

Mehmann, Jens; Frehe, Volker; Teuteberg, Frank

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Crowd Logistics - A Literature Review and Maturity Model

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Jens Mehmann, Volker Frehe and Frank Teuteberg

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Crowd Logistics (CL) is identified as a topic of high importance in the area of logistics. From the practical point of view, initial experiences and realizations have already been gained, however, scientific research regarding Crowd Logistics is still in its infancy and multiple research questions are still unexplored. By means of a systematic literature review (LR) as well as a quantitative data analysis (QDA) of existing business models, we obtained a scientific definition of the term Crowd Logistics. Furthermore, we set up a research agenda to counter the open research questions. Additionally, based on the results of the LR and the QDA as well as the knowledge gained in field studies, we developed a Crowd Logistics Maturity Model (CLMM). We evaluated the CLMM by the use of an existing company.

Keywords: Crowd Logistics, Maturity Model, Literature Review, Qualitative Data Analysis

1 Introduction

Currently, the topic of Crowd Logistics (CL) is of crucial importance. Uber for instance is a successful logistics provider, who is following the Crowd Logistics business model (Applin, 2015). In this business model the service is mostly yielded by the crowd (and not by the staff of the company). The persons within the crowd either demand or provide a service. Thereby, the company itself solely acts as a mediator. The mediator is responsible for the coordination and therefore mostly provides an IT platform capable to track communication, manage master data and fulfil payment transactions. This new business model is based on the idea of sharing economy through crowdsourcing and crowdfunding and benefits from short innovation to market time and new ways of customer communication (Bubner, et al., 2014, p. 22). In June 2015, also Amazon decided to use their customers (the crowd) for the last-mile-delivery (Fortune, 2015). This again shows that the topic Crowd Logistics is of great interest for practice and science alike. In our paper, we want to analyze Crowd Logistics from the scientific and practice-oriented perspective. The aim is to give a comprehensive assessment of the status quo. We conducted a systematic literature review to capture the scientific knowledge. In order to understand the viewpoint of the industry, we performed a quantitative analysis of several case studies.

We aspire to answer the following research questions:

- How can Crowd Logistics be defined (RQ1)?
- What is the current status quo in science and practice (RQ2)?
- How can Crowd Logistics business models be assessed (RQ3)?

Our paper is structured as follows. In Section 1 we briefly describe our motivation to address the topic. Section 2 explains the applied research methodology. The definition of Crowd Logistics will be detailed in section 3. Subsequently, in section 4, we present the results of the qualitative data analysis (QDA), discuss and formulate a research agenda. On the base of these results, as well as through a broad case study analysis, we build a Crowd Logistics Maturity Model (CLMM) (cf. section 5), whereas an evaluation of our CLMM is presented in section 6. The paper concludes with a summary in section 7.

2 Research Methodology

2.1 Systematic Literature Review & Case Study Research

We performed a systematic literature analysis (Fettke, 2006) in order to gather the scientific knowledge about Crowd Logistics. We used the keyword phrase <crowd AND (logistic* OR transport*)> and the databases EBSCOhost (all fields) and Google Scholar (only title), which resulted in 1,481 papers. These papers were checked for relevance. As the word crowd in combination with logistics is often used with the meaning "logistics FOR the masses", we identified many irrelevant papers. We only considered papers, in which the word crowd was used with the meaning "logistics BY the masses". Therefore, we first checked the abstracts. In cases where the relevance of a paper was still unclear, a second person was involved and further parts of the paper were included in the investigation. By means of this

approach, we identified 14 relevant contributions which represent the final database for our analysis.

In order to gather information about Crowd Logistics from the practice, we used the methodology of case study research (Myers, 2009, pp. 73-91). Therefore, we performed an internet search (using the search engine Google) by the use of the search term "Crowd Logistics". This yielded in more than 2,150 results, which were successively further investigated. By analyzing the results we identified 79 case studies in the area of Crowd Logistics among the first 190 results. As no further relevant case study could have been identified among the results 191 to 250), we then terminated our search.

Afterward the identified 79 case studies have been completely read by three scientists. Any documents which were rather promotion than a case study as well as documents without any information about business processes or models have not been considered further. As a result, 59 relevant case studies have been identified.

2.2 Qualitative Data Analysis

The Qualitative Data Analysis (QDA) was performed with the Software QDA Miner and the extension WordStat. The Software was used to perform Text Mining as well as Content Analysis for both, the paper and the case studies. Prior to the analysis, we prepared the data according to the recommendations of Provalis Research (2010, pp.1-127) in five steps:

1. Spellchecking to avoid any spelling mistakes
2. Deletion of hyphenation, brackets and unnecessary information (like headers / footers, author information, etc.)
3. Lemmatization and stemming whereby synonyms are removed
4. Deletion of stop word
5. Review results and extension of stop word list

After the data preparation, word frequencies (word count in a paragraph) and word co-occurrences (word pairs in a paragraph) are calculated. Subsequently, a cluster analysis was performed according to Jaccard similarity coefficient (Backhaus, et al., 2011, p. 403). The results were visualized in form of dendrogramms and 2D graphics for illustrative purposes.

3 Definition of Crowd Logistics

Crowd Logistics has its origin in the term crowdsourcing. Crowdsourcing is a neologism of the words "crowd" and "outsourcing" (Howe, 2008, p. 1), whereby "crowd" is defined as a mass of people and "outsourcing" describes the shift of processes, functions and duties to third parties. A first form of crowdsourcing was crowd working, where the crowd members act like an employee and take over the work which was previously performed "within" an enterprise (Blohm, Leimeister and Zogaj, 2014, p. 52). The development of new forms of work is massively supported by the increasing digitization of the society (Unterberg, 2010). Crowd working is organized through an information and communication platform, operated by an enterprise or an intermediary (Blohm, Leimeister and Zogaj, 2014, p. 53),

which can be accessed externally via internet or internally via intranet (Leimeister, 2012, p. 390). Due to the extreme pooling of knowledge as well as the expected economic benefits, the potential of crowd sourcing is considered to be very high (Howe, 2006). However, there are no sound and reliable scientific studies on opportunities and risks (Blohm, Leimeister and Zogaj, 2014, p. 62).

A variation of the term crowdsourcing is the term crowdfunding. It is described as an innovation within the financial services industry and denotes a form of investment banking (Kuti and Madarász, 2014, p. 355). Investors buy parts of companies or invest in projects (Wieck, Bretschneider and Leimeister, 2013, p. 5) and thus become venture capitalists (Gobble, 2012, p. 4). The handling is performed on (internet-based) crowdfunding platforms, where the project is described and investments can be executed. Open research issues are seen in the field of risks and legal requirements as well as in the area of acceptance of the investors. However, crowdfunding is still in its infancy and qualitative as well as quantitative research is still missing, e.g. Ordanini, et al. (2011, pp. 443–470) and Lehner (2013, pp. 289–311). This can be assumed for Crowd Logistics as well, so that we adapt these research methods to this new realm.

As there is, to the best of our knowledge, no broadly accepted definition of Crowd Logistics, we want to characterize it by adapting the ideas of crowdsourcing, crowdfunding and crowd working to the field of logistics.

Therefore, our definition is:

"Crowd Logistics designates the outsourcing of logistics services to a mass of actors, whereby the coordination is supported by a technical infrastructure. The aim of Crowd Logistics is to achieve economic benefits for all stake- and shareholders."

The technical infrastructure is mostly used as a communication medium. Therefore, an IS platform is provided, which can be accessed in a multitude of ways (mobile phone, web browser, etc.). The aim of the platform is to coordinate demand and supply for transport services. In addition, also management processes and invoice processing are tasks that are performed on the platform. The economic benefits are based on the sharing economy, a concept where an increased prosperity is achieved through sharing of goods (services, etc.) among market participants (Weitzmann, 1986, p. 470).

Following our definition, Crowd Logistics enable the generation of new logistics services and the improvement of existing logistical services (e.g., last-mile transport) in the range of volume, speed and flexibility (Bubner, et al., 2014, p. 22), which will cause economic win-win effects for all stakeholders. In general, the inquirer will get a more convenient and flexible logistics service, and the supplier achieves advantages of monetary value which would not be possible without Crowd Logistics (Pfenning, 2014, p. 4).

The potential of Crowd Logistics can also be seen from various successful companies, e.g. the taxi service Uber, the last mile delivery service Algel or the service tiramizoo, which provides same-day delivery of online purchased articles (Bottler, 2014, p. 28).

Thus, Crowd Logistics can already be seen as a competitive alternative to traditional courier express package service providers (CEP).

4 Development of a Research Agenda

4.1 Results of Qualitative Data Analysis

In our QDA of scientific articles, we analyzed the 30 most frequent words. Conducting a cluster analysis by using the Jaccard similarity coefficient (Backhaus, et al., 2011, p. 403), six clusters were identified (cf. Figure 1). The size of the circles corresponds to the number of word mentions; the proximity of the circles to each other describes the proximity of the words in the analyzed papers.

The white diagonal striped as well as the white cluster is not investigated further, as these topics are mentioned in most analyzed papers.

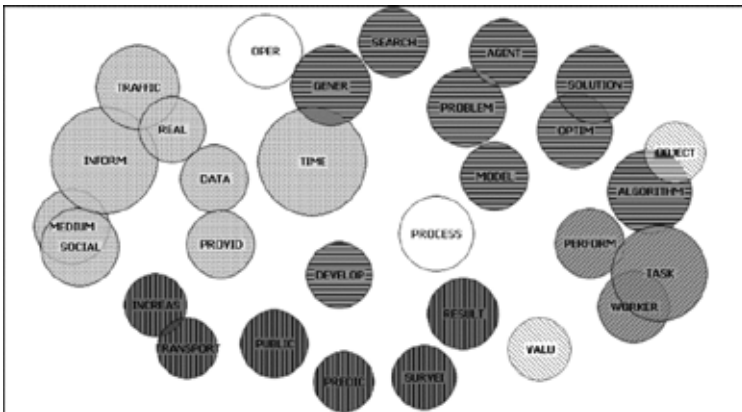


Figure 1 Cluster Analysis Result of Scientific Paper

The grey dotted cluster describes the usage of social media and real time data for traffic information systems. Pender, et al., (2014, pp. 501–521) conducted a literature review, which is about a network control system based on social media data. The use of real-time information for intelligent transport systems (e.g., for traffic jam management) is described by Lee, Tseng and Shieh (2010, pp. 62–70).

The dark grey vertical striped cluster deals with public transport. However, this cluster describes urban transport planning from a strategic, organizational point of view. Poister and Thomas (2007, pp. 279-289) describe how prediction can be used as an alternative for a survey, whereas Pender, et al. (2014, pp. 501–521) investigate how crowdsourcing can be used for disaster management and unplanned transit disruption.

However, Mulaik (2010, p. 34) investigates the field of crowd engineering (as part of in-house logistics) to build smart workforces. This is rather the same focus as in the case of the grey diagonal striped cluster: performance optimization of work tasks and the worker itself.

The grey horizontal striped cluster shows that optimization, modeling and algorithms are big topics in the field of Crowd Logistics. Sheremetov and Rocha-Mier (2008, pp. 31-47) describe, e.g., how supply chain network optimization can be addressed locally in order to globally optimize structures by the use of Collective Intelligence (COIN) theory and Multi-Agent Systems (MAS).

We use the information gathered from these journals as well as the identified open research questions to build the research agenda in section 4.3.

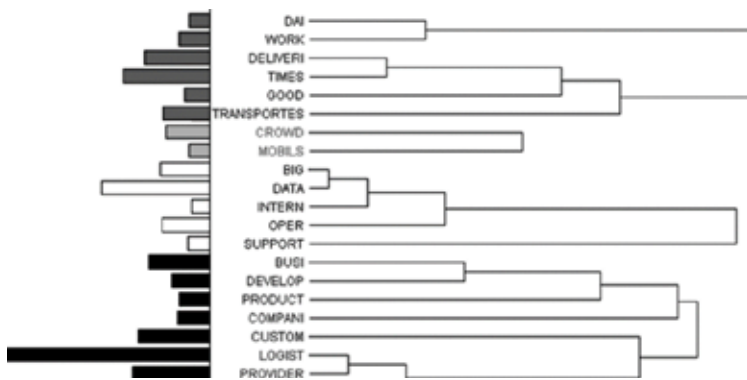


Figure 2 Cluster Analysis Result of Case Studies

The QDA of the case studies was performed in a synonymous way to the literature QDA analysis. The cluster analysis, using Jaccard similarity coefficient (Backhaus, et al., 2011, p. 403), resulted in five clusters (whereby three irrelevant clusters, that consisted of a total of nine words, have been removed from the analysis). Figure 2 shows the results of the cluster analysis in form of a dendrogram.

The result is comparable with the result of the paper analysis. The dark grey cluster deals with delivery time optimization in the area of transport, whereas the light grey cluster mainly addresses mobile crowd solutions in the area of public transport. The topic of (real time) Big Data is described in the white cluster, whereby this data is mainly used for internal process optimization. The large black cluster again deals with strategies in form of business models and product development in the area of logistics service providers. A detailed analysis of these case studies is accomplished in section 5. The information gained is used to build the maturity model.

4.2 Result Analysis

Due to the fact that 46 % of the analyzed papers address the topic of urban passenger transport, this seems to be the most important topic in the area of Crowd Logistics. In this context, the complexity of routing algorithms is mentioned as an aggravating factor by 31 %. For a further 15 %, data heterogeneity represents an obstacle. Communication (38%) and real time data processing, however, are seen as enablers. By analyzing the papers as well as the case studies, we identified several open research topics. We summed up the research theses and displayed them in table 1.

Further research is needed to explore these research theses. Therefore, we provide a research agenda in section 4.3.

Table 1 Research Thesis in the Realm of Crowd Logistics

Research Thesis	Based on
RT1	Big Data (Social Media) Analysis improves the prediction of Crowd Logistics.
RT2	There is a need for new algorithms to manage and control the crowd, which uses the services.
RT3	Uncertainty has a negative influence on the CL algorithm forecasting quality.
RT4	Sustainability has an influence on Crowd Logistics.
RT5	The acceptance of Crowd Logistics (Services) depends on the diffusion of the service.
RT6	Political acceptance is an essential condition for a successful and sustainable deployment of Crowd Logistics services.
RT7	Simulation (sentiment analysis) may discover influencing factors regarding the efficiency of CL transport networks.

4.3 Crowd Logistics Research Agenda

Based on the systematic literature review, we identified future research needs in the area of Crowd Logistics. With the help of our research agenda, these starting points can adequately be addressed (cf. Figure 3). The focus is on the development and evaluation of new business models and innovative technologies like algorithms. Moreover, also studies of acceptance and diffusion of these business models are necessary.

In section 4.1 and 4.2, we carried out the first step of our research agenda (collection of theoretical and practical knowledge) in order to uncover research needs and topics (cf. problem definition in figure 5). The next step (construction) is to build a hypothesis model to answer RT1 to RT4. Additionally, expert surveys as well as case study analyses can be used to strengthen or extend the hypotheses. In addition, a maturity model can be built (cf. section 5) based on the insights gained from practice (case study analyses, expert interviews). In the evaluation phase, the hypothesis model can be validated in the form of an exploration model phase by quantitative cross-sectional analyzes (e.g., surveys) and further analyses of the design science approach (Hevner, et al., 2004).

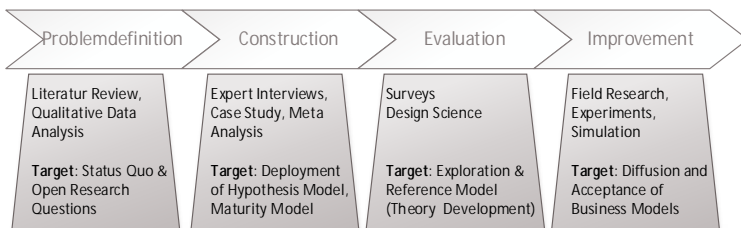


Figure 3 Crowd Logistics Research Agenda

Subsequently, the exploration model can be used for the improvement phase in order to make continuous adjustments and further developments. Therefore, the analysis of acceptance factors (RT5 and RT 6 in table 1) can be evaluated, e.g., via the Technology Acceptance Model (TAM) (Venkatesh and Bala, 2008), by the use of the "short scale for detecting technology readiness" (Neyer, Felber and Gebhard, 2012) as well as by means of other methods from the realm of field and action research.

5 Crowd Logistics Maturity Model

A maturity model (MM) consists of different maturity levels by which objects (e.g., processes, software products or business models) can be assessed (Becker, Knackstedt and Pöppelbuß, 2009, p. 213). Though, MM can also be used for benchmarking, as quality and performance criteria are rated by the use of specified criteria. Each maturity level has different criteria which must be fulfilled to achieve the level. There are four or five maturity levels (Martens, Teuteberg and Gräuler 2010, p. 56). Normally, a self-assessment is performed to define the maturity of an object. However, it is also possible to use available information about an object for the definition of its maturity. Based on the evaluated level, new targets (e.g., company's strategy orientation) can be defined.

The development of our maturity model is based on recommendations of Becker, Knackstedt and Pöppelbuß (2009, pp.213-222), who suggest an iterative process of development and improvement. The model presented in this paper is the result of a comprehensive literature search and a broad case study analysis (problem definition). Thereby, the case study analysis

incorporates input from thirteen companies (Bringbee, Uber, Lyft, Algel, MyWays, Hailo, GetTaxi, myLorry Food Express, checkrobin, mytaxi delivery, mytaxi, blackbay and MOBMover). The goal of our MM is to uncover improvement opportunities for Crowd Logistics Provider. Attention should, however, be paid to the fact that we present the results of the second iteration of the development process. A corresponding improvement will follow shortly (cf. section 7). We performed the development of our MM in 2 steps: Definition of the maturity criteria (step 1) and definition of maturity levels (step 2). Step 1 is divided in 4 sub-steps.

The first sub-step defines the model content by identifying the relevant design level. We considered organizational and subject-specific aspects and used existing maturity models in the area of logistics and business information systems for adaption.

The second step is to analyze and define possible dimensions for the MM. Therefore, we used dimensions from existing maturity models (like CMM (Paulk, 1993) and SPICE (El Emam, Drouin and Melo, 1998) and adapted them to the area of Crowd Logistics. Further, by means of the case study analysis, we identified additional dimensions. Then, we grouped the identified four main dimensions in categories.

The third sub-step is to devise the attributes for each dimension. As the assessment and definition of the maturity are based on an achievement of these attributes, they form an important pillar. The aim is to ensure significance, comprehensibility, identifiability and objectivity. As it is the objective to further develop the MM, the attributes should be flexible and exten-

sible. The results from the QDA provided first ideas for the creation of attributes. By the use of creativity techniques, three researchers performed the further development.

As a last step, we defined which attributes of each dimension are connected to the individual maturity levels. We decided to use a four-level structure, as this is adequate to ensure a differentiation. Moreover, this approach allows for enough flexibility needed for further development. Afterwards, we analyzed the dependencies of the attributes for each dimension. As some attributes require prior attributes and build on one another, an individual analysis was not possible, which is why we executed a holistic examination. By investigating the dependencies and the structure, the different attributes were assigned to the different maturity levels, whereby a cumulative approach was used at some dimensions. For all dimensions, we considered the possibility for further development.

We followed the assessment of the Spice model, where the criteria are rated by percentages of the achieved status. The classification as shown in table 2 can be used to compute the state for each criterion.

Table 2 States for Criteria Assessment

State	Percent	Commentary
Not achieved (N)	0-15%	Criteria not or poorly fulfilled.
Partially achieved (P)	16-50%	Criteria partially fulfilled. Improvements are possible and recommended.
Largely achieved (L)	51-85%	Criteria largely fulfilled. Only little improvements are still possible.
Fully achieved (F)	>85%	Criteria completely fulfilled. No deficiencies.

In order to achieve a maturity level, the requirements of the respective level must at least be rated "L" (largely achieved), and the requirements of the preceding level must be fully achieved "F" (Hoermann, et al., 2008, p. 10). Thus, a higher level of maturity can be reached by achieving an improvement of at least one criterion.

Table 3 contains the Crowd Logistics Maturity Model. The left-hand column shows the different maturity dimensions. The remaining columns show the attributes (requirements) of each dimension for the different levels. The "++" indicate that it is a cumulative attribute and all prior attributes must explicitly be fulfilled.

Table 3 Crowd Logistics Maturity Model

Maturity Level	1 Restrictive	2 Functional	3 Effective	4 Innovative
Environment				
Strategy	Trade Platform	Service provision	++ Service Billing	++ Service Optimization
Market	Regional	National	International	Worldwide
Acquisition	/	Internet Advertising	++ Social Media Advertising	++ bonus program
Cooperation	/	1-2 Partner	5-10 Partner	>10 Partner
Economy				
Revenue	/	Transaction based	++ Provision based	++ Subscription
Payment	/	Cash	Online-(Banking)	Secure payment
Billing	/	Paper	Digital	Monthly digital

Maturity Level	1 Restrictive	2 Functional	3 Effective	4 Innovative
Communication				
Access	Phone	++ Online Portal	++ App	++ Master User
Contact	/	E-Mail	++ Hotline	++ Portal
Certainty				
Transparency	/	Valuation of Company	Ranked Valuation of Service	Ranked Valuation of Service & Supplier
Supplier Verification	/	Registration	++ Authorization	++ Qualifying Certificate
User Verification	/	Registration	++ User Profile	++ Identity check
Security	/	Legally enforceable	++ Insurance	++ Tracing

A detailed version of the CL MM with precise explanations for each attribute can be accessed via <http://bit.ly/CL-MM>.

6 Evaluation

In order to evaluate our developed Maturity Model (cf. section 5), we analyzed the company Algel. By this approach, we demonstrate how the MM can be used to determine the Maturity level and how recommendations can be derived from it. Algel (acronym for "Alles geliefert"; in English: "all delivered") is a German Crowd Logistics Provider which enables customers to generate an online shopping list. Purchasing agents (from the crowd) get the list, buy the articles at partner stores and deliver it to the costumer. Therefor they get a provision.

Table 4 Maturity Level Assessment of a Company

Maturity Level	Reached Level	Explanation
Environment		
Strategy	3 F; 4 N à 3	A service as well as billing is provided.
Market	1 F; 2 L à 2	The service is available in 4 German cities and it is expanding
Acquisition	3 F; 4 N à 3	There are all forms of commercials; however, there is no bonus program.

Maturity Level	Reached Level	Explanation
Cooperation	2 F; 3 L à 3	There are several local supermarkets integrated as well as 3 supermarket chains.
Economy		
Revenue	3 F; 4 N à 3	Provision based payment is implemented as well as transaction based payment. However, there is no subscription model.
Payment	4 F à 4	Secure payment is offered.
Billing	4 F à 4	Suppliers get a monthly bill. The customer pays directly to the supplier.
Communication		
Access	3 F; 4 N à 3	There is a portal and an app. However, there is no user management that would enable to integrate master users.
Contact	4 F à 4	Email, hotline as well as a form on the portal are provided.

Maturity Level	Reached Level	Explanation
Safeness		
Transpar- ence	4 F à 4	The suppliers, the service, the customers and the company can be rated.
Supplier Ver- ification	3 F; 4 N à 3	Suppliers must be authorized, but do not have to provide a certificate.
User Verifica- tion	3 F; 4 L à 4	User have to register, a user profile is generated. However, an identity check is possible but not obligatory.
Security	2 F; 3 N à 2	If a service is booked, it's legally binding. No insurance is provided.

As can be seen in table 4, the company would gain an overall maturity level of 2, as this is the lowest level reached at the different items. There are two items (market and security) where the level 2 is reached. The recommendation for the company would be to integrate an insurance (e.g., a third-party insurance), to improve the security level as well as to extend the service to new cities.

For each category of the maturity model, we can sum up the reached levels. For instance, if we want to compute the overall maturity level for the cate-

gory communication, we will have to proceed as follows: use the level 3 (access) and 4 (contact), build the corresponding percentage, based on the highest level 4 (this will result in 75% for access and 100% for contact), and then calculate the mean (in this case 87.5%). Analogously, this needs to be done for all categories.

As is clear from figure 4, the created company performs well in almost every category, except in the category environment. This underlines our recommendations. Our recommendation to expand into new cities will lead to a higher market value. The recommendation to raise the security measures will finally lead to a higher distribution of the service, which in turn may result in an increased request for the service, also in regions where the company's service is not yet implemented.

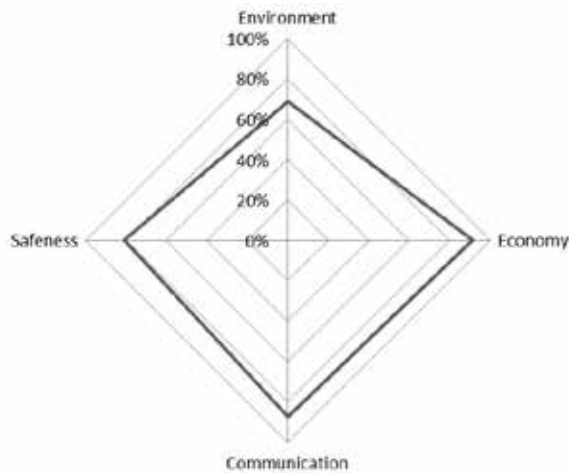


Figure 4 Strength and Weakness of the CL Company business model

Furthermore, it is possible to use the chart shown in figure 4 to benchmark the company's own development or to benchmark with competitors. Therefore, the results of different analyzes can be laid on top of each other, which makes changes directly visible.

7 Conclusion

As we have seen, research in the area of Crowd Logistics is still in its infancy and only few high quality studies are available. For this reason we have first shown a definition of Crowd Logistics. Our literature reviews revealed only a few tentative research approaches. In practice, however, there are several companies and case studies providing insight in the current state. Primarily in the area of passenger transport and last-mile delivery, the potential is seen in an optimized use of resources (based on monetary issues and with respect to sustainability). In this respect, the main driver is the digitization of the society.

The case studies show that there are several ideas that deserve further investigation. As the considered case studies encompass several business models and different stages of realization, a cross case analysis led us to the development of our Crowd Logistics Maturity Model. It is the aim of our MM to identify weaknesses of the selected business models and to deliver suggestions for improvement. With the help of a fictive company, we have shown how the MM can be used and which recommendations can be derived from the results. Furthermore, the MM enables a benchmarking against competitors as well as a historical analysis and a demonstration of the past development.

However, we are aware of the limitations of our research. First of all, we have only investigated companies and case studies from Germany. Beyond, the MM has been developed with publicly available information only, a deeper knowledge of internal processes and the IT/IS systems is thus missing.

But as in every paper, the limitations serve as a guide for future research. In the meantime, we have conducted two iterations of MM development. Moreover, we currently conduct expert interviews in order to enhance our MM by means of sound expertise. First insights show that two new categories will be implemented (the IT/IS category and the internal process category).

Furthermore, the potential strength of Crowd Logistics should be further investigated. In this respect, quantitative data analyses as well as simulations could deliver new insights (compare phases Evaluation and Improvement of figure 3 in section 4.3).

Last but not least, the risks of crowd logistics business models should be identified, quantified and valued. First analyses show, that the government and the legal regulation play a major role for the acceptance and diffusion of Crowd Logistics services (cf. table 1 in section 4.2). The implementation of standard and new regulations may lead to further diffusion.

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