

# Application of Crowdsourcing Technology in Terms of Digitization of Supply Chain Strategy

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**Abstract**— The article presents the study on the problem of crowdsourcing application in terms of digital development of supply chain strategy. The purpose of this study is to develop the algorithm of application of crowdsourcing technology in terms of digitalization of supply chain strategy in socio-economic processes. The application of crowdsourcing technology facilitates the search for the most effective solutions to enterprise's problems, minimizing the time-related and financial costs for their development. In the framework of this study, the methods of analysis, comparative analysis, generalization, decomposition were used. The novelty of the research is in the detailed examination of the crowdsourcing technology, comprehensive description of the algorithm of its functioning with application in addressing various tasks of supply chain strategy. The findings of the study can help enterprises to elaborate the workflow supply chain management with regard to public opinion.

**Keywords**— *crowdsourcing, digitalization, supply chain strategy, crowdsourcing algorithm, focus-group.*

## 1. Introduction

A completely digitized supply chain does rely on intelligent, integrated solutions rather than manual inputs or human intervention; the digital supply chain does incorporate advanced systems capable of communicating and data sharing for optimal workflows; and a digitized supply chain is a holistic reimagination of how manufacturing companies operate their supply chain management strategies from procurement to the production floor to the customer's front door. Crowdsourcing is an innovative approach to delegating solutions to a specific group of people using the maximum possible human potential.

The aim of the study is to develop an algorithm for the use of crowdsourcing technology in terms of digitalization of supply chain strategy in socio-economic processes. In conformity with the aim,

the following objectives were formulated:

- to identify the core principles of crowdsourcing;
- to examine crowdsourcing instruments;
- to develop a model of crowdsourcing technology;
- to develop an algorithm of crowdsourcing technology in terms of digitalization of supply chain strategy in socio-economic processes.

The level of development of the research subject is determined by a number of publications of Russian and foreign scientists. In [1] examine an idea and basic concepts of the digital economy. Characteristic features of digital reality formation in Russia are observed in the work of [2]. Problems and prospects of digitalization of the Russian economy are depicted in the work of [3]. Specificity and challenges of transition to the digital economy are covered in the work of [4]. In [5] studied the internet as a platform of interaction between social groups. In [6] wrote about the principles of implementation of digital information technology at the state level.

Definitions, approaches and examples of crowdsourcing application were covered in the work of [7]. In [8] specified the tasks, goals, types of crowdsourcing. In [9] examined the concept, principles and specifics of crowdsourcing implementation. In [10] wrote about conceptual foundations of crowdsourcing, models of processes for managing different types of crowdsourcing projects. In [11] observed the essence of crowdsourcing as a tool of social and management development at the regional level. Criteria for assessment of the crowdsourcing efficiency are considered in the work of [12]. The work of [13] presents a review of crowdsourcing software. In [14] considers the use of crowdsourcing in terms of digitalization and the development of modern information and communication technologie.

In [15] looks at the motivational aspect in crowdsourcing. This avenue was also studied by Baruch et al. [16]. In [17] focuses on the motivation of participants in crowdsourcing online communities.

The use of digital mobile platforms is observed in the work of Marzano and colleagues [18]. Features of the application of social media for the implementation of crowdsourcing technology are presented in the work of [19]. Characteristics of mobile crowdsourcing are examined by Feng et al. [20].

As suggested by Likhachev, crowdsourcing is at the intersection of business socialization and open innovation – two phenomena that are widespread in the modern economy. The former indicates the social component of crowdsourcing; the latter specifies innovative orientation of this process. Crowdsourcing is a social technology, which means that it has the basic properties of this pool of instruments, the main one in this context is overcoming the barriers of time and space by providing the social interaction between specialists in various areas in the online sphere, thereby providing the opportunity to work collectively on content [21].

According to [22] crowdsourcing is at the crossroad between several mainstream management disciplines. The list includes information systems management (e.g. technologies, platforms, mechanisms, algorithms); marketing (e.g. advertising and promotion, marketing research); organizational theory and design (e.g. influence on micro/macro design choices and behavior, influence on management, employees and external actors' behavior, motivation and performance); and strategy (e.g. strategic dialogue and involvement, business models).

In [23], noted, that crowdsourcing allows the company management to solve a wide range of tasks, including: personnel search, research and product development, product strategy adjustment, fundraising, search and solution of organizational problems of an enterprise, optimization of business processes, implementation of the concepts of “lean production”, etc., forecasting the behavior of markets and events, development of design, logos, slogans, advertising, marketing research, solution of routine tasks suitable for remote work. In practical terms, several types of crowdsourcing may be distinguished: Crowd Creation, Crowd Wisdom, Crowd Voting, Crowd Funding,

Crowdtesting, Crowd Recruiting, Crowdstorming [24].

In [21], notes that as part of crowdsourcing, all social interactions between the participants of the crowdsourcing project are regulated by the organizer of the project. In this case, the main purpose of the arrangement of these social interactions is the creation, discussion, elaboration, selection and rating of the created content in order to solve the task set by the customer. In most cases, when applied to crowdsourcing, it is about working with innovative content. That is why the social possibilities of crowdsourcing are so important, because most innovations are the result of the synergy of the work of specialists of a variety of professional fields on the solution to a complex transdisciplinary task. From the perspective of socio-innovative nature, crowdsourcing can be defined as follows. Crowdsourcing is one of the types of social technologies, which, based on the model of open innovation aiming at obtaining new knowledge about innovative means of development of the initiator subject, via internet, social media and specialized computer platforms allows to involve in this process an indefinite number of persons from the external and internal environment of the organization, using their knowledge, professional and consumer experience.

According to [25], in crowdsourcing, governance involves structuring roles and responsibilities, formal and informal rules, standards and regulations, outcome control measures, communication processes, or matters of task allocation in order to achieve the crowdsourcer's goal. The authors identify the following attributes of crowdsourcing: Task definition encapsulates mechanisms that enable the precise, understandable, and repeatable definition for crowdsourced tasks; Task allocation means the invitation of a specific group of contributors to participate in solving a task; Quality assurance involves the evaluation of contribution quality; Incentives are the means for motivating and activating the crowd to conduct tasks; Qualification mechanisms help achieve and retain a “qualified crowd” and include peer coaching, e.g., experienced contributors answer questions from their less experienced peers and help them successfully solve tasks, or tutorials; Regulation mechanisms aim at directly controlling the behaviors of contributors to avoid violations of law and other misconduct.

The target audience of the project is fully defined and depends on the tasks that are solved during the project. The importance of choice of the proper target audience and its correct involvement also determine the effectiveness of the project. Different types of participants can constitute “a crowd”, according to [23]:

- interested in a particular topic, “amateurs”, whose hobby is related to the subject of crowdsourcing project;
- freelancers, such as designers who work on a portfolio, or are trained on real-world tasks;
- internal employees interested in certain changes or possessing certain information, experience and knowledge;
- consumers of the products or people interested in the brand;
- different counter-agents of the company;
- socially active internet users interested in the project;
- other.

According to Waldner and Poetz, while it is likely that crowds possess relevant knowledge for business model innovation, it is, however, less clear whether or not (at least some) users within the crowd are also willing and able to contribute their knowledge, specifically with respect to ideas for delivering and capturing value. The authors state that crowd members’ willingness to contribute to business model innovation may be influenced by how much they are attached to the product or brand of the firm. A strong passion for the product or brand usually facilitates users’ willingness to share their ideas and participate in firm-hosted innovation efforts [26].

In [23], states that the most preferable crowd project is the realization of the synergetic innovative potential of the crowd community on the basis of effective approaches to the selection of participants with respect to the project goals and the arrangement of their social interaction online. In this case, with a comparatively smaller amount of costs on support, the crowd project has the key prerequisites to becoming a self-organizing system. Despite certain shortcomings (ideas are publicly available and can be used by competitors; the complexity of the ideas selection), as stated by Goncharova, crowdsourcing, as a method to optimize the functioning of an enterprise, has a number of competitive advantages. These include the low cost of the project, the use of non-standard sources of innovative ideas, the use of ideas and

information of an unlimited number of people and the ability to select the best idea almost for free, the involvement of authoritative experts in the business development, as well as the opportunity to increase the company recognition (brand, product) and customer loyalty [24].

In [25] noted, that as practice shows, often the best results are achieved by non-professionals, people who are interested in a certain problem as a hobby (for example, the study of the human genome, bird behavior, development of open source software, industrial design, etc.), enjoying the process and having a strong motivation to get the result. A distinctive feature of the business model of “pure crowdsourcing”, according to the author, is the complete transfer of production functions to crowdsource workers. This inevitably leads to a reduction in the amount of staff. Company, therefore, may formally fall into the category of small businesses, while engaging hundreds or even thousands of crowdsource workers, where company neither need to put them officially on the staff nor need to bear social responsibility for the preservation of their ability to work and pay for leave.

In order to obtain the most effective results possible, companies need to pay due attention to the choice of crowdsource participants that would be fully involved in the crowdsource project. According to [27], the involved crowdsource worker is the one who:

- dedicates a significant amount of own time and energy to crowdsourcing project;
- actively involved in various crowdsourcing projects, offering own ideas for all areas of work at the platform, participates in teams and crowdsourcing participant community;
- spends free time to study additional materials related to the task, not only in own area of knowledge, but also in related areas and the whole project;
- actively cooperates with participants in different areas for discussion of problems;
- positively represents crowdsourcing at external events, in communication with various people, recommends them to take an active part in crowdsourcing;
- constantly invents and implements new ideas on the platform, which positively influence the project;
- avoids any form of behavior that may cause direct or indirect damage to the crowdsourcing

participants and crowdsourcing platform as a whole;

- positively perceives the changes taking place on the platform and is always ready to continue to discuss the ideas of the participants, despite the circumstances.

In [27] highlights that crowdsourcing participants should know and understand exactly what is expected from them on the crowdsourcing platform. If the expectations are unclear, crowdsource worker may not be able to cope well with the tasks, which will cause *laissez-faire* approach to the process of generating ideas and, eventually, disruption of work. Thus, for the implementation of a set goal, the participants of crowdsourcing should have tasks that are clearly formulated.

Crowdsource workers should have good motivation for the successful performance of tasks they are given. The company may seek for different incentives for the promotion of productive work of project participants. As states [28], the possibilities of monetary incentives for participants in crowdsourcing projects are usually limited, but this does not reduce the effectiveness of other, non-monetary incentives. A very promising motivator is the possibility of promotion, development of a virtual career as a certain progressive movement through the stages of an organized hierarchy, which entails more opportunities for decision-making, more responsibility, more benefits and privileges. The author notes that managing motivation of crowdsource workers only in this direction can lead to the fact that, assessing their personal successes, participants will not seek to help each other, which means that there will be no synergistic effect from the interaction. The ground for the promotion of participants in crowdsourcing projects and a tool to stimulate their interest in the work performed can be a rating system.

In [27] notes that in the framework of the crowdsourcing project, in order to increase the level of involvement crowdsource participants into the work, crowdsourcing facilitators are of great importance. These are participants of the crowdsourcing platform, who engaged in the management and arrangement of group forms of work with the aim to increase their effectiveness. The task of the facilitator is to control compliance with the rules and to promote a comfortable atmosphere, group cohesion and productive discussion, to eliminate negative and provocative

attitude, which allows directing the discussion in a constructive course.

In [29], defined important factors that determine the effectiveness of the facilitators:

- daily activities to coordinate actions and develop a common vision of the project participants;
- introduction of formal structures as a basis for people communication with different viewpoints and life experience;
- maintaining a certain level of competition between participants and teams as a work driver;
- combination of individual work of facilitators with responses of the project manager to critical questions of individual participants;
- different modes of moderation of personal, working and general project communication channels.

According to [30], crowdsourcing benefits for the company in the following ways:

- Reducing transaction costs;
- Adding consumer value to products/services;
- Fostering of innovative developments;
- Interaction with consumers;
- Promotion of a project/product/service on the market;
- Increased demand for products/services, which is generated with the participation of diverse "crowd". Profit through the formation of additional demand for the project/product/service.

## 2. Materials and Methods

The methodology of the research work was defined mainly by the aim of the study, which is the development of an algorithm for the use of crowdsourcing technology in terms of digitalization of supply chain strategy in socio-economic processes.

Methods of analysis, comparative analysis, generalization, decomposition are used in the course of the study. Theoretical and empirical methods of analysis revealed the essence, types of crowdsourcing, the application of crowdsourcing instruments. The method of comparative analysis helped to reveal the possibility of using crowdsourcing. The method of comparative analysis allowed to develop an algorithm of crowdsourcing technology in terms of digitalization of supply chain strategy.

The method of generalization made it possible to assess the level of achievement of the research aim and to formulate the practical value of crowdsourcing technology for enterprises. The decomposition method allowed to separate the algorithm of crowdsourcing technology into constituent parts and to outline each of the sub-stages. The algorithm of crowdsourcing technology is considered as the object of research.

### 3. Results

Digitalization is a widespread supply chain strategy phenomenon. It has an impact on the social and economic structure of society, markets, as well as on the transformation of the system of social relations [1], significant improvement in labor quality and productivity, ensuring a high level of service functions. At present, there is an active process of replacing human labor with digital tools and technologies in accounting, personnel, management accounting, stock exchange activities, in the service sector up to medical procedures [2]. There is a tendency towards replacement of the teaching staff with robotic tutors, digitalization of the learning process, minimization of personal contact with students through replacing by electronic forms of interaction and knowledge control. There is an implementation of digital technologies for management of engineering infrastructure of enterprises, buildings, structures [4]. Digital interaction of government bodies with citizens and business units is actively implemented through the introduction of information and telecommunication technologies [31]. However, it is also necessary to pay consideration to the significant deficiencies of this process associated

with the transformation of workplaces, which can cause a significant increase in technological unemployment [3].

At the stage of development of the digital economy and digital society, it is important to use effective models of information collection and processing. In view of this, crowdsourcing technology should be used. Crowdsourcing is a digital process that is able to minimize the negative aspects of the multifaceted process of transition to the digital economy in modern society by involving via internet, customized computer platforms and social media of a group of people for addressing various tasks at the level of the state, region, and individual business [21].

Crowdsourcing is a technology of using collective intelligence, attracting a large number of people to the formation of an idea bank in order to solve problems at various levels [9]. Nowadays, crowdsourcing is used via the internet, which represents a platform for interaction between different social groups [5]. Crowdsourcing is aimed to solve complex interconnected problems:

- information collection and processing;
- constructive ideas collection and processing;
- gathering proposals for draft papers;
- formation of a pool of independent experts.

According to [8], there are several types of crowdsourcing depending on the degree of activity, the coverage of participants and the number of ideas (Table 1).

**Table 1.** Crowdsourcing categorization (made by authors).

Criteria	Type	Description
Activity degree	passive	information receiving
	active	constructive dialogue
Participants coverage	internal	within the organization or group of experts
	external	without limitation of participants
Number of ideas needed	traditional	search for the best idea among many others
	syntellectual	search for several best ideas through their collective selection

The principle of crowdsourcing is to accumulate knowledge and experience of many people interested in solving a certain problem, however, there is a need to create proper conditions for the implementation of this knowledge. It is possible to say that crowdsourcing is a methodically and

organizationally ordered model of interaction between the organization and initiative internet users [20].

There are following tasks that can be solved with the help of crowdsourcing in terms of digitalization of supply chain strategy:

- Discussion and assessment of the organizations' activities (either in the voting mode or by collecting specific opinions and finding solutions);
- Resolving (decision-making support) of a certain task faced by organizations directly;
- Collecting information (improving the reliability of information through the use of a wide variety of sources);
- Collecting opinions (the ability to reach hundreds of thousands of people to get feedback in the form of opinions, various responses);
- Identification of the needs of citizens;
- Increasing the loyalty of citizens through their involvement in the internal operations of organizations;
- Development of innovations (from idea generation to independent creation of a product or a service) [14].

In order to implement and develop crowdsourcing, it is important to create proper conditions, neglecting of which will put the given management tool at risk of defamation. The use of

crowdsourcing for problem-solving should not be permanent, because it is difficult to ensure the activity and motivation of public experts for a long period of time [10].

Crowdsourcing has to stem from extensive ideas about the state, problems and specifics of organizations, the current regulatory environment, the adopted system and management structure. Without this knowledge, basing only on the results of public expertise, the risks of a formal approach to solving social problems increase [11].

The core problem that can be solved by implementation of crowdsourcing in the workflow of organizations is the discussion of various initiatives, the evaluation of activities (either in the voting mode or by collecting specific opinions and finding solutions), as well as the solution (decision-making support) of a certain task faced by organizations directly [16]. In the framework of crowdsourcing technology, there can be used online focus groups, forum groups, online surveys, internet projects, which are associated with the following actions that can be applied when using crowdsourcing instruments (Table 2).

**Table 2.** Application of crowdsourcing instruments (made by authors).

Instrument	Description
Voting	May be built upon starting the forums in social media, which implies social media profile managing by corresponding specialists.
Expert group discussion	Search for solution, which may be implemented through the discussion involving the expert groups via online focus-groups. This is an intellectually intensive type of crowdsourcing due to the involvement of various platforms that address any issues related to the analysis of information and finding solution. This crowdsourcing type is fully represented by the platforms aimed at collection of ideas, their structuring, discussion and choice of the best solution. This type also includes the platforms covering the niche of microtasks by splitting the problem via facilitators into numerous small ones, each of which is assigned for a separate solution [18].
Search for crowdsource workers	Platform data exist both online and offline and for their operations they actively involve physical resource, volunteers mainly, that help to cover a large territory.
Information acquisition	Built upon performance of ordinary simple action (photo sorting, sound filtration, image identification) or an observation.
Opinion collection	Realized through either forum-groups, online surveys or online and offline focus-groups. One of the absolute advantages of crowdsourcing is a possibility to address hundreds of thousands of people to get feedback in the form of opinions and responses. Its value is attributed to the coverage of the large respondent database which should be segmented with subsequent selection of particular groups.

It is imperative that crowdsourcing technology is based on platforms covering the five actions presented above.

Limitations in the development and implementation of crowdsourcing may stem from unwillingness of citizens to take an active part in discussion of emerging problems. In view of this, it is necessary

to conduct an intensive public awareness campaign to involve the population in crowdsourcing, which is impossible without the development of appropriate motivators. Motivation of participants is one of the most important criteria, as only the interested person can offer really worthwhile ideas [17]. In addition, increasing the involvement of the population in the solution of various issues should be based on the development and implementation of effective communication policies, including the use of various tools, including public service announcement [15]. A model of crowdsourcing technology should be presented as sociological support of supply chain strategy with elements of active sociology (Fig. 1).

Each of these subsystems should be formalized and described, integrated into the model of management of the sociological support system.

The model of crowdsourcing technology relies on the formulation of the mission and goals of the implementation and use of the system of sociological support of organization operations. Thus, as a mission implemented by this system, the effective sociological support for organization

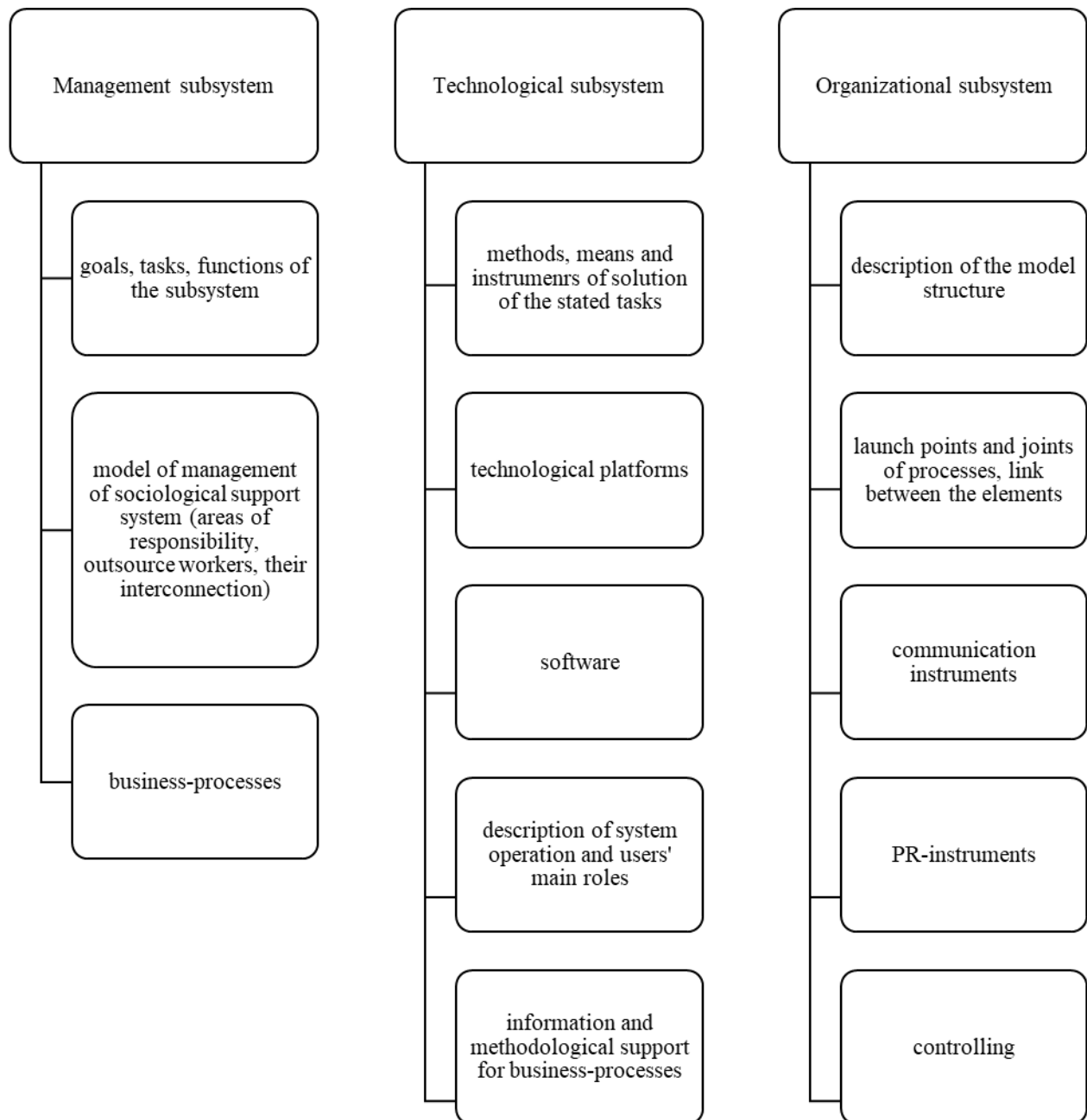
operations can be considered. At the same time, it is advisable to divide the implemented goals into several levels:

Level 1 – a global goal related to the digitalization of supply chain strategy, mitigation of the difficulties and barriers of this process in society;

Level 2 – goals of subsystems of sociological support model. At this level, the goals of management, technological and organizational subsystems are formed, which are developed in the process of establishment of these subsystems and their further improvement. The goals of the management subsystem may be:

- ensuring and support of effective business processes in the system of sociological support of organization operations;
- achievement of the highest level of indicators characterizing public opinion.

Level 3 – goals of the individual elements of the subsystems of the crowdsourcing technology model.



**Figure 1.** Crowdsourcing technology model (made by authors).

#### 4. Discussion

Digitizing the supply chain is the movement toward a completely integrated sequence of planning and production solutions that work in tandem to create a more visible supply stream across each touch point of the value chain. The end result is a more responsive, agile, and transparent supply network

that can readily adapt to a host of industry-wide unknown variables such as inventory shortages or overages, modifications to orders, and availability of resources. Crowdsourcing technology is a combination of interrelated actions, which should be presented in the form of an algorithm (Fig. 2).



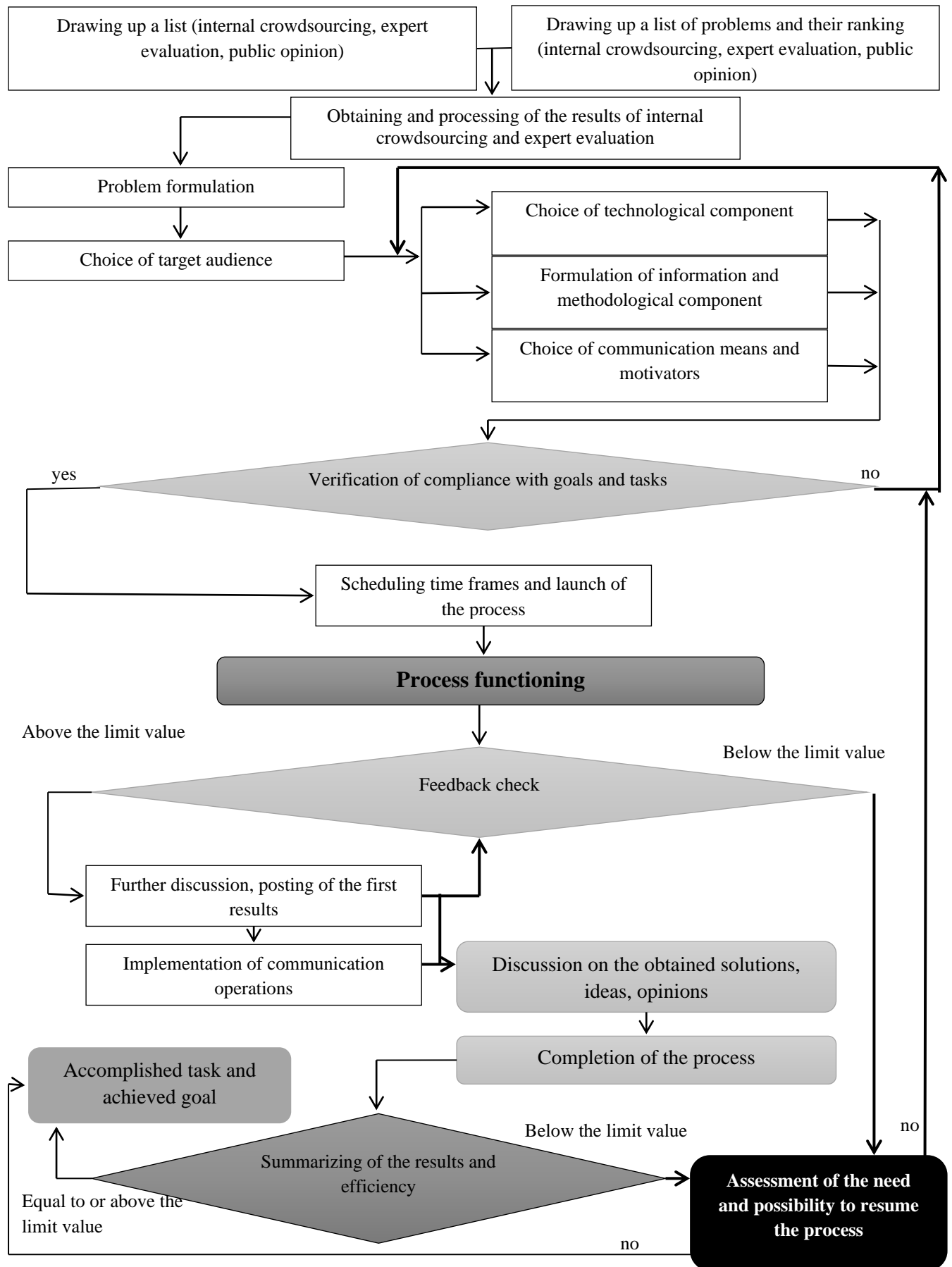


Figure 2. Algorithm of crowdsourcing technology in terms of digitalization of SCS processes.

The characteristics of the stages of algorithm of crowdsourcing technology functioning is presented in Table 3.

**Table 3.** Characteristics of the stages of algorithm of crowdsourcing technology functioning in terms of digitalization of supply chain strategy (made by authors).

Stage	Sub-stage	Description
Identification of the key problem	Formulation of a key problems list	- use of the internal crowdsourcing built upon the survey; - public opinion identification through online survey via social media and creation of specialized groups and discussion pages [19]. - arrangement of expert evaluation involving at least 20 experts or more by using the methods of personal interviewing.
	Formulation of the key problems	Involves the synthesis of problems identified on the preliminary stage with subsequent elimination of the least real ones, forming the single list out of three previous.
	Ranking	This stage comprises the identification of the most pressing problems through the mass online survey, online focus-groups and expert evaluation. It may be implemented through internet survey with use of open questions, such as “Please, arrange in the descending order the most pressing problems listed below according to your opinion...”
Launch of the process	Choice of a platform for crowdsourcing	Identification of technological solutions for crowdsourcing (selection from the available or development of a customized one are possible).
	Formulation of problem and identification of target audience	Identification and characterization of groups used in the process of crowdsourcing.
	Identification of instruments	Formulation and characterization of crowdsourcing means and methods used for a solution of a formulated problem.
	Choice of communication impact means and motivators	Formulation of a communication plan and motivational program, as well as means of their implementation. Such as, in case if a problem requires the involvement of a greater amount of participants, it is worthwhile to use the morning projects and major TV and radio shows, location of billboards in crowded public areas (railroad stations, malls etc.), running letter in transport etc.
	Scheduling time frames for the process	Setting the exact term for process implementation.
Process functioning	Control and regulation of the process, ensuring the information security.	This sub-stage implies the monitoring over the process behavior, elimination of technical and organizational failures.
	Elimination of information overload, spam, bots etc.	Regulation and monitoring over the filters operation, selective testing of a process in the form of various users and other monitoring actions.
	Grouping	Information processing, opinions and ideas grouping.
	Public awareness	Extended coverage in media on the process of project implementation, involvement of a greater amount of participants.
Completion of a process	Process termination	Summarizing the visible results, calculation of the number of participants, regions and other quantitative indicators that are possible to determine without preliminary processing.

Stage	Sub-stage	Description
	Filtration of the results	Processing and analysis of the data obtained, highlighting of the key solutions and ideas (identification of the opinion), ranking. This sub-stage may be implemented by involvement of two expert groups – the external and internal ones – thereby improving the objectivity of the results obtained and allowing to eliminate the a priori inappropriate solutions.
	Efficiency measurement	Implies calculation of the main indicators of the efficiency of the process, technological, information and methodological components. Its implementation requires the development of assessments and indicators system, methodology of their calculation and parameters.
Feedback	Announcement of the results	Extended coverage of the process results in media, announcement of winners (if applicable) etc.

There are many foreign technological platforms for crowdsourcing, such resources as Kaggle, CrowdFlower, InnoCentive, Academy of Ideas, Flightfox, DARJEELIN and other platforms offering opportunities of including holistic intelligent solutions and solutions to utilitarian particular tasks [13].

Among Russian companies, a special attention can be given to Witology and Millionagents.com. Witology offers its clients a variety of options – from a mini-project (an urgent task that requires a quick solution) to a “platform license”, which provides full access to the independent use of the platform, specially developed online working environment that has all the necessary functionality for collective intellectual work on the problem. In Russia, the platform Citycelebrity.ru is also presented, which target audience is medium and small businesses, as well as Millionagents.com, that offers field marketing research.

## 5. Conclusion

The future supply chain planning will largely benefit from big data and advanced analytics as well as from the automation of knowledge work. It needs fast and accurate process to use supply chain strategy which can be enhanced by digitalization. The obtained research findings in the form of a model and algorithm of crowdsourcing technology can be applied both at the state, regional level, and by separate business units in order to improve their performance. The use of crowdsourcing in enterprises contributes to the transparency of decision-making, increasing the level of involvement of citizens in solving of problems, minimizing time-related and financial costs in making management decisions.

The novelty of the research is in the detailed examination of the crowdsourcing technology, comprehensive description of the algorithm of its functioning with application in addressing the supply chain. The functioning of crowdsourcing technology based on the presented algorithm will enable to conduct effective actions promoting the solution of problems and organization development. The transformation into a digital supply chain requires two key enablers - capabilities and environment. Capabilities regarding digitization need to be built in the organization (see the chapter on capability building) but typically also require targeted recruiting of specialist profiles. The second key prerequisite is the implementation of a two-speed architecture/ organization. This means that while the organization and IT landscape are established, an innovation environment with a start-up culture has to be created.

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