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Monitoring Co-Creation: A Survey of Lithuanian Urban Communities

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***Abstract*—**In this paper, we conduct a systematic survey of urban communities in Lithuania to evaluate their potential to co-create collective intelligence or "civic intelligence" applying Digital Co-creation Index methodology that includes different socio-technological indicators. Civic intelligence is a form of collective intelligence that refers to the group's capacity to perceive societal problems and to address them effectively. The research focuses on evaluation of diverse organizational designs that increase efficient collective performance. The current scientific project advanced the state of the art by evaluating the basic preconditions in the urban communities through which the collective intelligence is being co-created under the systemic manner. The research subject is the *"bottom up"* digital enabled urban platforms, initiated by Lithuanian public organizations, civic movements or business entities. The web-based monitoring results obtained by applying a social indices calculation methodology and Pearson correlation analysis provided the information about the potential and limits of the urban communities and what possible changes need to be implemented to overcome the limitations.

***Keywords*—**Computer supported collaboration, co-creation, collective intelligence, socio-technological system, networked society.

I. Introduction

WHILE the traditional approaches to public engagement and governmental reforms remain relevant, this research paper focuses towards the growing potential of digital enabled citizens to solve their social problems. The co-creation concept fundamentally differs from the traditional public engagement approach, while it focuses on the collective intelligence, awareness and responsibility of all stakeholders by creating the public good. The main paper idea is based on a presumption that the networked society is one of the most prospective future society organizations' forms, because it has a decentralized structure and operates on a user-to-user mode developing productive computer supported collaboration. The field of ICT enabled Civic Technologies (or Civic Tech), an umbrella term to define ICT-enabled citizen initiatives, is growing annually 23% according Knight Foundation [1]. Around the world, civic organizations, individual citizens and even businesses experiment with ICT tools and available open resources to connect and collaborate with each other and with government to find innovative solutions for societal problems [2]. To support this, the international scientific society publishes the research results about the creative power of networked systems and their potential to grow under certain conditions "collective intelligence" [3], [4]. The recent research results of Engel et al. [5] indicate that a collective intelligence factor characterizes group performance for online groups approximately as well as for face-to-face groups. However, the enthusiasms and optimism regarding the efficiency of urban communities' activities and their influence on public good is supported only with fragmented research results [6]. The majority of scientific activities are oriented towards the governmental initiatives and integration of e-participation, e-democracy and open data tools. Because of the diversity in technological tools and information channels, the users of urban platforms face in praxis the problems with coordination, collective decision making and opinion structuring, security and privacy, information credibility, content quality, etc. Moreover, some of the citizens' initiatives focus only on the formation of the society voice, and do not emphasize the feedback from government and importance of co-creative synergy between all stakeholders [7], [8]. Lithuania and the whole networked society are in critical need for the progressive innovations to upgrade co-creation processes between the civic and public to the next qualitative level. A breakthrough in the finance sector was created through the "blockchain" technologies, which could be equally applied in Civic Tech management for implementing democratic-by-design models of governance**,** establishing a decentralized and transparent decision-making, motivation system, enabling secure, efficient and anonymous engagement. Instead of relying on the traditional top-down decision-making procedures, the "blockchain" allows for such procedures to be entirely crowd sourced, delegating to the community's collective intelligence the responsibility to monitor and evaluate its own achievements [9]. Hence, the scientific evidence based social models have to be developed in order to formulate objectives for IT developers to create and apply the better targeted and value creating technological solutions.

II. Co-Creation as a New Form of Collective Intelligence in Civic Tech

The new ICT paradigm, mobile communication, social media, Internet of Things and cloud computing, increasingly put the end user at the centre of innovation processes, thus shifting the emphasis from technologies to people. The success stories of services such as Google, Wikipedia, and Facebook rely on their users to create value with Internet 2.0 tools. In the private sector, the paradigm has been conceptualized under Service Dominant Logic (SDL) and Open Innovation 2.0 approaches, where the focus of co-creation is the value created for and by the users. The public

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sector implemented the change through the New Public Governance and Open Government initiatives, which suggest that the public value no longer needs to be created by governments alone, but could be generated in collaboration between the public entities, private sector, civil society organizations or citizens (Quadruple Helix model).

The networked communities are an ideal environment for a digital co-creation. The ICT enabled systems leverage the emerging "network effect" by combining open online social media, distributed knowledge creation and data from real environments ("Internet of Things") in order to create possible solutions requesting collective efforts" [10]. Several researchers [11], [12] propose that the roles, perceptions and capacities of actors involved play a central role in co-creation. These actors can be both drivers and barriers in the co-creative processes. A *top-down co-creation approach* refers to the government-initiated platforms, which deliver public services. Engaged in the government established platforms, the citizens contribute to data and content distribution, or/and are involved in the design, evaluation or improvement of public services, based on user-centric approaches (e.g. Design thinking, Service Co-Production). A *bottom-up co-creation approach* defines the platforms emerging from the outside of the governmental sector and without the governmental control. According to [13] and [14], the bottom-up civic technologies are not necessarily designed with the aim of being corporate and governmental disruptive (as was the case of the 2011 Arab Spring). They are designed "by, and for, average citizens, using existing open data in innovative ways that can complement the existing channels of information and communication previously controlled by the institutions alone" [13], [14].

This research paper observes the "bottom up" co-creation in online communities as a new form of collective intelligence, which defines an internal and external motivation of the platforms' users to act for the public good. "New knowledge, ideas, problem solving methods and solutions, shaped up or structured opinions, innovations, prototypes, etc. are considered to be the collective intelligence a platform co-creates and "public value" for society" [15].

Both concepts, the co-creation (CC) and the collective intelligence (CI), were influenced by the social media technologies and were developed in parallel. The efforts to more effectively leverage CI are improving the effectiveness with which "public value" is co-created [16]. According the collective intelligence paradigm, under certain conditions, the human group demonstrates the higher capabilities of information-processing and problem solving than an individual [4]. The "intelligence" in the system can be described as "collective", not only in the sense that it arises from the interactions between participants, but also that it does so according to specific principles for extracting "wisdom from crowds": diversity, decentralization, independence and an appropriate mechanism for information aggregation [3]. All these principals affect not only the emergence of CI, but also can influence positively the co-creation processes inside and outside the community enhancing the collaboration between all stakeholders. According to [17], the development in the field of Civic Tech is influenced by the innovations in the three fields: growing connectivity through ICT, open data movement and diversity in digital collaboration forms. The open data increases the visibility and faster identification of societal problems and new collaboration and knowledge aggregation methods enable self-organization and collective decision-making. The massive participants' inclusion into the interactions online ensures inclusion of the greater diversity and this results in a continuous flow-in of new ideas and knowledge. Following the Internet design, the networks adopted decentralized structure and distributed leadership, which influence the self-organization and self-governance capabilities of the community contradicting the functioning of the traditional hierarchical mechanism. The structural units (nodes) being unable to interact with the center of network (because it does not exist) have to interact with the whole network in the self-regulatory regime and develop one of the most productive forms of collaboration [18].

Although the online communities are often criticized for the lack of direct contact, yet, in comparison with the traditional communities, the networked ones can operate more efficiently without limitations of time and geographical space. However, certain threats linked with the communities' development can be discerned. According to [10] "one of the main risks … in citizen engagement is the danger of engaging only those people who are already engaged in an issue, thereby deepening the gap between those already participating and those left-behind". The capability of people to join communities can be influenced by such factors as discrimination for age, gender, sexual orientation, cultural background and disabilities, as well as factors such as income, educational level and geographical urban/non-urban location. Another problem is the maturity and quality of created content which of the "can vary from excellent journalistic work to spam or even abuse and insults" [19]. The nature of all these problems is interdisciplinary and having to be solved under the complex manner.

It is important to understand, that Open Data, Open Science, Open Source Freeware, Open Community-making value creation potentials are limited, if not supported by a resilient social system. If the value dimensions of the users, acting in a collective network, are not aligned, and if the technological decisions are implemented in an immature environment, these solutions can accelerate the negative aspects of the digital collaboration. These risks appear as "closing up within one's communities, constraints of individual freedom, privileged access to community resources and limitations on the engagement of outside persons" [20]. On the other hand, the technological design and structure of the network can give impetus to the purposeful collaboration towards the common good.

A critical reflection on the co-creation practices is relevant to the understanding on how the digital enabled managerial and organizational solutions influence the quality of co-creation results, to the perceiving on what works when the co-creations methods are implemented and what does not work

and why. The more profound comprehension of the co-creation dynamics is necessary to support the communities to deliver the intended intellectual outcomes.

III. Evaluating Digital Co-Creation Practices: Pilot Study in Lithuania

A. European and National Context

A number of EU policy strategic documents (e.g. Europe 2020 Strategy; EU Digital Agenda) have stressed the importance of the ICT-enabled society and open access to information as one of the key solutions to foster democracy. National governments around the EU invested considerably in e-government and e-democracy projects, expecting more active citizen participation and co-creation effect. The reality of open government practice is, however, different. According he recent research results [7], [8], it has taken a turn towards the market-based principles of performance measurement and competition, thereby reinforcing a framework which focuses on the customers who demand to be served rather than on the citizens working with their representatives to co-create public value. A Pew Research Centre survey [21] shows that the people across Europe extensively think that their voice is not important in EU institutions. The confidence of European citizens in their national parliaments and governments measured by the quarterly Eurobarometer is low and slowly declining [22].

Lithuanian democracy is facing similar challenges. The Web's growth in reach and capability set the stage for an explosive growth of online communities in Lithuania, but their potential has not been used to their fullest due to the lack of citizen engagement. The country has all the preconditions to become a networked society: relatively high level of the infrastructure of information technologies, high level of user accessibility, and a small number of inhabitants (2.7 m). Nevertheless, the perfect technological pre-conditions do not encourage the growth of collective intelligence since people do not collaborate, as they express their opinion but do not structure it, and do not assume the obligations to implement decisions, etc. The potential of non-governmental organizations promoting social innovation and business is untapped in Lithuania according Lithuanian Smart Specialization Strategy documents. Lithuania ranks the 13th place in DESI 2017 [23]. The country's performance is above the EU average in all dimensions, except for the Human Capital, where the progress has been limited by incapacity to use the digital technologies for solving social challenges. The majority of the public government initiatives to activate the dialog between the government and society are centralized and do not reach citizens' empowerment task, according to [24]. For example, there are only few proposals in the government-initiated portal for public consultations e-pilietis (e-citizen) comparing to the active citizens' initiated discussions in social media and portals.

B. Methodology

The main task of the pilot study, implemented in Lithuania 2017, was to evaluate the co-creation practices by examining the dynamics that reflect the impact of technology, context, and changes of various internal and external parameters. The research subject was the "bottom up" co-creation process in the urban communities in Lithuania, initiated by public organizations, civic movements or business entities. The monitoring of the urban communities was implemented by applying the Digital Co-creation Index Monitoring Technique [29] based on the methodology for calculation of Collective Intelligence (CI) Potential Index [15]. The methodology was validated by implementing the quantitative and qualitative research, by developing a system dynamic model to test causal relationships and by executing an experimental application of the method in praxis [25]-[29]. The Digital Co-creation Index (DCCI) evaluates the basic characteristics, functionality, and technological design of online platforms using a set of integral socio-technological indicators (Collective Intelligence Capacity, Collective Intelligence Emergence, Social Technologies and Social Networked Responsibility Index). The calculation of the four sub-indices integrates the quantitative data with the results of content analysis by monitoring the communities' activities in the virtual space. The CI Capacity Index is a relational conception that defines the capacity of the community for creativity, aggregating and creating knowledge, decision-making and problem solving. The CI Emergence Index evaluates the ability of online community for self-organization, potential for emergence of intellectual outcomes and adaptivity. The Social Responsiveness Index assesses the maturity of social impact on society, maturity of social motivation and maturity of social orientation. The Social Technologies Index explores the system's structure, design and technological solutions enabling the human-machine interaction. The sample size for the assessment consists of 50 urban communities in Lithuania identified during the pilot study based on following criteria: orientation to social issues, sustainability, critical mass of users, visibility, etc. The values of indicators underwent a qualitative evaluation and the numeric values were ascribed that correspond to their quantitative weight: 0; 0.5 or 1. To improve the users' perception, the obtained values of the composite indices were transformed into a more attractive scale by multiplying the obtained values by 100 (0 is the lowest and 100 the highest performance level) using the calculation software.

TABLE I
CI Capacity Index Calculation

Dimension	Indicators	Value
$CAI = 0{,}6\frac{DS+DF+PS}{3} + 0{,}4\frac{CM+DD+DI}{3}$,		
Capacity for creativity	DS Degree of diversity in source of ideas	52
	DF Degree of diversity in engagement forms	36
Capacity for aggregating and creating knowledge	DI Degree of interdependence	47
	CM Degree of adequate supply of "Critical mass"	43
Capacity for decision making and problem solving	DD Degree of decentralization and independence	20
	PS Degree of efficiency of problem solving	25
37.25		

TABLE II
CI EMERGENCE INDEX CALCULATION

Dimension	Indicators	Value
	$EI = 0{,}6\frac{DQ+FG}{2} + 0{,}4\frac{DC+AT+DM+AL}{4}$	
Potential for self-organization	AT Degree of adequacy in form of self-organization to the community task	50
	DC Degree of development of transparent structure and culture	66
	DM Degree of development of distributed memory system	45
Intensity of emergence of intellectual outcomes	DQ Degree of emergence of new ideas, structured opinions, competencies, activities, etc.	46
	FG Intensity of feedback from government and other stakeholders	20
Potential for adaptivity	AL Degree of adequacy to socio-cultural context (local, national, global)	35
	39.40	

TABLE III
SOCIAL RESPONSIVENESS INDEX CALCULATION

Dimension	Indicators	Value
	$SRI = 0{,}6\frac{DT+SR+MC}{3} + 0{,}4\frac{MM+SS+RS+IE}{4}$	
Maturity of social impact on society	DT Degree of sustainability	38
	SR Speed of reaction to social issues	68
	MC Maturity of generated content	46
Maturity of social motivation	MM Maturity of social motivation of community	47
	SS Level of social sensitivity of community members	52
Maturity of social orientation	RS Degree of diversity in cooperating partners and financing	32
	IE Strength of internal and external connections with stakeholders	35
	46.99	

The Social Technology Index has in total 22 exogenic variables and is divided into six categories. The value of Social Technology Index of the 50 Civic Tech platforms was determined by **50.90** applying the formula as follows:

$$STI = 0{,}4MD + 0{,}6\frac{EI+PS+DM+DA+SC}{5};$$

where, ***MD*** – Media/ design quality, ***EI*** – External and internal networking/collaboration technologies, ***PS*** – Privacy and security assurance technologies, ***DM*** – Decision making technologies, ***SC*** – Sharing/creating knowledge technologies, ***DA*** – Data aggregation and data access technologies.

As mentioned before, the DCCI is designed around four indices: CI Capacity Index, CI Emergence Index, Social Responsiveness, and Social Technology Index. At the current stage of the research, the assumption is that four indices are equally significant. The final mean of DCCI of the 50 urban communities is **43.63** (37.25+39.40+46.99+50.90/4).

The descriptive statistics of the composite DCCI is presented in Table IV.

The Pearson coefficient *r* between the CI Capacity Index, CI Emergence Index, Social Responsiveness Index, and Social Technology Index was calculated by evaluating the 50 Civic Tech platforms. Table II presents the Pearson correlation analysis results. The relationship is defined as stronger if |r| value is closer to 1. The value $r > 0$ indicates the positive relationship between variables. Consequently, when one random value is increasing, the other values are growing as well. The value $r < 0$ reflects the negative relationship, when one random value is increasing, the other random values are decreasing. The probability that there is a statistically significant correlation between the three indices (CI Capacity Index, CI Emergence Index, Social Responsiveness Index) and the Social Technology Index (all *p*-values are < 0.01) with 99.9% was confirmed. All null hypotheses, asserting that Pearson correlation coefficients equal 0, were rejected (Sig. 2 tailed) $p < 0.01$). The most significant theoretical correlation was determined between the CI Capacity Index and the Social Technology Index ($r = 0.908$). The linear correlation is positive, i.e., it is probable that the higher level of technological solutions influences positively the platforms capacity for creativity, aggregating knowledge and collective decision making. On the other hand, a moderate statistically significant linear relationship was identified between the CI Emergence Index and the Social Technology Index, as $r = 0.573$, and between the Social Responsiveness Index and the Social Technology Index, as $r = 0.650$. The significant correlation was found between the Social Responsiveness Index, and the CI Capacity Index with r = 0.937, and the CI Emergence Index with r = 0.736. The empirical results revealed the complexity of the relationships and identified the feedback loops between the different factors and indicators building the preconditions for digital supported co-creation.

TABLE IV
CORRELATION ANALYSIS BETWEEN INDICES OF COLLECTIVE INTELLIGENCE POTENTIAL INDEX

		CI Capacity	CI Emergence	Social Responsiveness	Social Technologies
CI Capacity Index	Pearson Correlation	1	0.505	0.937**	0.908**
	Sig. (2-tailed)		0.113	0.000	0.000
	N	50	50	50	50
CI Emergence Index	Pearson Correlation	0.505	1	0.736**	0.573
	Sig. (2-tailed)	0.113		0.010	0.065
	N	50	50	50	50
Social Responsiveness Index	Pearson Correlation	0.937**	0.736**	1	0.650**
	Sig. (2-tailed)	0.000	0.065		0.009
	N	50	50	50	50
Social Technologies Index	Pearson Correlation	0.908**	0.573	0.650**	1
	Sig. (2-tailed)	0.000	0.065	0.009	
	N	50	50	50	50

IV. Results

The CI Capacity Index of the evaluated communities has the lowest mean to compare with the other sub-indices. When measuring the *Degree of diversity in source of ideas* (value of 52) and *Engagement forms* (36), in the majority of monitored projects the demographic, gender and geographic diversity was evaluated as high. However, the national diversity was defined as relatively low. Almost all civic projects lack the advanced competition elements, game based approach, and the adoption for the different age groups. *Degree of decentralization and efficiency of problem solving* was identified as rather low. In the majority of the platforms only the registered users are able to propose an idea on already posted issues, and there are only few projects allowing an anonymous participation. The diversity in the ways to express opinions (such as voting, ranking, structuring, mass deliberation, etc.) is low in the majority of the observed communities as they lack the technological solutions for it. The Pearson correlation results support the presumption that the maturity in problem solving, diversity and quality of created knowledge/products are better maintained by providing the advanced technological tools for users not only to express their opinion, but also to vote, evaluate and make collective decisions. On the other hand, the possibilities for the users to initiate a new topic, aggregate or create knowledge are very limited in many cases, because of the clear leadership of platforms` initiators or managers.

The value of the CI Emergence Index is influenced by the *Level of self-organization* (50), *Development of transparent structure* (66) and *Development of distributed memory system* (45). The observed platforms demonstrate a medium performance in these dimensions. Moreover, the lower values were identified in the *Intensity of emergence of new ideas, activitie*s, and especially in the *Feedback from government and other stakeholders.* The level of diversity in the addressed problems, insights and proposed ideas varies from low to medium. With the rare exceptions, the exchanges of information in the civic projects are dominant. The Social Responsiveness Index has a higher value to compare with the CI Capacity and CI Emergence Index. The Lithuania`s urban communities demonstrate a high *Speed of reaction to social issues* (68) and a high *Level of social sensitivity* (52). However, the platforms lack sustainability, visibility and support from cooperating partners and stakeholders. Only the several platforms publish the data on the implemented actions and initiatives. The majority of the results is named as publications or implemented ideas that improve a performance of the platform itself. It is interesting to note, that the virtual projects with broad objectives to tackle societal problems demonstrate the wider variety of offered ideas, more mature discussions and higher quality solutions than those ones with a narrower focus on specific issues.

The social technologies perform as a supporting mechanism for effective and efficient activities of online platforms. According to the research results, the analysed communities demonstrated a relatively high level of technological readiness (the value of STI is 50.90). However, the technological solutions for collective brainstorming, collective assessment or decision-making are underdeveloped in majority of the projects. Consequently, more often participants are directed to register on the social networks and use the opportunities and tools provided by these networks. The level of knowledge aggregation and sharing among the monitored communities was identified above the average. The most developed technologies are those, which foster the formation of interest groups and sharing information. More attention has to be paid to the privacy and personal data protection technologies, because only half of the platforms have these IT tools installed in order to protect their users.

Limitations. In the absence of the index calculation results that were equally tested in another socio-cultural context, the comparative value of the outcomes of this research cannot be established. However, the numeric values of the final DCCI and the values of sub-indices can be compared with the average of the already evaluated platforms aiming to get the insights about the potential of the networked systems for generating the intended intellectual outcomes. The increase of collected empirical data would condition the increase in research data reliability and validity of the applied instrument.

Another limitation is a public value measurement. From the wider public value perspective, a public value should be measured not only by aggregating the data received from each platform, reporting against the measurement frameworks, but also from a whole society view [28].

V. Conclusions And Discussion

From sharing knowledge to producing the technology, from cooperation to competition, the way the computer supported collaboration works needs further research and still is an area of continuous exploration for the practitioners and research scholars. As the networked systems become more complex and include more connections between humans and machines, the characteristics of those systems become important in terms of determining the performance and successful development of the collaborations. The ability to influence the performance is critically dependent on an accurate assessment of the systems and their dynamics. The challenging task for the proposed Digital Co-creation Monitoring Technique was to correlate the different factors and to find the realizable possibilities for the networked systems performance in these causal relationships. Not all aspects of the platforms performance can be measured by the clear criteria, but collecting empirical numeric data is extremely important. Storing such data over a period could be useful in predicting the performance of the online community as a whole or help diagnose and prevent the reduction of community members' motivation or diminished activities.

The monitoring results provided information about the limits of the urban platforms and what changes have to be implemented to overcome the limitations. It can be concluded, that at the current knowledge level the technological readiness is an important feature of the co-creation process. The IT tools and solutions have to create the additional social value to the platforms' activities and contribute to the identity of the

community. It can be described figuratively that, by applying the assessment methodology, the Lithuanian urban communities passed the cognitive, emotional and social intelligence tests and revised their digital competencies. The evaluation conclusions provided a "helicopter view" on the computer supported collaboration in Lithuania, distilled the best practices, identified the game changing communities, and expanded the opportunities for designing the targeted engagement strategies and for developing an active citizenship. In addition, the Civic Tech progress in Lithuania and perfect technological preconditions in the country can be used as a test bed to explore the potential of computer supported collaborative work in the future. The understanding of the co-creation processes in the online platforms could contribute to solving the different social problems of the networked society through the virtual means. While the online platforms will probably be the first ones to experiment with these new IT tools, they could be easily brought offline to create and build new organizations that operate in the physical world by multiplying the successful cooperation models on the national or international scale.

Currently, the arising scientific questions regarding the Civic Tech management cannot be solved completely because the researchers have just started perceiving the entire complexity of similar systems, their possibilities and threats. In the research authors' opinion, the computer supported collaborative work is more than sharing, reacting, voting, making decisions. The phenomenon is more about the finding problems proactively and contributing to solving the different social problems. The digital co-creation has a potential to become global, both, geographically and content related, but it still has to be parametrized and credibly measured. The scientist should focus on the developing holistic interdisciplinary conceptions to understand the complexity of self-organizing and "emergent" networked systems and forecasting their development scenarios.

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