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Article

Network of Games: An Ecology of Games Informing Integral and Inclusive City Developments

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Abstract
This article analyzes possibilities for connecting individual city games for building a network of games working together. City gaming works along with the understanding that cities are self-organizing systems, influenced by multiple bottom-up and top-down actors with varying interests and powers. Affordable housing, climate adaptation, or area development are examples of urgent urban challenges city games typically focus on. The assumption is that if these specialized games could be linked, then a large game infrastructure built as a modular system, can offer various game combinations responding to urban challenges in an integral and holistic way. To test a working game network, city games, models, and digital apps have been linked through their shared datasets as well as game interfaces. Two city experiments have been conducted in two Dutch cities—Amsterdam and Breda—which enabled the testing to function as "constructive design research." In Amsterdam (Klimaatspel) two separate city games were connected through their datasets, while in Breda (Play the Koepel) datasets and interfaces merged to create a new game. Used data models are the Energy Transition Model developed by Quintel and the urban plan cost simulator software of Urban Reality. Used game interfaces (digital and analog) include the Typeform, the Network of Games app, the Urban Reality simulator, and the Play the City table-top game format. The testing considered two different approaches for a potential game network. The first option assumes an all-encompassing digital app, reformatting and involving various games and models in a single interface. The second option is an open approach that looks to link custom-made games with existing interfaces. The second option allows both simultaneous and sequential linking. Two experiments utilizing sequential and simultaneous integration of diverse digital tools suggest that a collection of interfaces connecting to each other throughout the entire process from a digital poll to an app, a simulator or a webinar, or analog game sessions is more effective than a single mobile phone app for all potential game interactions. Considering city games as an ecology of city tools that can be linked to one another becomes through this study a concrete goal to reach. Through combining specialized games, addressing complex city challenges becomes possible. This step enables a more effective participation environment for diverse experts and non-experts.

Keywords
city games; climate game; collaborative interfaces; integral planning; network of games; urban area development game

Issue
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1. Introduction

For over half a century, alternatives to single-handed, static city planning have been explored by discussing an integral and adaptive form of shaping cities with multiple stakeholders. The notion of collaboration in the city planning discipline has transformed largely since Team 10 members of the CIAM started questioning the human dimension of modernist city plans (Frampton, 1980). Today the notion of the city as a self-organizing system helps us discuss "participation" beyond the classical dichotomies of the bottom-up and top-down powers (Portugali, 1997). Today we conceive the city as a complex system where various interacting powers coexist.

In the decades following the Second World War, a political movement known as the civil rights movement came to the surface in North America and Western Europe. Students, intellectuals, and workers raised their voices in demand for better labor and education opportunities. Rising values, such as individual freedom, fairer social welfare, and the right to produce one's urban environment instead of solely consuming it, had a reflection in the field of architecture and planning. The modernist movement's focus on the production of the physical plans, ignoring the people inhabiting these cities, neighborhoods, urban blocks, and buildings, received wide criticism. Although the politics of the "populist movement" attracted the most attention, there was a background response through systemic thinking, specifically computational models (Tzonis & Lefaivre, 1975). The beginning of the 21st century has witnessed a comparable popularized civil rights movement. This time technology appears to be in the foreground, enabling the participation of crowds without the necessity of a political statement (Levy, 1990). While classical dichotomies of power between the state, the market, and society do exist, a new perspective offers new possibilities for conceiving cities as complex self-organizing systems as a result of the interplay of various powers. Self-organization in urban planning proposes a more relational interpretation that emphasizes relations of formal and informal planning and of top-down and bottom-up planning and surfaces a different understanding of urban power relations (Eizenberg, 2018). Participation is no more a simple dialectic of governance from above or below; participation becomes various manifestations of self-organization. Viewing cities as complex self-organizing systems requires re-linking planning to the substantive qualitative relations between the various urban elements (Alfasi & Portugali, 2007).

If 21st-century participatory urban planning is indeed grounded in a conception of the "city as a self-organizing system," we will need new city-making methods which are free from the outdated dichotomy of the bottom and the top to be put into practice. The fundamental question is now how diverse ideas become concrete in city-making methods that embrace real constituents, and, in doing so, how they can help a broad range of players to have a greater influence on the urban systems they inhabit.

2. City Gaming for a Collaborative City Planning

Looking beyond traditional and current planning and design methods, this article is based on the idea of city gaming as a method for negotiating and open city-making; games emerge as unique media which can combine multiple agencies, simple rules, and various complex states of orders that evolve through the interactions of agencies. In an era when not one but many makers are in charge, city games become the common language of learning and communication. Building on Alexander et al.'s (1987) urban design experiments with collaborative improvisation and several serious games set up by Portugali (2000) to study cities as self-organizing systems, city gaming is proposed as a method for open city-making (Meyer et al., 2012). Participants gather to strategize ideas and plans in a low-risk environment. In reaching collaborative city development, city games play a critical role: They make abstract data tangible for participating groups of actors. This allows participants to integrate individual and institutional knowledge, from both experts and non-experts. Through the simple and playful language of games, conversations become jargon-free. Informed decisions get supported from across disciplines, through stakeholders ranging from communities to governments. In this way, city games provide a space for top-down and bottom-up planning to meet.

Existing methods of learning and decision-making for cities include "expert workshops" where decision-makers meet experts who provide advice for ongoing challenges and "best practices" where workshops include site visits as well as presentations from project owners. Perhaps most common yet ineffective learning is performed through unearthing policy and project reports published online as "PDF documents." Games, as visualized data environments activated by multiple stakeholders, already offer a real alternative to traditional forms of knowledge exchange.

City gaming as a collaborative city-making method has been investigated over the last decades and has already aided various decision-making processes (Tan, 2014). Games for Cities (www.gamesforcities.com), a research project run through various scientific and practice partners in the Netherlands, monitors how city games worldwide are not only suitable for participatory processes, but they are also containing, visualizing, and communicating large sets of specialized data allowing multiple players to interact with the data and with one another (Figure 1).

One of the conclusions of the Games for Cities research indicates the ongoing tendency toward specialization in games: There are city games focusing on particular urban issues such as migration, circular economy, affordable housing, inclusive public spaces, vacant real estate, smart mobility, and energy transition, to name a few. These games are centered on specific topics and rely on deeply researched and organized sets of data that are important to the chosen topic. While specialized games are successful in focusing discussions amongst players, in reality, parts of a city do not operate in isolation.

3. Network of Games for an Integral Approach to Cities

There appears to be a new opportunity for existing city games to come together to create an interconnected infrastructure. Linking individual games to one another results in an ecology of games which can enrich themselves as well as inform a more integral city development

Figure 1. Map situating the city games worldwide as researched within the Games for Cities research project.

debate. Such an integrated support tool creates a real difference in how cities learn, plan, and decide. When supported by an interconnected infrastructure, we call this "network of games" (NoG) a family of interrelated games that could make a real difference in the integral planning and designing of cities.

NoG builds on the Games for Cities research, a rich collection of city games built to support city development processes. The assumption is that if these specialized games could be linked, then a large game infrastructure built as a modular system can offer various game combinations responding to urban challenges in an integral and holistic way. When translating this theoretical approach to the practice, the question is how to technically enable distinct games to communicate and work together. We tested two conditions where independent games could be connected despite distinct play dynamics and play rules.

3.1. Connecting Datasets

Although played with diverse play mechanics and interfaces, in their essence, most city games run on organized and visualized datasets. So long as the content of given games meaningfully can complement each other, their data will overlap. For example, a game on *affordable housing* that contains data on "land use," "land price," and "planned housing projects" can link to data from an *urban transport* game containing data on "location of transportation hubs," "shared vehicle schemes," or "planned infrastructure projects." With the connection of the distinct datasets, the connected game can inform players about affordable housing schemes in relation to affordable transportation possibilities.

3.2. Connecting Interfaces

As datasets connect games through their content, the question arises about which game interface and rules to use after games connect. There are a handful of hybrid city games hinting at how to link distinct game interfaces to work with or strengthen each other. For example, the gameplay may remain in the physical interface, while digital interfaces enable processing digital data, recording decisions, and reporting to larger audiences. Analog game formats include card games played with four to six people, tabletop games played in a workshop setting with around 20 to 30 people, or conference setting games where multiple tables play simultaneously and reach larger crowds of over 100 players. Digital games run on personal computer software, on mobile apps, or on a website, as well as in virtual and augmented reality environments. They can process data and record user behavior and outcomes. The combination of trust-building advantages of analog formats and data provision end processing, access to thousands of participants, as well as easy recording and reporting makes the connection between the two formats interesting for designers.

Since the development of the theoretical framework for the NoG in 2019, we could implement and test our

ideas through two concrete cases taking place in two Dutch cities: Amsterdam and Breda. In both cases, a number of games and simulation models are linked through their data as well as interfaces. In the Amsterdam example (Klimaatspel), two games connect through their datasets, while in the Breda example (Play the Koepel) datasets and interfaces fuse to create a particular new game. After introducing these two cases, we will compare the results and elaborate on achieved and failed targets and will describe further steps to develop the NoG research (Figure 2).

4. Network of Games Linked Through Their Datasets: Klimaatspel, Amsterdam

Klimaatspel is a location-based climate adaptation game developed for the City Technology Office (CTO) of the city of Amsterdam. In 2019, the CTO launched Amsterdam's climate program based on the Paris Climate Agreement. The game enables local residents (homeowners and tenants), housing corporations, energy providers, and civil servants to transition from existing residential neighbourhoods—in this case, the Apollobuurt en Stadionbuurt of the Plan Zuid in Amsterdam—to a climate-neutral city area as they progress through game rounds.

4.1. Datasets of the Klimaatspel

Designers of the Klimaatspel identified four components addressing climate adaptation: clean energy use, sustainable mobility measures, public space use, and management of urban water. Next, to detail these topics, they started building datasets involving strategies and actions for the selected four themes. These data have been collected from the works of organizations and practices with years of open research and experience. Clean energy strategies are based on the technologies involved in the Energy Transition Model (ETM) developed by Quintel Intelligence (https://pro.energytransitionmodel.com). Mobility strategies are selected from the doctoral research conducted at the Integrated Transport Research Lab (https://www.itrl.kth.se) of the Royal Institute of Technology in Stockholm. Green public space strategies are filtered from visions and strategies under the Project for Public Space (https://www.pps.org) research. Water management strategies have been based on the action toolbox of the Rainproof program of the city of Amsterdam (https://www.rainproof.nl; Figure 3).

To become a truly location-based city game, however, Klimaatspel needed to integrate information about the particular local community and location. That meant that, besides four relatively generic climate aspects detailed initially, the game needed to include spatial data and dynamics representing the given neighborhood: existing and/or planned building typology, number of households in city blocks, available public and green spaces, location of available solar panels and situation of rooftops suitable for solar panels, and existing sustainable local energy sources for heat and electricity. To develop and implement a place-based climate game for the city of Amsterdam's CTO team, selected

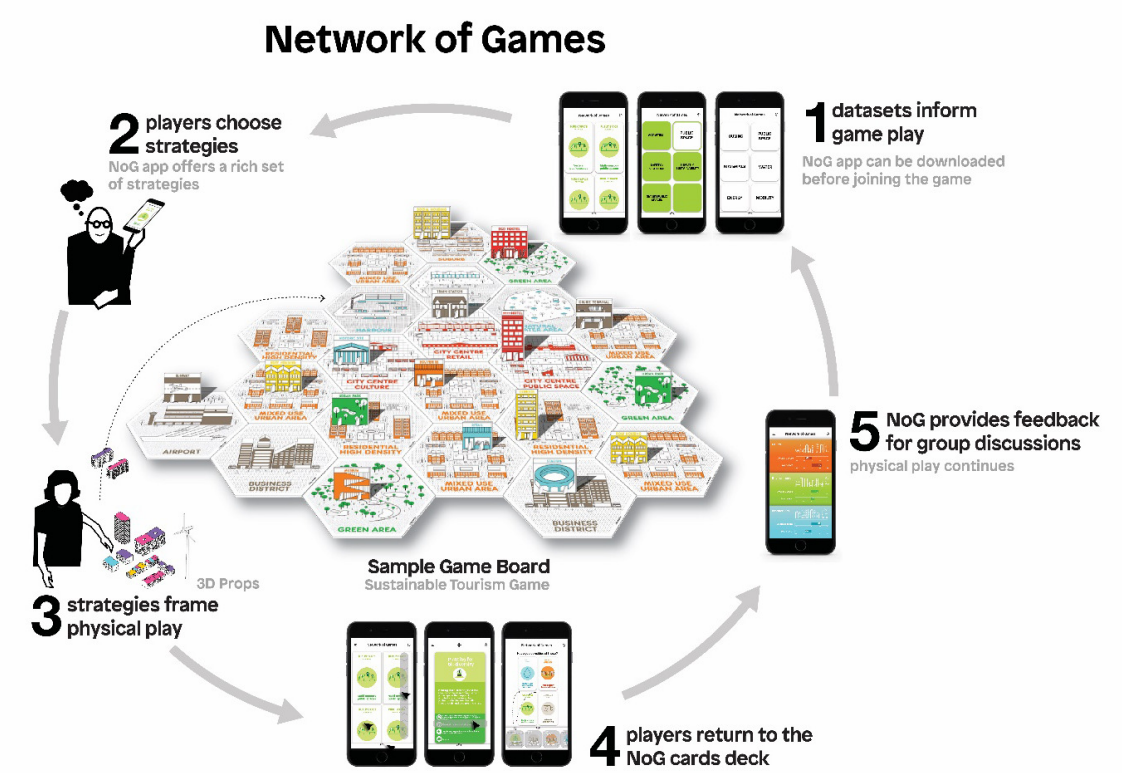

Figure 2. Diagram clarifying the idea behind how city games of various datasets and interfaces can be linked to one another.

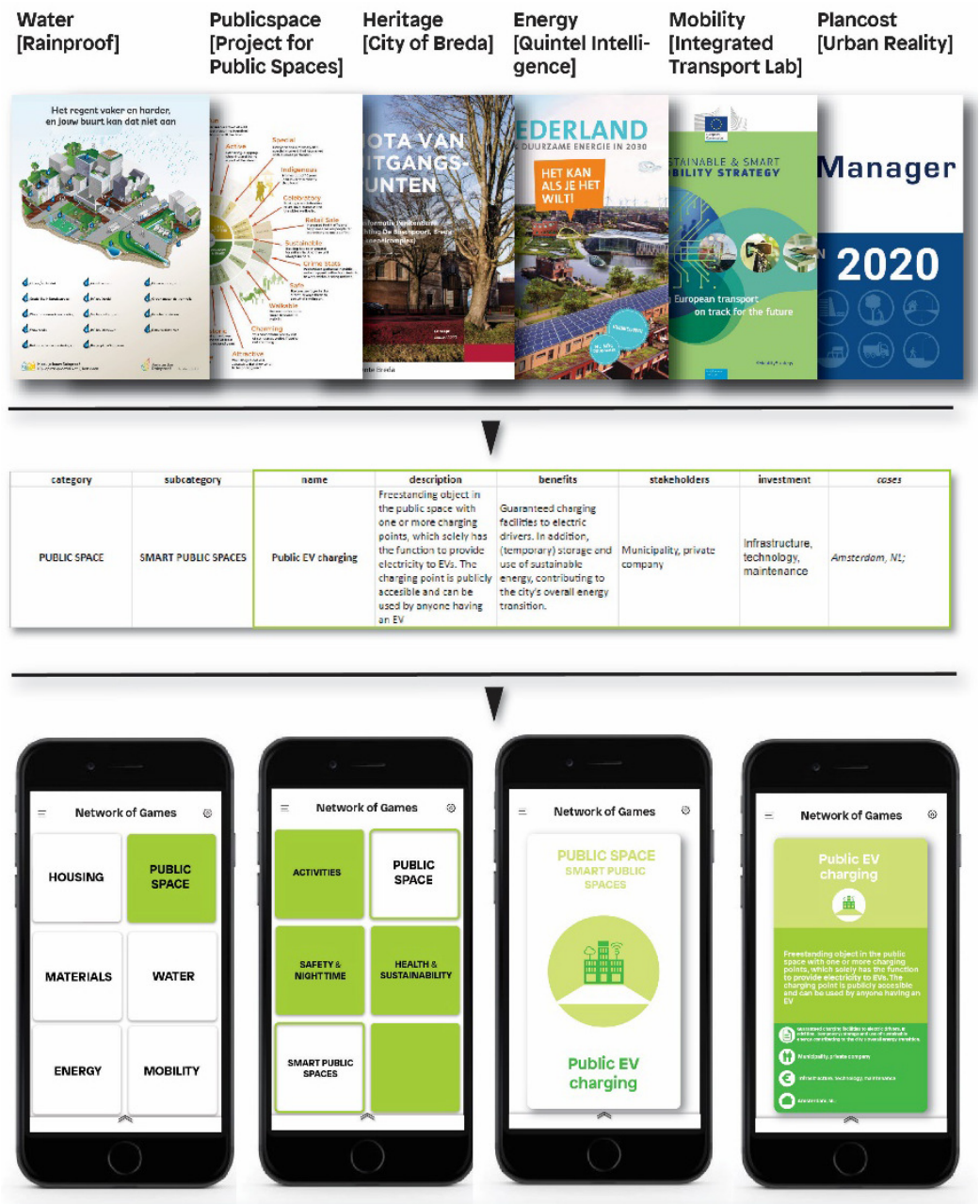

Figure 3. Original data sources, datasets excel sheet documentation, and visual translation of datasets as game cards.

generic climate strategy topics needed to be interlinked with local spatial information about the neighborhood. This could enable an integral urban development approach where spatial and climate experts, developers, and policymakers as well as residents will become empowered to communicate and think in an integrated environment. For example, players could make choices not only about a housing development but also about locating a water-permeable urban square adjacent to this housing development, introducing a shared electric vehicle fleet decreasing parking standards, clean energy generation possibilities, collective heat pumps and neighborhood battery, etc. At this point, a concrete demand was born for connecting the Klimaatspel with the Area Development Game (https://www.playthecity.eu/playprojects/Play-Noord), supporting the conceptual framework of NoG, a system of interdependent games working together to respond to complex urban challenges.

4.2. Datasets of the Area Development Game

The Area Development Game (Gebiedsontwikkelingsspel) has been first developed and implemented in Overhoeks, Amsterdam Noord in 2011. Since then, the game has been adapted to various cities in and outside of the Netherlands. The Area Development Game includes a comprehensive dataset category of *urban programs* (urban functions) with subsets such as housing, work, hotels, restaurants and cafe's, retail, public services,

culture, infrastructure and public space (squares, streets, parks, parking), energy, green infrastructure, and water. Every subset contains tens of functions with data such as area size, building height, number of households, etc. These data have also been translated to 3D building blocks and pieces enabling players to collectively design and test city areas, streets, and city blocks filled with desired urban functions. To achieve urban development that fulfils a given urban program and density with precision, these components carry quantitative data informing urban density, minimum green and parking requirements, etc. (Figure 4).

4.3. Connecting the Datasets of the Klimaatspel and the Area Development Game

Here, the question rises how to technically connect the dataset categories of the Climate Game (mobility, energy, public space, and water) and the dataset categories of the Area Development Game (urban functions). To provide compatibility and easy access, we started organizing the datasets of the Klimaatspel. Initially, to simplify the access to hundreds of climate adaptation strategies collected under categories such as energy, water, public space, and mobility, we introduced subsets for each category. For example, the clean energy strategies have been classified under subsets such as *save*, *generate*, *store*, and *network*. Similarly, the water category contained subsets such as *collect*, *retain*, *filter*, and *reuse*. Next, every data subset has been provided with spatial information (area size that a given clean technology occupies, the place that it will be situated in, or the number of households/office units/public services a given technology serves) so that overlapping data become possible with the urban program category of the Area Development Game.

Once the excel datasheets were complete, the following challenge was making such excessive amount of data accessible to players. The subsets could provide a certain degree of direct access. Players could be informed about the main purpose of strategies and thus, accordingly, could eliminate a subset of actions they found irrelevant. Even after such a quick selection, as most innovative technologies are new to players, it will take time to read what the meaning and impact of these actions are, understand the size they occupy in urban space, with which technologies can they be combined, and potential downsides. Given that the players are expected to combine their climate strategy choices with spatial choices such as where to locate them and how many households they serve, we needed to develop the Klimaatspel further to make it possible for a player to scan enough strategies, to evaluate their selection with fellow players, and test various locations during the limited amount of play time to finalize their decisions.

One of the techniques we applied for direct and simple communication was visualizing all strategies through comparable scale 3D drawings. We followed the drawing language of the Area Development Game in visualizing and modelling the 3D building units. Further, with

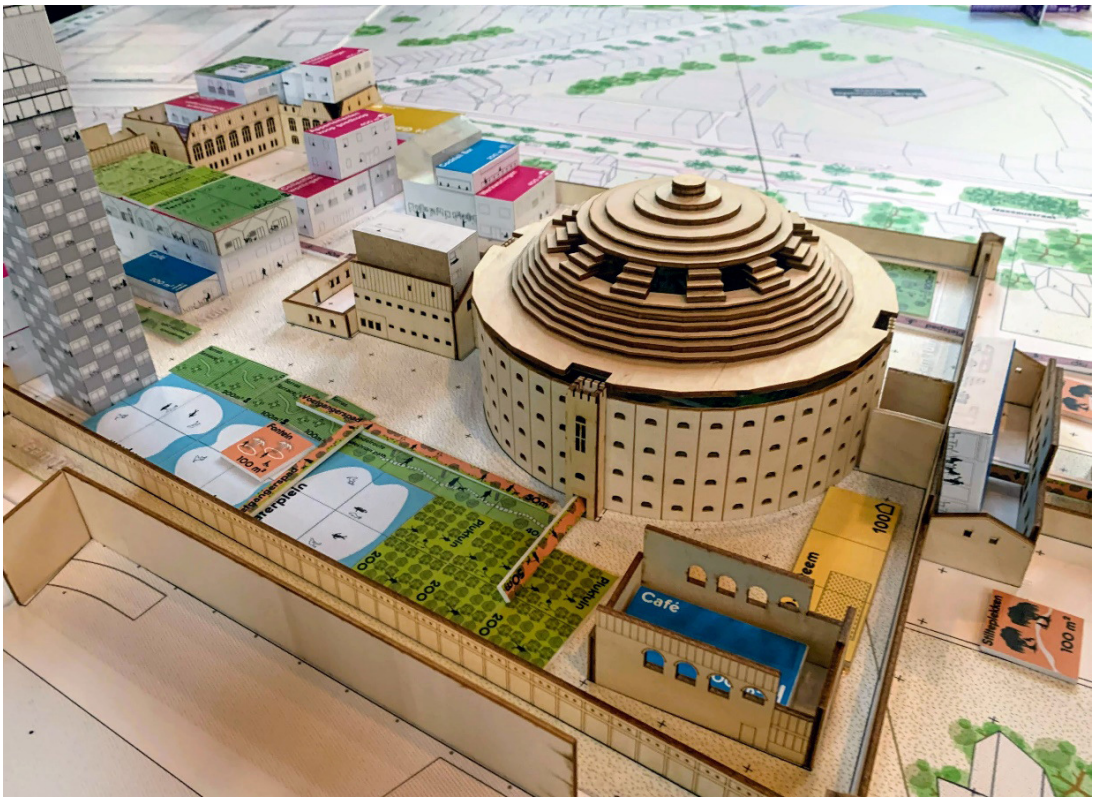

Figure 4. Data as translated to 3D building blocks.

a graphic designer's team, we created dedicated cards for each strategy with respective short verbal information (*simple descriptions*, *combination possibilities*, *application areas*, as well as *known positive and negative side effects of these strategies*). With this last step of containing all visualized *strategy cards*, a game system came to life with thousands of game components from two distinct games fusing into a single game interface. Finally, the Klimaatspel involved three major components: the game board with GIS information (of Stadion and Apollobuurt), 3D game building units, and visualized *strategy cards* based on the datasheets (Figure 5).

4.4. The Making of the Network of Games App (Beta Version)

Synchronization of data categories through an excel sheet, digital visualization of climate adaptation strategies, and building units in the same visual language cleared the way to a digital tool. We aimed at a smartphone app that could communicate all visualized strategies as a cards system where players can select, collect, and combine them into a card deck. Simple and pleasant navigation through various data layers was the major purpose of the NoG app, where urban strategies are present to address complex city questions. The convenience and common use of smartphones could potentially blend data easier with analog play through dedicated game rounds framing the location-based spatial scenarios. In the meantime, after a long search, we settled to work with young and talented developers through a partnership with the Bahcesehir University Game Lab. Several conversations led to an advice brief clarifying the technical background of the NoG written by the developers. Based on this, our team could develop an initial wireframe sketch for the mobile app built using the Unity development tool (https://unity.com; Figure 6).

There are three main parts of the app which is reading and loading the cards from an excel document, designing an algorithm to recommend cards, and the UI/UX arrangements of the digital game. The algorithm is developed in order to recommend players. The algorithm can be trained in time. Every time the user makes a choice, the cards in the deck are remembered to be recommended in the future. Once the NoG app (beta version) was ready to be played, the experts in the advisor team but also other experts in our network played sessions to train the app and eventually build connections between strategies belonging to distinct categories (Figure 7). The app can be viewed at the following link: https://drive.google.com/open?id=1pFGc5UBUGZj0_BIu6nehMqKhgSdFdO9V&authuser=r.ekimtan%40gmail.com&usp=drive_fs

4.5. First Evaluation for Network of Games

First with the production of the physical game components, later with the integration of the NoG app based on the datasets of two games, the Klimaatspel has been the first fusion games within the NoG project. We tested the game in various settings with local residents, experts, and students. In a period of two years (2019–2020), Klimaatspel has been played 10 times. Three of these sessions were implemented with residents (*renters* and

Figure 5. Visualized strategy cards based on the datasheets. Sample category: Energy.

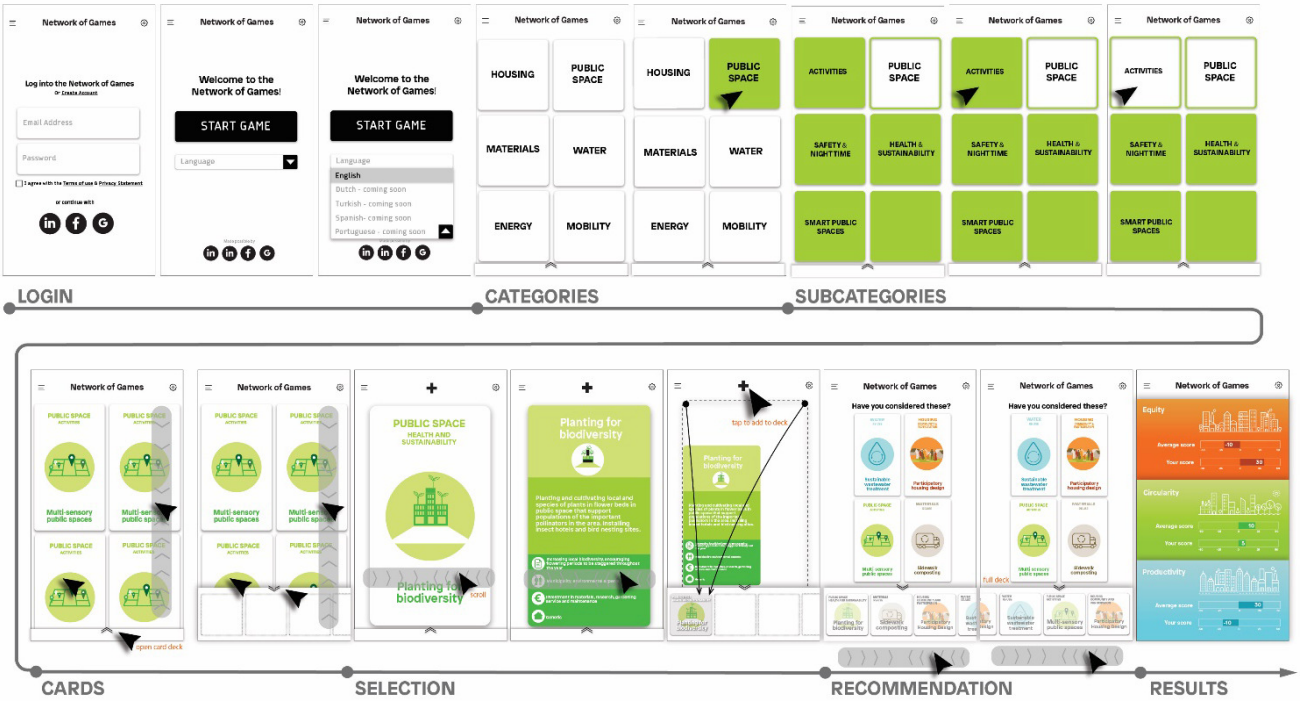

Figure 6. The wireframe.

homeowners) on site. The rest seven meetings took place with various city departments of the city of Amsterdam, expert organizations, and with the generation of the digital app with advisors committee and students (Figure 8).

Fusion of two games bringing spatial and climate questions together in one creates a rather complex field of decision, making it accessible to diverse experts as well as non-experts. Klimaatspel reveals the climate adaptation as an integral transformation question: *smart mobility*, *water balance*, and *inclusive public space*. Participants understand the complexity of transitioning to a climate-adaptive city by exploring multiple stakes necessary for a long-term change. Based on the system analysis, players take concrete steps in the game

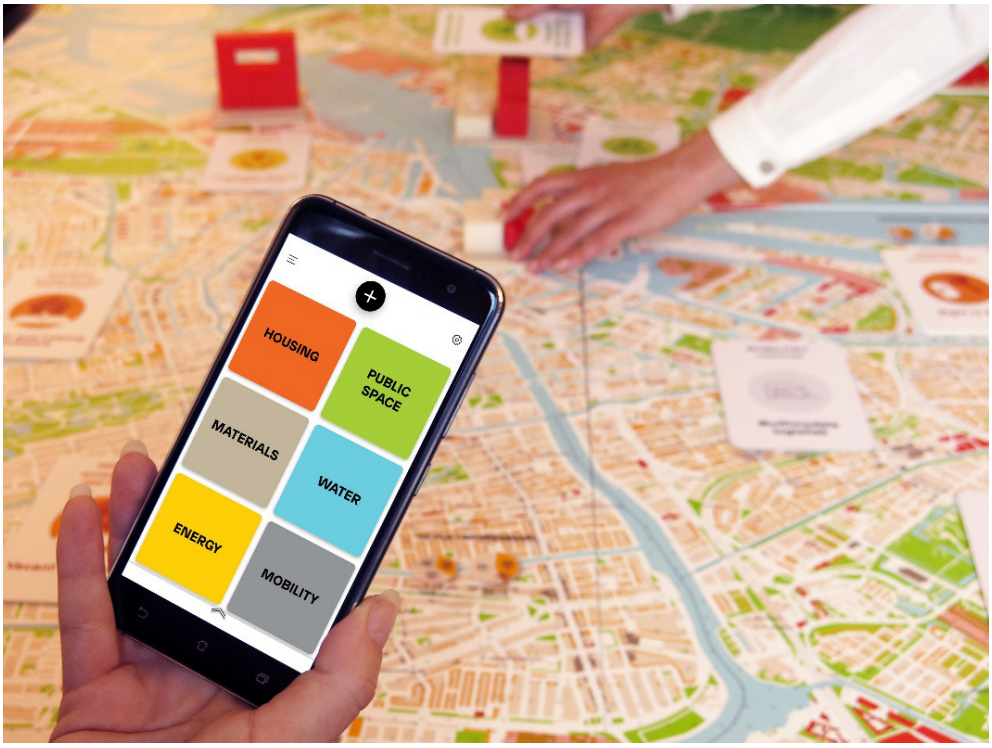

Figure 7. A shot from the NoG app.

Figure 8. Photo taken during a play session of Klimaatspel in Amsterdam.

such as neighborhood batteries, shared heat pumps for a given housing block, renewable energy co-operatives, and smart micro grids for a given neighborhood, and explore the impact of these new infrastructures on public space and individual building blocks. Participants also explore and interlink three scales of action: *home*, *housing block*, and *neighborhood*. This way they build shared narratives based on collectively selected actions such as energy cooperatives and neighborhood batteries.

During the play sessions, we received returning remarks both from residents as well as experts about missing quantified data (such as the approximate CO_2 reductions of strategy cards) to help compare and select the available technical solutions. We concluded this as feedback to improve the game by adding a new dataset comparing CO_2 reductions of various strategies that could positively support in reaching decisions and more coherent narratives.

While the test outcomes of the Klimaatspel were, content-wise, fulfilling, with the integration of the NoG app we could observe serious hiccups caused by the interface integration and play dynamics of the game. The NoG app has been activated in Klimaatspel sessions for two moments. The first moment was one week before the game, when all invited players received the link to download and explore the digital game app. This way, players could find the time to explore and compile their cards even before joining the game. Given the richness of the game content, this early interaction did help in earning time in exploring the game components. The second time the NoG app was used was during the physical game meeting contained within one of the game rounds. The app functionality of recommendations did help the players to surf easier through categories of energy, water, mobility, and public space, and make more holistic choices. Yet, recommendations that the app provided during selection of cards were not obvious for all the players. Furthermore, the switch from the NoG app to the game table was not always easy and flawless and we observed that players still needed the physical cards to hold in their hands or locate on the game board. Accordingly, we re-introduced the physical game cards as part of the game, despite digital scan and selection of cards remaining available before and during the game. Besides the transition between digital and physical interfaces, we observed that the narratives generated around the table among multiple players were much more engaging. The most important handicap of the beta app is that it did not allow choices to be made by players collectively. Accordingly, the emergence of collective

debates and narratives during the digital selection round remained rather limited.

When introducing data references of the Klimaatspel, we earlier mentioned the ETM developed by Quintel Intelligence. In ETM, users develop scenarios for CO_2 reduction relating to clean energy and mobility interventions in Dutch cities compared to 1990 levels. Based on the criticism we received in the first game sessions, we took an extra step in extracting quantitative data about CO_2 reductions. As a last iteration of the Klimaatspel, we ran a possible scenario for the current number of households city of Amsterdam in 2020 and generated CO_2 reduction values to clean energy and sustainable mobility strategies involved in the game. The last two game sessions played with students involved the quantitative datasets on CO_2 reductions and helped a more nuanced conversation among players (Figure 9).

We shared earlier that Klimaatspel used the climate adaptation actions based on Quintel's ETM. For calculations of carbon reduction from ETM, a scenario 2020 (existing) for the city of Amsterdam was taken and the value for CO_2 data relative to 1990 (A) was noted (63.6%). The values of each strategy in households, buildings, and transportation were noted according to the existing situation. The percentage for each strategy separately was made 100% using the slider and the CO_2 relative value (B) was noted. The difference between A and B is the calculated carbon reduction/increase for each strategy/technology, considering the impact it has when it is used in isolation. As an example, the current usage of photovoltaic panels is 1.4% of its potential in households. When they are used at 100%, the value for CO_2 relative to 1990 changes to 49.4% (B). This is subtracted from the original value of scenario 2020 (A), and the difference is 14.2%, which is the reduced CO_2 impact for the entire city, considering the rest of the strategies and their quantities remain the same.

5. Network of Games Linked Through Their Interfaces: Play the Koepel in Breda

Klimaatspel is made possible by linking datasets of the Climate Game and the Area Development Game resulting in a detailed and comprehensive excel document containing strategies on five categories. Visualized strategies, relations built among these strategies, and the recommendation algorithm formed the learning NoG app. Positive outcomes were booked by this integral think, debate, and design game. Hiccups in play dynamics were caused by the incompatibility between the digital app and physical storytelling format. This problem inspired our team in thinking further about linking games beyond datasets. It was necessary to develop a deeper understanding of the relation between offline and online (hybrid) interfaces and their synchronization. After studying various game examples in Games for Cities research, we concluded two major forms of reaching a hybrid game interface: *simultaneous* and *sequential* connection of analog and digital formats.

5.1. Analog and Digital Play Take Place Simultaneously

In this form, to achieve real-time feedback, choices made by players during a physical game are simultaneously linked to a digital platform that can store this information and process it through a particular algorithm. Here, various forms of scanning possibilities exist to connect the physical environment with phones, tablets, laptops, and

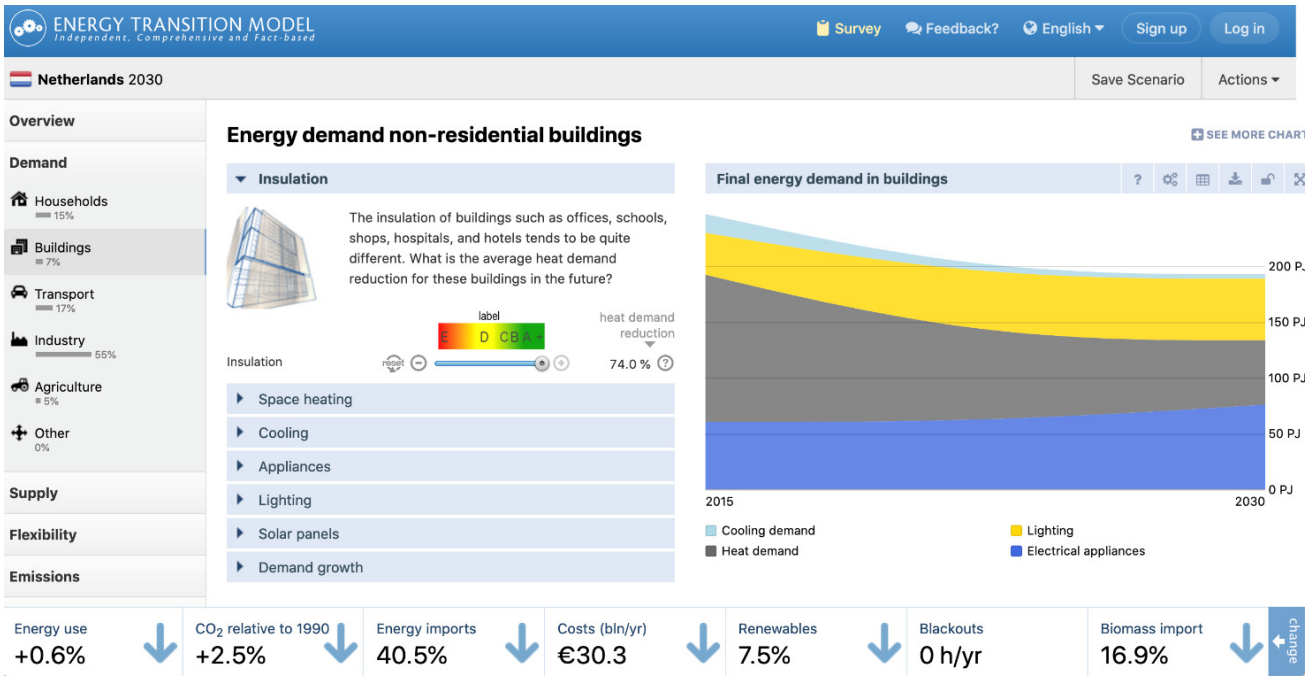

Figure 9. Screenshot from the ETM developed by Quintel Intelligence.

other devices through 3D video scanners, near-field communication, radio frequency identification, QR codes, and more. These technologies come with different sensibility, speed, and price ranges. Through direct communication to a digital environment, they make the analog play process accessible to a large audience. By digitizing choices made in the physical environment, they enable the recording and reporting for the longer term much faster and easier.

5.2. Analog and Digital Play Take Place in a Sequence

Hybrid play is achieved by connecting digital and analog formats in a sequential manner. The key to providing connectivity in this form is making sure outputs of a given format can be converted to the input of a following game interface. Namely without the direct scanning technology, connecting analog and digital formats becomes possible. As soon as the digital play takes place, its stored outcomes will become input for the analog game format and vice versa.

The beta version of the NoG app linked online and offline play formats sequential in the Klimaatspel case; yet, technically the app can be developed in such a way that physical components such as cards and 3D building blocks can be scanned directly during the analog play and real-time recommendations or quantitative feedback (for example number of parking lots based on the volume of urban programs used during the session) can be provided during the play session. During the Klimaatspel sessions, we received comments about how the play round with the app disconnected people from the collective narrative building around the table. This disturbance kept our team looking for alternative hybrid models where a smoother transition between the digital and analog formats was possible.

At this phase, we decided to include the city of Breda's challenge (transformation of the De Koepel prison campus) for a complex urban area development as a second case for the NoG project. A large number of residents needed to be consulted for the future of a former prison campus situated in the core of Breda. As in Klimaatspel, the city of Breda was seeking an integral planning approach that could combine themes such as spatial development and climate adaptation with special attention to the architectural heritage due to the historic prison of the De Koepel in Breda. The game needed to generate future scenarios for this central area. One week after the game brief Play the Koepel was formulated by the urban design team of the city of Breda, the worldwide Covid-19 epidemic reached the Netherlands resulting in a lockdown on 16th March 2020 (Figure 10).

Figure 10. Photo taken during a play session of Play the Koepel in Breda.

The need for an integral approach and the ongoing lockdown imposing digital solutions were precisely the conditions for implementing the NoG app. This NoG app piloted for the Klimaatspel could be redeveloped and tailored for the Play the Koepel process. All interested Bredenaars (with a smartphone running on Android) could download the app through a public invitation. The app was ready for scanning and selecting relevant climate and urban development strategies. As we explored deeper the requirements of the process and the output expectations for the digital tool, a few aspects of the NoG app were running short: Firstly, before sharing hundreds of rather abstract digital strategy cards with the users, we needed to share the background narrative about the Koepel (the conditions and expectations around redeveloping the historic prison, current and potential future owner of the building, the role of the municipality, the importance of innovation for today's Breda in a historically innovative prison building with the implementation of the panopticon, and the social reintegration ideas). Next, we needed not only to share the narrative of the city of Breda but also to let participants react to the storyline, telling their own tales about the transformation of the Koepel campus. Only then selection of strategy cards supporting individual visions made sense. Finally, a technical property we needed in the NoG app was user-based registration. Only then we could save and track the selection outcomes and analyze preferred strategies. The beta version of the app was designed so that future development around individual user login would become possible. Yet, we did not have the time and financial resources to further app development, as the digital participation needed to take place as early as June 2020.

Typeform is an application that offers the opportunity of loading customized visualized game strategy cards. It does not come with some of the properties of the NoG beta app, such as recommendations and relations between strategy cards. Yet, the digital poll app enables developing a clear narrative (what is the history of a given area, what are existing or missing spatial qualities, who are landowners, what are their expectations, which technologies were relevant options, what were the major dilemma's and why) supported with visuals that could inform users. Taking the participant by hand and sharing the background knowledge could enable players to develop their own visions built upon the selected strategy cards. Not only imposing a single-way narrative but by leaving open questions and room for adding new actions, this particular digital poll allows players to develop their own narratives. Given the affordability of the ready-to-use tool, we started installing the NoG datasets along with a narrative introducing the dilemmas and ideas around the redevelopment of the Koepel campus. A significant side note here is we could never achieve a highly visualized digital poll filled with well-researched data if the steps leading to the NoG app (data collection and digital visualization) were not taken in advance. Thus, selecting to move on with the Typeform for the Koepel process instead of the NoG app could only become possible due to the structural work leading to the NoG app.

5.3. Dataset Extension for the Play the Koepel With a New Data Category: Heritage

During the tests ran with the city team, we received concrete feedback from the city of Breda's expert teams that has been translated to the NoG data infrastructure. The heritage experts from the city introduced new knowledge that needed to be taken into account when planning a future scenario for the redevelopment of the historic prison and multiple strategies to support these scenarios. Using the excel datasheets with the dataset structure of various categories, the heritage team was able to translate their input into strategy cards following the same data structure, adding heritage as a new data category, with sub-categories, descriptions, and attention areas.

5.4. Linking to the Urban Reality Simulator

The input from the finance department was about implementing a reality check layer to the game. By introducing a feedback mechanism around the project's costs, the game could provide feasibility feedback to residents who can make more realistic choices. Urban Reality, a team of plan economists developing financial simulation models for large-scale urban development projects, joined the team at this stage. The calculation models Urban Reality develops are prepared with professional precision, taking weeks to calculate various development scenarios. Yet they took on the challenge of real-time feedback on the cost of developing scenarios during the game meetings as the players select strategies and locate 3D building blocks on the game board. This could happen only with the correlating of Urban Reality with that of the NoG. This way, the Urban Reality algorithm could calculate production costs or indicate the amount of parking needed for a given scenario, etc. The purpose of integrating this calculation model was not to provide players with the promise of cost precision but to give feedback about the financial feasibility of development and qualitative comparisons for scenarios generated during various game sessions.

With the collaboration of Urban Reality, we developed the idea of object scanning and registering physical building blocks and strategy cards and linking this information according to the user/team into the Urban Reality simulator. During the Breda session, we registered all these steps manually, thus developing the app so that it automatically registers physical developments digitally, remembers user login and choices, records, visualizes outcomes, and makes it possible to share outcomes during the physical gameplay.

With the integration of the Typeform and the Urban Reality algorithm, Play the Koepel has become a hybrid (online and offline) game where both sequential and

simultaneous integration of physical and digital interfaces has been conducted. The game started as a digital poll where most of the urban design narrative and the game content have been introduced to participants through visualized datasets. The poll included questions about the values and principles that will guide the future development of the area, the narrative about the new expected urban program, the combination of functions, principles about the architectural heritage, and climate adaptation measures. In total, 951 Breda residents responded to the digital poll, 250 of which registered to be able to join physical game meetings. Due to Covid-19 measures, 60 people could join three analog sessions with social distancing rules as a result of a lottery selection. Results of the digital polls were shared in real-time on the municipality's website. Before analog sessions began, we could add new game strategies and 3D building units based on the resident response digital poll collected. Analog game sessions helped to connect individual ideas to develop into collective narratives about the future Koepel. During these game sessions, the Urban Reality model ran simultaneously and provided real-time feedback about the financial feasibility of developing plans.

6. Design Recommendations for Building a More Comprehensive Network of Games

NoG is a game system to support a holistic debate and decision forming where experts and non-experts meet to explore urban questions from public space to energy and from heritage to mobility. It focuses on developing an interconnected modular game system through data and interface for an integral planning and design approach. With two concrete game integrations in Amsterdam and Breda, the transition from the theoretical NoG approach into implemented cases has been achieved. These experiments provided practical answers to the initial question of how to build a NoG. We can safely conclude that the hypothesis about linking games through their datasets and interfaces proved to be relevant and, to a large extent, manageable. We consider this a start where new additions of game datasets and interfaces will enrich the data infrastructure of the NoG. In this way, relevant combinations of specialized city games, enable bottom- and top-down actors to engage in holistic discussions and therefore integral decision making. Similarly, an infrastructure of NoG enables stakeholders of diverse backgrounds with a distinct set of knowledge and experiences to interact and reach negotiated shared solutions. This is in line with a new conception of cities as self-organizing systems where a plurality of actors exercise their influences in the making of the city.

6.1. Linking to New Relevant Open-Source Datasets

With datasets on climate adaptation and urban development developed, synchronized integration of data models (Quintel and Urban Reality), and addition of four interfaces (Typeform, NoG app, the Urban Reality simulator, and Play the City table format) linked to one another, a game ecosystem is already under development. In reaching and distilling, most of these datasets we used are publicly invested resources.

6.2. Making Own Datasets and Apps Open Source

Accordingly, we plan to make collected datasets and the beta version of the NoG app publicly accessible, also given that the NoG runs on a study financed by two major public grants (Stimuleringsfonds Creatieve Industries and Nederlands Organisatie voor Wetenschappelijke Onderzoek) and two local governments (city of Amsterdam and city of Breda) financed projects. With this step, we will make the data infrastructure of the NoG known to more urban designers and game developers. This potentially opens up the way to further growth of the game network and partnerships.

6.3. Actively Seeking New City Game Collaborations

In future iterations, we see possibilities for expanding with new datasets on sustainable tourism (a city game developed by Breda University's tourism department), food datasets (a city game in development by Utrecht's art and science institution Casco), and health and well-being datasets (game research conducted at the Australian Urban Design Research Centre).

6.4. Expanding Interface Integrations

Just as the datasets are subject to expansion with new categories, so are the interfaces allowing various forms of engaging with participants for the NoG. In the early phases of this research, our assumption was that an app containing interconnected game datasets would be the best answer for hosting a platform of interconnected games. After developing the beta version of the NoG app and subsequently working with the Typeform and the UR calculation model, we realized that an open approach (as in interconnected datasets) would become necessary also in the interface aspect of the platform so long as the data infrastructure can be integrated into these new interfaces. Two experiments utilizing sequential and simultaneous integration of diverse digital tools suggest that a collection of interfaces connecting to each other throughout the entire process from a digital poll to an app, a simulator, a webinar, or analog game sessions is more effective than a single mobile phone app for all potential game interactions.

Principles such as data sharing, relating, and connecting interfaces behind the NoG approach started spreading among city game developers, planners, urbanists, and architects. We expect that publicly sharing data categories and subsets will enlarge the ecosystem and generate a series of innovative game combinations in the

coming decades. We can only look forward to new meaningful collaborations and further maturing of the city gaming practice.

Conflict of Interests

The author declares no conflict of interests.

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About the Author

Ekim Tan (PhD) is an architect and urbanist from Istanbul based in Amsterdam. Before relocating to the Netherlands, she worked and studied in the US, Syria, and Egypt. Being trained as an architect, her growing interest and passion in cities and games led to a doctoral degree at the TU Delft, titled *Negotiation and Design for the Self-organizing City: Gaming as a Method for Urban Design*. In 2008, she founded Play the City, an Amsterdam- and Istanbul-based city consultancy firm that helps governments and market parties effectively collaborate with stakeholders. The city gaming method developed during her doctoral research at the TU Delft has been applied in projects worldwide, among others, in Istanbul, Amsterdam, Dublin, Shenzhen, Tirana, Cape Town, and Brussels. Following the book on her doctoral research (2014), Tan published *Play the City: Games Informing Urban Development* (2017) sharing special knowledge and experiences developed through the Play the City practice.