Crowdfunding in science: towards socially responsible innovations

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Abstract

Researchers nowadays face complex challenges to obtain adequate funding while at the same time preserving their academic, political and institutional freedom. The concept of "crowdfunding" is a response to these challenges. Crowdfunding is a new internet-based method of fundraising in which individuals solicit contributions for projects on specialized crowdfunding platforms. This paper explores crowdfunding for science in a broader context of organizational cybernetics, based on the analysis of the current landscape of independent fundraising in Russia. The author of this paper argues that crowdfunding for science can be viewed not merely as a tool to support independent research projects, but as a mechanism to mobilize academics and society members as agents for change within new innovative environments.

Keywords: *Crowdfunding in science, social responsibility, innovations, reflexive systems and interactions, organizational cybernetics, self-developing and self-organizing environments.*

Množično financiranje v znanosti: k družbeno odgovornim inovacijam

Povzetek

Raziskovalci se danes soočajo s kompleksnimi izzivi za pridobitev ustreznega financiranja, hkrati pa bi ohranili svojo akademsko, politično in institucionalno svobodo. Koncept „množičnega financiranja" je odgovor na te izzive. Crowdfunding je nova internetna metoda zbiranja sredstev, v kateri posamezniki zbirajo prispevke za projekte na specializiranih platformah za množično financiranje. Prispevek raziskuje množično financiranje znanosti v širšem kontekstu organizacijske kibernetike, ki temelji na analizi trenutne slike neodvisnega zbiranja sredstev v Rusiji. Avtor tega prispevka trdi, da se množično financiranje za znanost ne more obravnavati le kot orodje za podporo neodvisnim raziskovalnim projektom, ampak kot mehanizem za mobilizacijo akademikov in članov družbe kot dejavnikov sprememb v novih inovativnih okoljih.

Ključne besede: množično financiranje v znanosti, družbena odgovornost, inovacije, refleksivni sistemi in interakcije, organizacijska kibernetika, samo-razvijajoča se in samoorganizirajoča okolja.

1 Introduction and definition of crowdfunding

The growth of digitalization of science has affected almost all of its aspects, from scientific to organizational, by proposing to the scientific community new research approaches that are independent of the geographical distance of their participants and their disciplinary specialization.

Nevertheless, the financial aspect of the organization of scientific research until recently, in fact, remained separated from the progressive influence of information technology. Financing of scientific research is currently carried out according to the same approach as in the beginning of the 20th century — at the level of direct or indirect interaction between two categories of agents: clients and contractors. In this scheme both participants find themselves in radically different conditions, having minimal, if any, insight into each other's undertakings. Moreover, the differences between two categories of agents are only deepened as the subject matter of the study becomes more complex and the number of interdisciplinary connections rises. The aforementioned tendency is more evident in state scientific organizations and large corporations, however, independent research groups are far from being free from this malpractice. As a result, many promising research areas in modern science are left without proper support, only because their potential outcome is not valuable from a commercial or state-economic perspective. In this regard, it is worth to pay attention to those financial instruments that arose relatively recently in connection with the development of the information technology network segment, namely, the so-called schemes of public financing, or crowdfunding.

Crowdfunding is a relatively new internet-based phenomenon in research, which is now gaining momentum (Belleflamme et al., 2014). However, it is safe to say, that the original concept of fundraising has been around for centuries now (Lasrado and Lugmayr, 2013). Also, crowdfunding can be seen as a subset of crowdsourcing, (e.g., Lasrado and Lugmayr, 2013; Mollick, 2014; Zheng et al., 2014; Bretschneider et al., 2014), with an extra feature of generating funds for ideas and initiatives. The author of this paper adopts the definition of crowdfunding stated by Lasrado and Lugmayr (2013) as a “process of an individual or group of individuals or institutions raising capital for a cause; be it cultural, social or business by attracting small contributions from a large crowd by using social media and internet as the medium for communication”.

The practice of crowdfunding implies attracting large groups of people to finance a project, as a rule, via the Internet without the participation of large legal entities and financial institutions (banks, funds, venture capital companies). Crowdfunding has two mechanisms of implementation — collecting donations and issuing securities. The first method involves the adoption of small cash contributions in exchange for various types of remuneration in the form of priority access to the final product, or to its additional features. In the case of issuing securities, applicants offer to make larger payments in exchange for a share of ownership or future earnings. Regardless of the mechanism chosen, crowdfunding works according to the same scheme: the applicant publishes a profile describing the project on the Internet, and volunteers invest money if the project interests them.

From the point of view of scientific research, crowdfunding appears to be most promising for targeted innovation research, while large fundamental projects have better chances for funding from large customers, both private and public. However, funding from the “crowd” (be it the general public or a certain community) could be used to expand the total amount of resources

available for scientists, participating in large projects, at least partly compensating for tighter budgets of governmental and private agencies. Moreover, young scientists without established track records are more likely to find much needed financial support via crowd-based projects, than through traditional channels. And finally, crowdfunded projects may bring together diverse groups of individuals from different and often unprivileged backgrounds, paving the way to *participatory innovations*, where researcher and society are connected on a basis of shared values, transparent legal conditions and common responsibility. The author of the paper focuses on the phenomenon of this cooperation, based on Russian examples, analyzing it from the standpoint of a new direction in organizational cybernetics — third order cybernetics.

2 Scientific crowdfunding in a broader context of cybernetics and philosophy

2.1 Methodological analysis

The methodology of this paper is based on the theoretical concept of "third-order cybernetics", defined by V. Lepskiy at the Institute of Philosophy of the Russian Academy of Sciences (Lepskiy, 2018). It states that philosophy of science is passing through three stages: classical, non-classical and post-non-classical. (Stepin, 2005). Each of the three development stages of science are associated with the dominance of one of three types of scientific rationality — classical, non-classical and post-non-classical rationalities. The scientific rationalities are not alternatives. Each subsequent rationality has its own features but includes also the previous types of rationality. Post-non-classical scientific rationality integrates all three types of scientific rationality. It is necessary to state that each scientific rationality is defined by the dominant paradigm of scientific reflection. Classical science relies on simple and direct *subject to object* relations. All reflexivity in classical science is based exclusively on the researcher's perception of himself and his object of interest. Yet the object of interest is devoid of any reflexive activity, even if it is capable to provide such. Non-classical rationality, to the contrary, focuses on *subject to subject* relations, exploring reflexive activities between equally recognized subjects, capable of imagining themselves as well as others. Post-non-classical scientific rationality broadens the concept of reflexion, exploring interactions between *subjects and poly-subject environments* — complex societal and cyber-systemic models, which incorporate diverse intelligent agents, pursuing various (and sometimes radically different) goals.

According to the aforementioned concept, the evolution of cybernetics is also represented as a continuous shift from the methodology of "observable systems" (N. Wiener) to the methodology of "observing systems" (Foerster, 1979) and to the methodology of self-developing reflexive-active environments (Lepskiy, 2018a, 2018c). Self-developing reflexive-active environments are considered the cornerstones of organizational and systems interactions in the concept of third-order cybernetics (Lefebvre, 1982; Lepskiy, 2016). These environments permit combinations and interactions of diverse subjects (individual, corporate and social) in various forms of activity: traditional (process- or business-oriented) activity, communicative activity and reflexive activity. Such an environment is fundamentally different from networks, as it creates opportunities for subjects to project their identity and core-values on other individual subjects and their associations.

Reflexive-active environments have the following *inherent principles (Lepskiy, 2018a)*, which allow us to use their theoretical concept to classify relationships in crowdfunding:

I. **Poly-subjectivity and diversity**. Crowdfunded projects attract vast amounts of diverse agents or subjects, such as scientific and business entrepreneurs, hired experts, conducting peer-reviews, government officials and, — the "crowd" itself. The crowd, a large group or conglomeration of individuals, in this case transforms into a meta-subject, acquiring features beyond any individual or collective identity;

II. **Ability to project values and identity**. Crowdfunded projects operate within an interactive framework from the start, where every participant theoretically has equal means of communication as well as influence on the final result. Realizing that, project participants begin to identify their personal success with the positive outcome of the project as a whole;

III. **Democratic communication and influence matrix**. In crowd projects entrepreneur directly interacts with voluntary investors who have the opportunity to influence the course of work on selected topics, fully concentrating on financing the main direction of research works, or allowing the researcher to delve into the details of related and side branches. At the same time, Internet communications greatly simplify the process of reflexive interaction, ensuring continuous dialogue outside the framework of traditional project reports, while avoiding the formalism of rigid bureaucratic schemes;

IV. **Non-hierarchical leadership**. Traditional research process is organized into a pyramid-like structure. At the lowest level, less-experienced employees take direction from supervisors at higher levels. Communication typically flows from the top to the bottom. Crowdfunded projects often forgo this approach, focusing on task-oriented teams, which may also delegate parts of their work to the crowd itself (f.e. in crowdfunded crowdscience projects).

V. **Virtue ethics**. Successful scientific crowdfunding projects inevitably tend to focus on socially beneficial projects. This results from the inherent features of crowdfunding as a model. Commercial and creative entrepreneurs offer special material rewards to their backers, like product prototypes, or shares of future market profits. Scientific crowdfunding projects often don't have such means of stimulating compensation. Benefits for certain groups (like cancer patients) or society as a whole become the only rewards academics can provide to their supporters.

2.2 Crowdfunding in context of reflexive-active environments

Adhering to the principles outlined above, the matrix of relationship in crowdfunding, however, cannot be considered as a reflexive-active environment by itself. Rather, it can be viewed as a part of *support ontology* — another crucial theoretical concept in third-order cybernetics, which represents participatory models of subject-to-subject interaction within reflexive environments (Lepskiy, 2018a, 2018c). Currently, third-order cybernetics outlines five ontologies:

1. *Accompanying* — control of established activities and communications;
2. *Support* — overcoming "points of disruption";
3. *Development* — strategic objective-making;
4. *Construction* — creation of development projects (strategies) based on the results of strategic goal-setting;
5. *Innovation* — implementation of strategies and projects of strategic objective-making.

Ontology of support, part of which is crowdfunding, solves problems of "disruption points" in established activities and overcomes them. In science, such pitfalls occur on the road between discoveries, generated from basic research, to a commercial product.

Innovators and investors alike routinely claim that a 'funding gap' or 'Valley of Death' exists between basic research and commercialization of a new product (J. Ford, L. Spiwak, 2007). Yet, it is important to realize, that there is more than one gap on this perilous journey. The first pitfall, as mentioned earlier, innovators and investors routinely face when transferring from basic research to the commercialization of a new product (TRL 4-7)[1]. This gap most often occurs when public investments are made at earliest research stages without sufficient attention to the likely investment needs and decisions at later stages of the innovation process.
The second pitfall stems from the challenges of pushing an innovation out to a broader market (TRL 8-9), when innovators struggle with the low cash flow, caused by the first funding gap.

Currently, there are no universall institutional means to cover both of these gaps. Public and agency-related institutions typically lean toward early and broadly applicable basic research. Private investing institutions, on the other hand, make investments in businesses that emphasize strong management teams and products, not technologies or scientific discoveries (Helmstetter, 2018). Contrary to this practice, resorting to crowdfunding and crowdinvesting, enterpreneur can apply for financial support on all project stages. This aspect also strenghtens businness relationships of scientific enterpreneurs, as in crowdfunding it is sometimes difficult to differentiate between two seemingly opposing market groups — customers and investors. Fund donors of crowd projects may support interersting ideas not only bearing future profits in mind, but also willing to obtain the future innovation for private use.

2.3 Scientific crowdfunding and social responsibility

According to recent studies, the probability of success among scientific and tech crowdfunded projects depends on the type of innovation behind it (Chan and Parhankangas, 2017). In this regard, projects that bring radical innovative outcomes are less likely to succeed (Calic and Mosakowski, 2016). The negative effect of radical innovativeness on the crowdfunding campaign outcome can be explained by the fact that such projects seem to possess greater risks to lifestyles of potential fund donors, having disruptive effects on well-established socio-economic systems. Moreover, potential fund donors often find it difficult to understand ideas behind radically innovative proposals, which often tend to be more complex in nature and require extended competences both from their supporters and initiators. On the contrary, sustainability oriented projects, featuring incremental innovations, with positive impact on the society have greater success rates.

Bearing sustainability in mind, a possible way to enhance the social impact of scientific crowdfunding would be to integrate it into territorial projects based on smart communities — geocentric organizations, empowering local population to solve vital problems, which require extensive research and financial resources, unavailable from government agencies on site. Smart communities, acting both on-line and off-line can offer crowdfunders invaluable locally obtained data and well-motivated support. In this regard, it should be noted that some authors differentiate between communities and 'crowds' (Haythornthwaite, 2012), the first being

[1] Technology Readiness Levels according to NASA terminology.

defined as social groups that know each-other and share some common interests, while the latter suggests big groups of people gathered together (Merriam-Webster, 2017). Still, from the third-order cybernetics point of view, these differences are not evident anymore.

Although geographical proximity remains a determining factor that characterizes the community, face-to-face interactions between peers do not fully represent a reality anymore, due to the concept of *double subject* (Lepskiy 1998). This concept determines the most important technological procedures for interaction of subjects with social systems in the modern digital reality. The meaning behind double subject concept can be interpreted as the dynamic transformation of physical subjects into a virtual group (Umpleby, Lepskiy, 2019). Web 2.0 era has spawned diverse forms of interactions, usability and interoperability between individuals (Haythornthwaite, 2012), which made it possible for local communities and 'crowds' to form social identities and to generate common values. (Wieczerzycki, 2016).

In this regard, it is worth to pay attention to the case of "Beautiful Petersburg" — a community revitalization project based on crowdsourcing and crowdfunding technology. This project was started in 2012 in the Russian city of St. Petersburg as a free association of citizens creating around themselves a new socio-political and sociocultural environment to defend their mutual interests. For several years, from 2012 to 2019, the number of supporters of "Beautiful Petersburg" grew from one participant, the ideologist of the project, to 100,000 people, and a network of similar community projects was created in 33 cities of Russia.

"Beautiful Petersburg" has no legal entity, is not registered as an organization, and its members interact with the authorities as ordinary citizens of the country. Thanks to the website and the "Beautiful World" mobile application, both developed by the means of crowd technologies, members of this community solve problems of their urban environment, such as pavement deterioration, street-cleaning, historical monuments restoration etc. This process is organized into six steps. First, community-members collect data about potential problems to solve. On this step, every citizen with a smartphone becomes a data-contributor. Second, a problem map is formed with a description of issue and its geolocation. After it, crowd experts conduct assessment and research. In case of historical monuments issues it is not uncommon for the community to raise money to hire highly skilled academics, who could assist with restoration activities. Following the assessment, the package proposals are formed. These proposals are then submitted to authorities and volunteers alike to be resolved under community supervision.

Exploring interactions within smart-communities such as mentioned above can bring early insights into possibilities of reflexive-active environments of the future. A local level of deployment does not simply add new resources to crowdfunding, but shapes it into a broader social context of crowdsourcing as a functional mechanism of user-driven eco-systems. These would allow us to accumulate collective intelligence, attracting a large number of participants and their intellectual and financial capital to solve complex tasks, including those that are unachievable for small teams (J. Surowiecki, 2004).

Still, potential types and structures of future collaborative frameworks require further extensive examination from academics as well as substantial efforts on individual and collective levels. Considering that crowdfunding is of a social rather than solely technological nature, one can conclude that its progress will directly depend on the progress of society as a whole.

3 Scientific crowdfunding in Russia

3.1 State of the Art

Currently there are about 20 crowdfunding platforms in Russia, and 14 of them are accessible and functioning. The remaining 6 are out of service, being temporary or permanently blocked. However, of all functioning Russian platforms, only three accepted scientific and technical projects on their platform and can be used by the student and scientist community for the commercialization of their developments: “Planeta.ru”, “Boomstarter” and “Every little bit helps” (Table 2).

Table 2: Brief Characteristic of Russian Crowdfunding Platforms

Crowdfunding platform	**Types of projects**	**Number of active projects**
ThankYou.ru	Creative	406
Planeta.ru	Any (Scientific included)	315
Boomstarter	Any (Scientific included)	200
Rusini	Social, creative and IT	93
Kroogi	Music Video	9
Tugesa	Social	4
Every little bit helps	Any (Scientific included)	3
Electronic charity box	Social	1 per month
IT RockOut	Software development	0
Naparapet	Creative	0
First capital	Test mode	0
Rustarter	Test mode	0
Crowdpres	Under development	0
Where are my money	Under development	0

Judging by the data above, it can be safely stated, that Russian crowdfunding market is still in its early stages of development. For example, in 2014-2017 the most popular and successful crowdfunding platform in Russia — “Planeta.ru”, which also deals with scientific projects, raised 14 million dollars and had 2807 successfully funded projects. By 2017 Kickstarter, the world’s largest platform, raised 3,5 billion dollars in funds and successfully financed 138 thousand projects. Unfortunately, the scientific segment of Russian fundraising platforms is even less mature (Table 3).

Table 3: Scientific Crowdfunding Platforms in Russia — structure of financing

Platform	**Number of successful scientific and academic projects**	**Highest cost of the successfully funded project (USD)**	**Average cost of the successfully funded project (USD)**	**Number of active scientific and academic projects**	**Average project cost (USD)**
Boomstarter	31	23 682,96	3 514,12	32	67 154,34
Planeta.ru	73	3 844,23	1 871,17	28	16 104,47
Every little bit helps	11	997,96	356,39	N/A	N/A

Extremely low levels of funding and a small number of active and successful projects do not allow us to classify crowdfunding in Russia as a popular way to obtain funds for research. For example, US-based platform "Experiment.com" has about 1 820 active projects hosted, "Science Starter" (Germany) — 122, "Davincicrowd" (France) — 92. The disparity is evident and current Russian scientific and tech entrepreneurship system is to blame. Much of Russia's private sector is highly concentrated, with a small number of large companies that have neither the objectives to cultivate scientific entrepreneurship nor the necessary understanding of the requirements to do so. This reduces the prospects for young independent academic collectives and small tech companies in terms of partnerships and market entry for their innovations.

In Russia, even the most basic small-scale innovations face certain financial and legal risks during their initial development stages, and this problem is not a secret to institutionalized fund donors, who may have stronger preference for less risky projects. Unlike their western counterparts many academic and charity institutions in Russia are hesitant to provide their support to independent scientific collectives on a basis of joint research projects. As a result, relying mainly on individual investors, rather than large institutions such as 'funds of funds', makes fundraising a challenge for russian academic and tech enterpreneurs.

Finally and importantly, the Russian market lacks dedicated scientific crowdfunding platforms such as "Experiment" and "Consano", relying mostly on general-purpose fundraising services. These services do not possess any means of expert review and supervision for newly submitted proposals. As a result, potential fund donors often fail to recognize projects of dubious scientific and ethical merit.

3.2 Case of "Your Sector of Space" — aerospace innovations for society

Despite aforementioned limitations, however, Russian scientific crowdfunding has had several interesting projects. Probably the most prominent of them is "Your Sector of Space" (YSS) — a combined technological and educative project. The idea behind YSS project was to develop a nanosatellite to orbit the Earth, called "Mayak" (lighthouse in Russian). "Mayak" was intended to become the brightest orbital object in the night sky by deploying an optical reflector.

The satellite mission had three objectives:

- To demonstrate that space has become closer, and now it's possible for a group of friends and like-minded people to launch a real satellite;
- To perform real-life tests of an aerodynamic braking system that can be used to de-orbit space debris in the future safely and without a need for a booster;
- To collect new data about atmospheric density at high altitudes and use it as a basis for cross-checks of calculations of apparent magnitude of space objects and satellites.

YSS had four fundraising campaigns in total in 2014-2017, the most productive of them brought 2 million dollars (with a planned $1.5 million) from 2 717 individual sponsors. As a result, crowdfunding brought about 75% of the total project cost. "Mayak" was launched successfully in July 2017, but had failed to deploy its reflectors, either due to a manufacturing fault or because of a problem during separation from the launch vehicle.

Despite this failure, however, the YSS-team considers their project as a success because of its broader social role. "Mayak" acted as a complete educational program for students and young

engineers of the Moscow State University of Mechanical Engineering (MSUME), who constituted a majority of the project team. Fund donors also received access to project's construction labs and could take part in research and development process. Largest contributors even received invitation to the Baikonur Cosmodrome to witness the launch. In addition, project team prepared a series of educational presentations, lectures and movies for students, pursuing careers in aerospace and communications engineering.

4 Conclusion

In this paper the author has explored the concept of crowdfunding for science from the point of view of third-order of cybernetics, as an important element of open and user driven innovation environments — reflexive-active environments. The author of this paper states that crowdfunding technology can be used as viable and effective instrument of modern science: accessible, transparent and inclusive. But most importantly, crowdfunding allows us to correlate the obtained knowledge about the object of the research not only with the means and operations of the research activity, but also with the value-oriented structures, explicating the connection of intrascientific goals with non-scientific, social values and goals.

Crowdfunded projects differ from traditional financial schemes, primarily because their broader scientific and social impacts are integrated into the research process itself. Instead of rushing the results of the research to the market upon completion, crowdfunding connects researcher with society even before the project is initiated. Thus, crowdfunded projects are free from commercial, industrial, or departmental-bureaucratic lobbyism, while still possessing a reliable feedback mechanism.

Social outreach is at the forefront of crowdfunding proposals, spreading far beyond financial applications and connecting science and society in a way that was not possible to imagine before. Further analysis of this aspect from the organizational cybernetics point of view leads us towards new understanding of innovative processes, based on reflexive interactions within self-developing and self-organizing environments. From this point of view, crowdfunding is not merely a tool in the growing arsenal of science, but a cornerstone of a new model approach towards socially responsible innovations.

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