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Crowdsourcing in Logistics: Concepts and Applications Using the Social Crowd

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ABSTRACT

The introduction of crowdsourcing offers numerous business opportunities. In recent years, manifold forms of crowdsourcing have emerged on the market – also in logistics. Thereby, the ubiquitous availability and sensor-supported assistance functions of mobile devices support crowdsourcing applications, which promotes contextual interactions between users at the right place at the right time. This paper presents the results of an in-depth-analysis on crowdsourcing in logistics in the course of ongoing research in the field of location-based crowdsourcing (LBCS). This paper analyzes LBCS for both, 'classic' logistics as well as 'information' logistics. Real-world examples of crowdsourcing applications are used to underpin the two evaluated types of logistics using crowdsourcing. Potential advantages and challenges of logistics with the crowd ('crowd-logistics') are discussed. Accordingly, this paper aims to provide the necessary basis for a novel interdisciplinary research field.

Categories and Subject Descriptors

H.5.3 [**Information Interfaces and Presentation**]: Group and Organization Interfaces – *Collaborative computing, evaluation/methodology, theory and models, web-based interaction.*

General Terms

Management.

Keywords

Crowdsourcing; E-Applications; Business Model; Innovative E-Applications; Collaboration; Crowd-Logistics.

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1. INTRODUCTION

Due to the advancement of *information and communication technologies* (ICT), those technologies that allow users connecting and interacting with each other using mobile devices at any location in their private and professional life have become ubiquitous in recent years [1, 2]. In this context, businesses increasingly use the concept of crowdsourcing, as ICT enables companies to outsource tasks to the so-called 'crowd' [3]. In logistics, the main objective is to deliver goods and/or information to the right addressee at the right place at the right time [4, 5]. The concept of 'crowdsourcing' may contribute valuably towards this objective [6, 7]. Thereby, the 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 [8].

The concept of 'crowdsourcing' is basically not new. However, it is the development of ICT that enables the current crowdsourcing boom, since 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, etc.) may now be supported by ICT; and, thus, ICT opens for a whole range of new possibilities [9, 10], bridging the time-location gaps [11, 12].

Recently, new crowdsourcing subdisciplines were formed such as crowdfunding [13], crowdvoting [14] or crowdsearching [15]. In addition, crowdsourcing has been used in areas such as health care [16], public policy [17], astronomy [18], or journalism [19]. In logistics, services may engage the crowd and leverage the concepts of crowdsourcing applications in various ways. The present paper highlights the various capabilities of crowdsourcing in this area and discusses their advantages and disadvantages.

The remainder of this paper is structured as follows: In the next section a theoretical background about the preconditions and nature of crowdsourcing concepts using logistics is given; this overview will include the recent shift towards location-dependency and stakeholder-interaction. Section 3 pinpoints both types of logistics using crowdsourcing applications, classic as well as information logistics. Section 4 discusses the benefits and challenges of the presented crowdsourcing in logistics models. Finally, Section 5 summarizes the major findings of our ongoing research and concludes by discussing future perspectives of research in this area.

2. BACKGROUND

2.1 The Concept of Crowdsourcing

Crowdsourcing is a specific type of an outsourcing strategy: 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 [20, 21]. Typical 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, etc. [22].

Essentially, the idea of crowdsourcing is not new: Charles Babbage, the famous English mathematician and engineer, hired 'the crowd' to assist in computing astronomical tables already in the 19th century [23]. In recent years, however, crowdsourcing became very popular since ICT facilitate the crowdsourcing process, as every step in the entire process may be substantially supported by ICT. 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 [24, 25], problem solving [21], value capture [26], information gathering [27, 28, 29], and consumer engagement [30, 31, 32, 33].

2.2 Adopting Crowdsourcing for Logistics

Literature shows various perspectives on the origin and on the definition of the term 'logistics'. The prevalent definition, though, goes back to the *Council of Supply Chain Management Professionals* (previously the *Council of Logistics Management*). According to this source, logistics entails a process of planning, implementing, and controlling procedures [34]. 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 [4]. The supply chain begins at the point of origin and ends at the point of consumption for the purpose of conforming to customer requirements [4, 5]. In addition to the classic concept of logistics, the concept *information logistics* emerged. Basically, information logistics refers to the flow of information along the entire supply chain [5]. It includes the management and controlling of information handling processes optimally with regard to distribution, storage, and time [4, 5]. According to some authors information logistics refers to the part of logistics where information itself represents the good [34, 35, 36]. Other authors consider information logistics the information flow related to the flow of physical goods [5, 37, 38]. For the present paper, we adhere to the latter perspective on information logistics, as it appears that applications that adopt crowdsourcing for information logistics (see Subsection 3.2) are representatives for the latter approach.

Covering both, classic and information logistics, we adopt the term 'crowd logistics' if crowdsourcing is adopted for logistics processes: Companies (crowdsourcers) use the Internet to outsource logistical processing to individuals (crowdsourcees) [16]. This can be handled in two different ways. In 'tournament-based crowdsourcing', the crowdsourcees selects to work on its own solution to the problem. In this case, the solution of one individual is chosen as the winning one [39]. 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 [39]. 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/tasks and in return they are presented with a list of individual-task matches [20]. Such a matching list may be either generated by a matching algorithm or by an auction model, where individuals may choose from a pool of offered tasks. Such platforms target the phenomena of distributed workforce and micro-entrepreneurship where short-term jobs are redistributed, which cannot be carried out by the crowdsourcers themselves (for instance, due to a lack of time or lack of interest), and are thus assigned to self-employed people or freelancers. The ubiquity of smartphones (and the resulting mobility) and location-positioning services facilitate the task of matching, i.e. finding suitable persons, who are geographically located close by and capable of performing the task. Establishing additional services for crowdsourcees is an attempt to counteract the criticism that peer-to-peer crowdsourcing platforms might provoke precarious work [40].

2.3 Motivational Drivers

The main motivation for a company to apply a crowdsourcing strategy lies in the potential of a direct economic advantage [20]. For instance, many crowdsourcing projects are successful without any monetary compensation for the participating crowdsourcees [25]. In those cases where result-based compensations are involved, these are typically small monetary rewards, price incentives on products and services, or of non-monetary nature such as granting access to exclusive information [40].

From the crowdsourcees' perspective, the mentioned monetary and non-monetary rewards represent incentives for participation in crowdsourcing projects [40]. Frequently, though, the motivation to participate roots in rather 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 [25, 41]. Extrinsic values imply aspects such as excellence, satisfaction of the need of self-expression and uniqueness, or the accomplishment of shared goals [25, 41]. Especially non-economic rewards have high potential in crowdsourcing projects. Thereby, social factors play a significant role in crowdsourcing [22].

Google Inc.'s e-application *OneToday* provides a good example of how a social component is integrated. The app, which is available for Android and iOS devices, informs users in the United States about nonprofit projects and raises funds for these projects; it is done 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 collected, 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 what will happen to the donated money. By the donation of a friend the user might be encouraged to donate as well.

2.4 Crowdsourcing Applications in terms of Location

As ICT bridges the time-location gaps, one might assume that crowdsourcing projects supported by ICT are time and location independent [22]. In fact, among the most popular crowdsourcing platforms, the majority of crowdsourced tasks are indeed location-independent; as the platforms seem to support only such. However, recent research [42, 22] could observe a trend towards crowdsourcing tasks that are inherently dependent on the location. This form of crowdsourcing is coined 'location-based crowdsourcing' (LBCS) [42]. Individuals, who are at or close to a particular location, are called to carry out a task that is bound to the respective location [22]. LBCS projects are implemented as, for instance, location-based games with the purpose to collect urban data [43], location-based services in cities [44], local news platforms [45], and geographic information for disaster response [46], etc. While the location of the crowdsourcer may be relevant or not, the location of a crowdsourcee is significant [22].

The ubiquitous availability of personal mobile devices combined with the devices' awareness about their position (e.g., derived by using *Global Positioning System* (GPS) or *Wireless Local Area Network* (WLAN) positioning techniques) offer new potential to the concept of (location-based) crowdsourcing [21]. 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 so-called '*location-based services*' (LBS) [22].

LBS are mobile services providing the user with a wide range of information and services, based on location 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* (POI)) to a specific location [12, 22].

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 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 period of time within the money should be collected. Any person who has a registered account on the app and the platform can then help finance a specified amount of this project. When the desired amount is not reached within the set time frame, the project is considered 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. Another crowdsourcing application using LBS is *Charity Miles*. It has been developed for joggers, bikers and walkers, who also happen to want to donate some money for a good purpose The user opens, at the start of his or her sporting activity, the app, 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.

An e-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 related all world-class creatures available. The user can shoot photos of plants or animals, which are stored by the location function where these organisms are recorded. Other users can make certain plants or living things easier to find and obtain information about them. 2012 the app won the *World Spirits Award* (WSA)-mobile Awards in the category 'm-Learning & Education' Award.

Another crowdsourcing applications 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 microphone. Using GPS the exact location is calculated. The data is collected from each user and is then sent to the data center of *Noisetube*, which create an interactive map. Through the contribution of each individual, the card is filled with more and more data and thus gains added value. The user is able to give further information about the source of the noise (e.g., highway). For example in finding accommodation, the app helps to get a better understanding. The user is able to see the level of noises around the preferred location. The *NoiseTube* Cruises, a joint venture of Sony Computer Science Laboratory in Paris and the Free University of Brussels, works on Java, Android and iOS.

The online platform *Ushahidi* is an example of combining conventional and mobile crowdsourcing using location-based data. On the website itself, information from crisis regions are bundled and represented on visualized maps. The data is 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. This was done actively via SMS, call or e-mail.

Overall, the phenomenon of the so-called 'crowd-logistics' is complex, due to various aspects and approaches. Therefore, this paper zooms in on the issue of 'location-dependence' in logistics using crowdsourcing applications.

3. LOGISTICS USING CROWDSOURCING APPLICATIONS

Companies have to consider motivational aspects and provide incentives accordingly to make crowdsourcing applications work. Considering recent developments covering location-based aspects, we analyze both types of logistics using crowdsourcing applications, i.e. classic logistics and information logistics.

Typically, crowdsourcing tasks require either (1) interaction between the crowdsourcer (i.e. in many cases a company) and one or several crowdsourcees, or (2) interaction among the crowdsourcees. Whereas applications concerning classic logistics are mainly tournament based, tasks regarding information logistics are collaborative. In this regard Table 1 depicts different characteristics of crowdsourcing applications for both, classic logistics and information logistics.

Against this background, the following crowdsourcing applications bring into focus the aspects of location-dependency

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

Table 1. 'Crowd-Logistics': Crowdsourcing Applications Using Classic and Information Logistics

Criteria	Classic Logistics	Information Logistics
focus	flow and storage of tangible goods	flow and storage of information
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 crowdsourcees
locus of interaction	outbound logistics; rather towards the end of the value chain ('last-mile' delivery)	information management at any phase of the value chain
typical crowdsourcing applications	*Flexe, Myways, Checkrobin*,	*Crowdworx, Streetspotr, Telogis*

3.1 Classic Logistics

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 *Flexe*, *MyWays*, and *Checkrobin* have emerged recently.

In this regard, *Checkrobin* 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 *Checkrobin*. 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'), which 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. In order to use the application, crowdsourcer and crowdsourcee must first register on the platform through web or smart-phone 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 *Checkrobin*, 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 deliverered 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 C2C (i.e. individuals who deliver and receive packages), and B2C (i.e. people who 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 e-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 house work 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 US-American crowdsourcing application *Flexe* is a marketplace bringing together demand and supply of warehouse space. Potential customers can easily 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.

3.2 Information Logistics

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 an e-application to give their insights by entering their forecast. The e-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) or as your own product is used at home. 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 is shared with others. It is possible to calculate, for example, if traffic jams are currently occurring. The other users will use this information to change routes and can 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 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 and Windows Phone devices.

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

4. DISCUSSION

For classic logistics and for information logistics using crowdsourcing applications, 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 Europe, there are numerous showcase examples.

In particular, the European 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 [47], 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 environmentally 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 the European 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. [22]. 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., dogs delivery, last minute gifts, etc.).

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, location-based services 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. Against this background, this paper focuses on crowdsourcing applications covering location-based aspects. 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, the knowledge required by the solution on a problem, etc.

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 critical information may be provided incorrectly by any crowd-member.

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, 'random' people. The importance of this factor depends on company's image. Furthermore, some crowd-logistics models can cause additional costs for insurance, software development and its implementation, training for customers and contributors, routing instructions, GPS devices, packets for shipments etc. The reliability of contributors should 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 location-based crowdsourcing, 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 involved, 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).

5. CONCLUSION AND OUTLOOK

At present, 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 the so called 'crowd-logistics'. In addition, as new models appear in the market a systematic approach is essential to enable, yield and foster sustainability.

In the future, we call particularly for research that outlines technical perspectives concerning LBCS; for instance, it may address matching algorithms that identify crowdsourcee-task combinations for location-based crowdsourcing 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 in order to create high-quality results. Alternatively, a LBCS portal could suggest to its registered crowdsourcees the tasks that are available and 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 the combinations of collaboration-based and tournament-based crowdsourcing in logistics, a research field that is still in its infancy.

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