing projects.

Affordance 5: task-worker fit affordance
Several studies have argued that there is an alignment between the task and the worker in crowdsourcing context (Boutsis and Kalogeraki, 2014; Geiger and Schader, 2014).

Task-worker fit affordance refers to the cognitive ability that can facilitate the understanding and assessment on the interaction between the task and the crowd, and thus help the workers making an appropriate decision on the task selection. Although the task assignment and task-worker fit have some mutually concerned issues in task recommendation and task matching (Feldman and Bernstein, 2014), the subjects of these two affordances are different. The former relies on the platform to facilitate the match of individual interests and capabilities with the right tasks and thus create potential benefits for both contributors and requesters. For example, eliciting the preference of task workers and collecting their performance histories (Yuen *et al.*, 2011). While the latter aims to explain the alignment from the worker's perspective, for example, contributors that do not need to invest high search costs or settle for suboptimal tasks are likely to maintain a higher motivation (Geiger and Schader, 2014). Thus, the task assignment affordance deals with the performance level issues of the platform while the task-worker fit affordance is more likely to concern with the cognitive level of the workers. Some researchers have mentioned the challenge of improving the alignment of contributors and tasks in specific crowdsourcing contexts (Alonso, 2011). For instance, Feldman and Bernstein (2014) address the concept of cognitive diversity, i.e., finding the person whose cognitive capabilities are best suited to the requirements of a given task, and indicating that ignoring the diversity of workers' cognitive abilities will almost certainly lead to a mismatch in task-worker alignment, and therefore result in inferior performance. Furthermore, some researchers contend that the cognitive diversity of the crowd can be employed by profiling the user's personality and interests/preferences (Buettner, 2015). We agree with Buettner (2015) that future crowdsourcing research from the coordination problem perspective seems to be very promising and more design-oriented work are needed to extend the functionality of mechanisms for aligning the potential workers with the offered task artifacts. From the theoretical perspective, we argue that the flow theory can be adopted to examine the task-worker fit since it relates to the person's interaction with task (Finneran and Zhang, 2005).

A preliminary analysis of task affordances across various crowdsourcing categories

The list of task affordances above is not meant to be exhaustive, nor is it proposed that the categories are fixed and absolute. Rather, the affordance classification aims to offer examples as to the fundamental and pragmatic level at which task affordances should be identified and elaborated in order to meet the needs of task-related issues in the life cycle of crowdsourcing project. We believe that the categories represented in this study are expandable because other potential task affordances could be added when they are perceived or recognized by the actors in the crowdsourcing process. Furthermore, we assume that task affordances may differ due to the various crowdsourcing typologies, indicating that some key task affordances in a particular crowdsourcing type may not be a major consideration in another case.

In order to validate the concept and application of the task affordance typology proposed above, we conducted a preliminary analysis by schema-based rating approach in this section. First, we adopted the crowdsourcing taxonomy developed by Geiger *et al.* (2012), in which the crowdsourcing systems and cases are classified on the basis of two dimensions, i.e., whether they seek homogeneous or heterogeneous contributions, and whether they seek a non-emergent or an emergent value from these contributions. Combining these two dimensions resulted in a generic framework consisting of four archetypes of crowdsourcing platforms, namely, crowd processing

systems, crowd rating systems, crowd solving systems, and crowd creation systems (Geiger and Schader, 2014). Among them, crowd processing systems seek non-emergent value with very few task dependencies, and the large quantities of contributions are homogeneous with the same level of granularity. Typical examples include Galaxy Zoo and Camclickr. Crowd rating systems seek a collective value emerging from a large amount of homogeneous contributions, and the aggregation and synthesis are two key characteristics for such kind of platforms. Typical examples include the movie billboard rated by the audience, and bestseller list rated by the readers. Crowd solving systems seek non-emergent value with few task dependencies, yet the feedbacks are qualitatively different with multiple levels of granularities and diverse contributions. Typical examples include 99designs, InnoCentive, or Zhubajie (an online crowdsourcing contest market in China). Crowd creation systems seek a collective and collaborative value emerging from a large amount of heterogeneous contributions, which will be synthesized into a comprehensive artifact with a high level of aggregation on resources or knowledge. Typical examples include iStockphoto, Wikipedia, or Zhihu (a popular Chinese social Q&A site).

Second, we selected ten cases from each of the four archetypes above, and there are 40 cases in total for the further analysis. During our case selection, three main principles were followed: massive participation, which means that the crowdsourcing projects should involve a large number of workers, otherwise the wisdom of crowds may not be well reflected; completed cases, which indicate that the crowdsourcing task should be ended, otherwise the emergent characteristic may not be significant; and case diversity, which suggests that the cases should be selected from multiple sources and camps with a wide range of coverage, otherwise the representativeness of cases will be limited. Table II illustrates four different crowdsourcing cases in total from each of the archetype above. We briefly list the information of task, actors, platform, and domain of each case.

Case (archetype)	Task description	Time period	Requester	Platform	Number of participants	Domain
Movie rating (crowd rating)	Rating a new released movie and writing reviews	February 2015-April 2015	Wanda Pictures	Douban (an interest based online community)	12,580	Entertainment
Manuscript OCR (crowd processing)	Text proofreading and collation for the Chinese ancient books	August 2014-April 2015	Shanghai Public Library	A self-developed crowdsourcing system	3,645	Citizen science
Intergenerational learning (crowd creation)	An open call for suggestions, plans, or prototypes to improve the intergenerational learning	September 2014-December 2014	An internet company	Zhihu (an social Q&A site)	527	Education
Logo design (crowd solving)	Design a logo for a manufacturing company on the basis of some requirements	January 2015-March 2015	A manufacturing company	Zhubaijie (a crowdsourcing contest site)	268	Business

Table II.
Brief crowdsourcing cases description

Third, schema-based rating was conducted by three coders independently. We used the 1-7 point scale to measure the extent of task affordances in this study, from the lowest (1) to the highest (7). Each coder independently evaluated and rated the 40 crowdsourcing cases in four archetypes based on the five categories of task affordances. After the independent rating, we then calculated the three coder's average score of ten cases in each of the four crowdsourcing types according to the task affordance typologies, and made a comparison between the three coding sheets. In this paper, we set up three levels of task affordance, namely, low (less than three points, not included 3), middle (less than five points, not included 5), and high (above five points, included 5). We then used the three levels of task affordances to replace the actual scores, and calculated the inter-rater reliability of the rating results by Cohen's κ coefficient. The raw agreements between the coders are around 74 percent. Disagreements were resolved by consulting with the authors and the final agreement was 100 percent.

The findings shown in Table III demonstrating that the task affordances have varying degree and extend among the diverse crowdsourcing categories. For instance, task design affordances seem to be low in the crowd processing and crowd rating cases compared with that in the crowd solving and crowd creation cases, indicating that for those simple and routine crowdsourcing tasks, there is no need to spend much time designing the task itself, yet a clear instruction and short description is enough (Finnerty et al., 2013). For another example, in terms of the task presentation affordance, crowd rating cases need the lowest affordance while the crowd creation cases need the highest affordance, which implies that the design of the crowd creation platforms should pay great attention to the specification and representation of tasks in an understandable and meaningful way. Therefore, we believe that task affordance analysis across various crowdsourcing categories provides such an approach which focuses directly on the critical aspects of the crowdsourcing process and may yield some implications for the requester and platform operator when designing the relevant tasks or developing the specific crowdsourcing platform. Based on the four cases provided in Table II, we briefly summarize and propose some key affordance capabilities to explain how task affordances may work in crowdsourcing context (see Table IV). We will further examine the scope and requirements of the typical crowdsourcing cases to elaborate the relevant task affordance capabilities by case study. Moreover, we would like to emphasize that the successful adoption, implementation, and design of the task-oriented crowdsourcing owes to the careful examination of the relationships among the actors, artifacts, and environment of the crowdsourcing projects. That is also the reason why we adopt the affordance as a theoretical foundation in this study.

Crowdsourcing typology	Crowd rating	Crowd creation	Crowd processing	Crowd solving
Task affordances				
Design affordance	Low	High	Middle	High
Presentation affordance	Low	High	Middle	Middle
Assignment affordance	Low	High	Low	High
Task-platform fit affordance	Middle	High	Middle	High
Task-worker fit affordance	Low	High	Middle	High

Table III.
A preliminary analysis of task affordances across various crowdsourcing typologies

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Case (archetype)	Task design affordance	Task presentation affordance	Task assignment affordance	Task-platform fit affordance	Task-worker fit affordance
Movie rating (crowd rating)	Enables easy and fast access to movie introduction	Incorporates standardized templates and procedures for presenting the task	Enables control over task management	Selecting influential platform	n/a
Manuscript OCR (crowd processing)	Easy to implement	Incorporates necessary training	Splitting the task into operational pieces	Includes task management functionality	Provides considerate work support and materials for participates
Intergenerational learning (crowd creation)	Provides sufficient task information	Provides various presentation media	Enables collaboration and information sharing	Includes report generation and visualization functionality	Provides quick response to queries Enables various communication channels
Logo design (crowd solving)	Incorporates gamification elements to illustrate tasks	Customizable interface Provides automated update alerts	Enables various versions of task assignment	Matches the current task with the specification of platform	Authenticates users Fits existing company culture and structure

Table IV.
Desired task affordance capabilities across various crowdsourcing typologies

Conclusion

This paper presents a new concept-task affordance in crowdsourcing context. First, we systematically review the task-related studies in crowdsourcing research, and introduce the affordance theory and its use in information related studies. We then theoretically develop the concept of task affordance by investigating the properties and relations between artifacts and goal-directed actors in crowdsourcing cases. A definition was proposed and an ER model based approach was employed to illustrate the task affordance in crowdsourcing context. Furthermore, we develop a typology of task affordance and decompose the construct into five dimensions according to the components and process of crowdsourcing project. We also provide a preliminary analysis of task affordances across various crowdsourcing categories to validate our proposed concepts and typological framework. Our objective is to conceptually build the task affordance as a theoretical lens in crowdsourcing context, and help us reconfigure the notions, artifacts, and process in the task-oriented crowdsourcing projects. To date, this paper is the first study on conceptualizing the task affordance in crowdsourcing context. The study contributes to the academic literature on an overview of task-related studies in crowdsourcing, which are scattered in several information related fields. Furthermore, this research contributes directly to the area of information science and technology due to a common interest in studying the environments and contexts in which people, information and technology interact and interplay. Practically, this study may yield some implications for the requester and platform operator when designing the relevant tasks or developing the specific crowdsourcing platform.

While we have developed a foundation for affordance-based task theories in crowdsourcing context and conducted a preliminary analysis to validate the conceptual typology, there are still a number of open issues we did not address. First, we briefly mentioned, but did not really address the mapping between the posited dimensions of task affordance and the other task-related concepts or constructs discussed in our literature. More theory construction work is needed to highlight the similarities and differences by explicit explanation. Second, while we illustrated our theoretical arguments with a preliminary analysis of rating 40 crowdsourcing cases, we did not directly collect data and evaluate our new theoretical perspective. One of the best ways to continue this research topic is to rigorously theorize the task affordance as a construct and develop the measurement scale for each of the sub-dimensions. A formal Delphi method and interview will be employed to extend this study. Third, we did not situate the concept of task affordance within a nomological net, which may help to establish the role played by task affordance in extending our understanding of successful crowdsourcing adoption, implementation, and design. In future work, we will seek to examine possible antecedents and consequences of task affordance by empirical studies.

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