"Crowd logistics": the contribution of social crowds in logistics activities

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Abstract

Purpose – The paper aims to provide the necessary basis for a novel interdisciplinary research field. Various types and implementations of crowdsourcing have emerged in the market; many of them are related to logistics. While we can identify plenty of crowd logistics applications using information technology capabilities and information sharing in practice, theories behind this phenomenon have received only limited attention. This paper accounts for filling this research gap by analyzing the crowd's contributions in logistics of goods and information.

Design/methodology/approach – This paper is part of an ongoing research endeavor in the field of location-based crowdsourcing. It represents conceptual work that builds on a literature review enriched with an in-depth analysis of real-world examples in the field of crowd logistics. Using a scoring method, we provide an example how a company may evaluate the alternatives of crowd logistics. The main approach is an analysis of variants of how the social crowd may be integrated in logistics processes. The work is conceptual in its core. Thereby, we use real-world examples of crowdsourcing applications to underpin the evaluated variants of crowd logistics.

Findings – The paper presents relevant theoretical background on crowd logistics. The authors differentiate between variants of crowd logistics with their flow of materials, goods and information. Thereby they zoom in the type, significance and process flow of the crowd's contributions. They discuss potential advantages and challenges of logistics with the performing crowd and deeply discuss opportunities and challenges from a business and from an individual's perspective. Finally, they highlight a route map for future research directions in this novel interdisciplinary research field.

Research limitations/implications – As this work is conceptual in its core, generalizations may be drawn only with great care. Still, we are in a position to propose a route map for further research in this area in this paper. Also the integration of an analysis of a scale of real-world applications allows us to highlight our research's practical relevance and implications.

Originality/value – The main contribution of this paper is an in-depth analysis and consolidation of innovative crowd logistics applications to provide an overview on recent implementations. The authors propose a categorization scheme and contribute with a route map for further research in the field of crowd logistics.

Keywords Advanced web applications, Mobile computing, Collaboration, Crowdsourcing, E-Business models, Social crowd

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1. Introduction

Since the 1980s, the field of logistics has gained attention, as many businesses discovered the potential of rationalization and the benefits of the development of and concentration on core business activities/processes (i.e. specialization on core competencies) (Christopher, 1998). As a response to increasing customer demand and vast opportunities for differentiation against competitors, many businesses made an effort to achieve competitive advantage through logistics (Cooper and Ellram, 1993). The competitive advantage to concentrate on logistics is that innovative logistics concepts are typically only partially visible to competitors. Besides customer interaction and innovation, logistics and supply chain management have become core business processes (Bowersox *et al.*, 2002). As to company-integration, recent studies (Prajogo and Olhager, 2012) have shown that both, information technology capabilities and information sharing, significantly affect logistics.

As a result, *information and communication technologies* (ICT) are widely adopted in logistics and ICT-supported systems (such as *Advanced Planning and Scheduling*, *Supplier Relationship Management*, *Enterprise Resource Planning* or *Customer Relationship Management* systems) and technologies for localization and identification (such as *radio-frequency identification* and bar code) have emerged. The proliferation of highly advanced ICT has allowed users to connect, and to interact with each other using mobile devices at any location in their private and professional life (Kopetzky *et al.*, 2013; Novak *et al.*, 2013; Becker *et al.*, 2012). Due to the ubiquity of such technologies, businesses increasingly use the concept of crowdsourcing, as ICT enables companies to outsource tasks to the so-called "crowd" (Chatzimiliodis *et al.*, 2012, Brabham, 2008).

In logistics, the main objective is to deliver goods and/or information to the right addressee at the right place at the right time (Bowersox *et al.*, 2002; Voß and Gutenschwager, 2011). The concept of "crowdsourcing" is a valuable candidate to contribute toward this objective (Doan *et al.*, 2011, Mladenow *et al.*, 2015b): A crowdsourcer launches an open call on an online platform (which is typically hosted by an online intermediary) and people of the undefined crowd self-select whether or not to contribute to the call (Estellés-Arolas *et al.*, 2012).

Although the concept of "crowdsourcing" is not entirely new, only by means of the advancement of ICT the current crowdsourcing boom has been made possible (Mladenow *et al.*, 2015f): Every step in the entire value chain (e.g. publishing the problem statement, contacting potential crowdsourcees, interacting with them, carrying out tasks, coordinating activities, reporting approaches and solutions, providing results to a problem statement, granting rewards and remuneration) may now be supported by ICT (Poetz and Schreier, 2012). Thus, ICT opens up for a wide range of new possibilities (Kittur, 2010; Mladenow *et al.*, 2015d), bridging the time-location gaps (Thuan *et al.*, 2013; Mladenow *et al.*, 2015c).

The crowdsourcing concept is used by a wide range of businesses and spans various topics, providing benefits for many organizations. Also novel subdisciplines of crowdsourcing were established, involving crowds of individuals in, for instance, collecting money via crowdfunding (Brabham, 2009), online-polling via crowdvoting (Yan *et al.*, 2010) or looking for something/someone via crowdsearching (Belleflamme *et al.*, 2014; Bozzon *et al.*, 2012). In addition, crowdsourcing has been used in various fields such as health care (Ranand *et al.*, 2014), public policy (Aitamurto, 2012), astronomy (Wiggins and Crowston, 2011) or journalism (Hermida, 2010). In the field of

logistics, services may engage the crowd and leverage the concepts of crowdsourcing applications in various ways. In this paper, we highlight the various capabilities of crowdsourcing in this area and discusses their advantages and challenges.

The remainder of this paper is structured as follows: In the next Section, a theoretical background on the preconditions and nature of logistics, crowdsourcing and their combination (i.e. crowd logistics) is given; this overview also includes a brief discussion of motivational drivers for the crowd and companies to engage in crowd logistics. Section 3 zooms in the aspect of location dependency in crowdsourcing web applications; location dependency is a characteristic that is particularly relevant for crowd logistics. We present the idea behind crowdsourcing concepts for location-based systems and discuss several real-word example applications. Section 4 presents how logistics activities may be performed using the crowdsourcing concept, zooming in how the performing crowd may be integrated in logistics. Section 5 discusses the benefits and challenges of the presented models of web-based crowdsourcing in logistics and concludes by discussing future research perspectives in this area. Finally, Section 6 summarizes the major findings of our ongoing research.

2. Conceptual background

2.1 Logistics

Literature shows various perspectives on the origin and definition of the term "logistics". The prevalent definition, though, goes back to the *Council of Supply Chain Management Professionals*. According to this source, logistics entails a process of planning, implementing and controlling procedures (Candell *et al.*, 2009). The classic type of the concept of logistics includes an efficient flow and storage of goods including services and information along the entire supply chain (Bowersox *et al.*, 2002; CSCMP, 2016). The supply chain starts at the point of origin and ends at the point of consumption for the purpose of conforming to customer requirements (Prajogo and Olhager, 2012). In addition to the classic concept of logistics, the concept "information logistics" emerged. In its narrower sense, information logistics refers to the flow of information along the entire supply chain (Voß and Gutenschwager, 2011; Loebbecke and Powell, 1998; Augustin, 1990). It includes the management and controlling of information-handling processes with respect to distribution, storage and time (Mladenow *et al.*, 2015a). In its wider sense, information logistics refers to the part of logistics where information itself represents the good (Candell *et al.*, 2009; Sandkuhl, 2008; Dinter and Winter, 2009). For the present paper, we adhere to the latter perspective on information logistics, as applications that adopt crowdsourcing for information flow (see Subsection 3.3) seem to represent the latter approach.

2.2 Crowdsourcing

Crowdsourcing is a specific type of an outsourcing strategy with a typical, generic operational structure: A company places an open call (invitation) on an undefined group of people (the crowd) to perform a task that may have been carried out within the company (Howe, 2006). The steps in the crowdsourcing process include publishing the problem statement, contacting potential crowdsourcees, interacting with them, carrying out tasks, coordinating activities, reporting approaches and solutions, providing results to a problem statement, granting rewards and remuneration (Bauer *et al.*, 2014).

Essentially, the idea of crowdsourcing is not new: already in the 19th century, Babbage (1832), the famous English mathematician and engineer, hired "the crowd" to assist in computing astronomical tables. In recent years, however, crowdsourcing became very popular since ICT facilitates the entire crowdsourcing process in every step. As a result, numerous online platforms emerged that represent market places where crowdsourcing tasks are placed and assigned. Among the most prominent and successful examples are *Amazon Mechanical Turk*, *iStockPhoto* and *Threadless*. Crowdsourcing is used for many purposes including idea generation (Leimeister *et al.*, 2009; Bayus, 2013), problem solving (Howe, 2006), value capture (Afuah and Tucci, 2013), information gathering (Bozon *et al.*, 2012; Carvalho *et al.*, 2011) and consumer engagement (Kittur *et al.*, 2008; Brabham, 2010; Zheng *et al.*, 2011; Leimeister, 2012).

2.3 Adopting the concept of crowdsourcing for logistics

Covering logistics activities, we adopt the term "crowd logistics" when crowdsourcing is applied for logistics processes: Companies (crowdsourcers) use web platforms to outsource logistics processes and/or subprocesses to individuals (crowdsourcees) (Ranard *et al.*, 2014). This can be handled in two different ways. In "tournament-based crowdsourcing", each crowdsourcee generates his/her own solution to the problem. In this case, the solution of one individual is chosen on a competitive basis as the superior one (Afuah and Tucci, 2012). For example, the crowdsourcee, who accepts first to deliver a parcel from point A to point B is selected to solve the task. In "collaboration-based crowdsourcing" the crowdsourcees work together to solve a problem, and the result is one solution (Mladenow *et al.*, 2015b). For example, many crowdsourcees share their knowledge about real-time traffic information.

When using a peer-to-peer crowdsourcing marketplace (platform) for services, both, individuals and companies, may advertise jobs and tasks and in return they are provided with a list of "individual-task matches" (Mladenow *et al.*, 2014). Such a matching list may be generated either by a matching algorithm or by an auction model where individuals may choose from a pool of offerings (i.e. tasks to be performed). Such crowdsourcing platforms embrace the distributed workforce and micro-entrepreneurship phenomena; short-term jobs, which cannot be carried out by the crowdsourcers themselves (for instance, due to a lack of time or lack of interest) are redistributed by assigning those to self-employed people or freelancers. The ubiquity of smartphones (and the resulting mobility) and embedded location-positioning sensors and services (e.g. derived by using *Global Positioning System* (GPS) or *Wireless Local Area Network* (WLAN) positioning techniques) facilitate the task of matching, i.e. finding suitable individuals, who are geographically located at a required place and are capable of performing the task (including availability, skills, etc.). Establishing additional services for crowdsourcees is an attempt to counteract the criticism that peer-to-peer crowdsourcing platforms might provoke precarious work (Horton and Chilton, 2010).

2.4 Motivational drivers

The main motivation for a company to apply a crowdsourcing strategy lies in the potential of a direct economic advantage (Mladenow *et al.*, 2014). For instance, many crowdsourcing projects are successful without any monetary compensation for the participating crowdsourcees (Bayus, 2013). Result-based compensations are typically

(small) monetary rewards, price incentives on products and services or of non-monetary nature such as granting access to exclusive information (Horton and Chilton, 2010).

From the crowdsourcees' perspective, monetary and non-monetary rewards represent incentives for participation in crowdsourcing projects (Horton and Chilton, 2010). Frequently, though, the motivation to participate rather roots in psychological factors. Thereby it is essential to differentiate between intrinsic and extrinsic motivation values. Examples for intrinsic values are, for instance, the engagement in crowdsourcing activities because of the variation from daily life or the experience, the desire to experience something new, to share knowledge with others or the enjoyment of performing a task for its own sake (Bayus, 2013). In contrast, extrinsic values imply aspects such as excellence, satisfaction of the need of self-expression and uniqueness or the accomplishment of shared goals (Bayus, 2013). Especially non-economic rewards have high potential in crowdsourcing projects. Thereby, social factors play a significant role in crowdsourcing (Mladenow *et al.*, 2015a).

Google Inc.'s Web application *OneToday* provides a good example of how a social component may be integrated into so-called "location-based services" (LBS). The app informs users in the USA about nonprofit projects and raises funds for these projects on a daily basis. The goal is to donate US$1 per user to various projects of organizations. Doing so, a considerable amount of money may be raised, whereas the amount for each individual contributor still remains small and affordable. Since some users are afraid that their donation might not arrive at the intended place, the user will be informed in advance about the appropriate utilization of the donated money. By the donation of a friend the user might be encouraged to donate as well.

3. Crowdsourcing web applications in terms of location

As ICT bridges time-location gaps, one might assume that crowdsourcing projects supported by ICT are time- and location-independent (Mladenow *et al.*, 2015c). In fact, among the most popular crowdsourcing platforms, the majority of crowdsourced tasks are indeed location-independent. However, there is a trend toward crowdsourcing tasks that are inherently dependent on the location (Alt *et al.*, 2010; Bauer *et al.*, 2014). This form of crowdsourcing is coined "location-based crowdsourcing" (LBCS) (Alt *et al.*, 2010). Individuals, who are at or close to a particular location, are called to carry out a task that is bound to the respective location (Bauer *et al.*, 2014). LBCS projects are implemented as, for instance, location-based games with the purpose to collect urban data (Celino *et al.*, 2012), LBS in cities (Bentley *et al.*, 2014), local news platforms (Väätäjä *et al.*, 2012) and geographic information for disaster response (Goodchild and Glennon, 2010). While in LBCS the location of the crowdsourcer may be relevant or not, the location of a crowdsourcee is significant (Bauer *et al.*, 2014).

The ubiquitous availability of personal mobile devices combined with the devices' awareness about their position (e.g. using GPS or WLAN positioning techniques) offer new potential to the concept of (location-based) crowdsourcing (Howe, 2006; Becker *et al.*, 2012). Based on an individual's location, a wide range of information and services may be offered to the individual to enhance his/her crowdsourcing experience. With this extension, crowdsourcing aligns with the LBS (Mladenow *et al.*, 2015c).

LBS are mobile services providing the user with a wide range of information and services based on location-dependent data. A distinction is made between reactive and proactive LBS. In the case of reactive services, the user must explicitly request the

service. In the case of proactive services, however, the service responds automatically to specific events, e.g. when entering a certain geographical zone. New location-based social networks are able to link various kinds of information (e.g. messages, photos, videos, personally created *Point of Interests*) to a specific location (Bauer *et al.*, 2014; Mladenow *et al.*, 2015c).

Numerous variations of crowdsourcing applications use LBS. *Kickstarter*, for example, is an Internet platform used for project funding via crowdfunding. The company is considered as a pioneer and most successful provider of crowdfunding platforms. To reach an even wider audience, a mobile application has been developed. *Kickstarter* promotes collecting money from the social crowd. The capital seeker registers his or her project and specifies a minimum amount that has to be achieved through donations and sets a certain time frame within the money should be collected. Any person who has a registered account on the app and/or the platform can then contribute to co-finance this project. When the desired amount is not reached within the set time frame, the project is considered as a failure and the money will be returned to the user. The advantage of the app is that by geo-targeting, the user's project can be chosen by crowdsourcees based on the location, as donators have a preference to support projects in their surroundings. Another crowdsourcing application using LBS is *Charity Miles*. It has been developed for joggers, bikers and walkers, who also happen to donate some amount of money for a good purpose. As the amount of the donation will then depend on his/her physical effort, it motivates people to perform better in their workout. The user opens the app at the start of his or her sporting activity, chooses a charity event and the type of sport and presses "Start". During the exercise, the distance and the money that has been earned is measured via GPS. When the user finished his or her activity, he or she will be asked to accept the donation and then the money will be transferred to the selected charity campaign. Bicycle riders will donate 10 cents per mile, and runners and walkers 25 cents per mile. The goal is to collect $1 million and the user can choose from actions like *AutismSpeaks*, *Feed-game Rica*, *The Michael J. Fox Foundation*, *Stand UptoCancer* and many more.

A Web application using information of a specific location is *Project Noah*. *Noah* is an acronym for "Networked Organisms and Habitats". The goal of the app is to provide a mobile knowledge base of all creatures (organisms) existent in our world. The user may, for instance, take photos of plants or animals, which are stored by the location function where these organisms are recorded. Other users may make those pictures easier to find and to obtain information about by enriching the database with valuable information.

Another crowdsourcing application gathering information of a specific location is the app *NoiseTube*, which was developed to determine the noise level of a particular place. The app records the noise level of a certain environment by using the smartphones' microphone. Using *GPS* the exact Cartesian location is calculated. Data is collected from each user and is then consolidated at the data center of *NoiseTube*, which generates an interactive map. Through each individual's contribution, the map is increasingly filled with data and thus adds value. The user is able to provide further information (e.g. tags) about the source of the noise (e.g. highway). For example, when searching for an accommodation, the app may contribute to getting a better understanding of the location and its infrastructure: The user is able to see the noise level around the preferred location.

The Web platform *Ushahidi* is an example of combining conventional and mobile crowdsourcing using location-based data. On the platform itself, information from crisis regions are bundled and represented on interactive maps. Thereby, the data are collected from mobile phone users. For example, after the earthquake in Haiti in 2010, a large amount of information about the users' current situation was collected on the platform, whereby users contributed actively via phone call, SMS or e-mail.

4. Performing logistics activities with crowdsourcing

Logistics is the management of processes and possibilities for the coordinated realization of cross-company flows of materials and the associated information flows. The coordination of material flows includes particularly the horizontal coordination between suppliers, functional divisions and customers. In this sense, logistics is considered as functional specialization associated with efficiency advantages. This is achieved (i) by better handling of individual activities, and (ii) by bundling individual activities and vote effects between different processes. From this functional perspective, logistics includes activities such as transportation, warehousing and supporting processes (handling of cargo, commission, etc.). This way customer needs are satisfied by the delivery of goods.

Still, in this context, the major challenge is the determination and organization of activities and tasks the crowd may carry out. Based on a real-world example, Figure 1 illustrates how crowdsourcing can be leveraged. In the upper part of the figure, we illustrate the flow of materials, goods and information. Thereby (un)finished products and materials flow from (upstream) suppliers via goods receipt, production and distribution of a company toward internal (e.g. a company's premises) and external (e.g. chain of stores) customers and end consumers. As the process may also include return items, the flow of goods and information may be bidirectional. Thereby the crowd may take over activities that touch on the information flow (see Section 4.3) and/or on the flow of goods (see Section 4.2).

Many companies tend to differentiate themselves from competitors by increasing their product diversity. This leads to an increase of semi-finished products as well as raw, auxiliary and operating materials. Thereby, companies focus on core activities and reduce their production depth. As a result, the proportion of purchased parts rises.

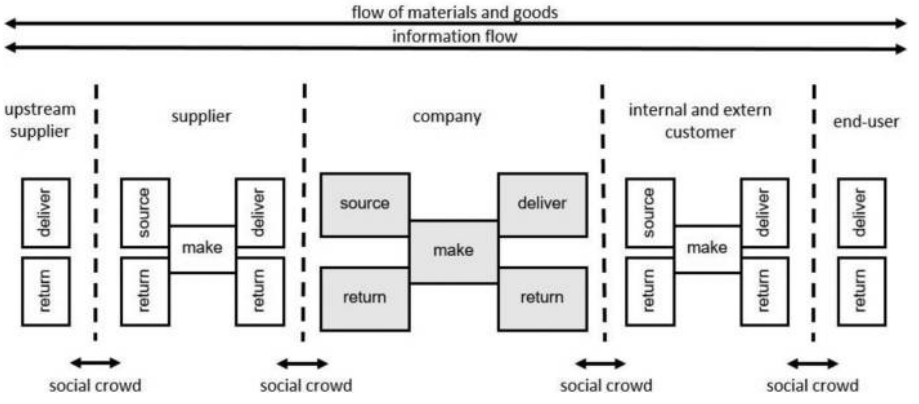

Figure 1.
Performing logistics activities with social crowds

Globalization of value networks and global markets take place. Companies can benefit from crowdsourcing by reducing transportation costs with both, same-day as well as last-mile deliveries.

Typically, crowdsourcing tasks require either (1) interaction between the crowdsourcer (i.e. in many cases a company) and one or several crowdsourcees, and/or (2) interaction among the crowdsourcees. Whereas applications concerning the flows of goods and of materials are mainly tournament-based, tasks regarding information flow are in most cases collaborative. In this context, Table I reflects different characteristics of crowdsourcing applications for logistics activities.

Mobile crowdsourcing is provided by people who use smartphones ("smartphone crowd") and therefore are typically in a constant move, providing data on their current location. This enables new services and applications such as LBCS (see Section 2.2). Smartphones' features include that they are widespread, used every day and always connected. Almost all of them are nowadays equipped with numerous sensors and actuators such as *GPS*, camera, audio and vibration. This allows users to easily engage in crowd-sourced computer services, contributing to the solution of different problems and tasks. Together with the multi-sensing capabilities, they offer great opportunities how existing web-based crowdsourcing applications may be transferred to and adopted by a larger crowd. Mobile crowd logistics is established as a viable commercial technology for urban sensing application such as finding cheap fuel prices (*GasBuddy*) or generating traffic prediction (*Waze*).

However, companies have to consider motivational aspects and provide incentives for crowdsourcees accordingly to make crowdsourcing applications work (see Section 2.3). Considering recent developments covering location-based aspects, we analyze various types of logistics using crowdsourcing applications (Mladenow *et al.*, 2015a). Against this background, the following crowdsourcing Web applications bring into focus the aspects of location-dependency and interaction between crowdsourcer and

Flow and storage of ...	... Goods and materials	... Information
Crowd logistics activities	Physical handling of goods and of materials relating to transportation, warehousing and supporting processes	Sharing all information relating to transportation, warehousing and supporting processes
Locus of interaction	Transportation (outbound logistics); rather toward the end of the value chain ("last-mile" delivery)	Information management at any phase of the value chain
Location dependency	In terms of crowdsourcees handling physical goods	In terms of crowdsourcees local knowledge
Type of crowdsourcing	Rather tournament based	Rather collaboration based
Interaction is required	Between crowdsourcer and crowdsourcees	Between crowdsourcer and crowdsourcees, and/or among crowdsources
Typical Web applications	*Deliv, Checkrobin, Myways*	*Crowdworx, Streetspotr, Telogis, GasBuddy*

Table I.
"Crowd logistics": Crowdsourcing integration for logistics activities

crowdsourcees. We categorize the described crowdsourcing applications and distinguish between classic logistics and information logistics applications.

4.1 Performing flows of materials and of goods

To store the right goods in the right condition and to get them to the right place at the right time, crowdsourcing applications such as *Deliv*, *MyWays*, *TaskRabbit* and *Flexe* have emerged recently.

In this regard, *Deliv* positions itself as an online *consumer-to-consumer* (C2C) platform for transport services. After a trial phase, customers were able to ship their deliveries using *Deliv*. For this crowd logistics application, the business model is based on the idea that many cars are every day on their way with unused loading space. If the driver would use this loading space, they could reduce their travel costs. In this way, "ride-sharing" for private shipments are offered, as the portal enables cross-linking between private individuals who want to receive or send shipment (crowdsourcer as a "sender") through the particular driver (crowdsourcee as a "driver"), who would drive the desired route anyway. In this way, the crowdsourcer can transport almost everything, taking into account that packages, which deviate from the standard norms (oversized, overweight) and are not on the planned route, are more expensive than standard ones. To use the application, crowdsourcer and crowdsourcee must first register on the platform through Web or smartphone app. After both requests are stored, the system searches for matchings of crowdsourcers and crowdsourcees. Then, the application enables them to establish communication in a target-orientated manner on the price, the pick-up/delivery address and the contact information (phone number). Once the sender and the driver agree on price and conditions, the performance is handled by *Deliv*, which receives a commission per shipment that has to be paid by the driver. It is also possible for the cost to be expressed in terms of so-called "credits" which in turn must be paid by credit card, via the app store, via *Paybox* or with wire transfer. After delivery, it is possible for the sender/driver to evaluate each other, which is designed to ensure quality, performance and reliability.

MyWays is a Swedish crowdsourced delivery service by *DHL*. On the one hand, crowsourcers may prepare parcels to be delivered and specify their destination. On the other hand, crowdsourcees select the parcels they want to collect and then deliver. The app is available for free for Android and *iOS*. The *MyWays* project, which was founded in 2013 in Stockholm, offers an innovative solution for the so-called "last mile" of the delivery that allows very high flexibility in package delivery. *MyWays* positions itself as an online platform for package delivery between *business-to-consumer* (B2C) and *C2C*, where people deliver the packages along their routes for a small fee. After registering, the receiver and the deliverer may contact each other via the app. When ordering online, the receiver may determine time and place of service, and the delivery fee. The package is then ready for pick-up in a *DHL* station and appears visible to all users on the *MyWays* app. The deliverer can decide which package he wants to transport to the given address at the appointed time, the receiver determines the amount of payment for the deliverer in credits. Credits are an internal currency of *MyWays* that can be exchanged at any time for "real" money; this can be done on credit card in the app.

The Web application *TaskRabbit* is the pioneer as concerns the concept of "Service Networking". Registering (*Facebook*, *LinkedIn*) allows stating ones' personal skills, interests and requested remuneration. A specifically designed matching-algorithm

connects crowdsourcers and available potential crowdsourcees possessing the required skills. A schedule, which is used by both parties, supports this process. The crowdsourcer can thus select a nearby-located crowdsourcee to perform the task on the basis of experience, ratings or monetary remuneration. By means of an app both crowdsoucer and crowdsourcees can exchange information. *TaskRabbit* is a one-stop marketplace for office and housework tasks, so called "to dos". Tasks include deliveries of parcels as well as tasks of organizational nature, such as shopping, auxiliary works, cleaning and many more.

The crowdsourcing Web application *Flexe* is a marketplace bringing together demand and supply of warehouse space. Potential customers can book space at a predefined place for specific time periods and for specific requirements. Customers are paying in a demand-driven way, i.e. they pay only for what they actually use.

4.2 Performing flow of information

European Social Forecasting vendor *Crowdworx* offers sales forecasting information as a service for existing and upcoming products for companies. In this regard, participants such as employees of a company use a Web application to give their insights by entering their forecast. The Web application provider aggregates the distributed knowledge of these crowdsourcees.

Streetspotr is a mobile application for *Android* and *iOS* devices; its purpose is to assign the tasks as an intermediary between persons who have tasks available and persons who would like to fulfill these tasks. Companies can distribute tasks to the crowd, for example, to collect business information (current photos on the spot, opening times). The necessary data can be obtained in a fast and cheap way. When a company issues a task, all users that are located near the task are notified automatically. A special team of *Streetspotr* ensures the quality of the information provided. Currently more than 200,000 people use this app in Europe.

The application *Waze* is a traffic and navigation app that is based on mobile crowdsourcing. The user of the app enters his or her destination and is navigated using the app. Meanwhile, passive traffic and other road data are shared with others. It is possible to calculate, for example, if traffic jams are currently occurring. Other users will use this information to change their intended routes and avoid the jam. The user can also actively inform the app where for example, stop-and-search operations or accidents take place. The use of the app is free, operates on most mobile operating systems and is based on a principle similar to Wikipedia: The users edit the road data (such as new streets or house numbers) and make them available to others. This also means that errors can occur, but these are corrected in general very fast by other *Waze* users or so-called area managers (*Waze* users with a great deal of experience). The crowdsourcees may edit (among other information) road data, announce latest news of traffic jams, accidents or road closures or passive GPS sent their data to *Waze*. In 2013, *Waze* won the "Best Overall Mobile App award" at the Mobile World Congress. Additionally, *Waze* also has a social component, because chatting with other *Waze* users is supported.

Also *Trapster* is a traffic and navigation app based on mobile crowdsourcing. With more than 20 million members worldwide, it is, together with *Waze*, the best-known and most frequently used app of its kind. It is used in capitals such as Berlin, Rome or London. Data on passive GPS are also collected and give quite useful information about the current driving conditions. Users of the app can actively warn other members about

accidents, wrong-way drivers, speed cameras and speed measurement. Furthermore, the app can give an overview where the nearest charging station for electric cars is located. The app is available for free for *Android*, *iOS*, *BlackBerry*, *Symbian* and *Windows Phone* devices.

The Web application *Telogis* allows drivers to submit route problems. This information can be forwarded to other drivers. To communicate consistently trustworthy information, the route problems data are checked by others at this cloud-based fleet intelligence platform.

4.3 Scoring method to compare classic versus crowd logistics

As in most sectors, costs are a crucial factor also in logistics. Market deregulation and increase in productivity were key drivers for the overall trend of decreasing prices in transport, which represents a major field in traditional logistics. At the same time, requirements for logistics services and activities increased due to higher complexity (e.g. multi-modal infrastructure, higher traffic volume, product diversity) and due to higher customers' expectations (e.g. fast delivery, quality).

In the following, we show an example how crowdsourcing may be evaluated against a classic logistics alternative. For this reason, we outline the performance evaluation that is a crucial part of the decision process to accept or decline an alternative/an offer. The numerical example shows possible evaluation criteria and applies a simple version of the scoring-model. The choice between various offers of transport alternatives is a problem with various goals (i.e. multi-objective problem) and quantitative and qualitative criteria. Table II shows an exemplary scoring table that supports the choice between two alternatives:

(1) the logistics service may be performed by a crowdsourcing provider (i.e. individual of the crowd); or

(2) a traditional transportation service provider.

The scoring-model provides decision support in making transparent which alternative performs better in terms of fulfilling the specified goals and requirements. The decision-maker identifies goals and criteria together with weights reflecting the importance of the criteria and their relation.

In our example the price is the most important criteria with a weight of 0.45, whereas adherence to schedules and same day delivery are of equal importance (0.20 each), and the possibility to track and trace the items is assumed to be of least importance in this arbitrary example (0.15). Then, each alternative is considered and a value is assigned that reflects the expectation how well that alternative will fulfil that criteria. This score

		Crowd logistics		Classic logistics provider	
Criteria	Weight	Score	Weighted score	Score	Weighted score
Price	0.45	10	4.50	6	2.70
Adherence to schedules	0.20	10	2.00	8	1.60
Same-day delivery	0.20	4	0.80	10	2.00
Tracking and tracing	0.15	4	0.60	10	1.50
Sum	1.00		7.90		7.80

Table II. Scoring table example for evaluation of logistics alternatives

may be any integer between 10 and 1, whereas 10 indicates a very good fulfilment and 1 a very poor one. In our example it is assumed that the criteria price will be very well fulfilled by crowdsourcing, but will be fulfilled only slightly above average (i.e. here 6) by a classic provider. Or—to describe another evaluation step—the criterion fast delivery will be fulfilled by crowdsourcing slightly below average (i.e. here 4), whereas the classic provider has an online tracking and tracing tool (i.e. here 10). For each alternative the weight of the criteria is then multiplied by the expected value of fulfilment, summing them up for each alternative leads to a value that represents an aggregated value over several decision criteria, and supports the identification of a superior alternative and operationalizes the evaluation of performance. In the numerical example presented the classic provider is dominated by the crowdsourcing alternative (cf. Table II).

Taking into consideration that the determination of weights and scores is a highly intuitive process, we emphasize that the result is a ratio or index, and therefore only a rough indicator of preference and dominance of alternatives. It is a necessity to take into consideration further determinants and perform thoroughly in-depth analysis to provide a solid basis for decision-making. The scoring method is only one (simple) method out of a multitude of decision support approaches (Vincke, 1992). In the following, a discussion on benefits and challenges on crowd logistics is provided. Besides making up the basis for the outlook on future developments, it contains numerous points to be considered in follow-up analysis and suggestions.

5. Discussion

5.1 Benefits

For advanced Web applications using crowd logistics, both, companies and individuals, may profit through achieving synergy effects. For example, the novel crowd logistics concept allows individuals to act as distributors. While in a traditional delivery concept an employee acts exclusively as a supplier and a customer only as a customer, these limitations are elevated through a crowd logistics concept. There, a company provides the technical infrastructure and every person may act both as a customer as well as a supplier. In this case, one has only to comply with company regulations.

In particular, crowd logistics models have great potential, which results from the current situation in the logistics area: currently a lot of the available transport capacities are not exploited. The inclusion of customers in the logistics processes can significantly reduce transportation costs. In addition, the participation in deliveries contributes in reduction of CO_2 emissions, as loading space will be used more efficiently, and—as a possible consequence—traffic might be reduced. A new community-relationship between the customer and company is formed through a tight collaboration with the customer (Mladenow *et al.*, 2015e), which consequently improves the company's image and increases the acceptance from the customer's perspective. The advantages for logistics companies include:

- building customer networks and local communities;
- enabling more efficient utilization of existing capacity;
- reducing acquisition and maintenance costs for expensive investments as well as the transportation costs *per se*; and
- as a result minimize the negative environmental impact.

By implementing crowd logistics, companies get a convenient and simple opportunity to serve the customer (e.g. "last-mile" deliveries), while creating the image of a customer- and environment-friendly company.

At the same time, the following benefits for customers can be observed: a new level of customer participation, additional earning opportunities, reduction of transport costs, also for the customer (by bringing along) flexible service and job opportunities. Contributors to crowd logistics companies have not only a commercial but also a strong social motivation. A high priority is given to the processes of exchange among persons, interpersonal aspects and the sustainability awareness of consumers (both, the crowdsourcer and the crowdsourcee). Customers register as contributors mainly because of social motivation: the earning potential plays a less significant role in it and it is not the main attraction (Mladenow *et al.*, 2014). In addition, through the development of crowd logistics, both the companies and the customers can benefit from reduced prices and faster or to-the-point deliveries. Crowd logistics is considered as convenient, simple, user-friendly and efficient. Furthermore, special transport needs may be fulfilled by crowd logistics (e.g. last-minute gifts).

For crowdsourcing projects where the dimension "location" is an important factor, the vast possibilities for ICT in supporting crowdsourcing to reach a global audience are facing physical limits. Indeed, when someone requires information about the current situation at a particular place next door, it is not efficient to involve a remote crowd. It is the crowd at a particular location that plays a vital role. Ubiquitous computing technologies may contribute for the identification of the relevant crowd and enable the interaction between crowdsourcer and crowd and the interaction among the crowdsourcees.

For logistics, LBS provide a considerable extension to crowdsourcing applications, particularly with respect to tasks that are inherently dependent on the crowdsourcee's location. As crowdsourcing applications increasingly use location-sensing capabilities of mobile devices to match task and crowdsourcee, existing taxonomies seem not to be sufficient to reflect emerging prospects concerning acquisitions of crowdsourcees on a local, regional or global level. The scope of alternatives for crowdsourcing applications in logistics depends on the characteristics of a specific problem, such as the crowd, the solutions to be evaluated by the venue crowdsourcer and the knowledge required by the solution on a problem.

5.2 Challenges

Crowd logistics is a management field that requires dealing with the unknown. The individuals, who form the crowd, are a priori unknown, and contingency plans for unexpected behavior of this interacting mass as a whole or some individuals cannot be fully predicted. Despite its benefits, several challenges are involved with crowdsourcing in logistics: For instance, LBCS raises critical issues such as security, safety and privacy concerns. If a physical product is involved, there is the risk of damage, loss and deterioration. A confident document may be uploaded by mistake, or any member of the crowd may provide critical information incorrectly.

Hence, it is also relevant to reflect on the drawbacks of the crowd logistics concept and to evaluate the potential risks. These include the question of the distribution of responsibilities, privacy issues, creating additional costs, delivery delays and security issues. The distribution of responsibilities is related to potential damage of the delivery

packages and on the question of who should be liable for these losses—the crowd logistics provider that holds only one intermediary function or contributors with whom there is no contractual relationship. Insurance of shipments does not fully answer this question; hence, the legal situation is somewhat ambiguous. Besides, it is possible that due to the protection of data privacy, it may also be problematic for some customers to share their addresses with strangers. The importance of this factor depends on the reputation of the platform or company. Furthermore, some crowd logistics models can cause additional costs, e.g. insurance, software development and its implementation, training for customers and contributors, routing instructions, GPS devices and packets for shipments. The reliability of contributors may be questioned: the priority of delivering the shipment might depend on the crowdsourcee. The safety of contributors and customer should be strictly monitored.

A further challenge relates to appropriate incentives for the crowd. It is essential to generate incentives that take the various situations and/or locations that crowdsourcees might be in into consideration. A tournament-based crowdsourcing setting may trigger motivational forces, which are ultimately decisive for a potential crowdsourcee whether to contribute to a crowdsourcing task. For instance, *Lego* heavily relies on the passion of its fans to engage with its crowdsourcing projects. By regularly reviewing, assessing and most importantly launching the best ideas submitted as new product ideas, *Lego* calls on psychological factors to motivate its crowdsourcees.

Additionally, cultural aspects have to be considered in every crowdsourcing application, which may be decisive whether people contribute or interact with each other. For instance, crowdsourcing outcomes such as the Japanese "Hayabusa '-product line as well as the American 'Ghostbusters"-product line of Lego are strongly influenced by personal cultural backgrounds of the crowdsourcees. Thereby, crowdsourcers have to consider that the contributing crowd may not be representative for the majority of consumers on the mass market. Even if a voting process is implemented for quality reasons, it is important to be aware of the fact that the majority of consumers are typically non-voters. Accordingly, voters may only represent a niche market. Another significant driver for participating in crowdsourcing projects is the local, regional or worldwide reputation of a company. While some big enterprises such as *DHL* attract crowdsourcees beyond regional levels, others rather attract participants from a certain country (e.g. the platform *Checkrobin* that attracts mainly participants from Austria).

6. Conclusion

At present, companies may benefit from novel Web applications using crowd logistics as both advanced ICT capabilities and information sharing have significant effects on logistics integration. Hence, there is a growing demand for outsourcing logistics support to a generally large network of people in the form of an open call. Location-dependent crowdsourcing for logistics business models have a strategic nature and aim to accelerate growth. The proposed categorization and analysis of crowdsourcing applications using classic and information logistics in this paper provides a coherent basis for future research on crowd logistics.

The paper presented an analysis of alternatives how the crowd may perform value-adding activities and how the crowd's contribution may be integrated into logistics processes. However, as in crowd logistics usually a group of individuals, who are (very often) anonymous or at least unknown volunteers, contributes to achieve a

greater result, non-trivial risks emerge as a consequence. Hence, crowd logistics is a case of dealing with the unknown.

We also call for research that outlines advanced technical perspectives concerning LBCS; for instance, it may address matching algorithms that identify good combinations of crowdsourcees with adequate tasks for LBCS services. In this regard the positioning technologies of mobile devices may particularly support deriving (or inferring) a potential crowdsourcee's location, which may form the basis for attracting a "suitable" individual in a favorable place for a certain task to create high-quality results. Alternatively, a LBCS portal could suggest to its registered crowdsourcees the tasks that are available and that would fit for them in terms of their location. Thereby the current location may be used as information, but also the location the potential crowdsourcee is heading to.

Overall, we particularly encourage research that explores the effects of crowd logistics and the combinations of collaboration-based and tournament-based crowdsourcing in logistics, a research field that is still in its infancy.

References

Afuah, A. and Tucci, C.L. (2012), "Crowdsourcing as a solution to distant search", *Academy of Management Review*, Vol. 37 No. 3, pp. 355-375.

Afuah, A. and Tucci, C.L. (2013), "Value capture and crowdsourcing", *Academy of Management Review*, Vol. 38 No. 3, pp. 457-460.

Aitamurto, T. (2012), "Crowdsourcing for democracy: a new era in policy-making, crowdsourcing for democracy: a new era", Policy-Making. Publications of the Committee for the Future, Parliament of Finland, p. 1.

Alt, F., Shirazi, A.S., Schmidt, A., Kramer, U. and Nawaz, Z. (2010), "Location-based crowdsourcing", NordiCHI2010, ACM, pp. 13-22.

Augustin, S. (1990), *Information als Wettbewerbsfaktor: Informationslogistik – Herausforderung an das Management*, Verlag Industrielle Organisation, Zurich.

Babbage, C. (1832), *On the Economy of Machinery and Manufactures*, Ldn. Knight, London.

Bauer, C., Mladenow, A. and Strauss, C. (2014), "Fostering Collaboration with Location-based Crowdsourcing", *Cooperative Design, Visualization, and Engineering*, LNCS: Springer International Publishing, New York, NY, pp. 88-95.

Bayus, B.L. (2013), "Crowdsourcing: new product ideas over time: an analysis of the dell ideastorm community", *Management Science*, Vol. 59 No. 1, pp. 226-244.

Becker, A., Mladenow, A., Kryvinska, N. and Strauss, C. (2012), "Aggregated survey of sustainable business models for agile mobile service delivery platforms", *Journal of Service Science Research*, Vol. 4 No. 1, pp. 97-121.

Belleflamme, P., Lambert, T. and Schwienbacher, A. (2014), "Crowdfunding: tapping the right crowd," *Journal of Business Venturing*, Vol. 29 No. 5, pp. 585-609.

Bentley, F., Cramer, H. and Müller, J. (2014), "Beyond the bar: the places where location-based services are used in the city", *Personal and Ubiquitous Computing*, Vol. 19 No. 1.

Bowersox, D.J., Closs, D.J. and Cooper, M.B. (2002), *Supply Chain Logistics Management (Vol. 2)*, McGraw-Hill, New York, NY.

Bozzon, A., Brambilla, M. and Ceri, S. (2012), "Answering search queries with crowdsearcher", *Proceedings of the 21st International Conference on World Wide Web*, *Lyon*, pp. 1009-1018.

Brabham, D.C. (2008), "Crowdsourcing as a model for problem solving: an introduction and cases", *Convergence: The International Journal of Research into New Media Technologies*, Vol. 14 No. 1, pp. 75-90.

Brabham, D.C. (2009), "Crowdsourcing the public participation process for planning projects", *Planning Theory*, Vol. 8 No. 3, pp. 242-262.

Brabham, D.C. (2010), "Moving the crowd at threadless: motivations for participation in a crowdsourcing application", *Information, Communication & Society*, Vol. 13 No. 8, pp. 1122-1145.

Candell, O., Karim, R. and Söderholm, P. (2009), "eMaintenance – Information logistics for maintenance support", *Robotics and Computer-Integrated Manufacturing*, Vol. 25 No. 6, pp. 937-944.

Carvalho, V.R., Lease, M. and Yilmaz, E. (2011), "Crowdsourcing for search evaluation", *ACM Sigir forum*, Vol. 44 No. 2, pp. 17-22.

Celino, I., Cerizza, D., Contessa, S. and Corubolo, M. (2012), "Urbanopoly – a social and location-based game with a purpose to crowdsource your urban data", *Proceedings of the 4th IEEE SocialCom, Workshop on Social Media for Human Computation, Beijing*, pp. 910-913, doi: 10.1109/SocialCom-PASSAT.,2012.138.

Chatzimilioudis, G., Konstantinidis, A., Laoudias, C. and Zeinalipour-Yazti, D. (2012), "Crowdsourcing with smartphones", *Internet Computing, IEEE*, Vol. 16 No. 5, pp. 36-44.

Christopher, M. (1998), *Logistics and Supply Chain Management: Strategies for Reducing Cost and Improving Service*, 2nd edition, Financial Times Prentice Hall, New York, NY.

Cooper, M.C. and Ellram, L.M. (1993), "Characteristics of supply chain management and the implications for purchasing and logistics strategy", *The International Journal of Logistics Management*, Vol. 4 No. 2, pp. 13-24.

CSCMP (2016), "Council of supply chain management professionals", accessed on 22nd March.

Dinter, B. and Winter, R. (2009), "Information logistics strategy-analysis of current practices and proposal of a framework", *System Sciences, 2009: HICSS'09, 42nd Hawaii International Conference on IEEE, Hawaii*, pp. 1-10.

Doan, A., Ramakrishnan, R. and Halevy, A.Y. (2011), "Crowdsourcing systems on the world-wide web", *Communications of the ACM*, Vol. 54 No. 4, pp. 86-96.

Estellés-Arolas, E. and González-Ladrón-de-Guevara, F. (2012), "Towards an integrated crowdsourcing definition", *Journal of Information Science*, Vol. 38 No. 2, pp. 189-200.

Goodchild, M.F. and Glennon, J.A. (2010), "Crowdsourcing geographic information for disaster response: a research frontier", *International Journal of Digital Earth*, Vol. 3 No. 3, pp. 231-241.

Hermida, A. (2010), "Twittering the news: the emergence of ambient journalism", *Journalism Practice*, Vol. 4 No. 3, pp. 297-308.

Horton, J. and Chilton, L. (2010), "The labor economics of paid crowdsourcing", *Proceedings of the 11th ACM Conference on Electronic Commerce, San Jose, CA*.

Howe, J. (2006), "The rise of crowdsourcing", *Wired*, Vol. 14 No. 6, pp. 176-183.

Kittur, A. (2010), "Crowdsourcing: collaboration, and creativity", *ACM Crossroads*, Vol. 17 No. 2, pp. 22-26.

Kittur, A., Chi, E.H. and Suh, B. (2008), "Crowdsourcing user studies with mechanical turk", *Proceedings of the SIGCHI Conference on Human Factors in Computing Systems, ACM*, pp. 453-456.

Kopetzky, R., Günther, M., Kryvinska, N., Mladenow, A., Strauss, C. and Stummer, C. (2013), "Strategic management of disruptive technologies: a practical framework in the context of voice services and of computing towards the cloud"", *International Journal of Grid and Utility Computing*, Vol. 4 No. 1, pp. 47-59.

Leimeister, J.M. (2012), "Crowdsourcing", *Controlling & Management*, Vol. 56 No. 6, pp. 388-392.

Leimeister, J.M., Huber, M., Bretschneider, U. and Krcmar, H. (2009), "Leveraging crowdsourcing: activation-supporting components for IT-based ideas competition", *Journal of Management Information Systems (JMIS)*, Vol. 26 No. 1, pp. 197-224.

Loebbecke, C. and Powell, P. (1998), "Competitive advantage from IT in logistics: the integrated transport tracking system", *International Journal of Information Management*, Vol. 18 No. 1, pp. 17-27.

Mladenow, A., Bauer, C. and Strauss, C. (2014), "Social crowd integration in new product development - crowdsourcing communities nourish the open innovation paradigm", *Global Journal of Flexible Systems Management*, Vol. 15 No. 1, pp. 77-86.

Mladenow, A., Bauer, C. and Strauss, C. (2015a), "Crowdsourcing in logistics: concepts and applications using the social crowd", *The 17th International Conference on Information Integration and Web-based Applications & Services (iiWAS2015)*, *ACM, New York, NY*, Vol. 30, 8 pages, available at: http://dx.doi.org/10.1145/2837185.2837242

Mladenow, A., Bauer, C. and Strauss, C. (2015b), "Collaborative shopping with the crowd", *Cooperative Design, Visualization, and Engineering: LNCS*, Springer International Publishing, New York, NY, pp. 162-169.

Mladenow, A., Bauer, C., Strauss, C. and Gregus, C. (2015c), "Collaboration and locality in crowdsourcing", *7-Th International Conference on Intelligent Networking and Collaborative Systems (INCoS-2015)*, *Taipei*.

Mladenow, A., Novak, N.M. and Strauss, C. (2015d), "Micropayments in virtuellen Welten – Prozessmodell und Nutzung bei 7-bis 12-jährigen Besuchern", in Cunningham, D.W., Hofstedt, P., Meer, K. and Schmitt, I. (Eds), *Informatik 2015: Lecture Notes in Informatics*, Köllen Druck, Bonn, pp. 1267-1278.

Mladenow, A., Novak, N.M. and Strauss, C. (2015e), "Online Ad-fraud in search engine advertising campaigns", *Information and Communication Technology LNCS*, Springer International Publishing, New York, NY, pp. 109-118.

Mladenow, A., Novak, N.M. and Strauss, C. (2015f), "Mobility for 'immovables' – clouds supporting the business with real estates", *Procedia Computer Science*, Vol. 63 No. 1, pp. 120-127.

Novak, N.M., Mladenow, A. and Strauss, C. (2013), "Avatar-based innovation processes-are virtual worlds a breeding ground for innovations?", *Proceedings of International Conference on Information Integration and Web-based Applications Services*, *ACM*, p. 174, doi: 10.1145/2539150.2539253.

Poetz, M.K. and Schreier, M. (2012), "The value of crowdsourcing: can users really compete with professionals in generating new product ideas?", *Journal of Product Innovation Management*, Vol. 29 No. 2, pp. 245-256.

Prajogo, D. and Olhager, J. (2012), "Supply chain integration and performance: the effects of long-term relationships, information technology and sharing, and logistics integration", *International Journal of Production Economics*, Vol. 135 No. 1, pp. 514-522.

Ranard, B.L., Ha, Y.P., Meisel, Z.F., Asch, D.A., Hill, S.S., Becker, L.B. and Merchant, R.M. (2014), "Crowdsourcing – harnessing the masses to advance health and medicine, a systematic review", *Journal of General Internal Medicine*, Vol. 29 No. 1, pp. 187-203.

Sandkuhl, K. (2008), "Information logistics in networked organizations: selected concepts and applications", *Enterprise Information Systems*, Springer, Berlin Heidelberg, pp. 43-54.

Thuan, N.H., Antunes, P. and Johnstone, D. (2013), "Factors influencing the decision to crowdsource", *Collaboration and Technology*, Springer, New York, NY, pp. 110-125.

Väätäjä, H., Vainio, T. and Sirkkunen, E. (2012), *Location-Based Crowdsourcing of Hyperlocal News – Dimensions of Participation Preferences, GROUP'12, ACM, FL*, pp. 85-94.

Vincke, P. (1992), *Multicriteria Decision-Aid*, John Wiley & Sons, New York, NY.

Voß, S. and Gutenschwager, K. (2011), *Informationsmanagement*, Springer, New York, NY.

Wiggins, A. and Crowston, K. (2011), "From conservation to crowdsourcing: a typology of citizen science", *System Sciences (HICSS), 2011 44th Hawaii International Conference on, IEEE, Hawaii*, pp. 1-10.

Yan, T., Kumar, V. and Ganesan, D. (2010), "Crowdsearch: exploiting crowds for accurate real-time image search on mobile phones", *Proceedings of the 8th International Conference on Mobile Systems, Applications, and Services, ACM*, pp. 77-90.

Zheng, H., Li, D. and Hou, W. (2011), "Task design, motivation, and participation in crowdsourcing contests", *International Journal of Electronic Commerce*, Vol. 15 No. 4, pp. 57-88.

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