Hack for impact – sociomateriality and the emergent structuration of social hackathons

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Abstract

Purpose – Social hackathons are events designed to craft social change using technology that enables citizen empowerment or addresses societal issues by deploying data. Hackathons provide a framework for organizing to help create prototypes and business models through interaction with technology. The relevance of the sociomateriality of the emergent technology (prototype) and organizational structure raises the question if viable and impactful solutions can be developed within such frames.

Design/methodology/approach – This study applies an inductive research methodology based on ethnographic participant observation, interviews with participants and event organizers, and qualitative insights from surveys.

Findings – Events such as social hackathons are centered around technology and share a vision of creating opportunities for change. The materiality of prototypes may define their interaction patterns. The differentiation of the embodiment and emergent structuration of technology may be a breaking point for in-group dynamics and a barrier to social innovation. The emergent structuration of technology with a longer initial phase of problem definition and ideation within a group was found to have more potential for impactful embodiment with the technological artifact. Some cases reveal that "expert" participants who shared visions of change enabled by technology were constrained by other members.

Originality/value – The paper suggests an extended view on the connection of sociomateriality, organizing and social impact.

Keywords Social hackathon, Structuration theory, Sociomateriality, Collaborative innovation

Paper type Research paper

1. Introduction

Hackathons are short events organized for problem-solving, involving collections of people who use technology for social or business goals (Trainer *et al.*, 2016). Hackathons have been the subject of broad interest, particularly from an instrumental point of view, as tools successfully adapted to corporate innovation activities based on crowdsourcing and design-thinking methods. Hackathons have also been documented to leverage unpaid or low-paid work: an exploitable project elaboration strategy of corporate organizers (Gregg, 2015; Söderberg and Delfanti, 2015). A growing number of hackathons are framed as "social-" and "issue-oriented" as they include public goals in their activities (Gregg, 2015). This may involve being sponsored by non-profits or governmental structures (Lodato and DiSalvo, 2016). Social hackathons aim to generate social-problem-focused startups (Briscoe and Mulligan, 2014). Despite this goal, hackathons

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continue to be tech- and design-oriented interdisciplinary and multi-stakeholder participatory events organized around collaborative practices and are often associated with prize-giving (Delvenne and Macq, 2020; Endrissat and Islam, 2021; Flus and Hurst, 2021; Longmeier *et al.*, 2022; Nolte, 2019). Contemporary forms of organizing constituted by emergent technologies call for addressing materiality in organizational research (Orlikowski, 2007, p. 435). Despite the growing number of accounts of collaborative organizing, innovation, and the purposefulness of hackathons, the role of sociomateriality in interpreting emergent technology in a collaborative process – in the context of hackathons – has attracted less focus.

Digital technologies are applied to address social challenges in many ways. Applications can connect communities and vulnerable groups (Gebken *et al.*, 2022), shift attitudes, raise awareness, and help overcome redistribution inefficiencies (Faludi, 2020a; Holzmann and Gregori, 2023). The voluntary collection of environmental data by citizens with easy-to-use sensors can be used to eliminate risks such as floods or for scientific or policy-adjustment purposes, such as documenting biodiversity or improving urban quality and livability (DITOs, 2018; Simeone *et al.*, 2021; Wehn and Evers, 2015). Measuring the potential of digital projects for social impact is challenging (Faludi, 2020a, b), and even highly committed projects are less likely to make changes within a restricted sociocultural context (Kiss *et al.*, 2022; Primecz, 2021). How can social impact and applied technology be aligned at a bounded-time events? Is there a connection between the materiality of technology, participant engagement, and organizing structure?

This study puts under scrutiny a set of educational- ($n = 3$) and citizen social hackathons ($n = 3$) to determine how the dimension of social impact is incorporated into the value-creation process. To grasp the perspective of the materiality of technology and organizing, the hackathons are viewed as at least two degrees of materiality: i.e. as based on intangible digital technologies and centered around tangible devices. This study applies structuration theory to capture the organizational dynamics invoked by the interaction of people with and around technology in light of the emergent structures associated with (non)collaboration (DeSanctis and Poole, 1994). The study contributes to the discourse on sociomateriality, technology, and organizing with a view to examining the possibility of social innovation at hackathons. The social hackathons under study were organized in Central Eastern Europe, so the study enlarges the geographical variety covered by the literature on hackathons.

2. Theoretical background

2.1 Hackathons and socioeconomic realities

Social hackathons are grounded on a positivist approach to technology and rooted in beliefs that technology can overcome human-bounded rationality and other inefficiencies with its "systems rationalism" (Rice and Associates, 1984). Vivid and fruitful interaction among participants and technology is expected to overcome the inefficiencies associated with socioeconomic realities based on a collaborative innovation approach. This suggests that the design of social hackathons is focused on an "ideal" set of conditions for efficient and productive interaction that can develop specific meanings connected to technology. Collaboration is an ideal-typical stance to integrate effort and interest to achieve shared goals. The rapid spike in this effort to construct meanings to technology may create a sense of community. However, ethnographic studies have revealed that such collaboration is a space for possible practices of individuals in the group "to avoid assimilation to common goals" (Gorm Hansen, 2017; Friberg, 2019, p. 172), as collaboration is constantly emerging and can be destabilized during the argumentative process (Friberg, 2019). The sense of urgency at hackathons can reduce the negotiation phase of ideation, meaning some views remain tacit (Briscoe and Mulligan, 2014). Since the early works of science, technology, society scholars and the social construction of technological systems (SCOT) approach, the economic power

behind artifacts and the problem of how different social groups are situated in their capacity to shape artifacts (Bijker *et al.*, 2012; Bijker and Law, 1992) has been of concern. Therefore, ideally, social hackathons embrace the social groups affected by the solutions that are being developed. However, the inclusion of potential beneficiaries is reportedly problematic, even if organizers attempt this (Briscoe and Mulligan, 2014; Gregg, 2015; Irani, 2015). Hackathons are a means of "socializing" workers (Zukin and Papadantonakis, 2017) into a culture of entrepreneurialism and innovation without actually achieving innovation (Irani, 2015; Richterich, 2019; Zukin and Papadantonakis, 2017). Even social-issue-oriented solutionist events do not lean toward solutions through invention due to their structure and processes (Lodato and DiSalvo, 2016). A further problem leading to the erosion of socially oriented innovation at hackathons, is the utilization of corporate sponsorship and investor participation, eroding the aim to address an issue of social concern (Briscoe and Mulligan, 2014). The instrumentalization of hackathons has taken them far from their original hacker ethics (Coleman, 2013) and given rise to a market that includes firms as professional hackathon service providers in various fields (such as Codemotion, Hackerearth, and Major League Hacking). Hackathons are used as a toolkit for generating ideas on various topics, from education to human-resource recruitment strategies.

2.2 Sociomateriality, enactment, embodiment and structuration theory

The social and the material are not distinct spheres of organizing in everyday life (Leonardi and Barley, 2010; Leonardi and Treem, 2020) – instead, everyday human action is entangled with technology, thus sociomaterial (Suchman, 2007). Increasingly, we think about cohabitation practices associated with technology, such as the use of the different apps that structure our everyday lives. The data we generate define our next interactions or decision-making through AI. The way we experience or "live" this entanglement can be explained through sociomateriality (Leonardi, 2013; Orlikowski and Scott, 2008). This analytical framework can explain how entanglement is enacted in organizational settings (van den Ende *et al.*, 2015) or collaborative processes associated with emerging technology (Aslam *et al.*, 2021).

A technological artifact is an entity that is "physically, economically, politically, and socially organized in space-time" (Lave, 1988), as its material and cultural properties transcend individual experiences (Orlikowski, 2000). From the *technology-in-practice* perspective, variations of objects are induced by use, depending on context or time. *Enactment* is defined by the very moment of use which grants new meanings, which are, however, bounded by the physical properties of the artifact. The prototypes produced at a hackathon can be considered the *embodiments* of the given space-time organizing and encapsulate the enactment dynamics of the team members. The interaction of the teams is structured by technology, which thus fits with organizations' institutionalized processes (DeSanctis and Poole, 1994), in the case of hackathons a temporary configuration defined by the event. During a hackathon, the interaction of people with and around technology creates *emergent structuration* based on a temporary collaborative or non-collaborative dynamics, with its own rules and resources. Technologies thus, go beyond the *embodiment* of social structures, as artifacts are instantiated in practice. Therefore, technology development can be analyzed through this process of *structuration*, where technology structures human interaction (Orlikowski, 1992). *Embodiment* (prototype) can be considered as a function of, but not equal to the collaboration dynamics (enactment) of the team. *Embodiment* encapsulates the enactment dynamics that grant meanings to the artifact. This study argues that *enactment* as well as *structuration* is defined by the degree of materiality. *Enactment* captures the series of moments in the technology-team dynamics defining the function or the meaning of the artifact, while *structuration* carries the possibility of institutionalization (establishing rules, etc), the definition of a team – that might

have implications for further collaboration after the event, thus if a prototype is taken with the team with the aim of commercializing it, creating a startup, etc. *Enactment* captures the meanings of the use in the moment, while *emergent structuration* implies further, forward-looking meanings involving organizational implications (formalized business team formation, impact for society). The initial Artifact (A) goes through a prototyping process (B, C, D) to become a Prototype (Artifact E), which is accompanied by the embodiment function and an emergent structuration function, where both processes imply enactment dynamics.

Acknowledging that sociomateriality goes beyond the technocentric perspective focused on the effects of technology and human-centered perspectives, Cooren (2020) stretches the boundaries of materiality. Departing from the usual association with the tangible and visible, thus technologies, artifacts or tools; he suggests that the intangible be regarded as material, if material means *made of matter*. The materialization of an organization through its employees is always incomplete; the experience of materiality comes with the experience of immateriality – and there are degrees of materiality. This study argues that collaborative teamwork that occurs during hackathons is the mediation, while the prototypes, or the ideas of software prototypes – which Irani (2015) calls *demos* – are the materializations of the hackathon as an organization. Therefore, in this study, devices such as sensors are considered to have tangible materiality, while apps and VR projects (demos) that do not result in prototypes at the end of the hackathon are considered of intangible materiality.

2.3 Research question

The hackathon is a particularly interesting field for observation that involves people interacting with technology, especially if the first-time encounter with the base technology is being mediated by "lab" technicians and onsite coaches. Through the enactment process, participants "appropriate" the features of the technology, then develop an emergent technology – a prototype for a pre-defined (in the present case) and refined social purpose with a business plan. Following the assumption that the connection between a group of people with the materiality of a technological artifact defines the outcome of their collaborative efforts, this study searches for answers to the following questions:

How are social design and technology development aligned at social hackathons? And, is there a connection between the degree of materiality of technology, participant engagement, and organizing structure? Does social impact design occur at social hackathons? The quest is threefold. Accordingly, the study examines (1) the entanglement of the social and material at social hackathons; (2) the connection of the process of embodiment and emergent structuration with organizational structures; and (3) the effect of the degree of materiality of technology on collaborative organizing and social impact design.

3. Method and description of data

3.1 Method

As ethnography is more than a method but rather a "distinctive type of research", data collection and interpretation took account of the "overall cultural framework," as "organizations are parts of society" (Watson, 2012, pp. 15–16). The approach taken for this research looked for structures, dynamics, interactions, and processes associated with the field of digital innovation, including makerspaces, an NGO organizing educational social hackathons and digital startup contests. Multi-event ethnography suggests that the organizers of such events are the actors who constitute the phenomena, thus, they define the boundaries of the field (Aguilar Delgado and Barin Cruz, 2014). The unit of analysis of this study is the social hackathon ($n = 6$) as an event. Given that the educational social hackathons (ESH) took place in three different countries (Hungary, Austria, and Serbia), the research may be considered multi-site observation (Falzon,

2009; Marcus, 1995), with one NGO implementing the same methodological approach in different localities. The citizen social hackathons ($n = 3$) occurred in two different locations in Budapest, Hungary, due to the relocation of the makerspace.

The ethnographic quest of the research project benefits from the embeddedness of the researcher in the field of *para-ethnographic* sites (Fisher, 2021). The author of this article was embedded in the field as an on-site coach at all the observed events, along with other coaches who contributed to the strategic social dimension of the ideation process at the demand of the groups, which allowed for participant observation. Moreover, the author's closer cooperation with the NGO involved taking on other roles such as mentor, evaluator, and jury member for digital startups and social innovation. Embeddedness in the field and collaboration thus located the researcher in *para-ethnographic sites* (Fisher, 2021), where other coaches, mentors, and jury members were active and knowledgeable experts in the field. Thus, the informants themselves produced academically relevant knowledge, being embedded in the cultural sites, presenting their cultures in analytical and strategic ways, and blurring the lines between informant and ethnographer (Holmes and Marcus, 2006; Islam, 2015) as a form of ethnography in the knowledge economy (Mills and Ratcliffe, 2012).

The two types of settings of the events, universities and makerspaces, were considered the "culture of the organization" nested in social reality (Watson, 2012, p. 17). Data were collected from February 2018 to May 2019 and included six hackathons (three of each type).

A multiple-method technique was applied; participant observation consisted of semi-structured field observation and note-taking and on-the-spot semi-structured interviews with participants and organizers. This was complemented with online surveys distributed among the participants. The field notes were validated by two participant-researcher colleagues. The interviews were conducted using the random-walk technique of selecting participants on the spot, especially during afternoon breaks when most tasks had been completed and the finalization of prototypes and presentation activities was taking place. Interviews were undertaken with other mentors and jurors either on-site or off-site at a later stage. This technique allowed for mapping instant experience without elapsed time, creating a distance from actual events.

At some events, the majority of participants participated in interviews, while at others, about a third or quarter did so. The surveys were designed to complement the observations and the interviews, and/or to provide feedback to the organizers, they were distributed online to the participants of the events, no further sampling techniques were applied. The participants were recruited by the organizers of the event, the two types of hackathons, therefore respondents were asked in their participant role (see later description in 4). Citizen hack participants answered one set of questions along with registering to the event (61 respondents in total), these included gender, age, expertise, motivation and expectations. Participants were invited to answer a further set of questions online from the second half of the event, with regards to the experience, the knowledge gained at the event. In this case the responses were scarce (15), interviews taken on the site gave more insight. At the educational hacks no survey was tied to the online registration, participants were invited to complete the survey during the event (83/38 responses). The surveys distributed during the event measured their commitment to the given social issue(s), the participants' experience of the hackathon, group dynamics, and visions about the future of the prototype and the potential of the team to form itself into a future startup. In total more respondents seem to have answered the survey at the human-sensing hackathons; this was primarily due to the online registration combined with a short survey. Also, propensity might be connected to the stronger ties between the organizers and the participants of the event; the level of commitment to the social projects explored during the hackathon. In general, participants showed a low level of interest in filling out the survey, despite the nudges. Interviews on the spot proved to be a more reliable method to elicit concerns or experiences. In one case – at an education hack – the survey itself was hacked, and the questions and answers

were rewritten in inappropriate language, reflecting harassment. The comments added to the questionnaire were largely undecipherable but explicitly revealed a lack of commitment to the "social": they included sexist comments, comments about easy sex, guns, and vulnerable groups "who are responsible for their own vulnerability." Interpretations of this event are manifold, but one is a lack of commitment to benefitting the community, the "social", or creating value for all. The unit of analysis was the event: a configuration of networked practices of meaning creation and interaction associated with technology.

4. Social hackathons – the two types

4.1 Educational social hackathons (ESH)

Temporary sites that gather participants together for shared purposes are important to understand in relation to professional and organizational processes (Aguilar Delgado and Barin Cruz, 2014). The ESHs were a configuration of the same methodologies and ways of organizing in different localities. The organizer, an international NGO, closely collaborated with a local university that was responsible for providing the space and recruiting local participants from the respective countries and the near abroad – e.g. in Vienna, participants arrived from the Czech Republic and Hungary too. In one case, the conference venue was provided by the sponsor (see Table 1).

	Education hack (ESH)	Citizen hack (CSH)
Goal	Creating value for social good and a marketable product	
Focus	Innovating digital solutions and prototyping (apps)	Digital and physical prototyping, developing solutions for local communities
Aim	Social digital youth startups	Citizen science projects
Target	Foster digital youth entrepreneurship: targeting both regional and international audiences	Local communities, and local authorities
Host	Educational institutions/Universities	Makerspace
Organizers	NGO	NGO
Funders	Grants, sponsors, stakeholder contribution	Grant
Themed	Selection of broad goals in line with SDGs (sustainable development goals): aging, health, financial literacy, active citizenship	Sensor-themed: solutions based on a given sensor: air, human sensing, noise
Networks of participants	Looser networks, clusters of participants who knew each other from the same organizations	Tight networks connected to the organizers, not overlapping with the personal networks of each participant, (first- and second-grade ties with organizers)
Teams	Voluntary, based on idea selection. Clusters of participants forming groups prior to hacking event who already knew strategy and were idea-driven	Voluntary, based on selection of a Persona, and arbitrary: based on whom you already know
Coaches	Stakeholders, sponsors, educators, organizations providing jury members	Stakeholders, host organization
Participants	HEI students of multiple disciplines (engineering, design, marketing and management, business development, social sciences)	Different backgrounds in terms of age, education, domain, and experience

Table 1.
Social hackathons – main features and attributes

(*continued*)

	Education hack (ESH)	Citizen hack (CSH)
Rewards	Sponsors giveaway, travels and contest participation	No rewards
Jury	Sponsors, representatives of corporations, stakeholders, startupers	Representatives of corporations, stakeholders
Outcome	Prototype of a digital app, mostly a concept (VR, AI) with a business plan	Prototype of a device with a business plan that could be pitched
Empathize/ knowledge integration	A) inspirational talks by developers, entrepreneurs (coaches), and award-winning startups, focusing on business plans and fundraising advice with an outlook that was often undefined "social". B) team warm up exercises to bring members together No real knowledge integration phase due to time shortage: coaches providing insight, and some research casually done overlapping with ideation phase	Diverse backgrounds, citizen experts present. Prior to the hackathon, storytelling event organized for collecting insights and building narratives and personas At the hackathon, a short description of the problem and the sensor was given
Problem definition	The first ideation involved a potential project: these project ideas competed and participants chose which they would implement Some arrived to the hackathon with explicit project ideas. After, teams defined themselves the problem	A specified device: a sensor with related capabilities. Given personas and narratives that the teams chose from to solve their problems. Then the team narrowed down the problem around the narrative
Ideation	With the supervision of coaches	With the supervision of coaches
Prototyping	Online coaches: only digital prototyping, no physical	The makerspace provided the expertise and tools needed
Iteration	Short or no iteration was possible. Coaches gave feedback on demand	Short/no iteration: built physical device was the first prototype
Timeframe	Two days split into three sessions	One day, with presentation the next or the same day
Division of labor	The boundaries within the teams related to their affiliations at their home universities: designers, developers, marketing, management, strategy	In-team boundaries in terms of experience and interest which were reshuffled at the beginning

Source(s): Authors' work

Table 1.

ESH attracted participants from various faculties and universities – such as engineering, design, marketing and business management – and the social sciences; thus, different organizational cultures and the perceived hierarchy of the represented sciences affected team dynamics. On-site coaches were recruited from previous award-winning startup entrepreneurs and business educators. One hackathon featured a larger sponsor that provided the space for the event, online coaches for business development, and most of the jury. The differences between organizational cultures could be spotted in the nature of the coaching. Some coaches, particularly from larger companies, pushed one or two selected teams on the issues of timing, business plan, and decision-making processes. Others, typically from the startup-freelancer scene, would provide insights, ask key questions, and then leave the groups to form their solutions. These differences might reflect the organizational cultures represented by the coaches: top-down pressure for structure and results and a bottom-up creative approach to project development could be distinguished. During the three hackathons that were observed, there was no representation of any of the social groups

being targeted in relation to the social issue – the teams had to find statistics/reports about the social challenge being addressed, with a strong focus on identifying KPIs and quantifiable estimations about the penetration and likely number of users.

The group dynamics and boundaries of organizing seemed to be defined by the attributes of the participants, such as age, gender and discipline, particularly at the larger ESH events. Participants were mostly students, on two occasions, also young coders and startuppers.

Identities related to belonging to a particular higher educational institution, especially when groups were overrepresented, seemed to contribute to the formation of subgroups within teams, as reflected in the division of tasks. Overly large groups with smaller subgroups struggled with coordination problems. One observation related to this phenomenon involved both a gender- and HEI-defined split within teams. Traits of a lack of ability to cooperate were observed, especially in the case of larger groups of "IT guys" and "designer girls" or "business girls." This could be spotted in how the project unfolded. Some of the performative acts of the young women are encapsulated in the following quote:

"*I do not understand the technological part fully, but I think that. . .*" said a girl whose idea had been selected for development but whose process had failed for many reasons, among them the knowledgeable comments of the "IT gurus" who, in the end, "hacked" the idea from all directions and ended up nowhere. The latter participants did not put too much effort into involving the "girls," who had worked on a fancy presentation that was delivered by one of the male team members (who was given the notes to read out the presentation but still did not succeed, leaving long, half-minute silences in the four-minute pitch presentation on stage). Smaller groups demonstrated better coordination, as well as groups that aligned around a cause. For example, one winning project team predominantly consisted of members struggling with food allergies which inspired them to develop an app prototype that ultimately won.

The opening presentations were held by the organizers to frame the themes, and then representatives of the startup scene and/or the sponsor gave inspirational talks on the importance of entrepreneurialism and digital innovation. After some team building exercises, the participants first drafted ideas about the broadly identified problems, such as health concerns, financial literacy, or open democracy, and showcased them – participants could choose from the ideas on a first come-first served principle – group formation, therefore, was primarily idea-centered. The teams focused on designing app prototypes and, in some cases drafting VR solutions – in this area, the online consultations with remote technical experts from various countries were particularly important. The participants did not have direct connections to the technology itself; ideation and solution development unfolded around the idea of a prototype or demo. As the jury in the case of ESH consisted predominantly of business stakeholders in top management, finance, or business development positions, the evaluation of the pitched projects mostly focused on their financial and business viability. The probable impact in terms of rewiring social structures or addressing inefficiencies in the socioeconomic structure was not part of the evaluation.

> I think that for a "social" hackathon, the event as a whole was very business-focused – no technology-critical views were presented at all (ESH, student).

4.2 Citizen social hackathons

The space and location defined the level of engagement in two ways. First, engagement with technology was connected to the availability of a physical workshop and technical infrastructure, and second, engagement with the participants of the event, which was structured around movement in space and occasions for interaction.

The citizen social hackathons (CSH) were organized by a local think tank in Budapest, Hungary, in the framework of an international multistakeholder, research-focused citizen science project. The hackathons were aimed at generating projects based on sensors, the crowdsourcing

of data, and the goal of creating a marketable product. Two hackathons featured a sensor that measured dust, and one featured a noise-measuring sensor. Therefore, the hackathons were themed around air-pollution- and noise-pollution-related local social issues.

The CSHs were located in a makerspace equipped with a workshop, so participants (with the help of professional technicians of the makerspace) could engage with the machines and the software needed for digital fabrication (laser cutters, 3-D printers, etc.) and other tools required to build prototypes. Technical support was also provided with understanding and designing the soft technology – thus the apps attached to the sensors – for collecting, systemizing, or mapping data. The organizers presented their sensor, the social issue to be tackled, the rules of the makerspace, and the rules of the game. Personas representing "real-life" citizen complaints connected to air pollution were developed prior to the event with the involvement of environmental experts, citizens, activists and a professional storytelling expert. The personas were presented at the hackathon, and groups signed up for one. There was a tendency for groups of participants who already knew each other to form, just as at the ESH events.

The task was to develop a prototype and a business plan and pitch it to a jury. As the device was at the core of the team's work, it represented an organizing force. Participants actively learned about the technological capacities of the sensor while working on a physical prototype. Coffee and snacks were available outside the workshop space but were strictly not allowed inside. A lunch break was organized in a nearby canteen, which gave a sense of being both in and out of the hackathon. This shift in perception from the inside of the makerspace and the street outside allowed organizers, participants, and coaches to step out of their roles and created opportunities for small talk unrelated to the project.

Furthermore, participants of the citizen hacks had opportunities to engage with each other across groups – for example, when constructing the prototypes under the supervision of the technicians. The makerspace technicians mediated the space through their host roles and also maintained the rules of conduct in the workshop area.

The process of discovering the space of the workshop nd acquiring new fabrication skills hindered the team attitude of some participants, who seemed to struggle to find their way back to the project and participate in achieving their team's goals. The hackathon and the makerspace were seen as connected to real life; a down-to-earth experience – as a bio-engineering student said, she was working on research with no immediate or tangible results at her workplace, thus "*want[ed] to create something useful*." These teams were more focused on building a prototype than creating a presentation (one team almost failed to prepare a presentation) or refining a business plan.

The makerspace attracted participants who were less interested in the hackathon itself but rather in the experience, including the sense of community with coders, makers, and hackers. Some of these participants were already ingrained into these communities – for example, the coders attending the hackerspace. For others, it was the first step to joining a site of digital fabrication, hacking, and peer-to-peer projects. It is worth mentioning here that universities in Hungary did not have fablabs at the time of this study (Faludi, 2020b). The comments of engineering students also testified to the lack of project-based and peer-2-peer work in their curricula: "*I've been searching for opportunities like this, but wasn't able to find a community before*"; "*I can be useful in these communities, not only in academia*"; *"I have never worked in a team at my university – it was nice to get this feedback that I can do this."* In general, the makerspace had a workshop atmosphere in which participants could explore hardwired technology and digital fabrication, offering them a tangible experience of technology, a sense of producing immediate results, and also empowerment: *"for ages, I have wanted to build a motorized bed frame in my room; now I will. I [know I] can."*

Citizen hacks gathered participants with heterogeneous backgrounds, including students, entrepreneurs, bioengineers, nanotechnology experts, IT and business practitioners, engineers, artists from various fields, business strategists, economists, designers, and so on. The first two hackathons hosted a larger number of participants, and several participants

connected to corporations or tech companies joined the first hackathon in particular. At citizen hacks due to the professional backgrounds of the participants most groups demonstrated familiarity with rapid project development, quick decision-making, and the efficient division of tasks and put participants with corporate experience in leadership positions. Efficient and quick problem-solution focus may sideline valuable inputs. An activist who left before the afternoon coffee break explained that her effort to shape the idea to make it a more socially engaged project was, which moved quickly to the prototyping and marketing phases. A further citizen activist was sidelined during the emphasizing and ideation phase. While this member also experienced exclusion in later phases of the work, she was ultimately reintegrated into the group with the intervention of a coach. Heterogeneity of the group created added value only when combined with coordinated teamwork. In one positive case, a young participant in his early teens with experience obtained from hackcamps and fablab workshops contributed with insights and worked on a presentation, taking care of the design, images, and structure. However, another young participant (below the age limit of eleven years), after several initial attempts by the team to listen and reflect during the phase of ideation, was implicitly excluded. The boy burst into tears and soon left with his mother. "*The age limit should be respected at these events; there is a reason for it. It is a workshop; there are rules,*" – commented an onsite technician.

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The final pitching presentations were assessed and ranked by the jury, which consisted of professionals invited to participate, such as business developers from the startup scene, marketing professionals, and environmental experts. The third hackathon was smaller in scale than the previous two, and the onsite coaches were the "jury", giving feedback rather than ranking or awarding the presentations.

5. Discussion

5.1 Socially-engaged, but how far? Views of technology and group constraints

Social hackathons are expected to result in a prototype of a technology that would have an impact at local or larger societal scale. However, the anticipated social and other goals are often left vague by the organizers, as the innovative process assumes an openness to emerging ideas.

Citizens hacks are closer to what is meant by *applied hackathons* (Briscoe and Mulligan, 2014), as the problem to be tackled was narrower, and focused on local solutions. Working out a relevant socially-oriented solution requires particular expertise, with time allocated to the empathizing and problem-definition phases. The sense of urgency at hackathons can reduce the negotiation phase and leave some views tacit or excluded. We know, that inclusion of potential beneficiaries at hackathons is an organizational challenge that raises issues (Briscoe and Mulligan, 2014; Gregg, 2015; Irani, 2015). "Experts" (activists, citizen activists, experts in the field that have experience in community projects) that were knowledgeable about the particularities of the problem, and about how to involve further vulnerable groups as potential beneficiaries were constrained by the perceived pressure of structure and timing of the solution-focused "pros" (corporate knowledge, design methodology, management), switching from the empathizing and definition phases to quick ideation of the business plan, prototyping and presentation-building. Business-focus, application of design methodology and a presentation-push – created an atmosphere of "professionalism" on the detriment of engagement with impact fostered by the experts. The constant sense of urgency is associated with the startup culture of efficiency, time-boxing, and pitching while the culture of activism and social intervention design suggests a thoughtful planning phase, followed by "a solutions on the spot" attitude. The latter dedicate more focus to developing inclusive schemes and stakeholder design without an outlook on the potential commercial aspects, and organizational set-up, the former is concerned with marketable and viable product development and making a presentable pitch for the jury. This pressure imposes barriers to explore the potential of technology for social impact.

The expert approach views technology as instrumental, as a potent problem-solver of dysfunctional areas of socio-economic reality, while the pros view technology as functional for accomplishing a task, to setup a startup, and create a market. Expert participants expressed their dissatisfaction with the prototypes and their impact, referring to the missed opportunities that technology could bring. The constraining behavior of other members was a resistance to larger change in order to adhere to pre-existing scripts of business-building. Constraining behavior of others is known to hinder people who act according to alternative visions to achieve change (Barley and Tolbert, 1997). An experienced hackathon-participant with the idea of a citizen-science community-run map, as well as the citizen activist bringing fact-based knowledge about the legislative, engineering, health and social issues around noise and air pollution expressed their concerns about the impact in the following ways:

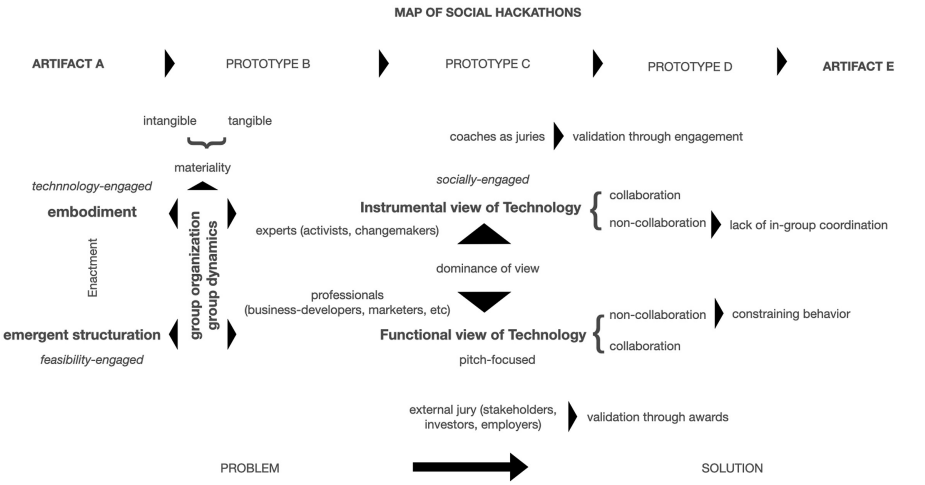
> The knowledge of people should be converted into science. Data and solutions lie within this knowledge (. . .) Making the best map ever was not my goal today. I wanted to contribute to the communities by making maps to meet citizens' needs. (. . .) I feel disappointed that there was not enough time and space to bring the project to the level of creating a map (engineer, CSH).

> Social change can be achieved through the steps that citizens take to solve their problems, and by going after them, not giving up, or ignoring them, as many from my neighborhood do (. . .). Technological solutions can and do solve local problems, which is also a step forward in the social domain (citizen activist, CSH).

Suggestions were sidelined, due to "*cooperation problems that may have stemmed from the age gap too*" – constraining behavior was masked behind implicit ageism.

The divergent views of technology – instrumental and functional – created temporary collaborative and non-collaborative dynamics as emergent structuration. Rules and resources were structured around scripts of design-methods and business plans within a presentation-focused frame that supported the functional view of technology, sidelining the impact-focused instrumentalists (Figure 1).

The functional view was dominant in general, where respondents were primarily interested in building networks and had plans for launching similar projects in the future as their source of professional motivation. The functional view of technology prompted edgy



Source(s): Authors' work

Figure 1.
Technology and impact map – embodiment and emergent structuration of social hackathons

and sharp presentations that received business-plan and feasibility-focused feedbacks from a professional jury of stakeholders, potential investors or employers, which added legitimacy and increased performative effort of the teams.

Less presentation push was observed at smaller events, and when the jury consisted of the coaches. This gave space to the instrumental approach to technology, and more time was dedicated to the empathizing, and definition phases. The coaches got engaged with the teamwork by intervening, responding and discussing the projects; which created some degree of evaluation bias, suggesting the acknowledgement of the process itself rather than the final presentation. Emergent structuration within teams dominated by instrumental approach to technology, also predicted non-collaboration among the members, however in this case instead of constraining behavior, group split and lack of in-group coordination could be observed.

5.2 Innovation for social good and tangible materiality in organizing

The tangible sensors and their characteristics represent one layer of the problem definition; an act of embodiment of the aims of the organizers of the citizen hack. Controlling for levels of noise or dust in any context has an impact on humans. The social dimension in these cases involved the level of scaling (organizations, communities, localities), the layers of stakeholders involved, and how vulnerable the targeted groups were – therefore, the inherent potential of use was explored through the process of structuration, the business model development phase. The rules and resources (or social structures, as Orlikowski (1992) calls them) were rendered into the prototypes in collaboration with business coaches.

Although the artifacts (sensors and prototypes) did not encapsulate all the potential defined in the business plans, the latter could not be designed or executed without the vision associated with a suitable prototype that encapsulated the design rules. For example, a sensor that will be attached to a vehicle (a bicycle) without falling off, getting soaked in the rain, or being overly hidden needs a solution in technical terms; a prototyping process. Sensors are hard-wired devices that should be strategically located to collect the appropriate data. They shall be placed in locations where noise or air pollution is critical, and the data cannot be altered by any intervention to distort the aggregated results. Business plan development usually relies on the premise of an ideal prototype that is technologically suitable for achieving the desired goals –

the reach of potential users and the quality of the data collected. The encapsulation of information about the impact the project could reach, and how to involve the users, along with the possible risks is also needed to create the appropriate business plan, therefore a constant interaction within the tasks and between the members of the group are crucial. When the groups formed, the existence of an "artifact" (the sensor) united the group – first, understanding how it *could* work, then exploring "how to make it work". Ideally, the group splits up on the completion of these two stages – the design rules of the "social impact" and the "technological feasibility" are encapsulated in later separated processes.

The built prototypes that encapsulate the sensors represent the materiality of the artifact fabricated by the team members, and as such their striving for creation of the ideal typical project. As long as prototypes are nested into the structures of technology used to define the rules of interaction, the technology becomes emergent, not embodied. Finally, the prototypes represent the potential of social use in their raw form as they did not go through an entire iteration process with users.

At this point, the separation of the embodiment and emergent structuration of technology is identified as a "break point" regarding the in-group dynamics of teams. In teams where either fabrication or coding was done in an isolation, members were focused on technological embodiment, and their motivation revealed the experimental and skills-learning attitude of participations at the hackathon. The part of the team that focused on the emergent structuration of technology was concerned about either the social impact or the potential for collective action or the commercialization aspects of the product and data. The embodiment and the emergent structuration functions thus operated separately within divided teams and did not become aligned by the end of the hackathon:

> It is a pity we didn't have a prototype finally, as our team fell apart after we all began working on our parts of the job. It was difficult to assemble all the pieces together at the end (CSH).

Finally, missing business plans and half-baked prototypes (hardware with a missing software draft) revealed the lack of coordination and experience to channel in the missing resources. Teams that managed to align the embodiment and the emergent structuration functions within their work – either through a longer and collaborative definition-ideation phase and/or a deeper empathizing phase shared the results and expressed more readiness to continue working on the prototypes after the hackathon. Participant M truly believed their product was feasible and viable on the market; while he was satisfied with the collaboration of the team, he had also managed to learn new things about coding. The members involved in the "dirty work" through hard prototype-building reported on the process of discovery concerning how to assemble things in a workshop. The smell of the wood and the smoke of the laser-cutter experienced while constructing the case for the sensor represented a physical experience of creation as enactment in the moment. This DIY activity added a layer of meaning to the prototype that was separable from the prototype as a project outcome. The tangible artifact constructed by the group also materialized the beneficial and efficient teamwork, thus converting the DIY layer into the materiality of the collaboration effort.

> I liked the idea of creating something tangible and useful (CSH bioengineer, student).

> I like these physical experiences. I work as a biochemist, and the results I get are never tangible. I am happy if I can at least polish a chair, let's say (CSH biochemist).

> I have already tried soldering at home, but I have never used a microcontroller before. I will get one for myself, too (CSH engineering student).

Each prototype is the materialization of teamwork if the team develops into an organization with decision-making and task-allocation processes. Groups that failed to cooperate concerning tangible and intangible elements, ended up without a physical prototype or with a flat business plan. This disentanglement of in-group organization of the embodiment activities from the

feasibility-engaged emergent structuration function could be observed in experts-dominated groups. This immersion into the tangible experience can be described as technology-engaged that is dominant in the embodiment function of the hackathon (Figure 1).

> It was difficult to assemble all the pieces in the end. Our team has fallen apart (CSH, art student).

Ideally, the business plan takes on mediating role between the materiality of the technology and the collaborative effort to deliver a socially-engaged project. The materialization of X into Y involves the mediation of a third party (Cooren, 2020), the presence of the external jury was an efficient push toward this direction, reinforcing the feasibility-engaged functions of the team-work. The total lack of these external frames leave structuration uncoordinated (Figure 1).

5.3 Impact and/or technology: intangible materiality

The intangible materiality of application and data design raises the question of the capability of the embodiment of the social issue. Elements of technology (such as voting procedures, stored data, and public display screens) are "external" to human action once they have been built into technology (Orlikowski, 2000, p. 406). Data collected by apps are dynamic due to their growth and potential for scaling. Data collected and stored by sensors are intended to initiate human action to take measures to lessen noise/air pollution. Therefore, they cannot be considered inscribed properties of technology, which implies that they should be seen as structures mobilized by users that structure human action through particular social practices, constituting rules and resources (Orlikowski, 2000). The process of structuring these elements (how data are collected and used and defining the rules of human action accordingly) is the core challenge of the hackathon. The data collected, processed and interpreted by the application (and identified, stored, and transmitted by the sensor) is the fundamental resource used to solve social issues. The tension is that the financial sustainability of these projects relies on the total or partial commercialization of the data associated with added revenue-generating activities. Accordingly, the boundary between the elements that are external to human action and those that are dynamic is defined by the entangled cooperation of the business plan and app development – the embodiment and the emergent structuration.

In the case of the emergent technologies of intangible materiality, there is a greater risk that the "socio-technological" layer, the social component, will be lost. In the case of ECHs, the lack of clear-cut problem definition was pointed out by several mentors as a problem at all three observed educational hackathons and confirmed by observation notes. The empathizing research phase either benefited from the insights of the socially engaged coaches or the personal experiences of the team members. When these were lacking, groups struggled with problem definition and finding relevant information about the social issue. Some groups merely skipped the relevant empathizing and research stages and jumped to the ideation phase; creating a general persona with textbook business model. Groups that enriched their persona with personal insights about a particular issue designed solutions that could embody the social cause and a business plan that would mediate social innovation.

An award-winning pitch was presented by a team of five, of which three members shared the same health issue, food allergies. One of the participants described her engagement and personal experience:

> I know by experience what it's like. During my vacation at the seaside, I got sick at dinner. I was not aware of my seafood allergy. I didn't know where to ask for help; my host gave me some medicine and took me to hospital (ESH).

Substantial time during the ideation process was spent discussing how the persona's needs could be best addressed, backed up by a detailed and well-elaborated business plan. Less time was dedicated to drafting the app prototype, but as the core elements were engrained in the

emergent immateriality of the draft, it nevertheless materialized the social impact of the project.

Immateriality relied heavily on the personal experience to define the social issue in the conditions of shortage of time, but as the example shows, time spent on empathizing paid off. Immateriality suggests more opportunities for scaling up impact, and builds a larger reach at a faster pace.

In another case, a group of coders (students) arrived at the hackathon with a half-baked project on open-data journalism. As several crucial elements of technology were already encrypted in the prototype they were working on, it became external to further team action – for example, to properly developing a business model. The group of coders failed to cooperate or share their work with their team, the members of which were supposed to "add" the business plan and the presentation. The prototype-in-progress thus quickly became "hidden" due to its intangible properties (code and data). Finally, it materialized the social dynamics of the coder group, and reduced the capability of embodying the social issue articulated by the event, despite the coaches, and the available team. In this case, the immateriality of the pre-made prototype made it inaccessible for others to grasp its meanings and functions, leading to a complete disentanglement of the embodiment and the emergent structuration functions. In contrast, the materiality of the device provided on spot united the teams at least at the beginning of the team-work (Figure 1).

6. Conclusions

This study was not intended to "read" technology itself; instead, the goal was to examine the process associated with the emergent technology. In line with Lodato and DiSalvo's (2016) findings, hackathons are events of material *participation* rather than material *production*, thus it is not the inventiveness of a particular prototype or solution that is important but how the event fosters opportunities for "collective issue articulation" (p. 555). There is no evidence about whether the presented prototypes or ideas of prototypes would be implemented or how users would give them meaning. Three projects were associated with genuine commitment to go further after the hackathon event. An "air hack" project continued for about a year and was presented at several startup-pitching events. A follow-up interview with a team member revealed that problems associated with intellectual property rights and the lack of time of the core members of the team had caused a split. A "noise hack" project finally failed to obtain seed-funding opportunities despite the positive feedback it received at several startup pitches. A project on open data in journalism was already in the making when the team brought it to the hackathon; in this case, no follow-up information was available.

Change-making is an expectation of prototypes at a social hackathon, as the latter are framed around themes of social relevance. Therefore, social interaction is assumed to be structured around the perspective of technology as capable of creating change (Barley and Tolbert, 1997; Kling, 1980). However, the hackathons that were observed were not, in all cases, structured to allow for change-making prototypes. The ESH events were backed by a grant and sponsor-funded project that promoted entrepreneurship and a startup culture among youth that reportedly hinders. The framing of innovation for good or innovation for social impact was associated with vague or entirely lacking definitions of actual social issues, and without the involvement of potential beneficiaries. This later is reportedly problematic (Briscoe and Mulligan, 2014; Gregg, 2015) and hinders developing socially-oriented, actually relevant solutions by definition. Instead, social impact was conveyed through the image of the entrepreneur-for-good, constructed through the presence of actual award-winner startuppers and entrepreneurs at the event. These reinforce the view of hackathons as events fostering tech-culture associated with collaborative practices, prize-giving (Longmeier *et al.*, 2022), centered around the heroic image of the entrepreneur.

The participants of the citizen events tended to share a vision of agency for change: by the end of the event, around three-quarters of the respondents believed that local initiatives could address regional issues, and that local problems can be addressed by such initiatives, and the potential to become "agents of change" was one of the aspirations reinforced by the hackathon (Zukin and Papadantonakis, 2017): "*I should have focused on more issues associated with my neighborhood at the hackathon*" (CSH). The initial aspirations and experiences of the participants play an important role in shaping their future commitment to finding socially-oriented solutions. Organizing around prize-winning or organizing around sensors make a difference.

Social hackathons create the opportunity for change, but not change in itself, as change could be reliably documented outside or after the hackathon. The point here is to align the instrumental and the functional views of technology with an efficient coordination of the embodiment and emergent structuration functions. For this end, a longer preparatory work would align the capabilities of the team-members. Experts' knowledge means nothing if sidelined, and without professionals' techniques and methods ideas will never reach the market. One-day hackathons seem to be less efficient unless anticipated by a preparation phase with information-gathering, stakeholder involvement and a pre-definition phase supported by potential beneficiaries and activists.

Tangible sensors represented a means-end relational stance in connection with developing projects to achieve goals due to the shared workshop space and low entry points. People in a defined context can relate to, reconfigure, and shape meanings of technology that involve different applications after the development of an artifact. This outcome flies in the face of the premise of social constructivism, which suggests that meanings are incorporated into artifacts before they actually reach the "market" or the "users". Hackathons are specifically designed to create these new meanings and forms of application. But can the institutionalized nature of hackathoning help achieve the desired goals?

The ideas that were produced were not marketable in general. Corporate hackathons are documented to generate innovation that may be later developed into iterated prototypes (Zukin and Papadantonakis, 2017). However, both social hackathons that were studied represented a culture of producing and a way of communicating the "social" and the "citizen" agenda rather than demonstrating activism.

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