



Gaming innovation ecosystem: actors, roles and co-innovation processes

Patrycja Klimas¹ · Wojciech Czakon²

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Abstract

Burgeoning research on innovation ecosystems offers a variety of conceptual approaches. Recent systematic literature reviews and syntheses provide a rich, diverse, but somehow abstract view of IEs. Our study advances the literature by taking the perspective of those involved in IEs. We aim to identify how various actors contribute to co-innovation in innovation ecosystems. In order to do so, our aim is to establish the various types of actors (who?), the distinct roles (what?), the different stages (when?), and the diverse engagement in co-innovation processes (how?). The study investigates the Polish Gaming Innovation Ecosystem as a globally successful example of a knowledge-intensive and highly creative innovation ecosystem. Data was collected over 3 years (between 2015 and 2017), in three waves of interviews (38) and non-participatory observations (5). We find that Gaming Innovation Ecosystem participants identify a total of 12 types of collective actors, 9 types of individual actors, and 1 community of individuals. Furthermore, we find four distinctive roles that actors may play in the co-creation processes, that is: direct value creation, supporting value creation, encouraging entrepreneurship, and leadership. Finally, we structure the co-innovation process into five stages: co-discovery, co-development, co-deployment, co-delivery and co-dissemination. We identify the diverse scope and varied intensity of actors' engagement, depending on the co-innovation phase, as perceived by our informants.

Keywords Co-innovation · Ecosystems · Co-creation · Game development · Gaming industry · NPD

✉ Patrycja Klimas
patrycja.klimas@ue.wroc.pl
Wojciech Czakon
wojciech.czakon@uj.edu.pl

¹ Department of Advanced Research in Management, Wrocław University of Economics and Business, Komandorska, 118/120, 53-345 Wrocław, Poland

² Strategic Management Department, Jagiellonian University, Łojasiewicza 4, 30-348 Kraków, Poland

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1 Introduction

Ecosystems (Adner 2017; Tsujimoto et al. 2018), and innovation ecosystems (IE) in particular (Durst and Poutanen 2013; Yaghmaie and Vanhaverbeke, 2019; Talmar et al. 2018; Adner 2017; Aarikka-Stenroos and Ritala 2017), are attracting a rapidly growing attention in both academia and managerial practice (Vargo et al. 2015; Thomas and Autio 2020). Typically for nascent fields, scholars underline the harmful conceptual shortcomings regarding the definition of ecosystems (Granstrand and Holgersson 2020; Klimas and Czakon 2022; Scott et al. 2021; Tsujimoto et al. 2018), blurry conceptualizations (Aarikka-Stenroos and Ritala 2017; Oh et al. 2016), or the deficit of operationalizations (Ritala and Almpapoulou 2017). Several gaps in the current understanding of ecosystems (Bouncken and Kraus 2021; Thomas and Autio 2020) are widened by rapid changes in the business environment, growing uncertainty (Bouncken and Kraus 2021), and increasing openness to both cooperation and competition (Zhang and Watson 2020). Additionally, it is also quite common to find different terms for the same type of ecosystems, the same term for different ones, or no distinction between various types of ecosystems despite fundamental differences (de Gomes et al. 2018; Pattinson et al. 2018).

According to the ecosystem perspective, every type of ecosystem is directly focused on value co-creation (Aarikka-Stenroos and Ritala 2017; Kapoor and Lee 2013; Vargo et al. 2015). However, co-creation is driven by different processes in different types of ecosystems e.g. knowledge co-creation in knowledge ecosystems, innovation co-creation in innovation ecosystems, or co-creation of new business ventures in entrepreneurial ecosystems. In contrast to networks or alliances, joint value creation in ecosystems does not necessarily involve explicit rules of value capture (Bouncken et al. 2020). Importantly, in ecosystems a multi-actor approach is adopted (Adner 2017; Pilinkiene and Maciulis 2014; Bacon and Williams 2021), as opposed to actor-to-actor orientation in value co-creation, transcending the classic dyadic (Vargo and Lusch 2011) linear, sequential approach to joint value creation (Vargo and Lusch 2004). Indeed in ecosystems, the co-creation with customers (Prahalad and Ramaswamy 2004) and even of communities with customers (Prahalad 2004), goes much further by involving co-creation with other external actors, and even entire networks of actors (Vargo and Lusch 2011).

Recent literature points to IE as currently fastest growing thread of research (Dąbrowska et al. 2019; Granstrand and Holgersson 2020; Klimas and Czakon 2022), but it also points out conceptual inconsistencies (Durst and Poutanen 2013; Lin et al. 2018; Thomas and Autio 2020) and shortcomings (Oh et al. 2016; Ritala and Almpapoulou 2017; Adner 2017). For instance, although the structural approach to IE acknowledges actors as constitutive components, there is no agreement regarding the types of relevant actors. Moreover, the ego-centric view focused mainly on the single most powerful actor dominates (e.g. Beliaeva et al. 2019; Dąbrowska et al. 2019), leaving other actors poorly recognized or characterized. Additionally, even though IE actors are acknowledged to play different roles

within IEs (Dedehayir et al. 2016), and to be engaged in IEs activities to various degrees (Granstrand and Holgersson 2020), there is no coherent view on how this engagement can be differentiated e.g. among the focal and peripheral actors. Furthermore, while the literature on IE expresses the need for pooling innovation capabilities across the entire co-innovation process, the bulk of research attention is paid to innovation output, which leaves other phases of the co-innovation process unexplored (Klimas and Czakon 2022). To sum up, our study addresses the above shortcomings and the gaps stemming therefrom.

We aim to identify innovation ecosystems from the perspective of those engaged in innovation processes. Such perceptions are consequential because they have implications for behaviours, including actions aimed at others in the business environment or carried out collectively with others (Czakon and Czernek-Marszałek 2021). We aim to establish the various types of actors (*who?*), the distinct roles (*what?*), the different stages (*when?*), and the diverse engagement in co-innovation processes (*how?*) as perceived by those involved in innovation ecosystems.

We empirically ground both the structural (Granstrand and Holgersson 2020) and the dynamic (Bouncken and Kraus 2021) views on IEs, and develop a framework for mapping the actors, their roles and their degree of engagement in co-innovation processes. Our in-depth study focuses on the Gaming Innovation Ecosystem in Poland, a globally successful example of a knowledge-intensive and highly creative innovation ecosystem. We collected field data over 3 years (between 2015 and 2017) using triangulated data sources including non-participatory observations (5), structured (13) and semi-structured interviews (8 exploratory and 17 member-checks). Following a theory-driven, directed approach (Hsieh and Shannon 2005), we coded our data with deductive codes derived from the academic and grey literature to map the actors, their roles and their engagement in the co-innovation processes in their own perception. Then, we matched the theoretical and empirical patterns (Bouncken et al. 2021) in order to theorize from these rich insights.

Our findings support, extend and alter recent conceptual developments regarding the innovation ecosystem (Granstrand and Holgersson 2020; Klimas and Czakon 2022) using the structural perspective (Adner 2017). We provide a synthesis of the literature and an empirical list of the various actors involved in innovation ecosystems. We single out the various roles played in innovation ecosystems, and the relevant phases of co-innovation processes. We develop an empirically grounded, fine-grained view on distinct roles and the involvement of actors in the five phases of the co-innovation process.

2 Conceptual background

The ecosystems approach emphasizes the strategic relevance of business surroundings in organizations' activities, which help firms in achieving a sustainable competitive advantage (Zhang and Watson 2020). Ecosystems are a way of seeing an organizations' environment (Sun et al. 2017), or as a useful way of operationalizing this environment (de Gomes et al. 2018). Compared to inter-organizational networks, ecosystems are more boundaryless (Durst and Poutanen 2013), but are not

open-ended (Adner 2017). Ecosystems have boundaries within which organizations may thrive, and beyond which their immediate interest is much limited. Therefore, setting out ecosystems' boundaries is crucially important for conceptual rigor and clarity, but is also meaningful to those involved in their operations (Walrave et al. 2018), because the way an environment is perceived has implications for competitive and collaborative actions (Czakon and Czernek-Marszałek 2021). An ecosystem's boundaries can be identified using such criteria as: actor (Gawer and Cusumano 2014a), structure (Phillips and Srari 2018), the ecosystem's value proposition criterion (Walrave et al. 2018), geography (Aarikka-Stenroos and Ritala 2017; Mazzucato and Robinson 2018; Valkokari 2015), technology (Aarikka-Stenroos and Ritala 2017; Autio and Thomas, 2014), and product (Tsujimoto et al. 2018). Depending on the criterion adopted, ecosystems may be defined differently in terms of scope and structure. Therefore, a key challenge for the ecosystems stream of research relates to delineation criteria.

From the output perspective, two types of ecosystems are important due to their impact on technological development, product creation and growth (Bouncken and Kraus 2021): innovation and entrepreneurship ecosystems. Given the scarcity of empirical findings on innovation ecosystems, they still appear as an emerging concept requiring research (Adner 2017; Dąbrowska et al. 2019; Granstrand and Holgersson 2020; Klimas and Czakon 2022; Ritala and Almpnanopoulou 2017; Thomas and Autio 2020; Yaghmaie and Vanhaverbeke 2019).

Innovation ecosystems are sets of *“interdependent actors who combine specialized yet complementary resources and/or capabilities in seeking to (a) co-create and deliver an overarching value proposition to end-users, and (b) appropriate gains received in the process”* (Walrave et al. 2018: 104). If actors are the constitutive component of any innovation ecosystem, defining an IE implies listing its participants. Surprisingly, the bulk of the literature takes an ego-centric approach, and the perspective of single actors, with either their direct or indirect innovation co-creative relationships with the firms responsible for the launch of innovation. Recent literature reviews clearly show that the pool of empirical works is limited, and innovation ecosystems *“are characterized in most cases by a one-on-one relationship between the focal firm and its partner. Inter-organizational relations involving multiple partners are rather rare”* (Yaghmaie and Vanhaverbeke 2019: 3). Such focus is increasingly seen as an impediment to the development of ecosystems understanding (Arora et al. 2019; Jucevičius and Grumadaitė 2014).

While the ego-centric perspective remains the most popular even in recent studies (Dąbrowska et al. 2019), scholars recognize the need to take a broader perspective (Klimas and Czakon 2022). Indeed, as pointed out by Granstrand and Holgersson (2020), innovation ecosystems can operate around one focal organization such as a hub firm, innovation orchestrator or anchor firm (Beliaeva et al. 2019; Dąbrowska et al. 2019), but also as eco-centric or operating around a few innovation leaders. In the same vein, Sun et al. (2019) indicate that innovation processes can be created and coordinated by one actor in a top-down approach, or emerge in a self-coordinated bottom-up way. Therefore, seeing IEs as *“organized around a focal firm or a platform”* (Autio and Tomas 2014: 3) seems to be too narrow, thus hampering conceptual developments (Arora et al. 2019; Jucevičius and Grumadaitė

2014). Few notable studies approach innovation ecosystems as intentionally orchestrated and collectively coordinated by several actors (Holgersson et al. 2018; Song 2016). Therefore, innovation ecosystems are more accurately defined as a “*cooperation environment surrounding the innovation activities of its co-evolving actors, organized across co-innovation processes, and resulting in co-creation of new value delivered through innovation*” (Klimas and Czakon 2022: 6). Hence, IE conceptually differ from innovation alliances, which are focused on value co-creation through co-innovation processes. IEs may be focused on innovation-related value creation (Bouncken et al. 2020) through collaborative innovation or open innovation, but not necessarily co-innovation, in other words through open models of innovation (less complex and less open) other than co-innovation (Lee et al. 2012).

Due to the deficit of empirical investigation on eco-centric innovation ecosystems, our study focuses on the Gaming Innovation Ecosystem (GIE) operating around the video game industry (VGI), but not organized around a single focal video game developer (VGD).

2.1 Gaming innovation ecosystems

GIEs are non-egocentric innovation ecosystems operating around many actors, none of which is a leader, focal firm or ecosystem orchestrator. Examining them takes the entire gaming innovation ecosystem as the unit of analysis (Ritala and Almpantopoulou 2017). GIEs are complex, multidisciplinary, dynamic structures comprised of co-evolving actors cooperating under co-innovation processes to release innovative video games, thus providing gamers and players with a co-created value proposition. Following Mercan and Göktaş, GIEs “*consist of economic agents and economic relations as well as the non-economic parts such as technology, institutions, sociological interactions, and the culture:* (2016: 102) related to games and gaming.

In terms of the institutional framework developed by Granstrand and Holgersson (2020), a GIE covers a set of various and evolving actors (video game developers, gamers, game distributors, publishers, etc.), their activities (video game development processes, sale, promotional events, market research, etc.), artifacts (various video games, their improvements, patches, etc.), and the institutions and relationships, including complementary and substitute relationships (inter-organizational, interpersonal, inter-community, etc.), that are important for the innovative performance of an actor or a population of actors (Banks and Potts 2010)

2.2 GIE actors

This study focuses on the actors, processes and resources involved in generating intended ecosystem outputs, that is co-innovations (Lee et al. 2012). Additionally, the outputs are seen as a feature of innovation ecosystems that distinguish one from another (Aarikka-Stenroos and Ritala 2017; de Gomes et al. 2018; Ritala and Almpantopoulou 2017; Valkokari 2015).

GIE actors can be characterized as: (1) operating in a hyper-dynamic, technologically advanced and knowledge-intensive industry (Xu et al. 2018); (2) running a

business in a fast-developing emerging industry that tightly links technology, art and business (Schmalz et al. 2014; Xu et al. 2018); (3) struggling with above-average uncertainty due to unilinear and unpredictable innovation development (Russell and Smorodinskaya 2018; Schmalz et al. 2014); (4) facing increasing and progressive digitalization (Oh et al. 2016), and (5) operating under high innovation and competitive pressure (Koch and Bierbamer 2016; Oh et al. 2016; Russell and Smorodinskaya 2018). Such environmental characteristics favour the creation of innovation ecosystems and encourage active participation in its activities.

An individual GIE consists of formal and informal organizations, individuals and communities of individuals interested, and engaged in co-innovation processes aimed at the development and release of new games. This multilateral structure is both complex and loose at the same time. On the one hand, the innovation ecosystem involves various types of actors targeting different main goals (e.g. developers vs gamers) with differing interest in the co-creation of new value (e.g. developers vs university). Moreover, these actors are connected through a set of dyadic, triadic and multi-actor relationships that take the form of innovation co-creation relationships, i.e. a type of co-creation relationship (Vargo 2009) aimed at the mutual realization of the innovation process, and thus exploited during the co-innovation process (Klimas 2019).

On the other hand, the innovation ecosystem is loose as the relationships among and between actors are usually exploited ad hoc and periodically in an informal way through social connections. Indeed, the development of video games runs cumulatively and it is hard to plan everything a priori, thus new product development processes are not only seen as risky, but uncertain as well (Schmalz et al. 2014). Additionally, the video game industry reflects typical features of the creative industry, including extraordinary uncertainty (Lingo and Tepper 2014), a high level of independent creativity (Tschang 2005), and favouring social relationships. “*Video game developers can be understood as a unique social group called an occupational community*” (Weststar 2015: 1238) strongly embedded in social relationships within the industry. Social relationships among developers are a significant source of value co-creation (Tschang 2007; Zackariasson and Wilson 2010), but social relationships with communities of users (Burger-Helmchen and Cohendet 2011; Parmentier and Mangematin 2014), communities of gamers (Marchand and Hennig-Thurau 2013), or communities of modders and hackers (Poor 2013)¹ are also important for co-innovation.

2.3 GIE co-innovation processes

Under the “*ecosystem of business, where individuals, organizations, governments, and economies are all networked and interdependent, we need a new innovation model*” (Lee et al. 2012: 818). This most open form of innovation is co-innovation (Lee et al. 2012), i.e. a process in which external partners such as firms, institutes,

¹ These specific types of gaming-related actors (e.g. different types of gamers, modders, testers, hackers, etc.) are characterized in detail in Table 1.

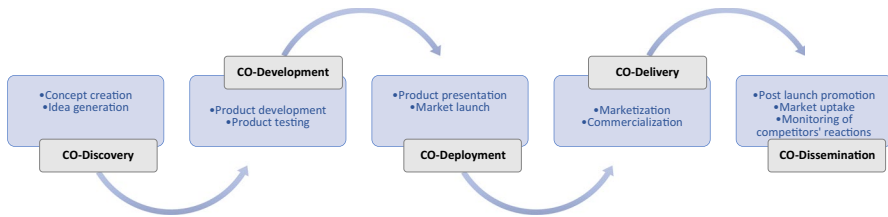


Fig. 1 The stages of the co-innovation process Source: own work using (Baregheh et al. 2009; Ernst et al. 2010; Hoyer et al. 2010; Klimas 2019; Krafft and Singh 2010; Song et al. 1998)

NGOs and customers are involved in the innovation effort through the sharing of knowledge, other resources, costs and benefits to create unique customer value (van Blokland et al. 2008). Co-innovation takes the form of interactive development (Bossink 2002), and therefore is a co-evolving process (Royer and Bijman 2009) based on ongoing convergence, collaboration and co-creation among actors (Lee et al. 2012). There is a gap in the ecosystems literature relative to the identification of actors involvement in subsequent stages of the co-innovation process. Some conceptual suggestions are available, but lack empirical examination. For instance, Autio and Thomas (2014) point to the discovery, development, deployment and delivery of new products or services. Klimas (2019) posits that co-innovation is a cooperative process covering: co-discovery, co-development, co-deployment and co-delivery of new products or services. Other relevant stages such as implementation (Ernst et al. 2020); adoption (Baregheh et al. 2009), post-launch (Hoyer et al. 2010), adjustments and diversification (Geissdoerfer et al. 2016) can be found in the new product development stream of literature. By integrating these propositions, we expand the 4-stage framework for the co-innovation process developed by Klimas (2019) by adding a process focused on innovation co-dissemination, as suggested in innovation management literature (Table III in Baregheh et al. (2009)). Therefore, we see the process of co-innovation as consisting of five subsequent stages (Fig. 1): co-discovery i.e., ideation and concept design; co-development i.e., prototyping and production; co-deployment i.e., product implementation; co-delivery i.e., marketization and commercialization; and co-dissemination i.e., late promotion, adjustments and re-configurations.

2.4 GIE outputs

GIEs main outputs are games, which are the medium of value created, co-created, appropriated and delivered to customers. Video games are typically developed as projects deployed across the innovation process, so game releases can be seen as an innovation output. Video game designing leads to innovation output resulting from “creative processes such as insight or inspiration, or from the form of creativity that ‘blends’ disparate concepts together in novel ways by adapting, adding or combining them” (Tschang and Szczypula 2006: 470). Further on, bringing a game from concept to market” always takes the form of a project in terms of project management (Schmalz et al. 2014). Video game developers (VGDs) are project-based

organizations (Legault and Weststar 2015). These project-based and innovation-oriented characteristics provide favourable conditions for the creation and development of a successful innovation ecosystem (Pombo-Juárez et al. 2017; Thomas and Autio 2020).

Video games can be characterized as: (1) integrated and highly modular products (Adner 2006); (2) complex and technologically advanced products (Dattee et al. 2018), (3) products based on several interdependent and complementary technologies (Holgersson et al. 2018), (4) products usually targeting new global demands and adopting new technological solutions (Ferasso et al. 2018), and (5) products with the potential to draw benefits from co-creation or co-development, also through relationships with communities of users (Autio and Thomas 2014; Russell and Smorodinskaya 2018; Niemand et al., 2021). These characteristics are important because they favour the creation of innovation ecosystems and encourage a wide range of actors to actively participate in co-innovation processes.

3 Research design

Our study aims to understand the innovation ecosystem from the perspective of those engaged in innovative processes. In line with managerial perception literature (Czakon and Czernek-Marszałek 2021), we rely on qualitative methods adequate for exploring the “*what*”, “*how*”, “*when*”, “*who*” and “*where*” research questions (Gioia et al. 2013) where theory is unavailable, scant or nascent (Graebner et al. 2012). Accordingly, we address the following research questions: *who* creates IE, *what* are the distinct roles of the actors, *how* do these actors engage in the roles and stages, and *when/where* are these roles performed in terms of the stages of co-innovation processes.

3.1 Empirical setting

Prior innovation ecosystem studies have focused on various industries: design in Great Britain (Sunley et al. 2008), telecommunications in Germany (Rohrbeck et al. 2009), healthcare in the US (Kapoor and Lee, 2013), biofuel in the US (Weil et al. 2014), high-tech manufacturing in China (Wu et al. 2018; Xu et al. 2018), aerospace in the US (Mazzucato and Robinson 2018), and the global jewellery industry (Dąbrowska et al. 2019). We follow calls to investigate industries other than high-tech manufacturing (Kapoor and Furr 2015). We selected the video game industry as it is technologically advanced, knowledge-intensive and at the same time highly creative. It remains surprisingly underexplored in management research (Burger-Helmchen and Cohendet 2011; Mazzucato and Robinson 2018) including ecosystems research (Feijoó 2012; Inoue and Nagayama 2011; Klimas 2019).

We purposefully selected the Polish Gaming Innovation Ecosystem as a globally successful example of a knowledge-intensive and highly creative innovation ecosystem (according to reports by the Entertainment Software Association, Euromonitor

International, NewZoo, the Polish Gamers Observatory and Statista). The main criterion used to select this GIE was the intensity of innovation, so the studied context provides a rich example for the study, but is not an extreme case (Suri 2011). The GIE is concentrated around the formal video game industry operating in Poland and covers the entire value (co-) creation processes, including various actors engaged across these processes such as video game developers, publishers, NGOs, gamers, players and different types of gaming communities. Also, video games, video game developers and the video game industry are quite novel industrial contexts in management research, including research on innovation ecosystems (Inoue and Tsujimoto 2017; Ozalp et al. 2018). Finally, prior studies on GIE were run in other national contexts (Inoue and Nagayama 2011), in GIE operating around global corporations (Inoue and Tsujimoto 2017; Ozalp et al. 2018), or were focused on mobile IE only (Feijoó 2012).

3.2 Data collection

To capture perceptions stable over time, we collected data over 3 years (from 2015 to 2017) in three waves of interviews (38) and non-participatory observations (5) with various actors involved in the GIE. We aimed to capture mutual perceptions and diverse views of the same focal GIE, including the view of the researchers through their observations. The general framework of the gaming innovation ecosystem was developed by reviewing prior systematic literature reviews (Czakov et al. 2019; Kraus et al. 2020).

To ensure the reliability and validity of our study (Humble 2009), five types of triangulation were used (Guion et al. 2011): data, investigator, theory, methodological, and context. Data was triangulated from two sources of data sources: secondary i.e., academic and grey literature including industry reports, industry and company websites, online forums and portals for game developers, gamers, game reviewers, etc. (Appendix 1); and primary, that is field research using structured interviews, two rounds of semi-structured interviews and non-participatory observations (Appendix 2). Investigator triangulation consisted in involving two researchers in the analytical process separately, then establishing convergent findings and discussing differences. Theory triangulation involved several theoretical views on co-innovation processes i.e., new product development, innovation ecosystems, and co-innovations. By mobilizing multiple analysis methods, i.e., deductive coding, thematic analysis, and flexible pattern matching we ensured methodological triangulation. Finally, by collecting data in different contextual settings: online and on-site in firms' headquarters, in neutral locations such as restaurants, and during trade fairs we ensured contextual triangulation. We reached out to individuals representing different industrial perspectives as key informants i.e., video game developers, publishers, a global consulting company and gaming media. Moreover, we run non-participatory observations during trade fairs (Game Industry Conference during Game Arena), B2B events (Digital Dragons and Mastering the Game), and game jams (organized by Digital Dragons Academy).



* The list of analyzed grey literature is presented in Appendix 1.

** Details are presented in Appendix 2.

Fig. 2 Data collection process

The research process (Fig. 2) consisted of a literature review (Appendix 1) and the empirical study. To collect data, we designed a long-term process starting in 2015 and finishing in 2017. This process covered two phases: one focused more on exploration and the second more on findings validation through member checks (Appendix 2).

Phase 1 involved three data collection techniques (Appendix 2): 13 structured interviews with VGDs attending Digital Dragons 2015 (May 2015); 8 semi-structured, direct interviews with open questions covering sources of firm innovativeness and a wide range of co-creation relationships used to build, leverage or defend firm innovativeness and create new games (October 2015-March 2016); 5 non-participatory observations (May 2015-November 2016) focused on observation of mutual connections of VGDs and relationships with other VGI members, as well as practices in project management, innovation management, inter-organizational cooperation and strategic management.

Phase 2 consisted of member checks in order to validate the accuracy of participant's subjectivity representation. This stage aimed to confront initial findings, eliminate inaccuracies, and identify missing evidence for the considered features, types, actors and their roles in the gaming innovation ecosystem from business practice. We collected data through 17 semi-structured, direct interviews with video game developers, between May 2016 and January 2017 (Appendix 2). We used open questions referring to identified co-creation relationships with different actors inside VGI, outside VGI and within gaming communities; key partners considered in business models. Due to important market differentiation, the interviewees represented different types of video game developers: PC, console, mobile game developers, as well as those operating using premium and fermium (face-to-face) monetization models (Klimas 2017). One firm, due to its extraordinary significance in terms of its capabilities in the implementation of different

forms of radical innovations i.e. breakthrough, disruptive and game-changing—participated twice in interviews, in the exploration and clarification phases.

3.3 Data coding and analysis

This study adopts a flexible pattern matching approach (Bouncken et al. 2021). We adhere to the postulates of logical consistency (literature-driven), subjective interpretation (emerging), and adequacy (hybrid involving deductive and inductive codes). Hence, we combine theoretical patterns and rigorously identified empirical patterns in a pattern matching exercise. Consistent with our research aim, we “*validate or (if possible) extend conceptually a theoretical framework*” because “*existing theory (...) is incomplete and would benefit from further description*” (Hsieh and Shannon 2005: 1281). Therefore this study focuses on expanding the transparency and granularity (Humble 2009) of existing views on GIE actors’ roles (Dedehayir et al. 2016; Spelmeyer and Lingens 2018) from the perspective of their engagement in the co-innovation process (Fig. 1). At a more general level, we strive for a “balance between rigid standardization and complete anarchy” (Bouncken et al. 2021: 252) by deploying a pattern matching framework, which operates as an interaction between the deductive and inductive approaches.

Initial coding is theory-driven (i.e., the contexts of new product development, innovation ecosystems and co-innovations in a given industry context). We then use directed content analysis (Fereday and Muir-Cochrane, 2006) as an analytical technique (Hsieh and Shannon 2005) to finally define the list of codes. To code and analyse our data, we followed the conventional process in qualitative research consisting of data reduction, data display and data verification (Miles and Huberman 1994). To address our research questions, we have structured the codes into three categories: actor, role, and co-innovation process.

Regarding the actors, we started with a comprehensive list derived from the literature. Regarding the roles played by actors, we used the four categories identified in prior literature and matched them with the roles reported by our interviewees. Regarding the co-innovation processes, we departed from the literature, which structures these into three, four, or five sub-processes, and found in our data that a more fine-grained list is used by our informants. In order to reinforce the trustworthiness of our coding (Miles and Huberman 1994), we first used data triangulation by confronting the primary data sources with the existing secondary data sources. Next, we validated our findings through member checks with our informants in the second wave of interviews. Thirdly, we triangulated the codes and related findings between the two researchers.

4 Findings

An accurate understanding of innovation ecosystems requires the actors, their respective roles and the processes carried out by those actors to be identified (Dedehayir et al. 2016; Galateanu and Avasilcai 2016; Pattinson et al. 2018; Sun et al. 2019). Accordingly, our findings are structured around actors, roles and co-innovation processes as reported and validated by our informants.

4.1 Who: the actors involved in gaming innovation ecosystems

The actors of IE are firms and other organizations, customers and their communities interlinked by the interest in increasing the innovativeness of products, industry, region, or sector of the economy (Pilinkiene and Maciulis 2014; Aarikka-Stenroos and Ritala 2017). By actor we mean an individual or collective entity directly involved in the co-innovation process (Carayannis and Campbell 2009; Aarikka-Stenroos and Ritala 2017), in value co-creation and value capture (de Gomes et al. 2018; Schroth et al. 2018), but also in fertilizing and accelerating innovation processes (Sun et al. 2019). Generally, actors of innovation ecosystems can be stratified by levels of analysis into four categories: networks of organizations, organizations, individuals, and communities.

Firstly, the literature suggests that innovation ecosystems can be seen as a meta-organizations (Russell and Smorodinskaya 2018; Valkokari 2015) consisting of multi- or meta-organizational (Gulati et al. 2012) actors such as networks, clusters, franchising networks, strategic alliances, etc. However, in our data this type of actor was not identified as no contributors represented the multi-organizational form. Our respondents do not indicate this category, which may be attributed either to its usefulness in GIE involvement or to the somehow abstract construct that networks are.

Secondly, different types of organizational actors including firms, public institutions and NGOs were identified within the GIE, such as: firms producing the final products, competitors, suppliers and complementors. Interestingly, producers of substitutes were not indicated as actors in the GIE. Besides firms, public organizations were also listed, including the government (Ministry of Culture and National Heritage), public institutions (Cracow Technology Park), research institutes (National Centre for Research and Development) and universities (Silesia University). Interestingly, regulators were not indicated by our informants as actors in the GIE. However, not-for-profit organizational actors such as industry regulators (SPIDOR, which informally coordinates the regulatory initiatives imposed by the government and triggers bottom-up ones) and NGOs (Polish Indie Games Foundation or Polish Game Association) are identified as actors in the GIE.²

² In the period covered by the research, there were approximately 300 game developers in Poland (Rodzińska-Szary et al., 2016 – no accurate statistics were kept). Currently, as reported by the Ministry of Culture and National Heritage and the Polish Games Association, more than 400 firms developing games are registered in Poland.

Thirdly, innovation ecosystems are pictured as distinctive because they frame the engagement of social actors (Aarikka-Stenroos and Ritala 2017), both individuals (Autio and Thomas 2014) and communities (Valkokari 2015). Indeed, in contrast to other types of ecosystems, innovation ecosystems cover both sides of the market, namely demand (communities of gamers and individuals such as modders or testers) and supply, and thus cover complete value chains (Stadler and Chauvet 2018: 113). Such a broad scope of actors favours drawing benefits from both co-innovation pushed by the market (producer-led innovation) and pulled by customers (user-led innovation, customer-led innovation, market-led innovation). Furthermore, it becomes possible to provide a new value proposition based on more complex solutions linking both of the above (Russell and Smorodinskaya 2018).

Relevant individual actors typically are: consumers (players and gamers diversified in terms of interest in getting involved in the process of co-innovation), non-user clients (not identified in our case), politicians (the director of the Department of State Patronage in the Ministry of Culture and National Heritage), and investors (not directly identified as really engaged in our case). Our data shows that the list of previously identified individuals is incomplete. We found additional types of individuals that contribute to co-innovation processes implemented within the GIE: modders, hackers and testers involved at the co-development stage of the co-innovation process, thus directly influencing the newly created value. Furthermore, we found influencers to be important individual actors (YouTubers, bloggers, game reviewers, etc.) involved in co-delivery and co-dissemination stages of the co-innovation process by video game developers (Sect. 5.3.).

Fourthly, communities manifesting an interest in engagement in the co-innovation process were also identified by our informants. These collective actors are seen either as communities of interest or communities of practice. Even though it is difficult to draw a clear demarcation line between these two, communities of interest seem to be more focused on improving and tailoring the co-innovation process to the needs of the participants being targeted by the newly created value, such as communities of gamers, amateur testers and modders considered to be a significant source of fan-based value or even determining a game's success. In turn, communities of practice focus on the business perspective, on value creation and value appropriation. Our informants identified such collective actors as: communities of developers, indies, professional testers, scriptwriters and 2D and 3D graphic artists. As suggested by Koch and Bierbamer (2016), these two types of communities can be differentiated through the type of work they carry out for the producer of the final products. Communities of practice are therefore seen as communities of specialists directly working for a producer (here for video game developers), while communities of interest are considered to be communities of users exploited informally, thus working indirectly for a producer.

To conclude, the actors that make up innovation ecosystems are diverse. Their different types (Table 1), importance and specific form seems to depend on the co-created products underlying the value proposition offered and delivered to the market, i.e. the product defining the innovation ecosystem's boundaries (Tsujimoto et al. 2018).

Table 1 Actors in innovation ecosystems

Actor type	References in IE literature	Actors identified in GIE
NETWORKS	Actors	Not identified
	Networks of organizations	
ORGANIZATIONS	Producers of final products video game developers	Video game developers (also labelled as game producers, game developers, development studios, game software producers and game software developers) are the companies that develop (produce) video games*. These actors trigger and organize their innovation processes within GIE with the support of other ecosystem actors Given the business specificity of VGDs, we can distinguish the following types of developers: producers of their own games capable of covering the whole new product development process (e.g. Techland), producers of their own games but also publishing games developed by other developers (e.g. Bloober Team), producers of their own games but also publishing and distributing games developed by other developers (e.g. 11 Bit Studios), producers of their own games requiring publishing and/or distributing support (e.g. Plastic Studio), and indie i.e. independent game developers (e.g. Carbon Studio). It should be explained that an indie is a producer entity (usually artistically, but not in financial terms) independent of an external publisher, for whom the logic of conducting business activity is usually not purely financial, but rather artistic. In the gaming industry, the term indie refers to small, often one-man development firms, but also to the video games they produce (indie as a type of developer and indie as a type of game) Given the scope of capabilities and business activities, VGDs are more or less predisposed (sometimes forced) to cooperate within gaming innovation ecosystems to carry out their own innovation processes (e.g. an indie usually needs support from a distributor) or to be involved in innovation processes carried out by others (e.g. producers of their own games but also publishing and distributing games developed by other developers)
	Velkokari (2015)	
	Carayannis, Campbell (2009); Kapoor, Lee (2013); Jucevičius, Grumadaite (2014); Autio, Thomas (2014); de Gomes et al. (2018); Dedehayir, Mäkinen, Ortt (2016); Scaringella, Radziwon (2018); Gomes et al. (2018); Russell, Smorodinskaya (2018); Granstrand, Holgersson (2020)	
	Competitors— video game developers	Direct and indirect competitors, namely other video game developers targeting the same (direct rivals) or different (indirect rivals) types of gamers and/or types of games can be invited to join the co-innovation process. For instance, the game Sniper Ghost Warrior was partly developed as a result of a cooperative innovation co-creation relationship between City Interactive and Techland, two large development studios
	Holgersson, Granstrand, Bogers (2018); Granstrand, Holgersson (2020)	

Table 1 (continued)

Actor type	Actors	References in IE literature	Actors identified in GIE
Suppliers—game publishers	<p>Kapoor, Lee (2013); Autio, Thomas (2014); de Vasconcelos Gomes et al. (2016); Dedehayir, Mäkinen, Ortt (2016); de Vasconcelos Gomes et al. (2018)</p>	<p>Game publishers are responsible for launching a game on the market. In the case of large productions (AAA games), the publisher is usually a large and specialized firm with appropriate financial and marketing resources (including sometimes global distribution channels). Depending on the specific arrangements, the publisher may be responsible for covering the costs of creating the game, which is processed into a physical product (recording onto an optical medium, packaging, etc.), commercial contacts with sales networks, and conducting an information and advertising campaign. It should be noted that quite often the rights to the game brand are transferred to the publisher. Within GIE, two types of publishers can be identified, namely publishers focusing on publishing only (e.g. Toy Headquarters) and publishers producing their own games and publishing games developed by other developers (e.g. Sony Computer Entertainment Publishers). Note, the latter is not considered as a VGD if the core business relates to publishing and not to game development</p>	
Suppliers—game distributors	<p>Game distributors are not but are shown as significant partners for video game developers also in terms of game co-creation, e.g. Tschang (2007); O'Donnell (2011)</p>	<p>Game distributors are companies responsible for the distribution of video games. Although digitalization has reduced the share of traditional distribution, there are still some types of games (e.g. blockbuster games labelled as triple AAA such as The Witcher or games targeting enthusiasts) sold in material form on a CD. Within the GIE, there are two main types of distributors offering support at the latter stages of the new game development process, namely traditional ones with a well-developed network of traditional sales points (e.g. Empik.com – one of the largest sales networks offering a wide range of entertainment-related products) and digital ones operating only online (e.g. Gamedia.pl). It should be noted that the biggest digital game distributors, including Steam, App Store and Google Play are not considered as part of a GIE. Firstly, such companies do not engage in co-innovation processes and consider their links with VGDs as typical transactional ties. Secondly, the global leaders in digital distribution are not classified as Polish</p>	

Table 1 (continued)

Actor type	Actors	References in IE literature	Actors identified in GIE
Complementors—hardware/console manufacturers	Kapoor, Lee (2013); Autio, Thomas (2014); de Vasconcelos Gomes et al. (2016); Scaringella, Radziwon (2018); Holgersson, Granstrand, Bogers (2018)	Hardware manufacturers are companies producing games consoles. The three key hardware manufacturers are Microsoft (the Xbox console), Sony (the PlayStation console), and Nintendo (the Wii console). It is common practice for console producers to provide technical information (including both requirements and feasibility) and prototypes of new consoles to VGDs to ensure technical compatibility of currently developed games with currently developed consoles. Sometimes, the game is intentionally designed to maximize the utility of the technical feasibility of the console, thus it is developed agily almost alongside the console (e.g. Bound is a game developed by Plastic Studio under tight cooperation with Sony). It should be emphasized that from a gaming perspective, PC companies, as well as producers of any handheld consoles and other mobile gaming devices (e.g. telephones, tablets, palmtops, etc.), are not included as hardware manufacturers considered to be potential partners for co-innovation	
Complementors—producers of complementary products for gaming		Producers of complementary products are companies offering a wide range of external equipment and accessories required for gaming. Within GIE, the role and the type of such complementors depend on the type of game that is being (or will be) developed. Firstly, given typical game segmentation distinguishing between PC, console, browser and mobile games, the role of complementors is the greatest in the development of console games. Indeed, it is important to ensure technical and software compatibility between the game and the control equipment (e.g. developers offering racing games quite often cooperate with Aerosoft, who provide a wide range of joysticks, pads and controllers). Secondly, given the technology underlying the gameplay and the world inside the game, the role of complementors is important in the case of any games based on virtual reality (VR). Among the most challenging issues are the weight and the data transfer parameters of spectacles, goggles, waistcoats and controllers, which determine the quality of immersion of gamers playing in VR (e.g. Cmoar designs and provides special waistcoats compatible with motor racing games)	
Producers of substitutes	Holgersson, Granstrand, Bogers (2018); Granstrand, Holgersson (2020)	Not identified	

Table 1 (continued)

Actor type	References in IE literature	Actors identified in GIE
Government	Carayannis, Campbell (2009); Jucevičius, Grumadaite (2014); Scaringella, Radziwon (2018)	<p>The MKiDN (Ministry of Culture and National Heritage, particularly the Department of State Patronage) does not engage directly in the innovation process, nevertheless, it should be seen as a significant actor of GIE. Indeed, MC&NH organizes conferences and workshops targeting the development of business, economic and legal issues in the context of the creative industries (e.g. the annually organized Creative Days or the Mastering the Game conference). Such initiatives enable the development of knowledge among VGDs, but also other actors in GIE operating in other creative industries (e.g. media, music, advertisement, etc.) and create an opportunity to meet and network. Furthermore, MC&NH introduces different forms of financial support for the Polish game industry, including special research grants available directly under the Ministry, lobbying for special grants track under the National Centre of Research & Development (e.g. GameInn with an annual budget of 100 m PLN; approximately 23 m EUR); and lobbying for tax reliefs for VGDs, to name a few. It should be noted, however, that in the case of tax reliefs, there is some influence of the government on new game development as reliefs are available only for those developers who develop games that include cultural content in the gameplay. One interesting aspect is that from the video game developers' perspective, there is space for intense support from governmental institutions, including for instance better education of students, help with promotion abroad (financing for taking part in expos, etc.), or co-financing of game development as identified in the latest report on the Polish Game Industry (2019)</p>
Public institutions	Jucevičius, Grumadaite (2014)	<p>KPT (Cracow Technology Park) organizes the biggest game trade fairs in Central Europe (Digital Dragons every year in May—http://digitaldragons.pl/), which helps in the dissemination of innovation process outputs. Furthermore, it is actively engaged (co-realization and co-financing) in preparation of reports on Polish gamers and the profile of Polish GameDev (both prepared every two years with financial support from the MKiDN). The findings it includes on gamers' behaviours and needs, market trends and changes are reliable and useful when designing a new game. Next, KPT also runs the 'Digital Dragons Academy'—an education programme providing training for future and young entrepreneurs; KrakJam—a 48-h video game development marathon (every year in January); and Inkubator Digital Dragons for beginner game creation studios, under which KPT offers training for business entities, mentorships, workshops, study visits to companies and open space for office work</p>

Table 1 (continued)

Actor type	Actors	References in IE literature	Actors identified in GIE
Research institutes		Autio, Thomas (2014)	The NCBIR (National Centre for Research and Development; www.ncbr.gov.pl) coordinates programmes of financial support for applied research (e.g. INNOTECH), also those related to video games, e.g. the Gamelnn program offering 65–80% of financial support for applied research and 40–60% of financial support for developmental projects. <i>NOTE: an indirect influence can be identified across the entire co-innovation process</i>
Universities	Carayannis, Campbell (2009); Jucevičius, Grumadaite' (2014); Autio, Thomas (2014)		Universities are seen as partners providing support in any research leading to technological development. Furthermore, an indirect role of universities in the co-innovation process is the supply of apprentices and trainees. Regarding the gaming sector, although there are hundreds of universities in Poland, including 23 technical ones, only one is interested in cooperation in the gaming field. The Silesian University, the Faculty of Arts in Cieszyn in particular, runs courses in tight cooperation with the VGD (e.g. The Game and virtual space design), engages in cooperation in research projects financed by grant institutions (e.g. projects implemented under science-business consortia and financed by National Centre of Research and Development), and runs business and economic training for small and medium-sized developers (e.g. free training in the field of project management, monetization performance, budgeting, marketing, etc.)
Regulators	Autio, Thomas (2014); de Vasconcelos Gomes et al. (2018); Granstrand, Holgersson (2020)		In Poland, there are no governmental regulatory institutions supervising video games. Nevertheless, there are some bottom-up regulatory initiatives mainly including those coordinated by SPIDOR (the Association of Producers and Distributors of Entertainment Software) publishing and popularizing good business practices (e.g. social campaigns against violence in games and recommendations for labelling games with minimum age ratings according to PEGI requirements)

Table 1 (continued)

Actor type	References in IE literature	Actors identified in GIE
NGOs	Not identified either in the literature on IE or value co-creation in the context of the video game industry	FIG Polska (the Indie Games Poland Foundation) is a non-profit organization, and to some extent can be considered to be a quasi-formalized gaming community taking the form of a community of practice. It coordinates the biggest online platform related to games, the game industry, game developers and gamers https://polskigamedev.pl . The foundation is the most important NGO related to gaming in Poland. It operates as an actor of GIE in two ways. First, it is indirectly engaged in co-innovation processes by providing business training for micro and small developers, including indies to the greatest extent. Second, it offers support in international and global marketing, promotion and sales by organizing shared promotion of Polish indies at global trade fairs. The SIG (Polish Games Association: http://polskiegry.eu) formally coordinates and leads intra-industry, bottom-up initiatives directed to government as it covers more than 95% of Polish video game developers. The role of the SIG in the gaming innovation ecosystem is however significant. On the one hand, it indirectly impacts the implementation of all innovation processes inside the video game industry through lobbying to obtain financial support, help in global promotion, purposeful support of specific technologies, etc. On the other hand, it directly impacts the co-evolution of VGDs as well as the co-innovation processes run by them as it creates communication and networking opportunities during official association meetings. <i>NOTE: the engagement and impact is narrowed down to co-innovation processes implemented by independent game developers only</i>
INDIVIDUALS		
Consumers— players	Adner (2006); Rohrbeck, Hölzle and Gemünden (2009); Velkokari (2015); Russell, Smorodinskaya (2018)	Players (labelled also as casual players or casuals) are usually not aware of being a player and a consumer of video games. Casual players are perceived as 'Sunday players' who treat playing as pure entertainment, a way of spending their leisure time, and thus do not show much interest and involvement in co-innovation processes, unless it takes the form of support in the dissemination of games through recommendations made to friends. This type of consumer usually chooses mobile games
Consumers— gamers		Gamers are people who play games for entertainment and leisure. They are aware customers who spend money on games from time to time and play games on different devices and platforms. Such type of gamers rarely engage in co-innovation processes unless it takes the form of unintentional support via in-game dissemination

Table 1 (continued)

Actor type	References in IE literature	Actors identified in GIE
Consumers—hardcore gamers		<p>Hardcore gamers (labelled also as true gamers or real gamers) are individuals for whom games and gaming are a passion, a hobby and one of their most important (if not only) forms of leisure activity. A hardcore player is a conscious participant of the gaming culture having extensive knowledge of the gaming medium. They identify themselves not only with gaming culture but even with gaming art. Commonly, a hardcore gamer devotes a lot of time in improving their gaming skills, developing the most effective gameplay strategies and learning the secrets of each game. Furthermore, it is quite common that hardcore players participate in various tournaments, leagues and rankings assigned to a given game. All in all, a 'true gamer' could mean the equivalent of a bibliophile, a music-lover, or a cinema-lover. Hardcore players mainly choose PC and console games due to uncontestedly higher technical and visual standards compared to mobile games. In contrast to casual players and gamers, hardcore gamers do intentionally engage in the co-innovation process. Furthermore, their involvement quite often covers more than one stage of the innovation process. Firstly, hardcore gamers engage in in-game testing (more details on testing below) before a game is released. Secondly, this type of gamer purposefully engages in in-game dissemination as they are active members of gaming communities</p>
Consumers—professional gamers		<p>Professional gamers play games professionally for profit, thus combining entertainment with the financial benefits of playing. Professional players are members of different game leagues (both formal and professional as well as non-formalized operating online only) under which they compete locally, regionally, nationally and globally at different types of e-sport championships. Within GIE, their involvement in co-innovation processes is comparable to that assigned to hardcore gamers, nevertheless, it is rather limited to games applicable to e-sport competitions, i.e. multiple player types of games. It should be added that, in contrast to hardcore gamers, professional gamers are recognizable, and as they influence gaming communities they are intentionally used by video game developers not only to test the game before its premiere but also at earlier stages of the new game development process, including even the creation phase in order to discuss the general idea for game content or required improvements in sequels.</p> <p><i>NOTE: the engagement and impact is narrowed down to the co-innovation processes of games suitable to e-sport only</i></p>

Table 1 (continued)

Actor type	Actors	References in IE literature	Actors identified in GIE
	Clients—people who buy games, but excluding customers	Autoio, Thomas (2014); Dedehayir, Mäkinen, Orttwon (2018); Scaringella, Radziolos Gomes et al. (2018)	Among the clients who buy games but are not product consumers are usually people who buy games as a present. These individuals are not considered as actors in GIE
	Modders	Not identified in the literature on IE hence supported by the literature on value co-creation in the context of video game industry: Ng, Khong and Thwaites (2012); Poor (2013)	Modders are people who, independently from the game producer, make changes to the game source code, thus changing either the world or the gameplay of the game. Generally, modders operate outside the control of producers and change games in any way they like. The game modification used requires breaking the security mechanisms. Nowadays, some VGDs intentionally give access to the source codes, thus allowing modders to modify the games. On the one hand, modifications are perceived as non-threatening ways to attract new gamers to the original title. On the other hand, more often modifications are intentionally used as a type of crowdsourcing. Indeed, some developers decide to give modders access to the source code to find out what kind of improvements can be made. If they find them promising, they implement the modifications in the original game and sell them either as an addition or extension. In both cases, there is an opportunity to leverage monetization output, extend the game's life cycle, strengthen the loyalty of prior gamers and attract new ones. Regarding modders, it should be emphasized that they are a highly integrated community. Therefore, under the GIE they can be considered either as individuals (e.g. a purposefully selected modder or modders who are asked to make modifications) or communities of modders (e.g. competition for the best modification announced at the largest forum for modders from all over the world: www.moddb.com)
	Hackers	Not identified in the literature on IE hence supported by the literature on value co-creation in the context of the video game industry: Ng, Khong, and Thwaites (2012)	Hackers possess extensive knowledge and skills in the field of computer science, including programming, databases and security systems, etc. Contrary to popular belief, they use these competencies to find and possibly exploit security vulnerabilities in computer software. Under the GIE, hackers are more often involved by video game developers to improve the security features of in-game software as they are highly experienced and have a high level of expertise and an unconventional approach. Similarly to modders, hackers are a highly integrated community. Thus under the GIE, they can be considered either as individuals or communities of hackers

Table 1 (continued)

Actor type	References in IE literature	Actors identified in GIE
Testers	Not identified in the literature on IE hence supported by the literature on value co-creation in the context of the video game industry: Cohendet and Simon (2007); Scholz (2012)	<p>Testers are people who test games before their premiere. Given that they are interested in and targeted on testing, we can distinguish between professionals (for-profit testers, usually ad hoc or employed by VGIDs) and amateurs (gamers who test for fun, social cognition, or to get early access to a game, and are not employed by VGIDs). Furthermore, given the stage of the game development process, we can distinguish between alpha and beta testers. Alpha testers are invited to test the alpha version of the game. This version of the game is at the initial phase of development, is not a finished game as it contains a significant amount of bugs, but is a playable game. If a developer decides to test this version, they usually use their own team of professional testers or a dedicated testing team. Hardly ever is the alpha version tested by amateurs, as gaming at this stage does not provide entertainment. Beta testers are invited to test the beta version of the game. This version is at the final phase of development (just before the premiere) and needs final verification of its playability. Beta tests allow us to identify possible technical errors, and balance asymmetry or delays (lags). Furthermore, this type of test is a source of opinions on the general impressions about the gameplay. Beta tests are usually conducted on selected parts of the game (levels, storyline chapters, etc.). They can be either closed beta (i.e. selected gamers are invited to test the game) or open beta (e.g. available to everyone). Participation in beta-tests is usually free of charge and, and is a sufficient incentive for players to be able to try out the game before its official release or to buy it via early access. Sometimes, developers decide to introduce a beta-tester award element in the final product (e.g. in the form of special items, character appearance). In the context of GIE, amateur testers are considered as individual actors as professional tester are employed by VGIDs, and are thus considered under this type of actor. It should be highlighted that amateur testers are usually hardcore and professional gamers. They reflect a strong embeddedness in testing communities or even identify with the game testing sub-culture</p>

Table 1 (continued)

Actor type	Actors	References in IE literature	Actors identified in GIE
	Influencers	Not identified in the literature on IE hence supported by the literature on value co-creation in the context of the video game industry: Poor (2013)	In any media and entertainment-related areas of business activity, a very specific role is played by celebrities. This is because celebrities are people who influence demand as well as new trends in a given field. Regarding GIE, the role of celebrities is marginal as gamers are very sensitive to manipulation, advertisements, recommendations and suggestions made for profit, which are thus perceived as not reliable or trustworthy. Nevertheless, there are influencers whose opinions do matter, not only for gamers in making purchasing decisions, but also for video game developers. Considering the role of influencers within GIE, they are engaged mainly in the first stage of co-innovation (co-creation of a new game to collect their opinions about the general idea for a new game) and the last stage (co-dissemination of a new game among players and gamers via traditional marketing is not successful unless the game is developed as a typical triple-A). Among the most important influencers are bloggers, vloggers, the most recognizable gamers who play games on the Steam platform, game reviewers commenting on games on independent gaming forums and the best e-sports players and champions, to name a few types
	Political decision-makers	Velkokari (2015)	Certain individuals influence political regulations, and are thus significant in any lobbying activities. Regarding GIE, a person who is actively engaged in legal initiatives facilitating and improving the conditions underlying the Polish video game industry is Maciej Dydo. As the director of the Department of State Patronage in the Ministry of Culture and National Heritage, he is one of the people who triggered such initiatives as GameINN (a research funding programme organized under the National Centre for Research and Development), dedicated tax reliefs for VGDs which develop 'cultural games' (this refers to newly developed games whose content passes the test for cultural values), Polish Game Research (a two-year research study and report on gamers and game developers financed by the Ministry of Culture and National Heritage)
	Investors	Velkokari (2015)	Not identified

Table 1 (continued)

Actor type	Actors	References in IE literature	Actors identified in GIE
COMMUNITIES	Communities of individuals	Autio, Thomas (2014); Russell, Smorodinskaya (2018)	Gaming communities are sets of people professionally or amateurly involved in gaming and/or game development. Gaming communities are usually informal and digital (they operate on different—open or closed—online forums and platforms), and are based on mutual understanding and trust, and are hence varied in terms of the level of professional knowledge useful in the co-innovation process as well as in terms of the need and willingness to be involved or the general motivation for engagement in the co-innovation process. In the case of the considered innovation ecosystem, gaming communities take the form either of a community of interest or a community of practice. First are communities of individuals, usually non-professionals, who are like game users and are thus interested in the further development of video games so that there are new value propositions more suitable to their needs, e.g. communities of gamers, modders and amateur testers (usually engaged in open beta tests). Second are communities of practice, including professionals willing to share and exchange knowledge and experience in video game development as they will participate in capturing the value created, e.g. communities of developers, indies, professional testers (usually engaged in closed beta and alpha tests) and professional gamers

* It is important to note that games developed by the studios are usually their own, original projects aimed at incremental innovation. Our observations show that every game should be innovative, although it should be an incremental rather than a radical innovation, as gamers do not accept revolutionary products. Furthermore, due to the increasing popularity of serious games (namely games aimed at the development of skills and competencies, e.g. used by the army, or addressing health problems, e.g. used by geriatric hospitals), video game developers are more often producing games to individual order. Nevertheless, this type of game remains outside the scope of GIE as they are not released onto the market.

4.2 What: the roles played in gaming innovation ecosystems

Our informants indicate that actors within the GIE play various roles in the ecosystem (Dedehayir et al. 2016; Galateanu and Avasilcai 2016; Pattinson et al. 2018; Spelmeyer and Lingens 2018; Sun et al. 2019). We identify four intra-ecosystem roles (Dedehayir et al. 2016): leadership, direct value creation, value support and encouraging entrepreneurship. Nevertheless, not all types of actors play these roles. As shown by Su et al. 2018, the roles should be considered across different areas of IE operations, and thus assigned to specific types of actors. Regarding the GIE, game developers might play all of these roles, however gaming communities or individual gamers and players are not interested in, or capable of taking on the role of leadership or encouraging entrepreneurship (Table 2).

In contrast to firm-centric innovation ecosystems, our GIE is collectively orchestrated by many actors. Hence, the leading role is undertaken collectively by video game developers rather than by one single game development studio. This supports recent findings that the leadership role does not have to be assigned to one player, usually a large focal firm (Spelmeyer and Lingens 2018).

Regarding the direct and supporting contribution to value creation, our informants suggest that although the direct value creation role can be assigned to all actors in the innovation ecosystem, the supportive role seems only to be applicable to those actors not implementing innovation processes i.e. co-innovation processes within the innovation ecosystem. Similarly, the role of encouraging entrepreneurship seems to least suit firms responsible for launching innovation on the market (video game developers).

Our data also shows that independently from taking on a role, some actors are more likely to strongly engage in that particular role than others (Table 3). Thus we map the perception of engagement by GIE actors.

4.3 When and How: varied involvement in innovation processes

The differences in actors' involvement can be seen through the lens of their involvement across the stages of the co-innovation processes implemented within the innovation ecosystem boundaries. Our data substantiates prior theoretical suggestions (Dedehayir et al. 2016; Spelmeyer and Lingens 2018) that various actors inside GIEs can be more, less, or not at all involved in the co-innovation processes (Table 4). As one of our interviewees, a developer of AA console games, stated "(...) *it depends on what kind of game is being made. Also, it is important at what moment the game is created, these are two things that decide what this co-creation is like and with whom*" (VGD_11). This remains in line with prior suggestions linking different actors and the performing of different roles with different impacts on the ecosystem's value proposition (Walrave et al. 2018).

Our informants structure the phases of the co-innovation process according to actors' involvement: co-discovery, co-development, co-deployment, co-delivery and co-dissemination. Co-discovery is focused on concept creation and idea generation, but also on collecting heterogeneous resource support inside the IE, including

Table 2 Roles of actors undertaken within the innovation ecosystem

Role*	The activities under the role	Examples of actors playing the role
Leadership	Orchestration/participation in IE collective coordination Attraction and involvement of participants, communication and cooperation management Value management within IE (e.g. managing tensions in value co-creation processes) Carrying out mergers and acquisitions within the framework of EI	The role is undertaken collectively by many organizations simultaneously, for instance: Game developers launching innovation processes within GIE, thus exploiting innovation co-creation relationships at selected stages of the new game development process. KPT focusing on industry promotion on a national and global scale, SGP takes informal decisions about industry development and its global promotion. It initiates and drives any lobbying activities related to the video game industry in Poland, and VGDs in particular This activity has not been undertaken so far
Direct value creation	Initiation and coordination of own innovation processes within IE Involvement in innovation processes implemented by other actors within IE	All actors undertake the role and decide on their involvement in the co-innovation process carried out within GIE. One should bear in mind that the level of involvement of particular actors depends on their capabilities as well as on the perception of those capabilities by the co-innovation process initiators, i.e. VGDs. Furthermore, it should be highlighted that the greatest contribution to direct value creation refers to video game developers. VGDs decide whether and to what extent to implement the process (or part of the process) of innovation by using innovation co-creation relationships. Therefore, VGDs determine both the total amount of value created within the ecosystem and its innovation performance to the greatest extent
Value support	Implementation and engagement in knowledge management processes within IE, namely knowledge creation, processing, sharing, distribution, transfer, dissemination and protection (including coordination of appropriate allocation of newly created knowledge and ensuring IP protection) Supporting internal communication and integration of IE participants	The engagement in the role remains an independent decision of a particular actor, hence if any of them decide to participate in the co-innovation process, they support value creation. Furthermore, as shown in Table X, there are some actors that indirectly contribute to value creation within GIE. First are the sources of managerial and legal knowledge indirectly related to co-innovation processes, e.g. Silesia University, FIG Polska, the MKIDN, or KPT. Second are organizations that organize a wide range of networking and communication possibilities, e.g. KPT, which organizes the biggest trade fairs in Poland – Digital Dragons – which includes specific zones that allow game developers to meet with other developers (i.e. business networking zone, Indie Showcase, CEE Showcase) and communities/individuals interested in game development (i.e. Pitching sessions, Student Talent Show)

Table 2 (continued)

Role*	The activities under the role	Examples of actors playing the role
Encouraging entrepreneurship	Stimulation of knowledge transfer mainly from science to business Bottom-up regulation and coordination of innovation ecosystem development; Caring for the appropriate structure of IE, including support for the launching of new potential actors	<p>The role is played mainly by two actors. First, the MKIDN has launched a funding programme for basic and applied research, developmental work, technology transfer, business and legal training titled "Development of the creative industries". Under the programme, there is a special track for organizations and individuals (e.g. researchers, investors, future entrepreneurs, etc.) interested in video game industry development. Second, the NCBIR has a financial support programme titled GameINN. Among the potential beneficiaries of this programme are research consortia created by at least one company and one scientific institution, hence the total number of participants does not exceed 3. It is worth noting that the stimulation role is indirectly carried out by other actors of the GIE which benefit from the above programmes (e.g. Silesia University, CD Project, Techland, Farm 51, to name a few beneficiaries). Game developers interested in forming research consortia with other developers and/or universities and research institutes. SGP, as it represents the video game industry in any lobbying activities. SPIDOR, as it was involved in the preparation of the Code of good practice on the use of game ratings in Poland. FIG Polska, as it integrates the community of independent game developers. KPT – organization of Digital Dragons Academy for newcomers, young entrepreneurs and independent developers aimed at business training and assistance in the opening/development of a business</p> <p>The content of the roles is developed based on Dedeheyir et al. [2016]; Spelmeyer, Lingens [2018]</p> <p>Note Dedeheyir et al., 2016 distinguish also the platform management role. Nevertheless, as discussed later in our paper, not all innovation ecosystems are platform-based</p>

Table 3 The engagement of actors into gaming innovation ecosystem

Actors' type	Actors	Roles within GIE				
		Leadership	Direct value creation	Value support	Encouraging entrepreneurship	
NETWORKS ORGANIZATIONS	Networks of organizations	NI	NI	NI	NI	
	Producers of final products—video game developers	XXX	XXX	XX	X	
	Competitors—video game developers	XXX	XX	XX	X	
	Suppliers—game publishers	-	X	XX	-	
	Suppliers—game distributors	-	-	X	-	
	Complementors—hardware/console manufacturers	-	XX	XX	-	
	Complementors—producers of complementary products for gaming	-	X	X	-	
	Producers of substitutes	NI	NI	NI	NI	
	Government	-	-	XXX	XX	
	Public institutions	-	-	XXX	XXX	
	Research institutes	-	-	XXX	XX	
	Universities	-	X	XXX	X	
	Regulators	-	-	X	-	
NGO	XXX	X	XXX	XXX		

Table 3 (continued)

Actors' type	Actors	Roles within GIE			
		Leadership	Direct value creation	Value support	Encouraging entrepreneurship
INDIVIDUALS	Consumers—players	-	-	X	-
	Consumers—gamers	-	-	X	-
	Consumers—hardcore gamers	-	XX	X	-
	Consumers—professional gamers	-	XX	X	-
	Clients—people buying games excluding customers	NI	NI	NI	NI
	Moders	-	XX	X	-
	Hackers	-	XX	X	-
	Testers	-	XX	X	-
	Influencers	-	XX	X	-
	Political decision makers	-	-	XXX	XX
	Investors	NI	NI	NI	NI
	Communities of individuals	-	XX	X	-
COMMUNITIES					

NI/ The type of actor not identified in the GIE

- The lack of involvement has been identified

X—XXX—the identified intensity of engagement

Table 4 The stages of the co-innovation process – variety of co-creative relationships among ecosystems: actors

Game life cycle				
Game pre-development	Game development (designing, writing, production, direction)	Game launch	Game sale and promotion	Game extensions (ref: mainly PC/console AAAA, AAA, and AA games) Game retention (ref: mainly to F2P/mobile indie and low-budget (single-A) games)
Co-innovation process				
Co-creation	Co-development	Co-deployment	Co-delivery	Co-dissemination
<p>Concept creation Idea generation Resource support</p> <p>[ref: investors] "the funders are the early investors because they are investing more in the whole idea, that is, before the product is even created, they share their ideas and suggestions (complementor; VGI.1) [ref: investors] "There is the need to involve investors who specialize in financing such companies, but ideas are scaldable" (global consulting company; VGI.8) [ref: gamers] "indies collect feedback not only after the release of the game but mainly before, to see what the perception is, how the players or gamers see it if anyone has any new or improving ideas about it. These relationships are with particular gamers;" (F2P mobile game developer; VGD.12) [ref: gaming communities] "We poll, via the Internet, of course, our gamers. What and how is hot. We take everything into consideration. We make games for them. Even they can dictate what game we make for them" (AA game developer; VGD.13)</p>	<p>Product development Product prototyping Product testing</p> <p>[ref: complementors] "I'm able to imagine it that some artist who is a graphic designer does something in exchange for I don't know, promoting his game;" (complementor; VGI.2) [ref: hardware producers] "They said us, future hardware generation for which we are making a game, this is the basis of compatibility;" (VR PC/console game developer; VGD.1) [ref: gamers] "Before they have a chance to see the game outside, they come to us. The most active gamers, or those who have cool ideas, we invite them (...) Those guys tell us, even mega-constructive, interesting things. And he starts saying interesting things. Usually, in this way, we also find the best people in the environment, who we then often engage again or even hire;" (AA game developer; VGD.13) [ref: gamers] "Nowadays alphas (ref: to the alpha version of the game) are made other gamers can participate in beta testing. Thanks to this the game is created fully for gamers;" (complementor; VGI.1) [ref: gamers] "We have a testing department, but the testing department,</p>	<p>Product presentation Market launch</p> <p>[ref: VGDs] "There is mutual support. For instance, we prepare a demo for them, and they exhibit this demo at the fair together with our logo and some information about our games;" (VR PC/console game developer; VDG.1) [ref: VGDs] "We scan our attendees if our premieres are close, then we create joint exhibition stands, and we even do a combo of our games surprising the visitors;" (AA game developer; VGD.13) [ref: hardware producers] "They send us the hardware for which we are making a game, or we agree that they will show our game on that hardware at some trade show;" (VR PC/console game developer; VDG.1)</p>	<p>Marketization Commercialization</p> <p>[ref: VGDs] "Cross-promotion is used for promotional purposes, but of non-competitive games. For example, a recent example, very fresh, from two days ago, that Microsoft's game "Forza Motorsport" featured a vehicle styled after the vehicle from the game "Fallout 3" such a wrecked, post-apocalyptic, with the logo" (game media; VGI.4) [ref: VGDs] "(...) we have huge shortcomings in business knowledge, but luckily we have permanent contact with other developers because there is a forum (ref: forum for preliminary invited and accepted developers) where you can get all kinds of information and sales advice;" (AA game console developer) [ref: gaming community] "We are always positioning ourselves in gaming communities to launch and amplify all kinds of PR activities" (VR game developer; VGD.9) [ref: gamers] "YouTube is very strong, and there are vloggers who have hundreds, if not millions of views and subscribers, and if a vlogger does an unboxing of a game and shows how it opens, that alone generates hundreds of thousands of views. That's how I think about it, in the context of games, it's</p>	<p>Post-launch promotion Market uptake After-sale support and improvements Monitoring of competitors' reactions and customers' opinion</p> <p>[ref: gamers] "They need to build a network, build a community using for example social networks like Facebook, even YouTube, Twitch (...) I'm talking about contacting potential buyers, players to do publicity and increase sales or maintain it in a long term;" (game media; VGI.4) [ref: gamers & gaming communities] "The gamers know our community managers by name. Our community managers meet them regularly at least once a month, or at red coons for gamers and talk about effective actions supporting the survival of the game on the market. We encourage cosplayers (ref: people who dress in costumes and make-up, representing characters from anime, video games, movies etc.) to be more active in social media and during the biggest trade fairs. We organize contests with great prizes, such as a real Witcher sword forged by a blacksmith, which is real, expensive, and unique;" (AAA PC/console game developer; VGD.7) [ref: gaming communities & media] "Media, pop culture, this is our world, in the sense that we communicate with people. We even create our own</p>

Table 4 (continued)

<p>[ref. VGDs] "(...) at various gaming events (...) we present our ideas and discuss them with gamers directly via F2F contacts and indirectly via workshops and seminars on game ideation". (AA console game developer; VGD_11)</p> <p>[ref. VGDs] "Being in a game dev community means that you can share your ideas quite quickly, but also the other way round, you get fresh ideas from others, the latest trends, technological highlights. And I think this is key: global consulting company; VGI_8)</p> <p>[VGDs] "I just have, let's say, friends and they have their own companies today or they work in other companies and I say that there is such an idea and they think about it and say whether they like it or not, or what they would do. That's how you talk, it's about discussing an idea." (F2P mobile game developer; VGD_12)</p> <p>[ref. VGDs & publishers] "We talk about what we do. I mean not always in detail because there is always someone who can help us to make this game, this project better than we can. Even if it's in the way that he gives us his opinion, that he likes this and dislikes that before we give it to the player. So the collaboration between developers or publishers is quite wide." (AA and VR PC/console game developer; VGD_17)</p>	<p>after going through the game. 152 times... they are no longer able to give valid feedback. On the bugs, glitches (...) whether they like it because they can't like it anymore. So we do so-called focus tests, which means we take a group of players, sit them down one by one, record them with a camera or even sit by them and watch their reactions. And then we give them a questionnaire to fill out." (AAA/AA PC/console game developer; VGD_7)</p> <p>[ref. VGDs] "I consult a little bit, you post your problem on such a closed forum gamespot, where you look for support or seek help for some problems." (AA and VR PC/console game developer; VGD_17)</p> <p>[ref. VGDs] "Now there was an event on Thursday (ref. during Digital Dragons) some computers were standing there, where we showed our games, we also showed one game we are making there. (...) there were game developers there. So everyone was playing, commenting and we have, I don't know, about six pages of notes, on what were the reactions to some feedbacks and so on and this will maybe be used for improvements." (indie game developer)</p> <p>[ref. VGDs] "there is a game developers forum, where a lot of people sit and you can find out various interesting things, especially some purely technical ones (...) we use other developers as friends to test our games. So we just invite them for a session, they play and give their opinions, and we use their ideas or not." (AA console game developer; VGD_11)</p>	<p>critical content in the form of videos. Nothing gets consumed so well when it comes to gaming than a picture, but in a moving picture, that is a video. It doesn't have to be a trailer, it doesn't have to be a spot, it can just be a snippet from gameplay that people are just sitting and playing. And that's what is best consumed. People want to see how other people play, they want to learn something, they want to see based on some fragment of gameplay how much it suits them, and they make a final decision about the purchase, whether they want to play it or not." (game publisher; VGI_5)</p>	<p>communities - thanks to this the game is alive and we know if we constantly like it." (AA game developer; VGD_13)</p>
<p>[ref. gamers & gaming communities] "(...) it's their inputs, their ideas, the quick verification of the product, which means that the company concludes that you should change something or close the project, because it doesn't make sense. This is crucial at the moment because Polish game companies cannot afford to invest in a product and then leave the project." (global consulting company; VGI_8)</p> <p>[ref. universities & research institutions] "We did a sector study for them (ref. game developers association) showing the validity and potential of cooperation</p>			

Table 4 (continued)

<p>with science, especially now with the support of Gamefam (ref. a special founding line for VGD), it is no longer a possibility but a reality. Availability of financial support for such inter-organizational cooperation has been a stimulus for many new projects focused on technology development.” (global consulting company; VGI 8)</p>	<p>[ref. VGDs] “The best specialists lecture on how they work on animations, or how they work on physics, what technologies they use, and there is no kind of keeping the knowledge to oneself. But everybody shares knowledge, even on internal successes and failures in project management.” (global consulting company; VGI 8)</p>	<p>[ref. gamers] “You can choose a vlogger who has a similar taste, and then practically one vlog always suits you. Well with such industry portals (...) generally speaking players do not trust them much. But such game-celebrities they do, so you need to look for them and include them permanently in the marketing and sales activities” (complementor; VGI 1)</p> <p>[ref. gamers] “Developers make strong contacts (ref. with gamers and their communities), ask them to rate something, ask for some feedback (...) it always works well because it's based on (...) the whole word-of-mouth marketing.” (VR PC/console game developer; VDG 1)</p> <p>[ref. distributors, publishers & gamers] “We've moved to new business models and now we have direct relationships with the gamers who help us to promote our games. But the new developer, usually, lacks the knowledge on marketing, on sale, on the advertisement, and that's why such a firm needs publishing, marketing, PR-focused relationships with the publisher or at least distributor. Hardly ever a new firm can use direct relationships with the gamers, which I think would be the most beneficial.” (AAA PC/console game developer; VGD 4)</p> <p>[ref. publishers & distributors] “Our key partners when promoting our game there are Sony and Microsoft and Steam also. We discuss timing and the general idea for game promotion with the leading distribution partners. Nonetheless, when it comes to release of the American market then all the details are set up with a local publisher, namely Warner Bros Games.” (AAA PC/console game developer; VGD 9)</p> <p>[ref. publishers & distributors] “To launch such a free to play the game you need to have a budget of at least a million dollars for development, and for marketing probably as much as twice that amount (...) it is more and more important to have the right publishers, but also a sound contact with the global community, which will engage in this promotion.” (F2P mobile game developer; VGD 12)</p> <p>[ref. distributors] “The relationships (ref. focused on marketing and promotion) mainly with the platforms they help to release the game and continuously promote (...) they are highly important for all the developers.” (AA game developer; VGD 13)</p>	<p>[ref. gamers] “A large element from the point of view of the importance of sales is precisely the involvement, such word of mouth marketing, that is opinions, reviews and subjective feelings of players, and that's where great involvement and good contact with players allows you to increase sales and achieve greater success, and even long-term monetization, profitability, and retention of the game. There are also streamers, let's say YouTubers, who are globally recognized players and such an effective and inexpensive marketing channel.” (F2P mobile game developer; VGD 12)</p>	
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Table 4 (continued)

	<p>[ref. gamers] "Very strong relationships with YouTubeers, with gamers, because the traditional model of publishing has collapsed. That is, new methods of game distribution have emerged, including those through the gamers." (AAA PC/console game developer; VGD 4)</p> <p>[ref. gaming communities] "The most engaged gamers get games at a lower price as the first in the world, and at the same time they can contribute to this product further development. (...) they can also give various suggestions for improvements, patches, and it's also, kind of, a very good opportunity to check the product itself and how it's perceived by the target customers, because they are immediately able to answer questions about the design or functionality, whether it's okay or not, what to improve, and these are certainly the advantages." (Complementor; VGI 2)</p>	<p>[ref. complementors & platform holders] "What happened (ref. dynamic development of VR games), is because they (ref. producers of VR equipment) shared their kits, hardware in a rather generic vision and so on, gaming companies, seeing that the demand was created, started to work on their projects - some on their own, but most of them together with the producers of the equipment - such a win-win scenario." (F2P mobile game developer; VGD 12)</p> <p>[ref. gamers & gaming communities] "Gamers join at different stages of game production because as the game is growing the different support is needed. When the project starts we look for comments on the very preliminary concept. Then we work using an in-house development team only. Then let's say we have a team of testers, let's say people who are just testing the game. They're players and they're testing, they're catching bugs, they're giving feedback too, everybody, but it's still internal. Then we have external testers or gamers. Those tests are run online, as if with people from all over Poland, let's say 300 people or 1000 people have access to the tested product, exclusively. (...) they can already play and help us, like, make the game better. And then we do open testing with a very open community, and at some stage, the monetization is discussed with gamers, e.g. which micropayments would be acceptable in terms of form, type, and value. And finally, even when the game is already on the market, we gain from community support in the field of an ongoing promotion." (AA and F2P game developer; VGI 6)</p>
	<p>[ref. publisher] "We provide the product, but all such things as help in passing the certification for consoles, providing some dev kits, some translations, for example, voiceovers, recording voiceovers, all translations into different languages, organizing fairs. For example, promoting the game in the U.S., everything is done by the publisher." (AAA/AA PC/console game developer; VGD 7)</p>	<p>[ref. VGDA] "These B2B conferences are naturally organized and they naturally integrate the whole industry. I mean, very often, some very specialized and valuable lectures are run, for instance here at GTC (ref. Game Industry Conference) or at GDC in San Francisco (ref. Game Developers Conference), where people from competing companies share their knowledge and even expertise." (game media; VGI 4)</p> <p>[ref. VGDS] "Developers don't directly and constantly support each other technologically, but rather we support each other periodically, spontaneously at various gaming events. We share knowledge, exchange information, especially about the latest innovations." (AA console game developer; VGD 11)</p> <p>[game publishers & distributors] "Involving the publisher throughout the product development process (ref. VGD 7) but also knowledge and support in project management." (AAA PC/console game developer; VGD 7)</p> <p>[ref. government, public institutions, local authorities & politicians] (ref. co-creation of radical innovations)"I really has to be an ecosystem of institutions such as universities, which actually are not yet engaging at the level that developers need. Such as universities, such as local authorities, such as politicians, such as any kind of top-down incentives that will create a place where breaking through innovations would love to come." (global consulting company; VGI 8)</p>

AA game—game with a bigger budget than indie but a smaller budget than a AAA (triple-A) game (<https://www.ign.com/>). AAA game—a major video game, in terms of budget (for both development and marketing). (<https://www.ign.com/>). Indie game – games developed by independent small or micro companies, low-budget games. (<https://dictionary.cambridge.org/>). F2P games –games not requiring users to pay to participate. However, F2P players are typically only allowed access to very basic features of the game. Upgrades to higher levels or gameplay-enhancing features usually have to be paid for. Some F2P games are designed to generate revenue through advertisements and sales of related items. (<https://www.cyberdefinitions.com/>). VR – virtual reality. VGD – video game developer. VGI – video game industry. Codes: VGI 1 – VGI 8 refer to semi-structured interviews run with different members of the video game industry (see Appendix 2). Codes: VGD_1 – VGD_17 refer to semi-structured interviews run with video game developers (see Appendix 2)

intellectual, cognitive and financial resources. The co-development stage refers to operational work on product development including its prototyping and testing. As reported by our informants, intensive co-creation actions are also aimed at product testing. These tests are carried out at different stages of product development, such as early testing, alpha testing, and beta testing run just before the market launch. The co-deployment stage, which seems to be the shortest sub-phase of the co-innovation process, is aimed at intensive product presentation through promotion assistance, mutual support during trade fairs, etc. given mainly by organizational co-creators and market launch. The co-delivery stage covers mid-term promotional activities aimed at full marketization and game commercialization, mainly carried out with individuals and collectives of individuals (gamers and gaming communities, for instance, in the form of staging game playing with the most popular influencers). The co-dissemination phase refers to involving ecosystem actors in such activities as post-launch promotion, different forms of market uptakes, after-sales support and further improvements of products, and finally monitoring of competitors' reactions and customers' opinions. This stage can be implemented over a very long-term perspective (referring to the extension of PC/console premium games) or even permanently (referring to the retention of mobile freemium games to maximize product performance).

Summing up, the theoretical path of co-innovation process (Fig. 1) generally matches our data. However, more activities are indicated by our informants than prior literature suggested. For instance, exploitation of resource support in the co-discovery phase, exploiting testing of products in the co-development phase, gaining from inputs into after-sales support and further product improvements, as well as from ongoing customer feedback in the co-dissemination phase (Fig. 1 and Table 4).

Furthermore, depending on the intensity of the involvement of actors across the co-innovation process, some types of actors may be perceived as most desirable and adding contributions at subsequent stages of the process. The engagement of a particular actor type may differ in different co-innovation processes – “*they (ref. to gamers or players) can be a co-creator, but on a different scale. As far as the developer allows them, so sometimes, in some areas, it's going to be a kind of consultative influence, but in other situations, it can be a strong impact including an impact on the gameplay or narration style. So, we ask gamers how to balance these weapons, do you like it, is this weapon too strong, is there a sword or a vehicle that's nice, how in the next patch we're going to balance the game, do you see any room for gameplay improvements? It can be extended again with the possibility of creating skins, it can be extended with the possibility of making locations, it can be extended with the possibility of making whole mods, yes, that is a completely different game, the inner game you can say, some advanced scenarios and so on. So, as I said, it's just a matter of what scope gamers will be allowed, what freedom they will be given.*” (video game developer producing AA and VR games; VGD_17).

5 Discussion and conclusions

The aim of this study was to identify innovation ecosystems from the perspective of those engaged in innovation processes by addressing the variety of actors (*who?*), the distinct roles (*what?*), the different stages (*when?*), and the diverse engagement into co-innovation processes (*how?*) as perceived by those involved in innovation ecosystems. We flexibly matched (Bouncken et al. 2021) literature-driven categories with the reported perceptions of those involved in innovation processes in order to advance the current understanding of the innovation ecosystem structure and dynamics, as well as the roles and involvement of actors in distinct phases of the co-innovation process.

5.1 Theory contributions

Our study offers three noteworthy contributions to innovation ecosystems literature: conceptual, structural and dynamic. We refine Klimas and Czakon's (2021) conceptualization of IE and Granstrand and Holgersson's (2020) three-dimensional framework by developing a more operational definition of innovation ecosystems: a multi-element cooperation environment surrounding the framework of innovative activity of its co-evolving actors, organized across the co-innovation process, and resulting in co-creation of new value, delivered to the market in the form of innovation. By introducing co-evolution and co-innovation, we shed light on the interdependencies relevant in ecosystems, and emphasize the variety of roles and interactions that unfold with time.

Secondly, we advance the structural perspective on innovation ecosystems by capturing the respective roles various actors play in innovation co-creation, as perceived by their participants. Prior literature listed actors, roles and processes from the perspective of an external, objective observer grounded in the positivist stance in management research. By adopting a social-constructivist stance, we complement, refine and extend prior claims with the perceptions of those involved in innovation ecosystems. As a result, we develop a two-dimensional view of the innovation ecosystem structure, singling out its actors and innovation co-creation relationships. On the one hand, we confirm and expand the structural view of IE in terms of the engaged actors (e.g. Adner 2017; Granstrand and Holgersson 2020). We identify 12 types of collective actors, 9 types of individual actors, and 1 community of individuals. Our study substantiates that individual customers and their communities are important value co-creators (Prahalad 2004), especially for co-innovation. Interestingly, some actors indicated in the literature, as well as some network organizations, were not identified by our informants, while actors not identified in the literature appeared in our study (e.g. regulators and NGOs). We substantiate respective actors' roles in practice (Dedehayir et al. 2016; Spelmeyer and Lingens 2018). In particular, we found four distinct roles that actors may play in co-creation processes, that is: direct value creation, supporting value creation, encouraging entrepreneurship and leadership. Our data helps to map various actors' engagement in the four identified roles. As in the case of entrepreneurial ecosystems (Bacon and Williams 2021), our

findings show individuals and communities of individuals with outstanding commitment to be critically important in terms of the intense implementation of an intra-ecosystem.

Thirdly, we also advance the dynamic perspective on innovation ecosystems (Beliaeva et al. 2020; Bouncken et al. 2020; Bouncken and Kraus 2021) by identifying the various degrees of engagement that actors take during the co-innovation process. Based on the GIE participants' perceptions, we structure the co-innovation process (Lee et al. 2012) into five stages: co-discovery, co-development, co-deployment, co-delivery and co-dissemination. We find that actors perceive others and engage in these processes to various degrees over time. Therefore, the roles of actors are not perceived as stable, and depend on the category to which an actor can be assigned. Instead, GIE actors have a broad understanding of co-innovation processes and their potential roles, and that they strategize within these frames and purposefully position themselves in the innovation ecosystem. Such a broad perspective suggests that GIE actors may act as prosumers actively engaged at different stages of co-prosumption (Bouncken and Tiberius, 2021). Furthermore, we find support for prior theoretical claims showing differences in the roles performed by particular actors (Dedehayir et al. 2016), but also uncover evidence that there is not an equal distribution of challenges across innovation ecosystem actors (Autio and Thomas 2014; Adner and Kapoor 2010). In line with Dedehayir et al. (2016), the highest engagement in co-innovation processes can be assigned to the companies responsible for putting the co-created value onto the market (video game developers—Table 4). Moreover, our findings show that co-innovation processes, just like innovation processes, require cross-functional cooperation (Ernst et al. 2010; Song et al. 1998), as particular actors engage in different or the same stages while undertaking different or the same roles across those stages. Interestingly, the trust-based rules underlying the very high engagement of competitors at every stage of the co-innovation process, show cooptation and the perception of competitors in cooptation as quite similar within ecosystems and networks (Czakon and Czernek-Marszałek 2021).

5.2 Practical, regional and social implications

Our study aims to understand IEs as perceived by their participants. The methodological implications of this stance do not allow for normative statements, as perceptions may vary across empirical settings. Additionally, we focused on identifying what GIE participants actually perceive, not what they should perceive. Therefore we refrain from setting forth normative implications for practice.

However, by finding that roles and degrees of involvement vary over time, we tap into a very important strategic decision that GIE participating actors take. Depending on the role and their engagement, their goals and value capture is likely to differ. Therefore, we encourage GIE actors to develop a broad understanding of the co-innovation process, to map possible positions they may be willing to take, and to purposefully strategize around this map. This may help in sensing opportunities and in effectively exploiting those opportunities.

Additionally, our method follows the social constructivist approach to the study of organizations. Its distinctive feature is that social structures and processes are enacted by the actors involved. Therefore, such constructs as social norms, identities and legitimate interaction processes come into focus. Innovation ecosystems are not just systems of interaction between innovation processes, but are embedded in social reality. This opens ways for the scrutiny of IE as socially embedded, and helps in fostering the creation and functioning of IE through social action.

Finally, our study reveals the multi-actor facet of IE, and differentiates this facet in terms of the roles and engagement in co-innovation processes. At the meso or macro levels, these findings can be used by local authorities or policy makers to screen, select and work with either the most influential actors, or those undertaking specific actions to expand innovativeness in a given region. The ecosystem concept assumes that the co-creation outputs of ecosystems are beneficial not only within their boundaries. We suggest that the engagement, roles and actions carried out by a wide range of IE actors can generate more general ecosystem effects by fostering regional entrepreneurship (Bacon and Williams 2021; Scott et al. 2021) or digitalization of a particular region or country (Beliaeva et al. 2019).

5.3 Limitations and further research

The limitations of our study stem from the methodological choices. Our exploratory and qualitative approach provides limited options for drawing general conclusions, but allows us to make moderate generalizations (Payne and Williams 2005) relevant in social sciences (Finfgeld-Connett 2010). The conceptual framework underlying our exemplification was based on a synthesis of prior systematic literature reviews. Although such an approach is suitable in a rapidly growing field of interest (Czakon et al. 2019), the results of such reviews, as any findings from a review of the literature, are not free from subjectivity (Hagen-Zanker and Mallett 2013; Kraus et al. 2020). In other words, our study's conceptual rigor is indirectly influenced by the emerging stage of innovation ecosystems literature.

Secondly, by taking an in-depth qualitative approach, we were able to map its relevant components as seen by those involved. We relied on individual perceptions, which revealed stability over time and across various respondents. However, we did not explicitly focus on collective understanding, social identity and norms. This opens avenues for further qualitative scrutiny at the collective level of analysis. Additionally, further scrutiny from a more objectivist stance, could be useful in complementing the subjectivity of those involved in IEs.

Qualitative studies are prone to subjectivity biases by the informants and the researchers. In order to address this we have deployed multiple triangulation types, and proceeded with member-checks to validate the accuracy of our findings with our informants to strengthen the rigor and trustworthiness of our findings. We also recognize that perceptions of those involved in GIE may not be stable over time. To address this concern we have run a longitudinal data collection process on a period of 3 years. Nevertheless, we encourage further research across different contexts,

periods of time, and types of innovation ecosystems in order to gather additional insights before proceeding with large sample studies.

Another limitation of our study stems from the industry focus. While the global nature of the gaming industry (Rodzińska-Szary et al. 2016; Niemand et al. 2021) encourages generalizations, they are bound to the context of gaming industries only. We encourage further scrutiny across other industries as well as dig deeper into recognition if there are any other types of actors relevant in different national context (e.g. probably software complementors including firms providing game engines can be recognized as important co-innovators while in Poland they have not been identified at all).

We also recognize that value co-creation, including the co-creation based on innovating experience (Prahalad and Ramaswamy 2004) that is so important in innovation ecosystems (Klimas and Czakon 2021), is highly contextual. This high level of contextuality can be seen as specific for studies on ecosystems in terms of both the national context (e.g. the Brazilian context – Beliaeva et al. 2019; Italian context – Del Bosco et al. 2020), as well as the industry context, as industry characteristics can also play a role (e.g. position inside the industry, industry dynamics – Bouncken et al. 2020; intensity of competition—Beliaeva et al. 2019; intensity and type of co-competition – Le Roy et al. 2021). Therefore, running a non-contextually limited investigation would be seen as unreasoned at this stage.

Further research could also investigate actors, their roles and their engagement in co-innovation or co-creation processes. Actors' roles (Dedehayir et al. 2016; Spelmeyer and Lingens 2018) and intra-ecosystem dynamics are shown to be relevant and under-researched issues in the entire ecosystem approach (Bouncken and Kraus 2021). This study sheds some light on these issues within innovation ecosystems. Therefore, future replication studies could be run in other ecosystems (Aarikka-Stenroos and Ritala 2017; Scaringella and Radziwon 2018; Tsujimoto et al. 2018; Valkokari 2015), including for instance entrepreneurial ecosystems (Scott et al. 2021), as a recent literature review showed “*innovation and dynamics: actors and norms*” to be one of the most significant trends in the literature (Fernandes and Ferreira 2021: (1). Furthermore, as the behavioural and cognitive issues have been shown as important for game-playing entrepreneurs (Niemand et al. 2021) they can be also explored in the context of innovation ecosystems. Replication research could also be run in other types of innovation ecosystems (Klimas and Czakon 2022; Pattinson et al. 2018) that are likely to differ in terms of global success, product type and creative nature. Both the choice of empirical setting following the purposeful criterion-intensity and the industry choice call for replicating our study in different contexts. We concur with prior suggestions (Durst and Poutanen 2013) that developing the understanding of innovation ecosystems requires explorative studies focused on delivering empirical data useful in country comparisons as “*comparative settings would clarify what factors are likely to remain constant under different conditions*” (p.11). We do believe that further replication (Finfgeld-Connett 2010) and explorative (Thomas and Autio 2020) investigations will cumulatively create a coherent and generalizable knowledge base on innovation ecosystems.

Appendix 1

Industry-related data sources used when exploring the Polish gaming innovation ecosystem

Industry reports

- British Council: *Mapping the Creative Industries: a Toolkit*. “Creative and Cultural Economy” (2001) [access: <http://www.creativeconomy.britishcouncil.org>]
- Deloitte: *2018 Media and Entertainment Industry Outlook Reaching new heights through personalization and mobility (2018)* [access: <https://www2.deloitte.com/content/dam/Deloitte/us/Documents/technology-media-telecommunications/us-tmt-2018-media-and-entertainment-industry-outlook.pdf>]
- Department for Culture, Media and Sport: *Creative Industries Mapping Document* (2006) [access: <https://www.gov.uk/government/organisations/department-for-culture-media-sport>]
- European Commission, Directorate-General for Internal Market, Industry, Entrepreneurship, and SMEs: *European Competitiveness Report 2010 (2010)* [access: <http://bookshop.europa.eu/en/european-competitiveness-report-2010-pbNBAK10001/>].
- Forbes: *New Reports Forecast Global Video Game Industry Will Reach \$82 Billion By 2017* [access: <https://www.forbes.com/sites/johngaudiosi/2012/07/18/new-reports-forecasts-global-video-game-industry-will-reach-82-billion-by-2017/#3c83066d440a>]
- Interactive Software Federation of Europe: *Videogames in Europe: Consumer Study. European Summary Report*. (2012) [access: http://www.isfe.eu/sites/isfe.eu/files/attachments/euro_summary_-_isfe_consumer_study.pdf]
- Interactive Software Federation of Europe: *Videogames in Europe: Consumer Study. Poland*. (2012) [access: http://www.isfe.eu/sites/isfe.eu/files/attachments/poland_-_isfe_consumer_study.pdf]
- NewZoo: *Global Games Market 2016* (2016) [access: <http://resources.newzoo.com/global-games-market-report>]
- NewZoo: *Global Games Market 2017* (2017) [access: <https://newzoo.com/insights/articles/the-global-games-market-will-reach-108-9-billion-in-2017-with-mobile-taking-42/>]
- PwC: *Entertainment & Media Outlook for Europe 2015-2019* (2016) [access: <http://nck.pl/media/attachments/318169/raport-media-outlook-pwc-2016.pdf>]
- PwC: *Global video games market, segmented by forecast rate of growth and scale, 2013-2018* (2014) [access: <https://www.pwc.com/gx/en/global-entertainment-media-outlook/assets/2014/pdfs/video-games.pdf>]
- Rodzińska-Szary, P., Bobrowski, M. & Socha, M. (2016). *Kondycja polskiej branży gier. Raport 2015*. [access: <http://kreatywna-europa.eu/wp-content/uploads/2016/01/Raport-na-temat-kondycji-polskiej-branzy-gier-wideo-1-1.pdf>]

- Bobrowski, M., Rodzińska-Szary, P., Krampus-Sepielak, A., Śliwiński, M. & Rudnicki, S. (2018). *Kondycja polskiej branży gier. Raport 2017*. [access: <https://www.cdprojekt.com/pl/wp-content/uploads-pl/2016/03/kondycja-polskiej-branzji-gier17.pdf>]
- SuperData Research: *De-risking game development in the digital era* (2016) [access: www.superdataresearch.com]
- SuperData Research: *Global Games Report - 2015. Entering the next era of interactive entertainment*(2015). [access: www.superdataresearch.com]
- SuperData Research: Payment preferences of digital gamers. Global payment methods & brands. Industry trends & analyses. SuperData - 2016 [access: www.superdataresearch.com]
- United Nations: *Creative Industries and Development* (2004) [access: http://www.unctad.org/en/docs/tdxibpd13_en.pdf]

Industry websites

Websites of the members of video game industry including video game developers (e.g. CD Project, Techland, the Farm 51), video game publishers (e.g. EA Games Polska), video game distributors (e.g. Steam, Twitch, Empic, Amazon), console manufacturers (i.e. Microsoft, Sony), independent game developers (i.e. <http://Indieworld.com/>), industry association (i.e. Indie Games Polska: <https://www.facebook.com/fundacja.igp/>; Polish Games Association: <http://polskiegry.eu/>), others (i.e. formal and informal meta-organizations such like www.eurogamer.net, www.alphabetagamer.com, www.kickstarter.com).

Online portals focused on video games, e.g. Mobygames.pl, Gameproducer.net, Gamasutra.pl, Gamewatch.org, Padportal.pl, Gameonly.pl, Gry-online.pl, Gram.pl, Miastogier.pl, Gamelog.pl, Gry.onet.pl, Gameplay.pl.

Online forums for gamers and gaming communities, e.g. <http://www.gamesboard.pl>, <http://www.giermania.fora.pl>, <http://game4fun.pl>.

Blogs and videoblogs run by gaming influencers, e.g. <http://www.11-22.pl>, <http://www.taisho.pl>, <http://wieotematycznyograch.blox.pl/html>, <http://mojegykomputerowe.blox.pl/html>, <http://blondynkitezgraja.pl>, www.bigfishgames.com/blog.

Appendix 2

Sources of triangulated primary data used in the study

Phase 1 of data collection – an initial exploration

Aim: answering the question if (and how) can we perceive Polish video game developers as operating within the gaming innovation ecosystem.

Data collection techniques applied.

- 13 structured interviews with video game developers carried out in May 2015 including:
 - 4 non-Polish companies;
 - 7 interviews with creative workers and 6 with owners/top managers;
 - Average time of reviewing: 21 min;
 - Codes: STR_1 – STR_13
- 8 semi-structured, direct interviews with different members of the video game industry carried out between October 2015 and March 2016 including:
 - 1 big video game development studio, 2 producers of complementary products for gaming, 1 branch of global video game publisher, 1 independent video game developer, 1 online portal about games and game industry, 1 consulting company preparing reports and industry analyses at the national and global scale, 1 newcomer so far operating as a business partner for big developers;
 - 8 interviews with top managers and owners;
 - Average time of reviewing: 65 min;
 - Codes: VGI_1 – VGI_8
- 5 field, non-participatory observations organized during the biggest trade fairs and industry conferences in Poland between May 2015 and November 2016 including:
 - Digital Dragons organized by Cracow Technology Park in Cracow – attended twice;
 - Game Industry Conference organized together with Game Arena Trade Show in Poznań by Poznań University of Technology and all industry association (formal and informal ones) – attended twice;
 - Mastering the Games organized by the Ministry of Culture and National Heritage in Warsaw – attended once.

Phase 2 of data collection – the discussion, verification, and enrichment of initial findings

Aim: support of initial findings, elimination of conclusions drawn in a wrong way, identification of missing evidence for considered features, types, actors, relationships in gaming innovation ecosystem from business practice.

Data collection techniques applied.

- 17 semi-structured, direct interviews with video game developers carried out between May 2016 and January 2017 including:

- 3 big / 6 medium / 3 small / 5 micro-firms;
- 9 firms developing premium games / 3 firms developing free-to-play games / 8 operating at both premium and F2P segments;
- 4 companies listed on the Warsaw Stock Exchange and 2 companies listed in NewConnect at Warsaw Stock Exchange;
- 9 companies operating only as video game developer / 3 companies operating as video game developer and publisher / 1 company operating as video game developer and distributor / 4 companies operating as video game developer, distributor, and publisher;
- 17 interviews with top managers and owners;
- Average time of reviewing: 83 min;
- Codes: VGD_1 – VGD_17

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Data availability Primary, raw data will be made available on reasoned request. Note that the study was run in Poland, therefore the collected empirical material is in Polish.

Declarations

Conflicts of interest The authors declare that they have no conflict of interest.

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