Understanding and Mitigating Challenges for Non-Profit Driven Indie Game Development to Innovate Game Production

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ABSTRACT

Non-profit driven indie game development represents a growing open and participatory game production model as an alternative to the traditional mainstream gaming industry. However, this community is also facing and coping with tensions and dilemmas brought by its focus on artistic and cultural values over economic benefits. Using 28 interviews with indie game developers with a non-profit agenda across various cultures, we investigate the challenges non-profit driven indie game developers face, which mainly emerge in their personal or collaborative labor and their endeavors to secure sustainable resources and produce quality products. Our investigation extends the current HCI knowledge of the democratization of technology and its impact on the trajectory of innovating, designing, and producing future (gaming) technologies. These insights may help increase the opportunities for and retention of previously underrepresented groups in technology production and inform effective decision/policy making to better support the creativity industry in the future.

CCS CONCEPTS

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

KEYWORDS

indie game development, game development, game production, gaming industry, developer support

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1 INTRODUCTION

The origin of independent [indie] games can be traced back to at least the 1980s and is rooted in "a struggle to find alternative modalities to make, play, and distribute video games" [40]. In this sense, indie game developers are not employed by or affiliated with tech giants or large gaming companies or publishers, and thus represent an alternative game production model compared to the traditional mainstream gaming industry. This alternative model is now a crucial part of the global game industry and has gained popularity and commercial success since 2008 [15, 25, 40] by producing various successful indie games (e.g., *Fez, Super Meat Boy,* and *BRAID*) and indie-focused conferences (e.g., *indieCADE* and *Independent Games Festival*). As the documentary *"Us and the Game Industry"* shows, some indie game developers even self-identify as practitioners of a new form of "rebellious entertainment" and a new counter-culture compared to the mainstream gaming industry [44], through acts such as highlighting feminist principles and queerness in game making [10, 19].

However, the indie game development community is also highly heterogeneous, as people often engage in indie game development for various reasons. Some people choose to be indie game developers not because they are "rebelling" and endeavor to innovate the gaming culture, but rather because they are hobbyists and just make games for fun, or are not yet qualified/skilled enough to enter the mainstream gaming industry [16]. In contrast to these indie developers who take part in game development only casually, *non-profit driven indie game development* has grown into an emerging movement for innovating game development and production. This subset of indie developers are inspired by the increasingly open and participatory dynamics in today's game production [20, 23, 46, 47]. They thus mainly operate on an activist agenda in hopes of innovating how digital games can be designed and produced by collectively advocating values of sharing, openness, and creativity rather than merely focusing on revenues. Following this agenda, *non-profit driven* indie developers of all levels engage in innovating game development and production by leveraging free-to-use game engines and digital assets, open scripting libraries, open source, and comprehensive online tutorials, among others [11, 13, 14, 36, 42, 48].

Although not every indie developer is operating on a non-profit and activist agenda, in this paper we focus on unpacking the various challenges that this subset of *non-profit driven* indie game developers face in their endeavors to innovate game production

and our subsequent reflections on potential technology designs for helping them mitigate such challenges. We believe that an empirical investigation of this community will advance HCI research by closing the the gap between the strong desire to continue transforming and innovating technology design and development from the bottom up (e.g., outside the established, mainstream gaming industry) and the urgent need to explicate novel opportunities and pitfalls of the resulting new technology production model (e.g., non-profit driven indie game development). Using 28 interviews with non-profit driven indie game developers across various countries and cultures, we endeavor to depict non-profit driven indie game development in a more diverse and non-Western-centric way. We especially explore the following research question:

RQ: How do non-profit driven indie game developers face unique challenges in their practices to innovate game development and production?

Our work contributes to HCI in three ways. First, we highlight the complicated tensions emerging in technology creator's/developer's personal or collaborative **labor** and their endeavors to secure sustainable resources (**capital**) and produce quality products (**production**) that a subset of indie game developers constantly face while pursuing their non-profit, activist agenda in game development, which is understudied in previous literature. Second, our critical reflection on the role the growing open and participatory model [20, 23, 46, 47] in today's gaming field plays in fostering or hindering the future of non-profit and activist indie game development extends our current understanding of the democratization of technology and its impact on the trajectory of innovating future (gaming) technologies and production. Third, we highlight potential directions for leveraging technology design to support non-profit indie game developers' navigation of the interplay of labor, capital, and production in their activist effort to further innovate game production. As supporting technology production and innovation is commonly seen as a key economic driver in modern societies, insights from our work may also potentially lead to broader impacts beyond HCI and games research. Our focus on understanding and mitigating non-profit indie developers' challenges to innovate game production helps shed light on the shift of power and labor relations in the technology workforce and increases the opportunities for and retention of previously underrepresented groups in technology production (e.g., women, minorities, and queer individuals). Our highlights of various legal and policy-driven barriers to non-profit driven indie game development across different countries and cultures may also inform effective decision/policy-making at the regional and national levels to better support the creative industry in the future.

2 RELATED WORK

Our work is grounded in two strands of research in HCI: non-profit driven indie game development as an alternative to innovating traditional game production; and understanding labor, capital, and production in the indie game development context.

2.1 Non-Profit Driven Indie Game Development as an Alternative to Innovate Traditional Game Production

Ruffino argued that "[i]ndie is that something most game developers have been, are, or intend to be" [40]. For example, the 2020 Game Developers Conference survey on the "state of the game industry" revealed that more than one-third of the 4,000 developers surveyed can be considered indie in some way – 36% of the respondents worked on the marketing of their own game and without a publisher, and 31% of the respondents used personal finances to fund their game development [6]. However, there seems to be no consensus on a fixed definition of *independence* in the context of indie game development, as how *independence* versus *dependence* is defined may vary across different elements involved in the game production process (e.g., in terms of creativity, technical skills, distribution, and financial resources) [40].

At a high level, indie games can be broadly described as games that are consciously created outside of the production and distribution structures of the mainstream game companies [29]. This open space has led to a growing body of research in HCI and game studies, including topics such as industry experiences, ideas, and beliefs that motivate game developers to go "indie" [16]; tensions between self-exploitation and a passion for work in indie game development [51]; the rejection of creatively constrained, hierarchically managed production models in indie game development [49]; organizational and managerial practices commonly adopted by indie game developers [37]; and what independence and autonomy actually mean in indie game developers' creative labor [15, 31], among others. Collectively, these studies have highlighted that "independence" in the context of indie game development can be achieved through various strategies involving aesthetics, funding, distribution methods, and game narratives/themes [40]. They have also pointed out that "being indie" is a complex multidimensional concept, which attracts a large number of developers with various purposes, goals, and motivations that can range from being hobbyists and just making games for fun, to learning/improving skills to enter the mainstream gaming industry, to pursuing a more activist and non-profit driven agenda of building a new form of "rebellious entertainment" and a new counter-culture to innovate game production [13, 16, 31, 42, 44, 49].

In this paper, we especially focus on this subset of *non-profit driven* indie game developers whose technological practices constitute an important alternative to the traditional game production model by advocating a more participatory and democratic form of game development through collaborative efforts [10, 11, 36]. Their activist agenda thus renders indie game development to be "a cultural phenomenon, a concept that has changed the cultural value of video games and the meanings associated with being part of the contexts of production and consumption" [40]. For these developers, the gaming industry - particularly in North America - is notorious for its highly intense and stressful work practices: long hours, looming deadlines, hardcore workers, big money payouts alongside tremendous losses [21, 35], and rampant sexism (e.g., Gamergate). Therefore, they believe that the indie culture should not merely focus on making profits or selling games in different channels, but should also reflect various non-profit driven artistic

and cultural values [29]. In this sense, non-profit driven indie game development appears to significantly differ from the mainstream gaming industry or more profit-driven indie game studios, which often consist of expert game developers and focus on sophisticated, profitable software products (e.g., triple-A level games) [15]. This subset of non-profit driven indie game developers thus shows the potential to foster a more open and participatory game production model and often depends on a broad community of developers of various levels, experiences, and skills [10, 36, 42, 48].

Despite these praises, however, a growing concern is that this view of non-profit indie game developers as counter-cultural and as establishment (the traditional game industry) challengers seems to be idealistic [22, 25, 31, 37, 51]. In fact, non-profit indie developers are facing increasing tensions between their non-profit driven and artistic-focused approach toward game development and the traditional game production approach. Examples include the emergent power dynamics between the mainstream gaming industry and the non-profit indie community [11, 22, 25]; conflicts between their small team style and the cultural, social, economic, and technological circumstances of the modern gaming culture [14, 15]; and the unstable and insecure working conditions for non-profit indie developers due to the exploitative and precarious nature of their work [51]. As mentioned above, non-profit driven indie game developers' focus on more artistic or cultural purposes over the pursuit of economic benefits has led to distinct labor setups, development life cycles, production models, and expectations for collaboration and participation in game development [10, 12, 14, 32, 35, 36]. Therefore, to further unpack these challenges for non-profit driven indie game developers to innovate game production, revisiting key concepts of labor, capital, and production in the technology space is crucial.

2.2 Understanding Labor, Capital, and Production in the Indie Game Development Context

In the broader HCI community, an extensive body of research has taken up the concepts of labor, capital, and production as a way to investigate the relationship between technology creator/worker, technology production, and economic development. Specifically, **labor** is often defined as an indispensable condition to every productive operation [26]. In this sense, labor can be either bodily or mental, material (i.e., creating a tangible product) or immaterial (i.e., producing the informational and cultural content of the commodity) and productive (i.e., terminate in the creation of material wealth) or unproductive (i.e., does not terminate in the creation of material wealth) [26]. **Capital** refers to the general requirements and physical requisites (e.g., shelter, protection, tools, and resources) for affording and sustaining labor during the production process, which can be perceived as saved wealth from previous production for generating new forms of wealth in reproduction [26]. **Production** is the increase of material products as an outcome of labor and capital, leading to the creation of wealth [26]. Built upon these understandings, Ekbia and Nardi's work highlighted the issues of social inequalities emerging in the changing labor relations, ownership of production means, and how a digitized economy impacts other aspects of life, including health, education, environment, governance, and so forth [8, 9]. Dillahunt focused on economically disadvantaged communities and explored ways through which technology can increase their social capital and achieve socioeconomic security [7]. Additionally, Raval and Dourish investigated the aspects of "the informal economy" and "immaterial labor" involved in crowd work [38]. In summary, existing HCI research has leveraged these three key concepts to understand how technology and technology production are seamlessly interwoven with "sociohistorical developments, socioeconomic systems, legal and regulatory frameworks, environmental impacts, and government policies and agendas" [8].

In the context of indie game development, prior work has also pointed to the importance of understanding the unique interplay of labor, capital, and production in this space.

First, to understand how labor is approached and organized in indie game development, research has shown that indie games focus on a small number of clear design and aesthetic goals and can be developed at a much smaller scale in terms of workload and manpower [12, 15, 35]. Freeman et al. added that such games are also developed by small teams of distributed developers who emphasize developer-player interaction [13]. As indie developers often need to negotiate their own work practices between self-exploitation and self-emancipation [24], there has also been an ongoing discussion regarding unionizing indie developers to better support their unique needs for work conditions and the surrounding work culture [40]. In particular, prior work has praised how the indie context has the potential to promote a more inclusive workforce in the gaming industry by welcoming previously marginalized and excluded groups in game development, such as women and queer developers [10, 19].

Second, to understand the role of capital in the context of indie game development, Garda and Grabarczyk explicated the relations between financial independence, creative independence, and publishing independence in indie game development [15]. Ruffino explained how indie game developers may gain new capital by "allegedly reach global audiences, bypassing publishers, producers, and marketing teams, thanks for the new tools of funding, production, and distribution" [40]. In this process, human relations have become an inevitable part of and an important capital for indie game development because "developers do not work in isolation" [40].

Third, as indie game development tends to approach labor and capital in distinctive ways compared to traditional game production, researchers have argued that a critical reflection of the resulting indie game production model can uncover the economic, cultural, and political structures that influence the final form of games [43]. For example, Martin and Deuze summarized production in indie game development as "somewhere between ownership and self-funding, between individual development and leveraged teams powered by specialization, and between the collaborative work with user communities and the vision of each individual as trying to tell their own unique stories," which may become a cultural production model for the future gaming industry [31].

Building upon these works, we are motivated to further explore the ongoing challenges for non-profit indie game development, which has a significant impact on the worldwide gaming industry, to innovate the traditional game production model. This subset of indie game developers tend to demonstrate different agendas,

aspirations, and expectations for game development compared to the mainstream gaming industry, more profit-driven indie game studios, and indie developers who might take part in game development casually and unseriously. Therefore, understanding their struggles is crucial to support and sustain the growing open and participatory model in technological innovation, especially considering the already complicated relations between labor, capital, and production in the indie game development context.

3 METHODS

Data Collection and Participants. This study is part of a broader, multi-year research project on studying indie game development as public engagement in technological innovation. To recruit a diverse sample of participants with various cultural backgrounds, we posted recruitment messages on Reddit, Facebook groups, and multiple international Discord channels for game developers. We were able to recruit interviewees from various countries who can speak English, self-identified as indie game developers focusing on artistic and cultural values, and had engaged in indie game development in the past 12 months. We also directly contacted game developers who we already knew from prior contact and asked about their willingness to participate using a snowball sampling technique. All developers who responded to our requests and agreed to participate were interviewed. In total, 28 semi-structured in-depth interviews were conducted.

Out of the 28 participants, 4 self-identify as women, 1 as gender non-binary, and 23 as men. Participants' ages ranged from 18 to 51 years with an average age of 28.4 years. 9 of them self-reported as full-time indie developers, while 19 self reported as part-time developers or hobbyists. Specifically, participants considered themselves "full-time" if they were developing indie games as a full-time job. They considered themselves "part-time" or "hobbyist" if they had other full-time job(s). Participants were located in various countries, including the US, Canada, India, Malaysia, South Korea, Australia, Nigeria, Brazil, Russia, Japan, the UK, Belgium, and Austria. Table 1 summarizes participants' demographic information.

Interviews. Interviews started with basic demographic questions and moved to participants' experiences of indie game development. Examples of interview questions included: *"How long have you been involved in indie game development?", "What challenges have you faced when developing games? How did you solve them? It can be a technical problem, labor problem, resources problem, or anything else", "What are the benefits and/or disadvantages of engaging in indie game development?"* and *"Do national or local policies or politics (think initiatives for economic development, STEM, education, etc.) affect indie game developers' practices?"* Participants were also asked about their experiences of live streaming and game jams when engaging in indie game development. Interviews were conducted via voice or text chat through Discord, Google Hangouts, or Skype based on participants' preferences from October to November in 2019. The average length of interviews was 60 minutes, and participants were given a $20 gift card after they completed the interviews.

Table 1: Demographic information of interviewees

ID	Gender	Age	Country	Occupation	Full/Part time Indie	Experience (Years)
P1	Man	30	USA	Unemployed	Hobbyist	2
P2	Man	26	Austria	Unemployed	Hobbyist	4
P3	Woman	24	N/A	Software Engineer	Hobbyist	2.5
P4	Man	35	USA	Wood Worker	Hobbyist	9
P5	Man	28	Malaysia	UX Designer	Hobbyist	4
P6	Non-binary	27	South Korea	Teacher	Hobbyist	N/A
P7	Man	24	UK	Indie Developer	Full Time	10
P8	Man	18	Canada	Student	Hobbyist	4
P9	Man	19	USA	Student	Hobbyist	6
P10	Man	31	USA	Architect	Hobbyist	19
P11	Man	18	USA	Student	Hobbyist	4
P12	Man	50	USA	Indie Developer	Full Time	28
P13	Man	20	USA	Student	Hobbyist	2
P14	Man	18	India	Student	Hobbyist	7
P15	Man	23	Nigeria	Indie Developer	Full Time	4
P16	Man	24	Brazil	Indie Developer	Full Time	7
P17	Man	22	N/A	IT Contractor	Hobbyist	10
P18	Man	40	USA	IT	Hobbyist	2
P19	Woman	30	USA	Indie Developer	Full Time	3
P20	Man	25	Belgium	Indie Developer	Full Time	7
P21	Woman	18	USA	Artist	Hobbyist	1
P22	Man	51	Russia	Indie Developer	Full Time	15
P23	Man	46	Japan	Indie Developer	Full Time	23
P24	Man	28	Australia	Unemployed	Hobbyist	15
P25	Man	37	UK	Unemployed	Hobbyist	27
P26	Man	22	USA	Student	Hobbyist	2
P27	Man	24	UK	Software Developer	Hobbyist	12
P28	Woman	36	USA	Indie Developer	Full Time	9

Note: Country – country of origin; N/A – participants preferred not to answer.

Data Analysis. We conducted an empirical, in-depth qualitative analysis of the collected data because qualitative methodologies are well-suited for investigating questions about "how people interpret their experiences, how they construct their worlds, and what meaning they attribute to their experiences" [34]. Based on McDonald et al.'s guidelines for qualitative analysis in CSCW and HCI practice, our analytical procedures did not focus on inter-rater reliability but endeavored to yield recurring concepts and themes of interest, find relationships among them, and formulate them into more complex groups and broader themes [33].

We first closely read through the collected data line by line to acquire a general understanding of the whole picture of non-profit driven indie game developers' challenges in their game development practices. We also wrote conceptual memos in this process. The research team discussed the memos, highlighted emergent categories in the data, and made distinctions and connections. We then conducted open coding [5] of each transcript, categorized participants' responses, and highlighted comparisons and connections emerging in participants' descriptions. Our initial coding process revealed a preliminary set of 10 narrative categories regarding non-profit indie developers' challenges emerging in participants' accounts, including *teamwork and collaboration, individual burdens, diversity concerns, infrastructure, financial resources, social support, publishing, distribution, copyright, and entrepreneurship.* Next, we carefully examined and reviewed these initial categories and synthesized them into broader themes for further analysis. In this process, the three key concepts of labor, capital, and production described in Section 2.2 informed how we merged, synthesized, and organized the categories for two reasons. First, they have been extensively used in HCI research to investigate the relationship between technology creator/worker, technology production, and economic development, which is highly relevant to the context of non-profit driven indie game development. Second, prior work on indie game development, in general, has also used them to unpack the distinct labor setups, development life cycles, production models, and expectations for collaboration and participation involved in the broader indie game development community. However, it should be noted that we did not use these three concepts to map our data. Instead, these themes naturally emerged in our data – for example, labor (teamwork and collaboration, individual burdens, and diversity concerns), capital (infrastructure, financial resources, and social support), and production (publishing, distribution, copyright, and entrepreneurship). We also worked together to discuss and refine categories, connections, and comparisons in a collaborative and iterative axial coding process [5]. We then extracted quotes based on the connections and comparisons refined in the previous steps through focused coding [5] and used the quotes to synthesize challenges in non-profit driven indie game developers' technological practices to answer our research question.

4 FINDINGS

In this section, we report unique challenges that non-profit driven indie game developers across various countries and cultures encounter in their endeavors to innovate how modern digital games are designed, developed, and produced. Specifically, our participants highlight three challenges mainly regarding their labor (tensions in both team-based labor and individual labor), capital (the lack of various resources to sustain their technological practices), and production (barriers to innovating the traditional game production model).

4.1 Emergent Tensions in Both Team-based Labor and Individual Labor to Pursue the Non-Profit Agenda

As part of an open and participatory movement in game development, non-profit driven indie game developers often emphasize the importance of teamwork and collaboration in their technological practices. Our participants praise the popularity of and willingness to offer mutual help and collaboration in the indie community for free. In their opinion, this openness highlights the fundamental value of non-profit driven indie game development (e.g., making game development open and more accessible to everyone) and makes indie game development as a whole inherently different from traditional game development. However, they also acknowledge that this more open and democratic model of game development raises emergent tensions in both their labor when working as a team and their own individual labor. In addition, issues regarding attracting and retaining a diverse and inclusive workforce in non-profit driven indie game development still remain.

4.1.1 Challenges to Seek Qualified and Reliable Team Labor Who Take Indie Development Seriously. Indie developers are often geographically distant from one other and non-profit driven indie game development is usually perceived as a niche technological area with limited public visibility and recognition. Therefore, all participants mention that they tend to develop indie games as small teams (e.g., 2 to 4 people) and highlight the team-based labor involved in indie game development. For them, working as a team is a core value of the indie culture, especially for those with a non-profit agenda. Teamwork defines the collaborative and creative nature of non-profit driven indie game development, which is crucial to maintaining the independence of this subset of the indie community from the main gaming industry (e.g., in terms of intellectual property and freedom to express and create) and supporting their focus on more artistic or cultural purposes over the pursuit of economic benefits. Yet, the emphasis and dependence on teamwork and team-based labor often lead to challenges when seeking qualified and reliable teammates who also share a non-profit driven agenda. For example, P1 (man, 30, USA, Hobbyist) shares his struggle:

"The first problem to develop indie games would be finding people who compliment your skills to work with. So, in my case, I don't know very much about programming. So I kind of rely on and hope to find a really good programmer. I have used a couple of websites such as Crowdforge.io to find people. I have used Discord channels, old fashioned forums, and Reddit, all that stuff. But it is still very hard to find a person who is good and whom I'm willing to work with. That's one reason I haven't made much progress in my development."

Though the non-profit driven indie culture is largely motivated by teamwork and collaboration, there seems to be no effective mechanism to help these indie game developers identify qualified teammates and build a team with a shared, non-profit driven goal. Developers like P1 have had to use various online platforms and

methods to seek potential teammates with desired skills but the result is still not satisfactory. In contrast, the mainstream gaming industry has well-established and sophisticated HR systems for identifying and recruiting potential teammates. More profit-driven indie game studios may also be able to provide higher incentives and long-term contracts, which can ensure the desired skillsets and compatibility for a certain team.

Even if non-profit driven indie game developers manage to find teammates with desired skills, they are still uncertain about the quality of their teammates' work and their work styles because their teamwork is mostly voluntary and not every indie developer takes indie game development seriously. P2 (man, 26, Austria, Hobbyist) and P19 (woman, 30, USA, Full Time Indie) describe their frustration,

"I heard stories about teams or people who are just not very communicative or lazy. For example, they didn't fulfill the tasks or fulfilled them poorly so there was a problem with the expectations and the promises." (P2)

"In indie game development, the challenge is getting people to work on things like revenue share and stuff like that. People tend to be a lot less reliable." (P19)

According to these participants, non-profit indie game development seems to promote a more democratic, flexible, and accessible model of designing and developing games. However, as previously mentioned in this paper, many indie developers may just be hobbyists who make games for fun and may not take their involvement in an indie project seriously, leading them to ignore their responsibilities, such as assigned tasks in teamwork. As a result, it is challenging for non-profit developers who take indie game development seriously to work within such a team due to the varying degrees of commitment. In particular, the contracts, policies, and/or penalties that mainstream gaming companies and even more profit-driven indie studios may utilize to reign in such behavior are otherwise lacking in the less rigid and more voluntary setting of non-profit driven indie game development.

In this sense, non-profit driven indie game developers seem to face a dilemma. They are expected to seek and value team-based, voluntary labor practices, as said labor represents the fundamental value of the non-profit driven indie culture and is critical to collectively innovating how games should be designed and developed as an activist community. However, there is a lack of essential mechanisms and resources for them to foster such labor and build a qualified and reliable team who actually are on the same page to pursue this non-profit driven agenda. This thus creates extra difficulties when trying to conduct their game development practices and working towards the non-profit driven indie community's aspiration for a more open and participatory game development model.

4.1.2 Non-Profit Driven Innovation as a Personal Burden. Our participants indeed recognize the above-mentioned dilemma regarding team-based labor in their endeavors to pursue the non-profit agenda in their game development practices. Therefore, sometimes they choose to solely rely on their individual labor to (1) maximize their independence and creativity to further focus on the artistic and cultural values of their games, and (2) avoid the risk of having to work with unqualified and unreliable teammates who do not share the same non-profit agenda. However, this may easily become a severe personal burden both mentally and emotionally. P4 (man, 35, USA, Hobbyist) describes,

"The biggest problem that I don't enjoy working alone as an indie. You spend hundreds of hours trying to solve an issue, and then nobody will have any idea that that ever happened. This is a very lonely and draining experience." (P4)

Obviously, developing games is a significant intellectual challenge to indie developers regardless of their skills and experiences. It requires a wide range of sophisticated skills from design to programming. Choosing to develop games alone further adds additional burdens to the individual, especially if this individual takes their engagement in game development seriously. They not only need to "wear different hats", especially in areas where they do not have the expertise, but also lack the necessary emotional support that usually comes from a co-worker, a teammate, or a colleague who shares the same aspirations, commitment, and seriousness about game development as them. This double challenge thus makes non-profit driven indie game development a *"lonely"* and *"draining"* journey.

Others also comment that non-profit driven indie game development could become a personal burden as it might significantly affect one's self-confidence. P14 (man, 18, India, Hobbyist) and P17 (man, 22, N/A, Hobbyist) point out:

"It's like a leap of faith. If you're jumping and you hit the target, it's awesome. But if you don't, you just go spiraling down. It's not so good for your self-esteem." (P14)

"You'll have somebody come in and start nitpicking you, which I think can really hurt a lot of people's self esteem, especially with programming." (P17)

These accounts raise concerns about the tension between the non-profit driven indie community's focus on creativity, independence, and openness to innovate traditional game production and the excessive stress on individual developers to pursue and embrace these values. As P14 mentions, the cost of making artistic, creative, and non-profit driven indie games that differ from the mainstream commercial games or the more revenue-driven indie games is a constant blow to one's self-confidence. Many non-profit indie games may not be appreciated by the mainstream audience and developers will need to shoulder the failure and disappointment themselves while pursuing their non-profit goal to focus on artistic and cultural purposes over economic benefits. According to P17, the cost of having an open and non-profit driven game development model is the possibility of over-criticism. In this open model, non-profit driven indie developers can openly share their work and receive various types of support from the community. Yet, they may also need to deal with criticisms for their work from the entire community, who may not share the non-profit agenda and consider their games unprofitable and thus worthless. Of course, many indie game developers tend to consider such criticisms constructive and beneficial for improving their game development practices. However, to some, this may significantly undermine their self-confidence and thus discourage them from continuing the non-profit agenda in their game development.

4.1.3 Diversity Concerns Remain for Building an Inclusive, Non-Profit Driven Indie Workforce. The gaming industry has a notorious history for being traditionally male and White dominated. Scandals of sexism and misogyny often emerge (e.g., the Gamergate

controversy). Therefore, as a counter-culture, non-profit driven indie developers often focus on fostering a more diverse workforce by engaging the underrepresented in game design/development rather than merely pursuing economic benefits, such as supporting women developers and providing queer alternatives to traditional gaming culture [10, 19]. In our study, participants also highlight how indie developers with a non-profit agenda work together to overcome the social stigma and engage the underrepresented populations (e.g., women) in game development. For example, P12 (man, 50, USA, Full Time Indie) explains that one of the main strategies to promote a more diverse workforce in indie game development is to showcase what indie game development can empower people to do, and introduce these visions to the younger generation:

"I have been very involved in promoting diversity in game development. In fact, today I'm giving a tour to a bunch of middle school kids on game development and what it's like to do that. My daughters have been in this organization called 'girls make games' where middle school and teenage girls make games in a camp for over the summer. And I've been heavily involved with that for a long time, like being a judge, promoting it, and things like that."

P12 believes that such a strategy will cultivate the next generation of game developers and help build a more diverse and inclusive gaming culture in the future. However, this does not mean that diversity issues do not exist in this subset of the indie community. Some participants express concerns that despite their efforts, non-profit indie game development still seems to be male-dominated. Our sample also reflects the relatively low engagement from women in non-profit driven indie game development: out of the 28 participants, only 4 self-identify as women and 1 as gender non-binary. This may partially be due to how we recruited participants (e.g., through Reddit, Facebook, and Discord), which we will discuss more in the limitations section. Despite this recruitment limitation, our women participants indeed note that women can still feel unsafe and harassed in the non-profit driven indie community, which is expected to be more diverse and inclusive than the mainstream gaming culture. P28 (woman, 36, USA, Full Time Indie) shares:

"I think that there could still be a lot better security and safety in this community. We didn't have many people come in who were racist or sexist but we had a few. The first time it happened, it was really uncomfortable because he followed me on all my social media after coming into the chat. And I didn't know if this person was going to seriously harass me more. We blocked him. But I didn't know if it would keep going, because for some people it does. And I think that's really scary. And you also have to be really smart about what you are sharing. And are you sharing things that are too much? Like could people figure out where you live? It would be a really scary thought."

P28 and other women in our study on the whole describe their participation in non-profit driven indie game development to be mostly positive because they feel more supported, valued, and respected compared to being in the mainstream gaming industry. However, more mechanisms and methods to encourage women's and other underrepresented populations' participation and to protect them from potential sexism, racism, and harassment are still much needed in the indie culture, regardless of non-profit or profit-driven. As P28 mentions, how to better protect women developers' safety and privacy and help them prevent online harassment is still an unsolved issue in the indie community, which can significantly discourage their overall participation in this field and their engagement in the non-profit driven agenda to innovate game production.

4.2 The Lack of Various Forms of Capital to Sustain Indie Developers' Endeavors for Achieving the Non-Profit Agenda

As described earlier in this paper, *capital* is critical in any work practice as it plays a central role in supporting productive labor and sustaining production. In the mainstream gaming industry or more profit-driven indie game development, capital emerges in wealth from the previous products (e.g., selling a popular game) and is used to maintain a stable workforce for the next production (e.g., recruiting and retaining skilled workers to develop a new game). In contrast, while non-profit driven indie game developers dedicate themselves to a more open and participatory model of game development, they often do not start with sufficient capital to support their ongoing endeavors to achieve their non-profit agenda, including *technological resources*, *social capital*, and *financial stability*. This lack of "startup" capital also prevents them from creating future capital in their current technological practices.

4.2.1 The Lack of Technological Resources. While people who work in mainstream game companies have access to comprehensive technical support and are provided with devices or a hardware allowance, indie developers, especially those with a non-profit agenda, often struggle with acquiring, sustaining, and actively controlling some of the most fundamental and necessary resources to continue their game development effort, including hardware, network, and software.

For example, for advanced game development, indie developers need hardware with high configuration (e.g., a computer with symmetric multiprocessors, a comfortable keyboard, large memory, and adequate bandwidth) to help them learn, communicate, and implement smoothly. Unfortunately, non-profit driven indie developers seem to face additional difficulties to access these essential resources. As P15 (man, 23, Nigeria, Full Time Indie) mentions:

"It's hard being an indie game dev. Because you have many other things to attend to, like technical difficulties, rather than just developing games. My computer is not that strong and I cannot afford buying a better one. So this definitely affects what I can make and how I can work on games."

According to P15, many non-profit indie developers cannot just focus on developing good quality games because of the lack of fundamental technological resources, such as an appropriate computer. Likewise, P14 (man, 18, India, Hobbyist) adds that not every non-profit indie developer can access high-speed Internet, and a poor Internet connection can significantly undermine their work efficiency and the quality of their game development. In our study, many non-profit driven indie game developers started as freelancer developers, artists, or everyday users who had little programming/development experience. It is through their engagement in game development that they gradually develop strong technical skills and professional work styles. In this process, fast and stable access to the Internet and various online platforms (e.g., live streaming for learning, sharing, and communicating) become necessary resources that help them stay connected and learn from each other. However, many

non-profit developers may not have such access and thus have to compromise their game development practices (e.g., watching live streams in low resolution).

In addition to hardware and network, non-profit driven indie developers also lack access to necessary software, such as those for professional file management and version control. P2 (man, 26, Austria, Hobbyist) and P4 (man, 35, USA, Hobbyist) highlight:

"A question for all indies is how to manage the resources, for example version control. We have music and image assets. So the challenge is where to put your art and where to put music. We don't really have a common version control repository where we can decide on the hosts, for example, GitHub or Bitbucket." (P2)

"Any big company has systems that do all the version control for them. They set up such things for their internal teams, like the intranet. But when it comes to indies, it becomes tricky." (P4)

These participants point out yet another important difference between working as a non-profit indie versus within the mainstream gaming industry or a more profit-driven indie studio: while the latter is often equipped with a clear division of labor and powerful internal tools, non-profit driven indie developers have limited resources to purchase or develop essential tools to support and facilitate efficient and organized technological practices. For these developers, it is challenging to even have certain fundamental technical support such as an asset repository.

In particular, non-profit driven indie developers' game production is largely supported and mediated by free tools and middleware (e.g., free game engines such as Unity and Unreal). Many developers believe that this model mitigates the technological barriers to entering game development and helps developers focus on the artistic/cultural values of their games rather than building tools from scratch. This model also increasingly opens up game development to everyday technology users. However, they express concerns about how "independent" non-profit indie developers can really be from the mainstream gaming industry due to their dependence on these free tools. P9 (man, 19, USA, Hobbyist) points out, *"Without Unity, you can't really model a game. [...] I cannot imagine how I can develop games if Unity is gone."* As shown in P9's account, indie game developers, especially non-profit driven indie developers, often use a special free platform or engine to develop their games. However, despite being open and free to the indie community, such tools are developed and shared by the mainstream gaming industry, while indie developers have very limited power to affect their functionalities and availability. In this sense, non-profit indie developers' pursuits of artistic and cultural values in their games and their ultimate goal to innovate game development are at risk, as they not only lack the necessary technological resources to start and sustain their game production but also are highly dependent on resources that they cannot control.

4.2.2 The Lack of Social Capital. Social capital refers to "the sum of the resources, actual or virtual, that accrue to an individual or a group by virtue of possessing a durable network of more or less institutionalized relationships of mutual acquaintance and recognition" [4]. In the indie community, such capital is often demonstrated as the public visibility and acknowledgment of one's reputation and work. Yet, many developers still tend to consider non-profit driven indie game development an "underdog" that lacks adequate recognition from the broader gaming community and the general public. For them, this lack of social capital discourages their game development practices and may eventually drive them away from this field. For instance, live streaming platforms (e.g., Twitch) and spectatorship have grown into a critical component of the modern-day gaming culture [18, 27, 50]. Though non-profit driven indie developers have increasingly used these free platforms to promote their work and improve publicity, they are still not quite visible even to the heavily gaming-focused live-streaming community. P18 (man, 40, USA, Hobbyist) describes how difficult it is for non-profit driven indie game development streams to receive public attention and earn revenue:

"I have not seen people who do indie game development live streams that have gotten more than 1000 views. It feels like no one paid attention to them or to this field."

P8 (man, 18, Canada, Hobbyist) also adds that the current design of live streaming platforms further undermines the public visibility of the indie community, especially those with a non-profit agenda. According to him, even Twitch, the largest game-based live streaming platform, does not provide a clear and straightforward way to appropriately label and categorize "game development" relevant streams. Rather, such streams are irretrievable as they are mingled with other gameplay streams or science and technology streams. This not only weakens the public visibility of the indie community but also creates additional barriers for non-profit driven indie game developers to build their community and make such a community more impactful.

Additionally, this issue of lacking social capital seems to be more severe in cultures where game development is not perceived as a legitimate profession, making engaging in non-profit driven indie game development even less socially acceptable. P16 (man, 24, Brazil, Full Time Indie) and P15 (man, 23, Nigeria, Full Time Indie) share their concerns:

"I see that people in Brazil, for instance, don't quite value games as an art form or as a legit medium. This creates a barrier. It's hard for people to appreciate games; it is also hard for them to get into game development." (P16)

"In my country, it's hard being an indie game developer because there is not an indie culture here. And there's no institution that teaches game development here. So learning is harder for us and it feels like no one knows what you are doing and no one appreciates what you are doing." (P15)

Our data clearly shows that non-profit driven indie game development has become a global movement rather than a Westernized trend. Developers from all over the world, such as P16 from Brazil and P15 from Nigeria, are passionate about creating games in a more open, independent, and democratic manner to further highlight digital games as artistic and cultural products rather than merely as commercial products for revenues. However, some of them seem to suffer from even lower social capital than others. As the above accounts have demonstrated, the broader sociocultural expectations for game development as a career in a society can significantly affect how people perceive and appreciate non-profit driven indie developers' aspirations and efforts, which may make people more unwilling or unable to become an indie developer who aims to innovate traditional game production.

4.2.3 The Lack of Financial Stability. Non-profit driven indie developers do not perceive profit-seeking as their main goal when engaging in indie development. However, this agenda obviously often leads to a trade-off: their games may never be profitable and their effort may never pay off. Such uncertainty of financial stability thus makes it difficult for them to sustain their innovation or devote themselves to indie game development as a full-time job. P18 (man, 40, USA, Hobbyist) reflects,

"I do not see any way that I could transit to making games full time and be able to replace my current day job wages. A good clean stable job is way more important to me if I want to continue making games."

As we already mentioned in this paper, the mainstream gaming industry, especially in North America, has often been criticized for its long work hours, stressful working atmosphere, and sexism [35]. However, developers who are employed by the mainstream gaming industry or the more profit-driven indie studios also have certain financial security (e.g., a stable paycheck). In contrast, non-profit driven indie developers like P18 do not affiliate with any main company or publisher. They already lack financial capital when they first enter game development, as many of them are self-funded to start the development process. It is also challenging for them to create financial capital, as they do not emphasize economic benefits over the artistic or cultural values of their games.

In fact, this lack of financial stability may directly contradict these developers' pursuits for artistic and cultural values within their games, as P20 (man, 25, Belgium, Full Time Indie) and P28 (woman, 36, USA, Full Time Indie) discuss,

"In general, I've struggled to find artists who are interested in making games without compensation because most projects usually, like smaller projects, don't really create revenue. And if you go into it just for the experience or just for fun, I've noticed that it can be pretty hard to find some other people to work with." (P20)

"If you want to make games and you're indie, you probably have to do many of the roles yourself because there's sort of an understanding that you probably don't have the money to hire really great people to do things you don't know how to do." (P28)

Both participants are full time indie developers and they both highlight the insecurity of pursuing non-profit indie game development as a career: they might suffer financial pressure due to an unstable income, and they also could not afford to recruit skillful teammates to create a high-quality game. In this sense, non-profit driven indie developers seem to be trapped in a complicated cycle where they do not have the established financial capital to support their effort to create high-quality products of artistic and cultural values, while the challenge to create such products prevents them from establishing sufficient financial capital in turn.

4.3 Barriers to Innovate the Traditional Game Production Model Through the Non-Profit Agenda

Non-profit driven indie game developers endeavor to innovate the traditional game production model by offering an alternative to the closed, capitalist profit-seeking model in the mainstream gaming industry. Yet, there are several obstacles for them to actually innovate the traditional game production model through this approach, including copyright and intellectual property concerns and the technology and economic policy barriers for entrepreneurship.

4.3.1 Concerns about Protecting Non-Profit Indie Developers' Copyright and Intellectual Property. The non-profit driven indie community highly encourages and promotes values of openness and sharing in game production. However, to many of our participants, it is unclear how indie developers of a non-profit agenda can protect their intellectual property and ensure that their creativity and innovation are not stolen in the process of sharing. For example, P3 (woman, 24, N/A, Hobbyist) explains,

"Live streaming is great for promoting the indie community but I have not used it to stream details of my project. I want to keep the specifics of my project private and confidential. Note that somebody's going to watch my stream and copy my game, it's always the thing that kind of freaks me out. Like, maybe they'll steal my ideas if I'm programming it right in front of them."

Developers such as P3 are willing to share and open up their development process to others via various ways (e.g., through live streaming) without charging others a fee. However, they are cautious about what they can share and to what degree they can share. In P3's opinion, sharing too many technical details of her ongoing project may risk losing her intellectual property rights.

In particular, some participants highlight that non-profit driven indie developers in fact do not have the freedom to share their game development practices that they claim to have because they have obligations to protect not only their but also others' copyrighted content. P4 (man, 35, USA, Hobbyist) points out,

"If you're developing a Switch game and you're using Nintendo assets and their back-end things, you're in this gray area and you are not supposed to share those technically."

P4's account further highlights the complicated relationship between non-profit driven indie game development and the mainstream gaming industry. As we have described in section 5.2.1, the mainstream gaming industry provides the indie community with the free tools and middleware they use in game development. It also offers them necessary digital assets if they develop for a certain platform. Therefore, if non-profit driven indie developers create their own content and assets for their games, they cannot completely share their game development practices in order to protect their intellectual property. Further, if they gain resources and materials from a third party for their games, they still cannot completely share their game development practices due to the regulations on copyrighted content from the third party.

Additionally, there seem to be no copyright policies/regulations at the national level to address this double challenge, which appears to be a universal issue across different countries. P14 (man, 18, India, Hobbyist) shares his experience in India:

"In India, you don't have a 'if you made it, your own the copyright' policy. It is 'you made it, you have registered it, and then you have the copyright.' So the copyright system in India is not friendly to indie game developers [...]. For every tiny idea and every tiny thing that you make, you have to file a copyright. Things in the USA may be better but the same issue is still there."

According to P14, the copyright and intellectual property concerns about non-profit driven indie game development are not

unique to only one country or one culture. As he notes, no matter whether in India, the USA, or other countries, the existing copyright policies appear to be unfriendly to these indie developers and the alternative game development and production model they pursue. Such policies are also insufficient and inadequate to balance the culture of mutual help, sharing, and openness in this model and the urgent need to protect non-profit driven indie game developers' intellectual property rights.

4.3.2 Technology and Economic Policy Barriers for Entrepreneurship. Many non-profit driven developers in this study express their aspirations for becoming entrepreneurs in gaming. Compared to being employed by a mainstream gaming company or more profit-driven indie studios, they consider entrepreneurship a relatively flexible alternative path to both establish certain financial stability (despite being non-profit) and continue their aspirations to focus on creative, cultural, and artistic values in the gaming field. However, they cite multiple technology and economic policy barriers to actually pursue entrepreneurship for their non-profit agenda, including complicated platform policies for self-publishing and distributing games, bureaucracy for startups and non-profit organizations, and the limited government support for the creative industry.

Traditionally, games are funded, published, and distributed through major game companies/publishers, while individual game developers have little impact on this process. In contrast, non-profit indie game development seeks to implement a new game production model with a focus on independence and open sharing where self-publishing and distributing games outside the traditional publisher model plays a critical role. In doing so, the non-profit driven indie community believes that developers will be more empowered and gain more agency over their own creative products. Participants admit that many platforms, such as Apple's App Store, Google Play Store, and Steam, do support and allow non-profit driven indie developers to self-publish and directly distribute their games to customers without an official traditional "publisher."

However, such services are still neither developer-friendly nor free. Participants complain that these platforms often reinforce complicated and strict policies that make self-publishing and self-distributing difficult and costly. For example, P2 (man, 26, Austria, Hobbyist) shares his opinion:

"Apple recently made it mandatory to have a notary review for new apps on your OS X. So this adds another layer of complexity for the release cycle. For example, if you want to push updates, they have to review it first and they take a certain view for that. So basically all the decisions are to force you to do something more or pay for things that could possibly be influential even for some people who just want to make games for fun. The hundred dollar release fee is an issue."

Developers such as P2 appreciate and understand the importance of the self-publishing/distributing model to non-profit driven indie game development. Yet, the problem is that non-profit indie developers themselves still do not have much independence and power in this model. According to P2, instead of being subjected to traditional game publishers' rules and regulations, they now have to acquiesce to other third parties who provide self-publishing/distributing services. They also have to pay for whatever amount these platforms charge them for such services out of pocket. For many non-profit indie developers who are already dealing with limited financial security, this constitutes an additional burden if they wish to continue their game development practices.

Therefore, as an endeavor to gain more power and agency in publishing and distributing, some developers explore the possibility of starting their own studio or non-profit organization – but this route is not easy either. P14 (man, 18, India, Hobbyist) reveals,

"Triple A studios don't exactly have to jump through the hoops that any indie developer might have to, simply because a lot of things for setting up their company are already made and in place. Most indie developers have to go through a 'company-formation' route if they want to start their own thing. But they often get this huge bureaucracy. If it was a bit easier to set up your own company, it would be really more useful."

Based on P14's experience in India, few business and economic policies exist at the regional or national level to support establishing startups or small businesses that focus on arts, cultural creativity, and innovation. As a result, non-profit driven indie developers continue to lack strong voices in game production as it is difficult for them to build their own brands.

Even in cultures that have a long tradition of appreciating the creative industry, non-profit driven indie developers receive limited support from policymakers. P23 (man, 46, Japan, Full Time Indie) shares his experience in Japan, a country with a robust gaming culture and a prosperous gaming industry:

"Indie game development is considered part of the innovative business in Japan. So they have on paper a lot of grants and help from the government. It's like the government pays you back 30% of the price of game development. It looks really great but in reality, it takes a lot of time. They pay you like three years after they love the game. So the result on paper is a lot of help, but the reality there is not a lot of help."

Compared to some cultures where policies to support non-profit indie developers' pursuits for artistic and cultural values simply do not exist, P23, as a full-time indie developer, acknowledges the supportive economic policy for his game development practices at the national level in his country. However, his concern lies in the fact that such policies are neither proactive nor timely. As we have discussed in this paper, one common challenge for most non-profit driven indie developers is that they lack the necessary financial capital to jump-start their development process. In P23's opinion, government help for supporting non-profit driven indie game development should come before or upon the beginning of the game development activity rather than much later when developers have been struggling to sustain their game production for too long – in P23's case, three years later.

5 DISCUSSION

In answering our research questions, we have revealed unique challenges that non-profit driven indie game developers may face when pursuing an alternative game production model. Table 2 summarizes our main findings. In this section, we further discuss how these findings provide a more comprehensive and critical view of the role of the growing open and participatory game development and production model in fostering or hindering the future of gaming. Based on these findings, we also discuss implications for

better supporting non-profit driven indie game developers' creative technological practices.

5.1 Innovating Gaming through Non-Profit Driven Indie Game Development: A Critical View

The growing open and participatory production model in today's tech field has contributed to creating new workforces, supporting novel technological practices, and restructuring power relations in the global tech industry [1, 3, 17, 28, 45]. The creation of new software, emergent interactions, and physical prototypes is no longer restricted to well-funded professional designers and developers but is instead accessible to everyday users through various movements such as DIY making, hacking, crafting, and open design/manufacturing, among others [3, 17, 28]. Our study's focus on the subset of non-profit driven indie game developers in the indie game development community undoubtedly confirms a similar trend in the gaming industry. People who are passionate about games but have had limited game development skills and experiences can collectively contribute to innovating how modern games are designed, developed, and valued by pursuing a collaborative and open game development model, which differs from the mainstream gaming industry or even the more profit-driven indie studios. In this sense, this non-profit driven model has the potential to innovate traditional game production by emphasizing the unique artistic and cultural values of games rather than merely pursuing economic benefits and by focusing on new settings and organizations of labor, capital, and production channels in game development.

However, our study also further reflects the significant concern about a rather "idealistic" image of non-profit indie game developers as counter-cultural and as establishment (the traditional game industry) challengers [22, 25, 31, 37, 51]. Our findings highlight several ways through which this more open and participatory game development model does not foster or support non-profit driven indie game developers toward innovative game development but rather sometimes creates tensions and challenges, especially regarding the unique interplay of labor, capital, and production in this space. Therefore, we consider it necessary and important to provide a critical inquiry to elaborate on these tensions emerging in non-profit driven indie game development as a potential alternative production model to innovate future game development [31].

Critique 1: Who are able or unable to engage in the non-profit model to innovate game production? Prior work that focuses on labor relations in indie game development highlights that the indie model often renders and encourages new work conditions, team setups, and work cultures compared to the mainstream gaming industry [12, 13, 15, 35, 40]. Indeed, in our study, non-profit driven indie developers claimed and took actions to welcome and encourage *everyone* to participate in innovating game development. Compared to the traditional game production model in the mainstream gaming industry, the non-profit model seems to attract diverse developers in a more open and inclusive way. While we acknowledge and appreciate these game developers' aspirations, endeavors, and promising insights to encourage participation in game development through the non-profit focus, we note the significant *socioeconomic* barriers to entering and staying in non-profit driven indie game development. Many participants in our study admitted that it required tremendous time and economic investment to develop indie games, and many of them, in fact, did not have sufficient capital - either financially, socially, or technologically - to start and

Table 2: Summary of Key Findings

Challenges	Key Findings	Examples
Labor	• Difficulties to seek qualified and reliable team labor who take indie development seriously	• No essential mechanism to build a team who share the same non-profit agenda and foster satisfactory teamwork
	• Non-profit driven innovation as a personal burden	• Developing alone as an exhausting and draining experience; potential damage to one's self-confidence
	• Diversity issues for building an inclusive, non-profit driven indie workforce	• Women could still feel unsafe and harassed
Capital	• The lack of technological resources	• Hardware, network, and software
	• The lack of social capital	• Limited publicity; inadequate recognition from the broader gaming community and the general public; the general perception that indie game development is not a legit career
	• The lack of financial stability	• Depending on self funding; unstable income; hard to afford recruiting skillful teammates
Production	• Copyright and intellectual property concerns	• Risking losing intellectual property when sharing an ongoing project; restricted by other copyrighted content; no adequate national copyright policies/regulations for this field
	• Technology and Economic Policy Barriers for Entrepreneurship	• Complicated platform policy for self publishing and distributing games; bureaucracy for startup companies and NGOs; limited government support for the creative industry

sustain their ongoing labor and production in this field. Such socioeconomic disparities may exclude broader participation in indie game development. As a result, many non-profit driven indie developers struggle between self-exploitation and self-emancipation [24] and consider the pursuit of the non-profit agenda a significant personal burden as shown in our findings. Due to these challenges, only a particular type of developer is able, willing, and comfortable to pursue non-profit driven indie game development as an alternative game production model. For example, they either already have access to abundant technological resources and financial security through other means (e.g., from a wealthy family or having a well-paid but flexible full-time job) or have established a certain amount of social capital (e.g., a well-known AAA developer who decides to go indie). Therefore, despite the non-profit indie community's effort and relative success with attracting, supporting, and retaining a diverse workforce (e.g., women and minorities), it still seems to privilege certain types of actors - usually male, White, tech-savvy, and highly educated. This concern also aligns with critiques of other tech communities pursuing the more open and participatory production model, such as making culture and the open source movement [2, 39]. Whether indie developers acknowledge it or not, this insight leads to critical questions regarding how to make game development more open, diverse, and inclusive through the non-profit agenda. While prior works warn that non-profit indie game development can become "exploitative" and "precarious" [24, 40, 51], we further ask: if only certain types of people can participate in non-profit driven indie game development, who can (or cannot) afford to pursue this agenda for their artistic and cultural goals?

Critique 2: Does the non-profit model strengthen or weaken capital for the indie community to innovate game production? Prior work has painted a promising image where indie game developers may gain new capital by accessing new tools of funding, production, distribution, and human relations to innovate game production [40]. Likewise, indie developers in our study consider themselves to be empowered because they pursue a non-profit agenda, which helps gain more independence, agency, and control over both their funding (e.g., self-funding), development process (e.g., not subjecting to company rules), and the final products (e.g., having their own intellectual property and controlling how their games are published and distributed) [15]. However, developers also express concerns that, rather than empowering them, some aspects of the non-profit driven indie model in fact weaken their capital as individual developers and make them more vulnerable and subject to the established power structure in the tech industry [11, 22, 25]. For example, they heavily depend on various technological resources (e.g., tools, middleware, and sometimes even copyrighted content) provided by the mainstream gaming industry, which they claim to be independent of, to conduct their technological practices. Non-profit driven indie developers still have to adhere to the regulations set up by other tech giants (e.g., Apple) for self-publishing and distributing, and they often have to cover the cost themselves from a limited position of negotiation power. Compared to those more profit-driven indie studios, non-profit indie developers, in fact, have to shoulder the financial uncertainty with little institutional or organizational support. In this sense, while this alternative game production model promotes important values of openness and independence in game development, it still cannot and should not ignore the intertwining power relations between the largely revenue-driven traditional gaming industry, more profit-driven indie studios, and the indie game development community with a non-profit agenda. This leads to a critical question: how can individual indie developers gain more influence and capital in the non-profit model rather than becoming more vulnerable in the complex power structure, as the mainstream gaming industry still controls both technical and financial resources?

Critique 3: How to sustain non-profit driven indie game developers' long-term efforts? Prior work has envisioned that being indie may become a crucial production model for the future gaming industry [31] and could economically, culturally, and politically influence the final form of games [43]. Therefore, the final and ultimate critique we propose is: how can we sustain these non-profit driven indie developers' efforts to innovate game development in the long run? Addressing this critique is not only important for mitigating potential tensions between this specific game development style and the modern gaming culture [15] but also crucial to helping non-profit driven indie developers build more stable and secure working conditions [51]. We believe that our findings have shed light on two concerning issues that may hinder non-profit indie game developers' long-term efforts. First, there are high expectations and excessive personal burdens on individual indie game developers to achieve, preserve, and embrace various non-profit driven community values (e.g., open sharing, collaboration, and independence) but lack effective mechanisms to support their efforts for pursuing these values. Second, in many countries (e.g., US, Japan, and UK), promoting creativity from the bottom-up for economic development has become a national strategy. However, it is still unclear how and what national or regional policies should be designed and implemented to support this alternative game production model that focuses more on artistic and cultural values than seeking profit, ranging from issues with copyright laws and government funding to the assistance for non-profit organizations, small studios, and startups. Without such support at the national or at least the regional level, it would be challenging to sustain non-profit driven indie game development as a long-term collective and systematic effort to influence and advance future games and gaming technologies. Rather, it may just be reduced to certain peoples' or certain communities' personal aspirations.

5.2 Leveraging Technology Design to Support Non-Profit Driven Indie Game Development

We understand that supporting non-profit driven indie game development as a more open and participatory game production model would require advocating fundamental changes in material working conditions such as unions [40], communities, and activist groups. Therefore, we acknowledge the challenges identified in this research to be fundamentally sociotechnical, meaning that leveraging various technical design directions in parallel with social initiatives will be necessary to mitigate these challenges within the indie community. To contribute towards this goal, grounded in our findings and critical reflection, in this section we highlight two high-level design directions for re-thinking technology design as a mechanism for mitigating the non-profit driven indie community's challenges

regarding labor, capital, and production in game development as revealed in our study.

5.2.1 Designing for the Seeking and Building of Diverse and Collaborative Indie Workforces Who Share the Non-Profit Agenda. As our results indicate, the open and collaborative nature constitutes the very foundation of non-profit driven indie game development. Yet, the difficulty in identifying qualified, reliable, and diverse labor - i.e., potential team members who also share the non-profit agenda - presents a persistent issue for these developers. Additionally, collaboration via teamwork can be used in a positive manner to decrease the isolation associated with individual work, but too much collaboration can be inherently restrictive to an individual's autonomy and agency over their creativity. Thus, designing for a balance between teamwork and individual creativity is an important approach for supporting non-profit driven indie game development, especially if this community is to address the pervasive issue of the lack of inclusion and diversity. To achieve this goal, we argue that any technology design for potential tools (e.g., crowdsourcing platforms and team member matching systems) to facilitate non-profit indie developers' endeavors to identify qualified, reliable, and diverse labor and promote effective teamwork should especially focus on (1) the capability to evaluate the compatibility of skills, quality, and reliability of potential teammates; (2) the capability to evaluate the compatibility of personality, work styles, and goals of potential teammates; and (3) embedding diversity throughout the game development process.

Designing for evaluating the compatibility of skills, quality, and reliability of potential teammates. As detailed by our participants, non-profit driven indie game development often constitutes people with highly varied skillsets, skill levels, and expertise, which can result in frustration in a teamwork setting. Being inclusive of developers at all skill and expertise levels while still maintaining effective teaming outcomes is a vexing challenge. For example, designing an algorithm to automatically match non-profit indie developers with similar skillsets and skill levels together seems to be a simple solution; but it may also create a culture of exclusion and discouragement of growth that directly violates the core ideals of the non-profit driven indie community. Rather, it appears to be more important for non-profit driven indie game developers to proactively evaluate the compatibility of potential teammates' skills, quality, and reliability and then make a conscious and informed decision based on their own goals and purposes (e.g., educating new developers, focusing more on artistic than technical elements, etc.) instead of solely depending on an algorithm based matching system. Therefore, we envision that designing such tools would focus on both self-reporting and peer rating one's skillset, experience, and reliability. Such tools should also facilitate informed and data-driven personalized decision-making to identify compatible teammates based on specific project needs and priorities.

Designing for evaluating the compatibility of personality, work styles, and goals of potential teammates. There is a long tradition of using personality inventories to match team members [30, 41]. For example, Lykourentzuo et al. demonstrated that personality is a major factor in teamwork and that balancing a team with different personality types leads to better team performance in crowd teams [30]. The role of technological systems in supporting team personality matching has also grown in recent years. Our non-profit indie game developer participants demonstrate an understanding of the importance of the types of social elements (e.g., personalities and emotions) that foster proper communication and coordination in creating a team that is effective and performs well. They have also collectively highlighted the importance of "being on the same page," which means sharing the same non-profit agenda and taking indie game development seriously to achieve this agenda. Therefore, to enhance teamwork and ensure the balance between teamwork and individual creativity, we envision that tools to support non-profit indie developers' collaboration should be designed to allow for self-reporting/rating personalities, work styles/preferences, and motivations to participate in indie game development (e.g., for profit, for learning and self-improvement, for artistic and cultural purposes, for self-expression, for activist goals, etc.). Such tools should also allow the filtering of specific personalities, work styles/preferences, and motivations to help non-profit indie developers proactively identify potential teammates with desired personalities and work styles who are also on the same page with them.

Designing for embedding diversity throughout the game development process. As prior research has shown, indie development, especially in the vein of experimental and counter-cultural game-making, directly contributes to the democratization of the games industry by empowering and engaging previously marginalized and excluded populations (e.g., women and queer developers) to transform the traditionally hegemonic and male-dominated context of digital game production [10, 19]. In this sense, diversity and inclusion have been and continue to be a central focus in non-profit indie game development. As our findings show, our women and non-binary participants feel supported in this community, but they also confirm the need for more future work to support marginalized developers in indie game development. Such support does not only involve creating a safe and inclusive community for these groups but also involves better promoting their aspirations and values throughout the game development process, such as feminist principles and queerness in game design [10, 19].

Supporting and sustaining non-profit indie developers' focus on diversity and inclusion throughout the game development process will require a multitude of social and technical design solutions working together, but we are particularly concerned with how technology-supported teamwork can play a role in that process. Part of what makes teamwork a powerful participatory tool is that it promotes interaction and discussion among members. Therefore, we envision that any tools that are designed to support non-profit indie game developers' teamwork should take into account demographics and balances for diversity on indie teams with the same respect it gives to other variables mentioned above. Simply put, at a minimum, such tools should provide methods to ensure that efforts are made to reach and recruit team members who are not White men. For example, currently, platforms such as Reddit and Discord servers are commonly used by many non-profit indie developers to recruit potential teammates. However, these platforms seem to be mainly male-dominated, and seldom reach underrepresented developers such as women and queer individuals. This limitation is also reflected in our own male-dominated sample after recruiting

on these platforms. In this sense, such tools should help raise developers' awareness of considering diversity as a variable identical in weight and importance to compatible skills and personalities (e.g., a system-generated message can be used to remind developers of considering diversity as a variable identical in weight and importance to compatible skills and personalities). They should also enable posting cross-platform recruitment messages, including platforms often used by women and queer developers such as Twine [19]. In addition, such tools should allow for sharing of diverse values and aspirations of different groups through the game development process to make sure that their voices and opinions can be heard.

We also want to note that any tools built for the indie community must be open-source and free to use. Financially restricting the level of access individuals can have to a system designed to alleviate the challenges they face would further re-entrench issues of power, access, and privilege in indie game development. Equally important is the recognition that the issues identified by our participants are inherently social in nature, and thus require significant democratization of social interactions and technology in order to see progress and long-term change.

5.2.2 Designing for Leveraging Capital and Enhancing Game Production. In this research, we have identified significant barriers relating to both issues of the lack of capital and limited production rights in non-profit driven indie game development. As is the case in the previous section, some of these limitations are profound social issues that are not within the scope of technology design recommendations. Yet, with that in mind, we do believe there are potential avenues where sociotechnical systems can be utilized to leverage non-profit driven indie game developers' capital and enhance their game production. From our perspective, there are two issues at play here: 1) non-profit driven indie game developers lack resources and rights to leverage both capital and production, and 2) the resources that are available to them are fragmented and not organized in a manner that supports developers in a meaningful way. For this discussion, we will focus more on the latter than the former, though the conversation around resources and rights should receive its own separate research.

At a high level, aggregation of all existing resources for non-profit driven indie game developers is needed, ranging from software, hardware, promotion, and community support. Our participants note a lack of these resources at times. However, through our analysis, we can see that there are available resources despite being fragmented and not easily accessible through one platform. For example, these resources are currently distributed via a complex network of various platforms (e.g., Reddit, Unity, Youtube, Discord channels, and Twitch), making it difficult to initially find and subsequently cross-share resources across virtual spaces. In response, we envision that technology design for supporting non-profit indie developers could potentially focus on a multi-sourced platform approach, ultimately aggregating information in one easily accessible and shareable space. Characteristics of this shared platform should, at a minimum, include: 1) open sourcing and free resources; 2) promote a culture of sharing via a fair reputation system (e.g., the more one shares, the higher reputation one will have in the community); 3) providing specific, tailored, and dedicated mechanisms for specifically promoting individual creative workers; and 4) the ability to donate to individuals based on need. These characteristics are not reinventing the nature of indie game development, but rather attempting to coalesce all of these resources to better leverage them in a more feasible manner for the non-profit indie community.

5.3 Limitations

First, our findings are representative of the experiences of the participants in non-profit driven indie game development that we interviewed. We acknowledge that our findings may not represent all indie game developers' perspectives, especially those who are not on an activist and non-profit agenda. In addition, we acknowledge that our sample leans heavily toward men game developers, with many being hobbyists. This lack of diversity in our sample may partially be due to our recruitment methods, as we mainly used Reddit, Facebook, and Discord servers to recruit interviewees. As we have mentioned in the Discussion, these platforms are mainly male-dominated and may not reach underrepresented developers such as women and queer individuals. Considering the crucial role that marginalized populations such as women and queer developers play in indie game development, especially in the vein of experimental and counter-cultural game-making [10, 19], our future work will focus on leveraging more diverse methods, platforms, and channels to recruit marginalized developers to better understand their non-profit agenda. Further, we recruited participants from various countries and cultures to depict indie game development in an inclusive and non-Western-centric way. However, we also acknowledge that about half of our participants were located in North America. In future work, we will attempt to encapsulate a larger and more diverse sample of participants across different countries, races, and cultures. As different countries and cultures may foster various relations between labor, capital, and production in the gaming industry, it will be necessary to unpack how non-profit driven indie game developers may face different challenges to innovate game production across various countries and cultures.

6 CONCLUSION

In this paper, we used empirical data gathered from a multi-country pool of non-profit driven indie game developers to investigate the nature of the challenges faced in these communities. What emerged was a tremendous tension between inadequate and unsuccessful teaming versus emotionally and materially draining individual work; inadequate technological, social, and financial support compared to their privileged counterparts; and numerous legal and policy-driven barriers to technology production. Our findings provide vital insights for future HCI research to extrapolate how the more open and participatory game production model, as an alternative to the mainstream gaming industry, faces unique challenges and how such challenges can be confronted with intentional socio-technological design - an area of research that has been underexplored thus far. We contend, for example, that such an alternative game production model seems to inherently privilege the individuals who have the social, political, and economic capital necessary to engage in comparatively risky and unstable game development practices. This in turn means that individuals who are underprivileged in society at large are excluded from this model, and thus

from participating in shaping the trajectory of future games and gaming technologies. We thus believe that the HCI community must continue to explore how technology design can push the non-profit indie game development model in a direction that does not just facilitate game development and production for the privileged few, but instead support a more diverse and inclusive population's engagement in innovating game development.

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