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CHI 2019

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Human Factors in Computing Systems

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**Association for
Computing Machinery**

Advancing Computing as a Science & Profession

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General Chairs' Welcome

We are excited to welcome you to CHI 2019 in Glasgow! This is the first time CHI has been in the UK and we very happy to host it in Scotland. Our theme is 'Weaving the Threads of CHI', reflected in our celtic knot symbol of strength and friendship. The threads of CHI are people from different disciplines, cultures, communities, backgrounds – designers, researchers, practitioners – weaving together around the common purpose of technology that works for people and society.

The theme of weaving informed all our planning and we are excited to present a vibrant programme for you to experience. Apart from an outstanding technical programme, we have created many other opportunities for 'weaving' to happen: Lunch@CHI on Monday-Wednesday; CHI Stories on Tuesday evening; and an evening UX Industry event with a special invited speaker. We have also organised open social events every evening, including a Newcomers reception on Sunday and a sponsors reception on Wednesday in the Science Centre.

A particular highlight is the Interactivity and Demonstrations programme, launched at the Reception on Monday evening, giving a live glimpse into the future with 50 hands-on prototypes, artworks, design experiences as well as inspirational technologies, and including a special 20 year anniversary exhibition from Nottingham University's Mixed Reality Lab.

We are thrilled with our dynamic keynote speakers. Aleks Krotoski is a broadcaster, journalist and academic who presents the BBC Digital Human series and The Guardian newspaper's Tech Weekly podcast. Ivan Poupyrev (Google) is an award-winning technology leader, scientist and designer working at the cutting edge of interactive technologies and textiles.

We are also excited to continue the commitment to making CHI, and CHI content, more widely accessible. We will be live-streaming most paper sessions. We will support remote attendance to social sessions through a new form of telepresence being trialed this year. We also support diversity and inclusion by providing a nursing room, all-gender bathrooms, badge pronouns, a desensitization room and a prayer room. We have appointed Equity chairs for the first time to take a broader overview of equity concerns. Our new Sustainability chairs are also helping us take steps towards making the CHI event more sustainable.

We have also had many organisational changes to CHI this year: a virtual programme committee meeting, a new submission system, new paper templates, a new logistics company and a new registration system, to name a few. Some of these have caused you and us headaches but all of them will make CHI stronger for future years.

We welcome you to Glasgow and our hope is that, over the next six days, you weave yourself ever more as a part of the CHI community, exploring technology and world-class research, engaging in discussions with your community of designers, researchers, students, and practitioners and all attendees!

Stephen Brewster

CHI'19 General Chair

University of Glasgow, Scotland, UK

Geraldine Fitzpatrick

CHI'19 General Chair

TU Wien, Austria

TPC Chairs' welcome

The CHI 2019 conference will kick off with a weekend packed with 35 workshops, 6 symposia, and the doctoral colloquium. This year we have introduced part-day workshops, to enable increased participation across the whole range of topics that are of relevance to CHI.

The main conference will run from Monday to Thursday across 23 parallel sessions that will include papers, panels, case studies, Special Interest Groups, courses, video showcase, alt.chi, and the popular student research and student design competitions. This year interactivity will consist of both demos and installations, with the latter being larger and more substantial exhibits that will be on display at the conference.

This great programme is included in the Proceedings and Extended Abstracts of the conference. As with previous years, there are two fundamental categories of contributions that become archived in the ACM Digital Library. Papers are the most rigorously peer reviewed and are considered the most prestigious material presented at the conference, all of which are collected in the Conference Proceedings. The remaining categories of work are collected in the Extended Abstracts of the Conference. These include peer-reviewed, juried, or curated contributions, and reflect the breadth of research, design, education, artistic, scientific exploration and engineering activity within the HCI community.

Making this programme possible was a challenging and rewarding experience. This year our community used a new template for the submissions, and a new platform for receiving submissions and managing the review process. In addition, this year the program committee meeting was largely carried out using online video conferencing.

We are truly excited that this year CHI received 4652 submissions and accepted 1298. For papers, we received 2958 submissions (the 2018 conference received 2592) which were rigorously reviewed, resulting in 703 accepted papers (acceptance rate 23.8%). In addition 21 journal papers will be presented at the conference.

As always, we give a huge thanks to the 116 members of the organising committee who made sure the conference is organised successfully, the 541 members of the programme committees who wrote 7996 reviews, and the 3950 external reviewers who wrote 7176 reviews.

We also wish to thank the staff at Sheridan Communications (particularly Lisa Tolles) who worked extremely hard to ensure that all submissions were processed, and who managed to do so at a time of transition in our community's templates and submission system.

We hope you enjoy the technical program and it inspires you!

Anna Cox & Vassilis Kostakos

Technical Program Chairs

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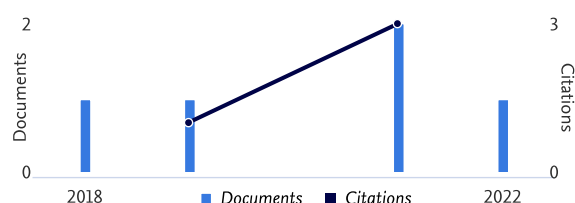
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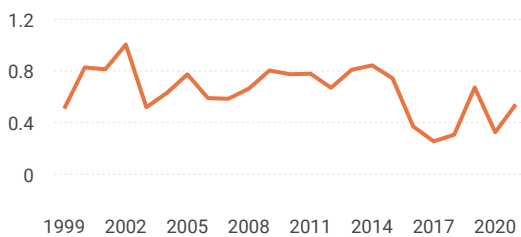
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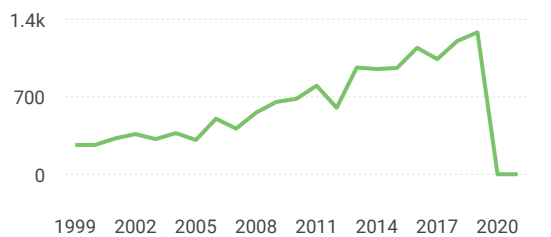
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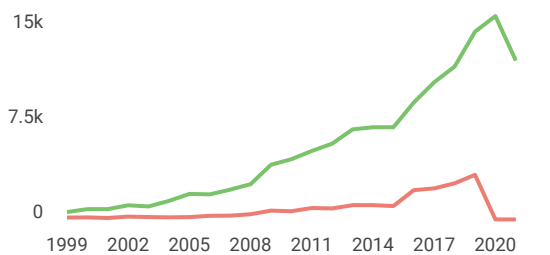


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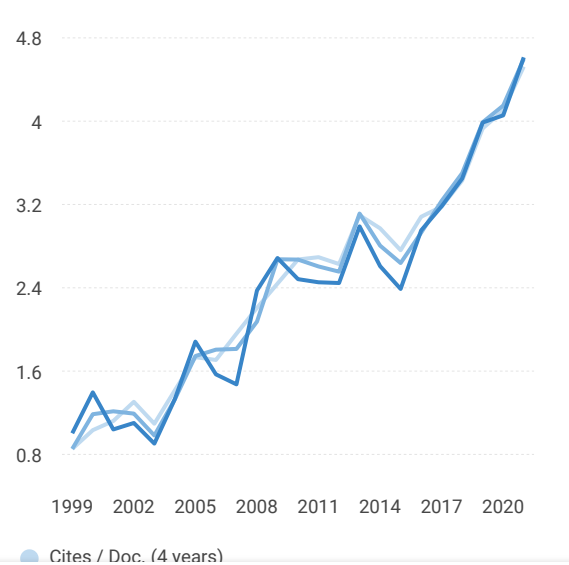


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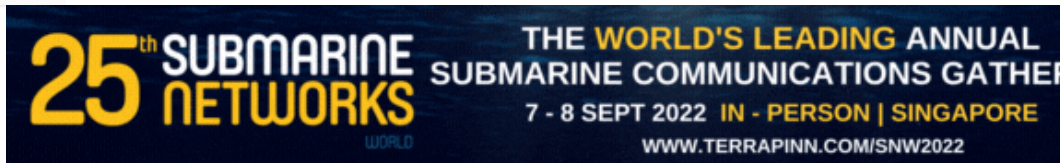
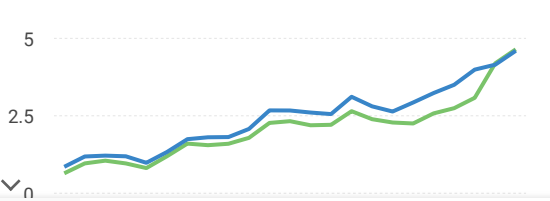


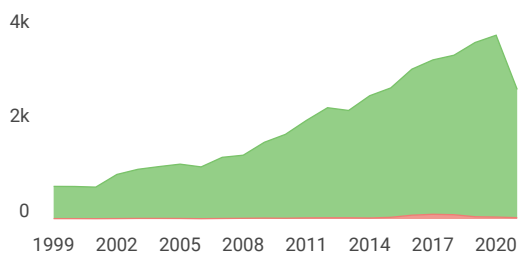
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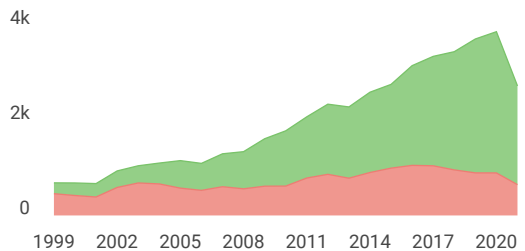
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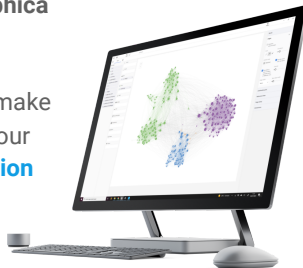
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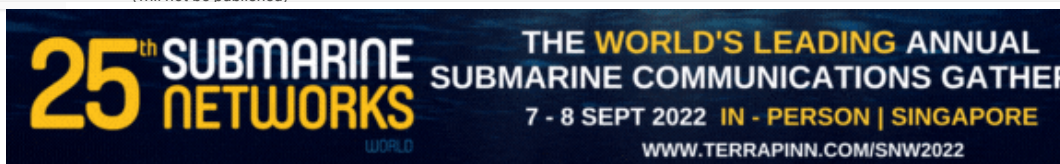
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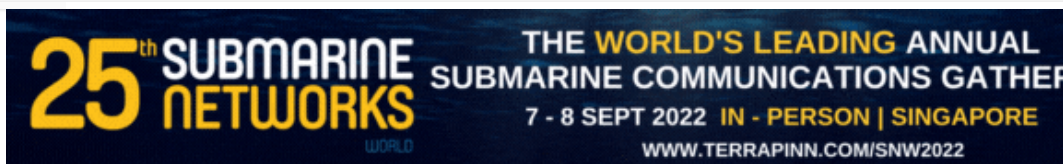
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Virtual Hubs

Understanding Relational Aspects and Remediating Incubation

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ABSTRACT

We have recently seen the emergence of new platforms that aim to provide remotely located entrepreneurs and startup companies with support analogous to that found within traditional incubation or acceleration spaces. This paper offers an understanding of these ‘virtual hubs’, and the inherently socio-technical interactions that occur between their members. Our study analyzes a sample of existing virtual hubs in two stages. First, we contribute broader insight into the current landscape of virtual hubs by documenting and categorizing 25 hubs regarding their form, support offered and a selection of further qualities. Second, we contribute detailed insight into the operation and experience of such hubs, from an analysis of 10 semi-structured interviews with organizers and participants of virtual hubs. We conclude by analyzing our findings in terms of relational aspects of non-virtual hubs from the literature and remediation theory, and propose opportunities for advancing the design of such platforms.

CCS CONCEPTS

• **Human-centered computing** → **Empirical studies in HCI**; *Empirical studies in collaborative and social computing*.

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1 INTRODUCTION

In recent years, we have seen platforms emerge that seek to offer remotely located entrepreneurs and startup companies with support analogous to that found within traditional (i.e. in-person and co-located) incubation or acceleration spaces. These ‘virtual hubs’ aim to provide their participants with support such as mentorship, access to investors and investment, and networking, over the course of fixed-duration and cohort-based programs [5, 23]. In doing so, these platforms aim to accelerate the growth of newly emerging ventures. This is currently done by utilizing tools such as video conferencing, learning management systems and shared documents, as well as building customized software.

By offering access to incubation from anywhere, this virtual hub model can provide a number of benefits for certain businesses. In traditional ‘in-person’ incubators and accelerators, participation relies heavily on co-location in a specific location. This means that participants must often at least move office, if not city or country, to gain the benefits of participation. As such hubs are often found in capital cities or other major population centers, this requirement may exacerbate uneven concentration of work, talent and wealth across countries — and, as a result, cause “cultural homogenization and a lack of regional cultural influence on products of hubs” [17] — or simply act as a barrier to entry to those who are not easily able to move their business. However, by adopting a virtual model of incubation, such platforms also risk undermining the social and relational aspects that have been shown to contribute strongly to the value of the in-person hub experience [17].

In this paper, we aim to provide an understanding of the current form and practices of existing virtual hubs. We specifically ask: what kinds of support do existing platforms seek to offer new businesses; how are they organized and configured in order to provide such support to their remotely located participants; and how effective are these platforms in offering such mediated incubation processes? We answer these questions in two stages. Firstly, we provide a general understanding of the current landscape of virtual hubs by documenting and categorizing 25 existing platforms in terms

of their form, support offered and a selection of further qualities. Secondly, we uncover more detailed insight into the effectiveness and experience of such platforms via 10 semi-structured interviews with hub participants and organizers.

Our findings reveal and categorize the range of support offered by virtual hubs and the processes they employ, many of which bear similarities with their in-person counterparts. We also identify and describe a set of common themes that span the hubs featured in our interview sample: they increased participation, they are also startups, they considered aspects of participants like diversity and incompleteness, and they experimented with online approaches for realizing their incubation model. In particular, our findings reveal that the virtual incubators and accelerators deal best with the absence of the in-person element in areas such as participants, model, organization, and digitalizing. To conclude, we analyze these findings in terms of relational aspects of hubs found in previous work and remediation theory and, subsequently, present opportunities for advancing these platforms.

Our study contributes to HCI by providing the field with a first understanding of these newly emerging, but potentially impactful, socio-technical platforms. This paper presents the support they seek to offer and the complex relational factors that affect their success in the context of current technology. Moreover, by exploring successes, failures and promising developments in how virtual hubs seek to mediate the incubation process, we may provide insight that can inform related social-technical platforms for non-co-located human collaboration. Thus, these findings will be valuable in helping researchers to understand these emergent socio-technical platforms and inform design that aims to support and improve them.

2 RELATED WORK

Virtual Hubs: Toward an Experiential Understanding

Participation in an incubation process can support the development of startups, by providing linkages that help new businesses survive, accelerate, scale-up, and grow [8, 9, 20]. Such processes are commonly implemented in the form of physically co-located “technology business incubators” [20], “business incubators” [8] or fixed-term, cohort-based “accelerators” [9, 21]. In recent years, however, we have seen the emergence of a new class of ‘virtual’ incubators and accelerators that attempt to deliver the incubation process to startups that are not physically co-located, usually via the application of digital media.

These new platforms have yet to be studied extensively, and research that has considered virtual hubs has principally addressed them as a secondary concern in the broader analyses of co-located incubation and acceleration spaces; has focused primarily on their function, rather than participant

experience; and has not considered how they are supported by the user-experience design of their technical platforms in-depth. For example, a recent study of UK incubators and accelerators reported that 7 virtual accelerators and 4 virtual incubators were active — offering support services remotely, but not providing or relying on presence in physical space [5]. This study acknowledged the presence of virtual hubs in the context of the UK’s broader landscape of business acceleration and incubation and noted a range of support functions offered by virtual hubs across pre, during- and post-incubation stages. The same authors also showed that these support functions included: mentoring, access to experts, access to investors, networking connections, training, seminars/workshops, investment readiness, and funding advice [4]. Virtual hubs can also engage in “post-incubation activities” [20], such as alumni networks, but recent studies of virtual incubators and accelerators have not explored this phase in detail yet.

While such studies that reveal the more functional aspects of virtual hubs (e.g. the particular services offered) are highly valuable for understanding their operation and informing future platform design, previous research has shown that the experience and value of participating in business incubation and acceleration programs is also strongly affected by a range of complex, non-functional, factors. For example, previous studies of traditional, physical incubators report the important value of the social capital gained through participation to entrepreneurs, especially in the technology sector [2, 15, 22] — and, in particular, the role that such spaces play in establishing trust, norms, identification, obligations, and expectations in relationships between tenants [27]. Additionally, our own previous work has shown how the value gained from hubs by their members stems from how these spaces support and nourish the development of individual and business relationships via subtle aspects of their physical, social and operational configuration, which include: the size of teams; the development and, sometimes, enforcement of community ethos, values and rules; infrastructure design; and shared participation in social and business activities and events [17].

Our previous work has hypothesized that it might be these non-functional aspects of hubs that are most likely to be degraded when moving over to a virtual platform [17]. For this reason, we argue that the lack of attention as yet paid to them in the study of virtual hubs in the literature is a critical knowledge gap, which could significantly hinder future efforts to improve existing, and develop new, socio-technical platforms for business incubation and acceleration. In making this assertion, we make reference to the broader field of CSCW, which has demonstrated the importance of developing an in-depth experiential focus in research exploring, and designing to support, distributed collaboration (e.g. [1, 6, 11]).

Remediation

In the conclusion of this paper, we employ remediation theory to scrutinize the digitally mediated approaches to supporting business incubation and acceleration examined in our study. In doing so, we look at virtual hubs as new media that comprise prior media: speech, written forms, face-to-face communication, and audio-video material; “the content of any medium is always another medium” [19]. Furthermore, new media refashions, reshapes previous media and previous media also refashions itself, or in short, remediation [3]. Remediation involves two logics, on the one hand, the idea of removing mediating aspects from previous media (the logic of immediacy) and, on the other hand, the notion of making visible and multiplying the new medium (the logic of hypermediacy) — “Our culture wants both to multiply its media and to erase all traces of mediation” [3]. Remediation practically implies “existing content and forms are borrowed, adapted, sampled, or remixed to create new expressions, new relationships, and new content” [14]. Digitizing sticky notes is an example of doing remediation because the built-artifact mediates the same activity as the prior one, mediating brainstorming with sticky notes, but also changes and reshapes that practice [13].

3 METHOD

Our study of existing virtual hubs followed a two-stage process comprising, first, the identification and categorization of 25 hubs based on the documentation provided on their websites and, second, a set of semi-structured interviews with 10 virtual hub participants and organizers. In following this process, we sought to provide an overall picture of the current landscape of virtual hubs (primarily from the website analysis) and more in-depth insights into a sample of those hubs, with a focus on the relational aspects that contribute to their experience (primarily from the interviews).

Broader Understanding: Categorizing Virtual Hubs

We began the first stage of our study by compiling a list of 203 candidate virtual creative hubs from different sources, including: 41 incubators from Open Movement [24]; 55 creative hubs found by searching the European Creative Hub Network with the keywords ‘digital’, ‘incubation’ [10]; 80 virtual incubators and accelerators from Ideagist [25]; 11 virtual incubators and accelerators from a NESTA UK dataset [4]; and 16 from a list developed in our previous research [17]. Next, we included or excluded each candidate from our sample based on information available on each hub’s public website. To be included in the sample, a hub had to meet the following criteria: offer services that aim to support business incubation or acceleration; have geographically distributed participants; deliver services virtually or semi-virtually; and

offer sufficient information for the researchers to have confidence in drawing conclusions about it. 27 hubs were eliminated in the first stage due to insufficient information.

Following the initial application of our inclusion criteria, we were left with a sample of 32 hubs. We then surveyed the websites of these hubs in more detail to categorize them in relation to categories including: type (incubator or accelerator); form (e.g. fully virtual, hybrid); support offered (e.g. mentoring, funding advice); business stage of participants (e.g. pre-startup, later-stage venture); duration of support (ranging from 10 weeks to 12 months); tools used (e.g. video conferencing, learning management systems); cost of participation (e.g. free, fee paid, equity taken); and key relational qualities of physical hubs from the literature exhibited (e.g. social capital, knowledge exchange). The full categorization of our sample can be found in Table 1. Following our detailed categorization, seven of the 32 websites were branded as either a virtual incubator or accelerator but they did not comply with all the selection criteria above. Hence, we used the data collected from 25 virtual incubators and accelerators.

Exploring Hub Experiences in Detail: Interviews

In the second stage of our study, we conducted 10 semi-structured interviews. Our interview sample spanned two continents including 6 in Europe and 4 in North America. The 13 hubs were chosen as a sample to represent a selection of different hub types and forms (fully virtual, hybrid; course-based, non-course based; hub for global participants or region-based participants) and different ways that they were established (from fully virtual; from physical to virtual; from business consultant to virtual hub; and formed by a big company) from the first stage review. Of the thirteen virtual hubs contacted through email, we received approval from seven virtual hubs that represented the above-mentioned variations.

The first author interviewed the hub organizers and participants via Skype, Zoom, and Hangout. The hub organizers (HO) were:

- HO1: Chief operating officer of a virtual incubator that had developed customized web-based software for its platform.
- HO2: Founder & managing director of a virtual accelerator that utilized digital communication tools.
- HO3: Founder & coach at a virtual incubator that utilized video conferencing tools.
- HO4: Founder & CEO of a virtual incubator with customized web-based software.
- HO5: Co-founder & mentor of a virtual accelerator that had developed a platform using learning management system (LMS) software.

- HO6: Program head of a hybrid (online and offline) accelerator program that utilized digital communication tools.
- HO7: Program director of a virtual accelerator program that utilized digital communication tools.

Hub participants were recruited via organizers, with the sample size restricted by challenges including availability, loss of contact and commercial sensitivity. The three participants (HP) were introduced by the hub organizers. The participants' businesses were in different stages of development: HP1 was in the early stage, but now has their business running; HP2 was and now still is in the development stage; and HP3 was in the early stage, but now has expanded.

The semi-structured interviews were held for 30-60 minutes. These interviews sought to provide more detail about the features of virtual hubs discovered in the first phase, in particular how they were experienced by participants and organizers in action. Additionally, it was intended that the interviews would open up discussion of topics that weren't covered during the website categorization, such as: the definition of incubator or accelerator employed in the hubs; motivations to 'go online' and provide virtual instead of in-person hubs; experiences of the incubation or acceleration process and actual services provided; the perceived and actual values of such online systems; challenges experienced connecting remote participants through a virtual hub; evidence of presence, or lack, of relational aspects found in traditional physical hubs; and, specific to the hubs that employed a hybrid-approach, the difference between their online and in-person programs. We analyzed interviews using Thematic Analysis[7]—an interpretive approach in which transcribed data was first open coded, and then emergent patterns among codes were identified and iteratively refined.

4 SUPPORT OFFERED AND QUALITIES

The next two sections present findings from the two methods of data collection described above. The first part describes a broader understanding of virtual hubs based on the website categorization. The second part provides more detailed findings from the interviews.

According to their websites, the virtual hubs included in our sample offer support in three common areas: mentoring and knowledge transfer, networking and access, and investment and funding. The support offered in these three areas can be broken down into further clusters (Table 1). First, mentoring and knowledge transfer was found to comprise activities including: mentorship (80%), seminars/workshops (32%), training (44%), provision of learning resources (16%), specialized support like legal/accountancy (12%) and technological support (8%). Next, networking and access consisted

of: networking (80%), access to experts (60%), access to investors (48%) and demo days (12%). Last, investment and funding support encompassed: investment readiness (52%), direct funding (20%), funding advice (20%) and demo days (12%). The above-mentioned demo days allowed participants to present or pitch in front of audiences including: investors, other startups, and mentors. Demo days are included in two of the areas because they were observed to provide opportunities for both networking and for securing investment. The support offered in these three areas was observed to primarily be targeted at emerging companies and businesses (e.g. pre-startup, startup and early-stage venture).

The virtual hubs delivered these forms of support using a range of tools. We found that three of the hubs had built customized tools to support their operation and the rest utilized existing tools, for example, video conferencing, group messaging apps, and shared online drives. The three hubs that had developed customized tools publicized this as an advantage when marketing their service to prospective participants. The hubs also delivered support to the process of incubation and acceleration over varying periods of time, ranging from ten weeks to twelve months. Contact between participants and other stakeholders in the virtual hubs was not found to take place on a daily basis. Rather, support was provided at scheduled or pre-arranged regular online meetings and via set tasks during the interim period. This way of organizing was seen to be common across the websites surveyed — and was described as a way for these hubs to keep the participants on track and to provide a flexible contact-point between participants, mentors and organizers.

The information provided on the hubs' websites suggested that their existence and configuration was driven by the provision of three key processual qualities, which have previously been noted as valuable traits of traditional creative hubs [17]. These were social capital, knowledge exchange, and incubation. 40% of hubs placed an emphasis on expanding the social capital of their users, in order to provide them with access to information and know-how, in the materials on their websites. Examples of materials that evidenced this included: profiles detailing the experiences and achievements of the incubator/accelerator and its team, a set of previous participants' success stories, a collection of companies and big brands that they are affiliated or cooperate with, and a set of processes that they have designed. Secondly, 96% of hubs included information on their websites that evidenced the importance they place on providing access to knowledge exchange for their participants. Examples of this included detailed descriptions of their curriculum or course syllabus; the kinds of seminars, training and learning resources they offer; and also detail about who their mentors and potential mentors are. Thirdly, 76% of hubs exhibited a focus on incubation in the description of their activities. That is to

Table 1: Website Categorization Result

Categories	<i>f</i>	%	Categories	<i>f</i>	%
Type			Form		
Virtual incubator	14	56%	Fully virtual	19	76%
Virtual accelerator	12	48%	Hybrid	5	20%
Support Offered			Business Stage		
Mentoring	20	80%	Pre-startup	17	68%
Seminars/workshops	8	32%	Startup	9	36%
Funding advice	5	20%	Early-stage venture	7	28%
Demo days	3	12%	Later-stage venture	1	4%
Networking connections	20	80%	Not specified	1	4%
Access to investors	12	48%	Duration of Support		
Training	11	44%	Up to three months	7	28%
Legal/accountancy support	3	12%	Four to six months	4	16%
Direct funding	5	20%	Seven to nine months	1	4%
Investment readiness	13	52%	Ten months and greater	2	8%
Access to experts	15	60%	Not specified	11	44%
Tech support	2	8%	Cost of Support		
Learning resources	4	16%	Free	4	16%
Tools Used			Participation fee	9	36%
Video conferencing	10	40%	Equity taken	4	16%
Group messaging	3	12%	Others	1	4%
Project management	0	0%	Not specified	9	36%
Shared documents	6	24%	Key Qualities		
Customized software	3	12%	Social capital	10	40%
Learning management system	3	12%	Knowledge exchange	24	96%
Others	4	16%	Experimentation	0	0%
Not specified	10	40%	Incubation	19	76%

Note: (i) *f* = frequency of hubs classified within a certain sub-category; (ii) % = percentage of hubs (e.g., 56% of the total sample is classified as a virtual incubator); (iii) an entry can have multiple properties, so the sum of *f* in each category may be > the sample size and the sum of % > 100.

say, these hubs placed emphasis on nurturing, developing and supporting emerging businesses to survive, grow, and scale, rather than providing support to more established enterprises, in their online materials. Examples of this included detailed case studies that focused on how the development of particular startups had been facilitated by their method or approach and information about how the accumulation of the knowledge and experiences from the hub management and mentors could benefit prospective participants from early stage businesses.

76% of the virtual hubs surveyed showed evidence on their websites that they delivered their processes fully-virtually. 20% showed evidence that their processes happened through a hybrid approach where the participants and mentors spent time online, but would also meet in-person.

5 DIGITAL INCUBATION

In the second stage of our study we conducted follow-up interviews with organizers and participants from a selection of these virtual hubs. In doing these interviews, we aimed to discover further detail about the support and qualities documented and, crucially, how they were being delivered and experienced in practice. In the following sections, we describe a set of patterns that emerged from our analysis of the qualitative data from these interviews (HO: Hub Organizers; HP: Hub Participants).

Advancing Participation

A key advantage of virtual hubs noted in the interviews was the potential they have for increasing and diversifying participation. Virtual hubs were valued for offering remote participation and, as a consequence, greater accessibility for participants. Hub participants were said to be able to take part in the incubation and acceleration programs from

anywhere at an arranged time with their mentor. All the interviewees noted that the founders or entrepreneurs that used these services came from different cities, countries or continents. As a consequence, the participants of these virtual hubs were able to benefit from incubation remotely. Prearranged contact points took place in various time slots, for example, once a week [HO1, HO3, HO5] or twice a week [HO2]. This contact-point flexibility allowed founders or entrepreneurs, whose businesses required day-to-day attention [HP1, HP3], to join a program without relocating to a city where a hub was based. It also allowed some of the users of virtual hubs to keep doing other full-time activities while engaging. For example: “they were working full-time, their business idea was not their full-time job, but, they had just as much entrepreneurial potential” [HO3]. The virtual nature of the hubs was found to also offer benefits for later stage startups: “the physical space no longer makes sense because that type of startup is growing out their team and does not see any need to relocate to a new location” [HO6].

The potential for virtual hubs to advance participation was also noted in relation to the higher capacity they can have in comparison to their in-person equivalents, which can allow the number of participants accepted to be expanded. Interviewees noted the fact that in-person hubs have limited availability. “They received maybe a hundred applications to take 20 spots or 15 spots, so, we need to find a way to democratize access to incubation” [HO1]. In another example, one in-person hub “turned away 97% of the applicants” [HO2], it then experimented with an online version and invited all of them (i.e. the 97% rejected applicants) to join this program. While some in-person hubs have scaled their operation to different countries, virtual hubs were viewed as having much greater potential for international scalability. “We can take it around the world, and differently or at the same time because this is online because it is module based” [HO4]. The startups can participate “from anywhere in the world once the model is virtual” [HO6].

Another way that virtual hubs can advance participation is by offering support to companies at a very early stage, when they traditionally would not be able to engage with an in-person hub. This very early stage was understood differently by different hubs — such as the aspiration stage, ideation stage, and product-market fit stage — and according to the study’s participants would often be overlooked by in-person incubators [HO1, HO3, HO4, HO5, HO7]. Virtual hubs, on the other hand, were said to target those who are looking for a “model and viable way of just starting the project” [HO1], “some sort of structure, and how we would develop our idea” [HP2], and to offer support “from an inception of an idea to actually launching a minimum-viable product (MVP)” [HO4]. Nevertheless, the virtual hubs also accepted later stage startups, such as those with less income [HO2].

Moreover, one of them decided to only “[work] with later stage companies” [HO6].

“We are Still Startups Ourselves”

The virtual hubs studied were also exploring and validating their business strategies and delivery models, in a similar way to the startups involved in their programs. The hubs ranged between adopting both business-to-customer (B2C) and business-to-business (B2B) models. Those following a B2C model would directly offer their services to participating businesses. This approach was said to introduce risk as it relies on recruiting individual companies with various marketing strategies, but also offers the potential for diversity as participants can come from various backgrounds: “any entrepreneur can come to the web page and do the program with us” [HO1]. On the other hand, those operating under a B2B model would provide a platform that would enable another institution to deliver an incubation or acceleration program. The B2B model was said to offer security by building on a partnership with a corporation, government, foundation, physical hub or university by, for example, offering a platform as a “white label” product “to streamline their own entrepreneurship program” [HO1]. For example, one virtual hub pivoted from the B2C model to the B2B model because cooperation with a certain institution could ensure members of that institution used the platform [HO5]. Another operated with these two models simultaneously, and stated that it had “reached 300” participants by doing so [HO1].

The virtual hub organizers interviewed, reported having explored a range of different ways of delivering incubation processes. HO2 and HO6 reported that they had originally offered their service in-person, but chose to move to an online version: “We explicitly set out to learn about online programming like creating a 100% online version” [HO2]. Another organizer noted that they moved from an in-person to a virtual model because of a change from working with early-stage startups to working with later-stage startups: “Our motivation was to start working with later stage companies, therefore, we moved to this virtual model” [HO6]. They described how a virtual model would allow them to reach later-stage companies, because those who have had their operation settled and based in a specific location would be unwilling to move to an in-person hub. However, they also noted that they still maintain a small portion of the in-person approach. Differently, HO3 and HO5 reported that they had moved from offering a fully virtual model to a combination of virtual and in-person. In these hybrid models, this combination of delivery could vary from one incubation phase to another: “The six-week boot camp is delivered 100% virtual, the bi-weekly check-ins and three-month mentorship, a combination of in-person and online” [HO3]. Or, it can be

in the same phase of a cohort, “We also have offline session as well, we have once a week, a lab day” [HO5].

HO4 reported they are following their road map to have a large user base just like a startup usually seeks. In order to achieve this, they operate with two programs: a do-it-yourself program and a managed program. In the first, “anybody can come in and anybody just follow the process [provided by the platform] and they are on their own” [HO4]. While in the second, “The managed program is only open to ideas that are, that have a social purpose, so they are basically ideas to bring a social change” [HO4]. By operating this way, they intended to create a large user base without being limited by the additional resources required to offer all users their full, managed program: “This is all about creating it at a scale, and create value because of the scale” [HO4].

Customization and Managing Non-Completion

Another common issue noted in the interviews were the challenges of managing virtual hub participants. The virtual hubs organized a range of participants and endeavored to maintain their participation throughout the program. By doing digital incubation, the virtual hubs were able to include participants from different time zones, with different business focuses and from different geographical locations. This broad spectrum of participants introduced challenges, which were addressed through a set of customizations into their programming. In a program where the participants came from two continents, the hub “did not have both cohorts meet together because of the time zones. So, we ran basically two simultaneous sessions. We had two separate sets of facilitators to run both program” [HO2]. When a platform received the variety of participants with different business focuses, it had to put additional effort in the pre-mentoring stage. “The first stage is the matchmaking. The idea is for them [participant and prospective mentor] to get to know each other. If they do decide to continue, they sign a mentorship agreement” [HO1]. As a result, this modification benefited hub participants, for example, one participant expressed that a mentor from a reputable institution “gave me a huge boost” [HP3] and, since that mentor had the same field of expertise to them, “[the mentor] understands this approach that I am trying to have” [HP3].

The interviewees noted that working together in an online environment over a period of time increased the chance that participants would not complete their program. The rate of non-completion varied across the hubs discussed in the interviews, for example: 2% [HO1], 30% [HO7], and 70% [HO4]. The interviewees described a range of creative methods they had developed to motivate and enable participants to complete. In managing this issue, “We just basically keep sending them messages on that you are left behind” [HO4]. Aside from such follow-up tactics, further efforts described

included gamification: “We do have gamification built-in, we use a fair amount of motivational techniques” [HO5], and building a tool that is “interactive, gamified, step by step, very practical as much as possible because they really want to grow the businesses, they don’t want to do homework” [HO1]. These hubs also made efforts to configure their pre-mentorship phase to increase the chance of completion by “includ[ing] geography as a [mentor-participant] matching criterion” [HO1] and contacting participants in advance to ensure their level of enthusiasm for the virtual process: “[we work with] only those who put real interest actually to the platform” [HO5].

Exploring Online Approaches

The virtual hubs described in the interviews had explored a range of ways to configure their platforms so that they would replicate the benefits of being in an in-person hub. This replication was motivated by a desire to keep the human experience: “We want to keep the interactions and experience very human, so, they meet through video, in between each tool, to really have a debate and talk” [HO1]. In other hubs, such human connections were maintained using existing tools during incubation activities such as: group messaging apps, video conferencing tools and shared documents. Hubs also reported aiming to replicate some of the incubation activities offered by in-person hubs by running online and hybrid (i.e. some participants co-located and others attending via video conferencing) versions of “boot camp[s]” [HO3, HO5], “demo day[s]” [HO2], and long-term engagement [HO6].

Interviewees were split in their opinions about the success of such efforts, in particular in terms of their efficiency. For example, when asked about the efficiency of doing the process online, HO6 said: “yes, absolutely [its efficient], it’s the only way we can do it if we are going to operate a global program.” HO2 on the other hand had found that such activities often required more resources than running their in-person equivalents (e.g. due to additional meetings to account for time zones): “it’s not that it is difficult [to replicate], it is inefficient. It just takes more time, more money”.

HO1, HO4 and HO5 reported that they had developed their own platforms to ease the digital incubation process, and organized their mentorship processes using these customized tools. Functionality in these platforms included support for knowledge transfer (“the platform consists of, we have training modules and videos, we have practical exercises” [HO5]) and organization (“the platform allows them to record the outcome date, lessons learned, attached the documents that they need at every step” [HO4]). Another custom platform had been designed to assist entrepreneurs in aggregating and automatically visualizing their business plans so that they could use them “to look for funding, or to use it as a road map for the team because not all the entrepreneurs

want to raise funding, they just want to get started with the project and get their first client” [HO1]. As reported before, creating such custom platforms can enhance and offer flexibility for a virtual hub’s own business model; as they can be used for B2C or B2B or both. HO1 described how marketing their platform as a B2B offering provided a revenue stream that, in turn, enabled them to offer a service to individual businesses: “the price [registration fee] is very low for the [individual] entrepreneurs. We subsidize them. So, our main revenue model is basically to offer the platform to entrepreneurship programs [institutions]” [HO1]. HO4 envisaged an alternative benefit in creating their own platform. They aimed to develop a large user base for the platform (by making participation free), who would then become a market for service-based revenue streams: “To offer those [incubation] services like marketplace” [HO4].

6 DISCUSSION

Our study has revealed a range of insight into virtual hubs including: reasons why virtual hubs have emerged, what kind of support they offer, and how they deliver this support and extend the incubation process. The virtual model explored in this paper has been shown to offer opportunities to address limitations posed by traditional in-person hubs, but to also introduce new challenges that relate to the online delivery of incubation and acceleration programs. In this section, we discuss our findings to reflect on the ways virtual hubs deal with this *in-person conundrum*, and then analyze our findings in the context of relational aspects of traditional in-person hubs from the literature and remediation theory.

In-person Conundrum

A core challenge of the virtual model that cuts across our findings is how to deal with the absence of in-person interactions. As our findings show, this absence presents opportunities to expand both participation, in terms of numbers and diversity, and the kind of support offered. However, it also inherently poses new challenges, in particular relating to the experience of interaction between participants. This conundrum was a key driving factor affecting how the virtual hubs operated, and a range of strategies for both taking advantage of its opportunities, and addressing its challenges, can be seen in our findings. These can be categorized in terms of four areas of concern: participants, model, organization, and digitalizing (see Table 2).

Participants. The hubs in our study had taken advantage of being virtual to increase participant numbers and diversity. The hubs accepted individual or group participants at different stages of business development, with diverse business focuses, with different relocation constraints and from a wide range of geographical locations. While some virtual hubs

did include some in-person interaction, none required participants to relocate to a specific location for a long period of time. Also, the virtual model was seen to be attractive for hub organizers seeking to establish programs for later stage companies. The virtual model was seen to support participants in idea testing, for developing an idea to a product, for finding a viable way to start a business, and for expanding their companies’ business operations. In terms of the registration fee, the virtual model was seen to offer a free or cheaper participation cost in many cases.

Model. We use the term model to refer to the set of ways the virtual hubs were seen to run their programs. All of the virtual hubs in our study had been operating in some form for, at least, a year, and were observed to regularly evaluate and improve their model in response to challenges faced and opportunities identified. In terms of their business model, some hubs focused on one approach for selling their services, such as business-to-customer (B2C) or business-to-business (B2B), while others sought to provide a platform that can simultaneously serve both approaches. In terms of delivery model, some aimed to provide incubation or acceleration through a fully online service, while others adopted a hybrid approach based on a mixture of online and in-person interactions. The decision to go for one delivery model over another was based on a range of factors, including: the aim to focus on institution-based or individual participants, a change in the stage of business that a hub would focus on, and the circumstances of participants and mentors. Lastly, some of the hubs configured their model with the aim of creating a scalable service that could reach a large user base. Reasons for this included opportunities for monetization and to add a large acceleration service to complement an established incubation program.

Organization. The hubs in the study employed a range of organizational strategies to ensure that incubation and acceleration activities would remain effective when delivered using a virtual model. The virtual hubs were able to provide a range of support also found in their in-person counterparts (e.g., mentorship and access to experts), but chose to alter some aspects of their delivery to ensure that they would work in a mediated process. The hubs conducted pre-session activities to prepare mentors and participants for the challenges of the virtual model, which included the selection of suitable and motivated applicants and mentor-participant matchmaking. The hubs also put extra effort into designing and implementing activities to address challenges of going virtual, such as: providing customized content and building gamification into their platforms. Alongside pre-arranged mentorship sessions, hubs also organized various activities to support engagement in the virtual process like sending follow-up messages, using motivational techniques

Table 2: Strategies of the Virtual Hubs

Strategies	How the virtual hubs best deal with the absence of in-person interactions?
Participants	<i>Virtual hubs can accept:</i>
Number	Higher scalability
Location and relocation	Anywhere, without & short-term re-location
Stage of business	Very early and later stage
Kind of participants	Individuals and groups
Participation fee	Free or cheaper
Model	<i>Virtual hubs run with models:</i>
B2C & B2B	Focus on one model Simultaneously two models
Online & hybrid	Start off-line, move online Start online, move to a hybrid Start online, still online
Scale	Building large user based
Organization	<i>Virtual hubs organize the program through:</i>
Pre-sessional activity	Selection of applicants Mentor-participant matchmaking
Customization	Customized session based on the participants' profile, business focus, and geographical proximity Customized content Interactive and gamified platform
Non-mentorship activity	Send follow up messages, apply motivational techniques. Create online group channel
Digitizing	<i>Virtual hubs digitalize:</i>
Interaction space	Meet through existing channels
Incubation activities	Replicating boot camp, demo day, and long-term engagement.
Incubation tools	Integrate tools into a platform

and providing channels for group communication among participants.

Digitalizing. The hubs in our study primarily attempted to support their participants by digitalizing a set of incubation

and acceleration activities found in in-person hubs. Digitalizing in this sense means replicating spaces for interactions (e.g. one-on-one and group meeting spaces), incubation activities and tools used in their in-person counterparts (e.g. business model canvas and financial projection). This was seen to happen through the utilization of various existing digital communication channels and/or the building of custom platforms. It was also seen to happen through appropriate adjustment of some previously in-person activities like boot camps, demo days, progression meeting points, and long-term mentorship.

Relational Aspects for Virtual Hubs

The operation of the virtual hubs in our study all depended to some degree on the mediation of interactions, and relationships, between stakeholders using communication tools or platforms. Our previous work has explored how aspects of the relationships between stakeholders in traditional, in-person hubs underpin how those spaces are experienced [17]. Drawing on this work, we highlight two points here, activities and events and experience sharing, and present opportunities for advancing the design of virtual hubs.

Activities and events have been shown to offer opportunities at in-person hubs for relationship building, knowledge sharing and for similarly-motivated individuals to convene around problems [17]. Our findings showed that the organizers of the virtual hubs in our study also recognized the importance of running such events on their platforms to some degree — as some had sought to create virtual and semi-virtual versions of events found at in-person hubs like demo days. Hackathons — practical events in which participants are encouraged and catalyzed to collaborate around a shared challenge or issue [16] normally during a period of brief and intensive co-location [28] — have been found to be particularly valuable in facilitating development of social capital and knowledge sharing at in-person hubs [17]. Yet, creating virtual versions of these kinds of events was not mentioned by those in our study. It may not, of course, be the case that hackathons will easily translate *as-is* to a virtual model. However, comparative activities that seek to bring together non-located participants around a shared focus or challenge may be developed to replicate some of their benefits for virtual hub participants. Conversely, recent developments in the online organization of hackathon events [e.g 12] suggest that the running of effective hackathons as part of a virtual hub's process may not be as challenging as anticipated.

Secondly, experience sharing has been shown to happen at in-person hubs on an informal and ad-hoc basis between participants. For instance, in the form of trickle-down mentorship, where knowledge sharing from veterans (i.e., more experienced members of hubs) is passed to beginners [17]

during frequent and casual interactions with those whom they share a space. In contrast, the interactions between participants in the virtual hubs studied were found to be dominated by more formal, structured and comparatively infrequent meetings — with fewer opportunities for the kinds of ‘water cooler’ moments observed in the above-mentioned research. Developing tools or features in a platform that organizes such casual interactions may, therefore, contribute to enhancing the activities of virtual hubs. Those interviewed in our study did mention using group chat channels that might support such ad-hoc experience sharing, but no specific practices to encourage it were mentioned. We envision the development of an online co-working and communal space that is integrated into the platforms of virtual hubs. This could be an additional virtual space, aside from the one-on-one mentorship space, for users to meet and make connections, to share updates, and to perform other relational activities. We anticipate there will be challenges in operationalizing such spaces, for example, how efficient this could be, and what would be the unique selling point to encourage participants to stay there during the incubation period.

Remediating Incubation

In the final stage of our discussion we analyze the design of virtual hubs by considering our findings through the lens of remediation theory. We firstly frame our findings around digital incubation as remediating incubation from its physical counterpart. We then reflect on our findings in relation to opportunities and challenges of this remediated form — drawing inspiration from the work of Thomas et al. on digital personhood and remediation [26]. For instance, the remediated form of the hub advances participation by offering remote engagement and, hence, greater accessibility to a broader range of participants, but also presents challenges in customizing the support provided and managing incomplete participation. Moreover, through this lens, we look at how the choice to frame and configure these services as remediations of previous physical phenomena offers benefits (e.g. a marketable value proposition) but also creates expectations of authenticity that impact the perception, expectations and experience and, in turn, impact service and platform design.

We argue that the virtual hubs digitalize the incubation process. As explained before, the digital replication process endeavored to reflect the activities, interaction space and tools of a traditional incubation. Virtual hubs then, at this point, are a kind of respectful remediation [3] of the previous form, i.e., the physical hub. They remediate the physical and in-person incubation into the digital incubation form, but do not leave behind its predecessors. For instance, video conference tools that are able to accommodate multiple users are used to refashion the one-on-one and group in-person

mentorship found in in-person hubs. By adding an automation feature into its platform, one virtual hub enhanced the written/digital form of the business canvas tool. This platform aggregates the filled questions based on that incubation tool, and then, automatically visualizes those answers as a business plan. Thus, the virtual hubs remediate the activities, space, and tools of the incubation process through replication and enhancement.

By remediating the incubation process, the virtual hubs are involved in the logic of immediacy and hypermediacy. First, the physical hubs mediate the incubation process, and then, the virtual hubs attempt to unmediate the process. We view this effort as a manifestation of immediacy, in which the virtual hubs aspire to efface mediating aspects of the in-person experience such as access to and space availability of the co-located hubs. The developed platform and the employed digital tools constitute the virtual hubs’ intention to give a transparent experience to its users. An experience to the participants, mentors and organizers to have an incubation process without co-locating in a physical space, an experience to have access from anywhere. By doing so, the process of incubation is now visible through the screen — and this brings us to the notion of hypermediacy. The users of these virtual hubs have to access the platforms and the tools in order to do the incubation process; so, now the object or the content is being represented in this new form. However, a challenge in bringing the two logics together is a social dimension. This remediation is inseparable from social arrangements like the authenticity of experience; the appeal to the real experience is socially constructed [3]. If the users do not feel the experience of mediated incubation as an experience of the incubation process, then the virtual hub might lose its importance, and eventually its users.

We can say that remediating incubation means representing the form and content of incubation from the physical hub into the virtual hub. This remediation analysis can inform us on two opportunities to advance virtual hubs. Firstly, designers of such platforms can consider the social dimension of remediating incubation, i.e., the appeal of the authenticity of the experience. Since individuals and groups may perceive authentic incubation experiences differently, we believe that virtual hubs can be advanced further by exploring and redefining this authenticity of experience from users. Secondly, the remediation of the incubation process so far involves replication and enrichment, but it can go further up to absorption [3]. For example, building an online platform for a specific stage (e.g. the ideation-stage or fundraising-stage users) re-purposes the form and content of the incubation process into a platform. In other words, in the language of a medium [18], the physical hubs have been developed throughout the in-person interactions as one of its characteristics, the virtual hubs surely can also be built

throughout its language, e.g., as a platformized incubation process.

7 CONCLUSION

In this paper, we have explored the services offered by existing virtual hubs, and how they are currently delivered. We have observed that many of these services bear similarities with their 'physical' counterparts, but also that the transition to their delivery using a virtual model presents both challenges and opportunities. Moreover, we have observed a range of strategies developed by virtual hubs that both cope with, and exploit, the absence of the in-person element, which relate to their participants, model, organization, and digitalizing.

Our findings were informed by an analysis of 25 virtual hub websites as well as interviews with 10 participants and organizers from a selection of these hubs. In following this method, we have provided a broader understanding of the current landscape of virtual hubs, as well as a further, more in-depth analysis of a selection of specific hubs. We acknowledge that our findings are only a first investigation of this still under-explored space and recognize the need for future studies that extend our work — in particular, by augmenting our findings with interview data from members of additional hubs. We also note that the ratio of our interview sample included more hub organizers than participants. While the organizers' broader vantage point was valuable in providing a holistic understanding of the operation and challenges of virtual hubs suitable for this stage of our work, we encourage future researchers to explore the experience of virtual hubs further from the perspective of those participating in, as opposed to organizing, programs.

By analyzing our findings in the context of relational aspects of in-person hubs and remediation theory, we have proposed opportunities for advancing the design of such platforms. Firstly, activities that encourage and catalyze collaboration among the participants of a virtual hub, such as online hackathons, may contribute to customization, non-mentorship activities, and the building of a large and strong user base. Secondly, manifesting informal and ad-hoc sharing between participants through a post-incubation platform and a virtual communal space. Thirdly, considering the social dimension in remediating incubation such as the feeling of an incubation experience's authenticity. Lastly, we suggest exploring another way of remediation that is absorption, where the platformization represents the incubation process.

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