

# Key Types of Crowdsourcing in Science: Systematic Literature Review

Regina Lenart-Gansiniec

Jagiellonian University in Krakow, Krakow, Poland

[regina.lenart-gansiniec@uj.edu.pl](mailto:regina.lenart-gansiniec@uj.edu.pl)

**Abstract:** Recent changes in information systems technology, combined with the postulates of open access to information, are causing the processes of knowledge production and dissemination to change. The necessity of the democratization of science, scientific openness, social orientation of science and the involvement of stakeholders from outside the scientific community in conducting research becomes a necessity for researchers. This is also in line with the guidelines of the European Commission's Community Research and Development Information Service, according to which academics are expected to change the ways of creating knowledge, be oriented towards solving social problems or transgress traditional disciplinary boundaries. Crowdsourcing in science is a collaborative online process through which scientists involve a group of self-selected individuals of varying, diverse knowledge and skills, via an open call to the Internet and/or online platforms, to undertake a specified research task or set of tasks. While research efforts to date have focused on the benefits of crowdsourcing in science, its typology has yet to mature. Typologies are important in describing complex, multidisciplinary organizational forms such as crowdsourcing in science. The main purpose of this article is to identify and provide a typology of crowdsourcing in science. Based on the thematic analysis of publications collected in a systematic manner and focused group interviews, 12 types of crowdsourcing in science are identified. The proposed crowdsourcing in science typology matrix may be a starting point for future research and decision-making by practitioners regarding the choice of a specific type of crowdsourcing in science.

**Keywords:** crowdsourcing in science, typology, academics, academic crowdsourcing, thematic analysis

---

## 1. Introduction

Crowdsourcing in science is part of the knowledge economy. Crowdsourcing in science is a collaborative online process through which scientists involve a group of self-selected individuals of varying, diverse knowledge and skills, via an open call to the Internet and/or online platforms, to undertake a specified research task or set of tasks. The basis of crowdsourcing in science is not only collaboration with a large number of people, but also the access to external knowledge, engagement in knowledge creation, and knowledge sharing between scientist and crowd.

Previous publications in the field of crowdsourcing in science concerned the identification of its significance for science, society (Law et al. 2017), the functionality of crowdsourcing platforms (Schlagwein & Daneshgar 2014), as well as the threats, limitations and barriers of crowdsourcing in science, ways of motivating the virtual community, characteristics of the virtual community participating in research projects (Franzoni & Sauermann 2014). The main purpose of this article is to identify and provide a typology of crowdsourcing in science. We define typologies as organized systems of types that break down overarching concepts into component dimensions and types. On the other hand, type as an analytic category that may be (but is not necessarily) situated in and defined by a typology. We also provide an extensive literature review aimed at determining the attributes of individual types of crowdsourcing in science in business disciplines. This is important because previous research on crowdsourcing in science was conducted from the perspective of biology, medicine, physics, geography, anthropology, scientific information and engineering (Lukyanenko et al. 2019). To identify types and develop the crowdsourcing in science typology, we relied on Kluge's (2000) guidelines on empirically grounded typology construction in social research.

## 2. Methodology

Our research aims at identifying and providing a typology of crowdsourcing in science. We provide a comprehensive overview and determination of the attributes of the types of crowdsourcing in science in business disciplines. We followed the typology guidelines (Kluge 2000), which include the following steps: (1) developing the relevant analysing dimensions, (2) extracting and grouping types, (3) exploring crowdsourcing "ideal types", and (4) representing typology.

First, we conducted a systematic review of the literature to rigorously identify the typology of crowdsourcing in science. Its choice is supported by the fact that it is a helpful method to assess the state of knowledge and it

provides reliable results, from which conclusions can be drawn and decisions made as to further research directions. The literature on the subject was selected on the basis of foreign scientific databases, such as Scopus and Web of Science.

Only English-language articles published in the years 2006-2022 (until 1 February 2022) were analysed, where the starting date is related to the first publication devoted to crowdsourcing. Due to the fact that researchers use different terminology when referring to crowdsourcing in science (Tauginienė et al. 2020), the following filtering criteria included in titles, abstracts or keywords of the publication, synonymous equivalents and related terms in relation to crowdsourcing in science, were applied: “crowdsourced science”, “crowdsourcing science”, “crowd science”, “crowd research”, “scientific crowdsourcing”, “science 2.0”, “crowdsourcing in the science”, “crowdsourcing for research”, “crowdsourcing for science”, “academic crowdsourcing”. We included articles in the analysis that contained: the definition of crowdsourcing in science, various dimensions or features, and a description of types or uses. We then performed backwards iteration (Webster & Watson 2002) to collect a relatively complete set of relevant literature. In this way, we selected 56 publications in total. Dimensions that were identified through a systematic literature review were subject to their content analysis.

Focus group interviews were conducted in May-June 2021. In line with the recommendations, we interviewed people who were most helpful in achieving the research goal. Particular attention was paid to heterogeneity. It took into account the balance of gender, age, position, field and discipline represented. In total, nine focus group discussions with 36 researchers were conducted, including: 25 women, 11 men (8 assistants, 10 assistant professors, 10 university professors, 10 titular professors) in the following fields: social sciences, medical sciences and health sciences, humanities, agricultural sciences, natural sciences, engineering and technical sciences.

In step 2, for extraction and grouping of types, we distinguished the “ideal types” (Doty & Glick 1994) from the many different crowdsourcing activities or initiatives that we identified through the literature review and focus research. For extraction and grouping of types, we used the most commonly used dimensions of crowdsourcing, by Estelle-Arolas and Gonzalez-Ladron-de-Guevara (2012), such as: crowd (who does what and what receives in return), initiator (who and what receives in return from the crowd) and the process (type of process, type of call, and medium used). In Stage 3, exploration of crowdsourcing “ideal types”, we have described the emerging “ideal types” or key categories and highlighted their particularities. Finally, we presented the crowdsourcing in science typology using a typology matrix in which we took into account the dimensions of crowdsourcing in science like crowd (nature of crowd collaboration) and process (task characteristics).

### **3. Results**

#### **3.1 Step 1. Development of the relevant analysing dimensions**

Crowdsourcing in science is a heterogeneous concept (Karachiwalla & Pinkow 2021), which determines the various perceptions of its dimensions. Despite the growing interest of researchers in the issues of crowdsourcing in science, there is only one attempt in the literature to distinguish the dimensions of crowdsourcing in science, while other researchers used the dimensions assigned to crowdsourcing. With regard to crowdsourcing in science, Keating and Furberg (2013) distinguished the following five dimensions: research goal (formulating a goal before starting a crowdsourcing initiative), crowd (the specificity of a virtual community participating in a crowdsourcing initiative and defining the task that will be given to this community), engagement mechanism (designing engagement mechanisms, strengthening the motivation of members of the virtual community to join and perform the task), platforms (a platform supporting crowdsourcing activities and providing a forum for communication and exchange of values with members of the virtual community). However, as Keating and Furberg (2013) themselves claim, their dimension proposal is based on the success factors of a crowdsourcing in science initiative and recommendations for using crowdsourcing methods to support research. Additionally, the above proposal of the components of crowdsourcing in science was not appreciated by other researchers. In order to capture and identify the dimensions of crowdsourcing in science, we analysed the publications obtained as part of a systematic literature review, and for this purpose we conducted a thematic analysis. This allowed for identifying the following three dimensions of crowdsourcing in science along with their *differentia specifica*: crowd, initiator, and process.

### **3.2 Step 2. Extraction and grouping of types**

In the second, we noticed that other researchers often used related concepts, which makes it difficult to distinguish different types of crowdsourcing in science. The above is not made easier by the polymorphic nature of crowdsourcing (Kietzmann 2016). Moreover, individual types of crowdsourcing in science rarely exist in pure form and overlap with the benefits and tasks that are transferred by the initiator to members of the virtual community (Uhlmann et al., 2019). Our thematic analysis of systematically collected literature identified 49 different types of crowdsourcing in science grouped according to four criteria: types of assets, types of tasks, types of results and the degree of inclusiveness. Using the identified types on the basis of a literature review and focus research, we proceeded to distinguish “ideal types”.

### **3.3 Step 3. Exploration of crowdsourcing “ideal types”**

In the third stage, the twelve “ideal types” distinguished were analysed taking into account the results obtained from the scientific literature review, grey literature, results of focus research and crowdsourcing initiatives dedicated to researchers. Additionally, in order to establish the final typology, three stages of the scientific research process (conceptual, empirical, and documentation stage), the support aspect of the research process (Keatinga & Furberg 2013) and three dimensions of crowdsourcing in science (crowd, initiator, and process) were taken into account. The first criterion focuses on this conceptual stage, which includes conceptualization, explication, and operationalization. This stage includes the following types of crowdsourcing in science: crowd ideation, crowd assembling resources, crowd literature review, crowd research question, crowd creation.

### **3.4 Step 4: Typology representation**

To determine the typology representation, we took into account the dimensions of crowdsourcing in science. After Estelle-Arolas and Gonzalez-Ladrón-de-Guevara (2012), the identified types of crowdsourcing in science differ in the degree of difficulty of tasks directed to the crowd and the degree of crowd involvement and cooperation. Crowd tasks range from simple to complex and creative (Durward et al. 2020). With regard to simple tasks, these are usually works that do not require close cooperation of many people, but the involvement of individuals, which does not involve a huge amount of work and time on the part of crowd members. Simple tasks require little cognitive load from the crowd. The crowd may be involved in complex tasks where there is a need for knowledge-based activities.

## **4. Discussion and Conclusion**

Our research broadens the knowledge of the types of crowdsourcing in science. We extend the existing findings (Uhlmann et al. 2019) and contribute to the crowdsourcing in science theory by providing a typology. Literature on type of crowdsourcing in science is scattered and the number of crowdsourcing in science initiatives that appear means that not all of them are covered by naming conventions. Our literature analysis showed 49 different types of crowdsourcing in science grouped according to four criteria: types of assets, types of tasks, types of results and the degree of inclusiveness. On the other hand, focus research allowed us to organize the identified types within the framework of the literature review. This allowed for the emergence of three additional, complementary types of crowdsourcing in science: monitoring, sharing content and communicating with other researchers. We eliminated the types not indicated by our interlocutors. Ultimately, we identified twelve types of crowdsourcing in science: crowd ideation, crowd assembling resources, crowd literature review, crowd research question, crowd creation, crowd science, crowd data collection, crowd data analysis, crowd review, crowd writing, crowd decision, and crowd networking.

Our findings provide some practical tips on the type of crowdsourcing in science. Firstly, the proposed crowdsourcing in science typology matrix may be a starting point for future research in the field of making decisions by practitioners regarding the choice of a specific type of crowdsourcing in science. It can also facilitate the analysis of crowdsourcing in science profiles, providing scientists with a more robust protocol to evaluate, compare and report their types. Secondly, irrespective of the type, initiators of crowdsourcing in science should clearly define the nature of crowd collaboration and task characteristics. It is indicated that crowdsourcing in science initiators can direct simple or creative tasks to the crowd, while the nature of collaboration with the crowd may be integrative or selective.

This study has several limitations. To identify the type of crowdsourcing in science, we conducted a literature review on crowdsourcing in science based on two electronic databases, Scopus and Web of Science. We included full-text English-language peer-reviewed publications in our review, which may have resulted in some articles being omitted. To prevent the risk of missing publications, we additionally conducted focus group interviews.

Another limitation of the study is related to the fact that crowdsourcing in science involves new initiatives that are evolving rapidly, which means that some types may have been omitted and not included in our proposal. Therefore, future research may focus on identifying new crowdsourcing in science initiatives such as open science, crowd research, and responsible research and innovation. The current research can also be expanded to include crowd motivation mechanisms, which may contribute to the provision of new types of crowdsourcing in science.

## **Acknowledgments**

This project was financed from the funds provided by the National Science Centre, Poland awarded on the basis of decision number DEC-2019/35/B/HS4/01446.

## **References**

- Doty, Harold, D. and Glick, William, H. (1994) "Typologies As A Unique Form Of Theory Building: Toward Improved Understanding And Modeling", *Academy of Management Review*, Vol. 19, No. 2, pp. 230-251.
- Durward, David., Blohm, Ivo, & Leimeister, Jan Marco (2020) "The Nature Of Crowd Work And Its Effects On Individuals' Work Perception", *Journal of Management Information Systems*, Vol. 37, No. 1, pp. 66-95.
- Estellés-Arolas, Enrique and González-Ladrón-de-Guevara, Fernando (2012). "Towards An Integrated Crowdsourcing Definition", *Journal of Information Science*, Vol. 38, No. 2, pp. 189-200.
- Franzoni, Chiara and Sauermann, Henry (2014) "Crowd science: The Organization of Scientific Research in Open Collaborative Projects", *Research Policy*, Vol. 43, No. 1, pp. 1-20.
- Karachiwalla, Rea and Pinkow, Felix (2021) "Understanding Crowdsourcing Projects: A Review On The Key Design Elements of A Crowdsourcing Initiative", *Creativity and Innovation Management*, Vol. 30, No. 3, pp. 563-584.
- Keating, M., Rhodes, B. and Richards, A. (2013) *Crowdsourcing: A Flexible Method For Innovation, Data Collection, And Analysis In Social Science Research*, In: *Social Media, Sociality, and Survey Research*, Craig A. Hill, Elizabeth Dean, and Joe Murphy (ed.), John Wiley & Sons, New Jersey.
- Kidwell, Mallory C., Lai, Calvin K., McCarthy, Randy J., Riegelman, Amy, Silberzahn, Raphael (2019) "Scientific utopia III: Crowdsourcing science", *Perspectives on Psychological Science*, Vol. 14, No. (5), pp. 711-733.
- Kietzmann, Jan H. (2017). "Crowdsourcing: A revised definition and introduction to new research", *Business Horizons*, Vol. 60, No. 2, pp.151-153.
- Uhlmann, Eric Luis, Ebersole, Charles R., Chartier, Christopher R., Errington, Timothy M., Kluge, Sussan (2000) "Empirically grounded construction of types and typologies in qualitative social research", *Forum: Qualitative social research*, Vol. 1, No. 1.
- Law, E., Gajos, K. Z., Wiggins, A., Gray, M. L. and Williams, A. (2017) "Crowdsourcing as a Tool for Research: Implications of Uncertainty", *Proceedings of the 2017 ACM Conference on Computer Supported Cooperative Work and Social Computing*, Portland, Oregon, USA.
- Lukyanenko, Roman, Parsons, Jeffrey, Wiersma, Yolanda F. and Maddah, Mahed (2019) "Expecting the unexpected: effects of data collection design choices on the quality of crowdsourced user-generated content", *MIS Quarterly*, Vol. 43, No. 2, pp. 623–648.
- Schlagwein, D., and Farhad, D. (2014) "User Requirements of a Crowdsourcing Platform for researchers: Findings from a Series of Focus Groups", *PACIS*.
- Tauginienė, Loreta, Butkevičienė, Eglė., Vohland, Katrin, Heinisch, Barbara, Daskolia, Maria, Suškevičs, Monika, Portela, Manuel, Balázs, Bálint and Průse, Baiba (2020) "Citizen science in the social sciences and humanities: the power of interdisciplinarity", *Palgrave Communications*, Vol. 6, No. 1, pp. 1-7.
- Webster, Jane and Watson, Richard (2002) "Analyzing the Past to Prepare for the Future: Writing a Literature Review", *MIS Quarterly*, Vol. 26, No. 2, pp. 13-23.