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Key Factors for Using Games Such as WhereWeMove in Municipal Flood Risk Communication and Collaboration

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Abstract. This study identifies key factors for integrating the WhereWeMove game into municipal flood risk communication and collaboration strategies. The game started as a research initiative to support the design of adaptation policy by helping risk management organizations to explore how risk perception and resources shape players' adaptation choices. During the game rounds, players take the role of a homeowner to learn about their choices given the available game resources and adaptation options. After the gameplay, participants discuss the relations between their game and real-life choices to envision strategies to strengthen homeowners' capacities. By considering that government organizations often hesitate to adopt innovations according to their available resources, we carried out semi-structured interviews with two municipalities and a province representative to explore their adoption intentions and needs. Thereby, we identified which factors to finetune in the game prototype or pursue at the adopting organizations to use the game in the municipal communication and collaboration strategies. On one side, successful adoption depends on integrating the game into a broader communication strategy aligned with the adaptation priorities across government levels. Conversely, adequate municipal resources and expertise, as well as the game's ease of use, local relevance, and sufficient data privacy, are required to make the gameplay part of municipal efforts. Adoption is initially considered with a dedicated group contributing to the design of government policies to observe policy-related effects and outputs. Players are conceived as a limited group of professionals and representatives of residents or an advisory organization at the municipality or province.

Keywords: Serious game adoption · Flood risk management · climate adaptation

1 Introduction

Floods due to extreme rainfall and river overflow in (sub)urban areas are becoming more frequent and severe, causing property damage and endangering lives [1]. Flood exposure increases in lowland areas due to the limited capacity to drain excess surface water and the combined effect of land subsidence [2]. The July 2021 floods in Germany, Belgium, and the Netherlands revealed that urban drainage systems may not be built for

such extremes, and river protective measures like dikes or storage zones are not possible to implement everywhere [3]. Floods often affect public and private property, so flood management strategies should coordinate and share responsibilities accordingly [4]. Therefore, governments increasingly require complementary adaptation measures, for example, by homeowners [5]. Homeowners can move to a better-protected location or take structural measures at the current house to permanently prevent the entry of excess water, such as raising the ground, installing door panels, or temporarily placing sandbags if there is a warning time. They can help increase the drainage capacity by using measures such as green gardens or limiting damage to their private property by repurposing spaces [6]. Designing government policies to strengthen the capacity of homeowners to take action is difficult for various reasons [7]. Technically, private house adaptations depend on factors like house type, flood exposure, and possibilities to provide warnings [8]. Institutionally, municipalities may not have the expertise or resources that national guidelines require for planning adaptations [4]. Climate adaptation strategies could further worsen socio-spatial inequalities [9]. Socially, many residents lack the resources to act or do not know the flood risks and the feasible adaptation options. Such is the case in the Netherlands, where risk perception is low due to the dike protection [10]. With little experience of severe river flooding and increasing rain floods, residents struggle to grasp the potential consequences. Residents need support to strengthen their knowledge or financial capacities to take action [11]. To address these challenges, communication strategies should better consider residents' motivating factors and preferences for action and build trustworthy relationships to share responsibilities accordingly [12]. Clear and actionable communication to residents is essential from all government levels [13]. Particularly, communication from provinces and municipalities towards homeowners helps to make them aware of the flood risks and the measures they can take before, during, and after a flood event [14].

Serious games are increasingly used to support players' decision-making and collective action [15]. Such games further allow players to experience (flood) scenarios and (adaptation) options that are otherwise difficult to try [16]. Serious games are further developed as a communication and collaboration tool for flood risk management [17]. According to the organization and innovation characteristics and capacities, the public sector is generally hesitant in adopting innovations in its day-to-day practice [18]. To plan adoption efforts, this study addresses the question: What factors influence local organizations' adoption of serious games in their communication strategy? The adoption of serious games in educational settings [19] and corporate environments [20] are extensively studied, but not as much in a public organizational setting [21]. To this end, we adapted the framework of innovation adoption and diffusion in the public sector as developed by De Vries et al. [22]. We used WhereWeMove as a reference to identify key factors for using games in municipal flood risk communication and collaboration. To this end, we carried out semi-structured interviews with representatives from two municipalities and one province in the Netherlands.

2 Antecedent Factors Influencing Adoption in the Public Sector

This section outlines the antecedents (i.e., attributes of an innovation or factors that should be present) for adopting innovations, such as a serious game, in the public sector. In theory, the design and implementation of an innovation should “*reduce the uncertainty in the cause-effect relationships involving a desired outcome.*” [23(p. 13)]. An individual or organization considers these factors when seeking additional information about the innovation. Then, diffusion is “*the process by which an innovation is communicated through certain channels over time*” (p. 5) among interested actors. To plan adoption and diffusion efforts, one should consider the innovation-decision process, which includes five steps:

- (1) Knowing about an innovation through available communication channels.
- (2) Raising interest (often through others) to help representatives of intended adopting organizations form an attitude towards the innovation.
- (3) Support the adoption decision by recognizing that the decision can be made independently, collectively, by order, or contingent on a first experience.
- (4) Facilitating the innovation implementation.
- (5) Confirming (or not) the implementation decision and offering alternative options when needed.

To support this process, De Vries et al. [22] identified antecedent factors from a meta-synthesis study, noting that adoption and diffusion depend on the innovation and the organization. Table 1 brings together: First, public management (PM) studies about administrative, technological, service, product, or conceptual innovations. Second, public policy (PP) studies about governance and conceptual innovations. Third, e-government (EG) studies about technological and product service innovations engaging various actors in government practices through Information and Communication Technologies. Although serious gaming does not necessarily contain digital elements, e-governance factors influence those that include them. De Vries et al. [22] further grouped the factors into five categories: environmental, inter-organizational, organizational, innovation, and individual factors. The following sections summarize which factors were expected to be relevant for our case based on a literature search about flood risk management communication and gaming.

2.1 Environmental Factors

We distinguish the site-specific environmental factors from (inter) organizational environmental factors. We further used this category as a selection criterion to approach municipalities to interview. As such, this category refers to the problem relevance and the socio-economic characteristics of the area concerned, such as the area’s wealth and urbanization. Moreover, flood risk depends on the geographical exposure and the socio-economic, physical, environmental, and institutional vulnerabilities and capacities of at-risk people. Key environmental flood factors include magnitude, area, and duration, influenced by water channels, drainage, protection, and catchment management [1]. Risk perception further depends on the past experiences, reaction capacity, and hazard awareness of the people at risk [14]. For instance, younger, less experienced, less educated,

Table 1. Factors referred by De Vries et al. [22] from the Public Policy (PP), Public Management or E-government (EG) literature. (*) The factors considered as a selection criterion for the interviews. (**) The factors not considered in the interview protocol due to their limited relevance to this study. In italics, the factors reframed to the scope of the study.

Category	Factors	Source
Environmental	Socio-economic characteristics, <i>local relevance</i>	PP
Inter-Organizational	Learning, mimicry**	PP/PM
	High levels of collaboration, regulatory mandates*, competition**, socio-economic characteristics, frequent dissemination, <i>two-way communication and co-creation opportunities</i>	EG/PP/PM
Organizational	Training for employees, <i>ease of training</i>	EG
	Supportive leadership, organizational structure	EG/PM
	Slack resources, Supportive culture	EG/PP/PM
	Large size*, Intra-organizational networks**	
Innovation	High ease of use, absence of security/privacy issues, low implementation costs	EG
	High compatibility, relative advantage, trialability and observability	EG/PP
Individual	Personality characteristics, perceived peer pressure	EG
	Skills of public servants	EG/PP
	Innovation resistance	EG/PM
	Demographic aspects	EG/PP/PM

and/or less privileged respondents are arguably more hesitant to share their risk perceptions [24]. Low-income homeowners with short tenure in a community may further lack the resources to take action [16].

2.2 Inter-organizational Factors

Inter-organizational factors refer to the collaboration or relations with external stakeholders to carry out the processes that the innovation supports. It includes disseminating information about an innovation. Further, it includes the regulatory aspects (laws or mandates) influencing innovation diffusion or adoption. We interpreted the regulatory aspects as the mandates requiring local government to more actively engage with private actors, such as homeowners, for climate adaptation [4]. We did not consider the competition between organizations when dealing with the innovation process, and the extent to which mimicking the innovative behavior of other organizations as important given the societal aim of the organizations. However, public organizations need to learn from each other on how to improve the effectiveness of government policies and deal with flood risk management challenges [9]. Learning across organizations through inter-organizational networks is also considered a relevant game application factor. According

to Janssen et al. [15], games support knowledge about the situation, common values, and learning about each other's perspectives. As such, games can integrate various flood risk management roles or limit the game experience to a few roles. Games can further be part of participatory processes to enable inter- and intra-organisational learning and collaboration. This leads to two-way communication and the co-creation opportunities of flood adaptation policy and capacity-building [7]. This factor is essential for social innovations, encouraging collaboration between actors to address societal problems [25].

2.3 Organizational Factors

Organizational factors refer to the level of resources available inside the organization (slack resources, such as money, employees, and ICT facilities), supportive leadership for the innovation's implementation process, organizational structure, and the dominant organizational risk culture. In flood risk management, governments struggle to engage actors, reframe issues, share responsibility, adapt rules, and manage resources like finances, knowledge, and skills [26]. For the implementation of games, factors such as the possibility of training employees and the difficulty of training and/or use of the games are also relevant. Skilled facilitation from coordinating or collaborating organizations is crucial to support this process [16]. We approached large and small municipalities, regardless of their intra-organizational networks to account for diverse adoption needs.

2.4 Innovation Factors

The innovation factors focus on the characteristics of the innovation itself. These include the ease of use, the compatibility or relative advantage, the perceived usefulness, security and privacy issues, costs, trialability (or possibility to experiment with the innovation), and observability (or the extent to which others can see the innovation being used). Games are increasingly designed to support flood risk management communication. However, there are limitations to overcome in the game design [28]. The game narrative and adaptivity should enhance the experience. Poor evaluation and unclear indicators reduce usefulness and effectiveness. Designers should ensure the innovation is reliable, relevant, and user-friendly by considering the player and contextual characteristics of the gameplay. Focus on enjoyment, usefulness, privacy, and security is further necessary [29]. The ability to experiment and the visibility of an innovation are key to relative advantage [30].

2.5 Individual Factors

The factors include the individual attitude towards the innovation and the necessary ICT skills that can positively or negatively affect the diffusion or adoption. It further includes the perceived peer pressure, and the demographic aspects of individuals adopting the innovation, such as their educational background or tenure. Individual factors are related to both the players and the coordinating organizations [31]. Although there is a trend towards active, collaborative, and technology-rich serious games, the necessary

ICT skills may engage some and limit others from participating, both from the players and coordinating organizations. Players often prefer games that have some personal interaction and facilitation [16]. Though preferences may vary with the familiarity and accessibility of the game technology [17].

3 Research Set up

Through interviews with representatives from two municipalities and a province, we identified which factors from Sect. 2 are to finetune into the current game prototype. This study uses WhereWeMove as a reference game to discuss key factors to pursue for using games in municipal flood risk communication and collaboration strategies.

3.1 The WhereWeMove Game

WhereWeMove is a housing game combining a tabletop board with a website that players access through their phone to track their game choices (Fig. 1). The game started as a research initiative to [32]:

- (1) Help risk management organizations to explore how risk perception and resources shape players' climate choices.
- (2) During game rounds, support players in learning about their choices given the available game resources and adaptation options.
- (3) After the gameplay, facilitate players discussions on the relations between their game and real-life choices to envision strategies accordingly.

Six to eight players representing homeowners sit around a table with a facilitator who manages the game resources available to players. The game aims to achieve the highest score possible by increasing satisfaction or earning points for the available income. To this end, every player receives a welfare-type budget, which determines their financial resources and the satisfaction rating for their desired house. According to the game settings, players can decide each round whether to stay or move between the three-game neighborhoods, each with different protection levels against rain and river floods. Whenever players decide to move, it costs satisfaction points. They should choose a new house from among the available houses or negotiate with another participant to buy his/her house. After making their house choice, players respond to climate events and government announcements by choosing flood adaptation measures to prepare for floods or buy satisfaction measures to increase their satisfaction score. Flood events could occur every round, and, depending on the location and adaptation measures, flood damage reduces the player's satisfaction score.



Fig. 1. Tabletop board and game elements impressions.

3.2 Interview Set up

Table 2 outlines the interview guide that the first author used to explore the factors from Sect. 2 as part of a larger study [33]. As national Dutch mandates require local governments to engage with private actors in climate adaptation more actively, we initially limited our interview participants to municipalities. Similarly, according to the government maps, the environmental category was not used in the interview guidance but as a selection criterion to shortlist nearby municipalities located in high to medium flood-risk areas. The short list included 15 municipalities, which we approached via email to ask for an interview during the week of June 3rd to 10th, 2024. After a week, we sent an email reminder and followed up with a phone call. Finally, three municipalities reacted positively to having an interview. Others declined the invitation referring to their lack of resources and priority or simply did not react. One interview was cancelled one day before the meeting.

Finally, we had two interviews: one with a water safety advisor on a large municipality (<650,000 inhabitants), and one with a sustainability climate adaptation advisor on a small one (<65,000). A third interview was conducted with a game designer from the province in the region. As interview participants did not have experience playing the game, after the first question, the game materials were placed on the table and introduced in slides, which included key results from some gameplay sessions and the after-game discussions. The following interview questions referred to the organizational and inter-organizational categories by asking about the current practices of flood risk communication, public engagement, and co-creation. Interviews were face-to-face meetings lasting 1 to 1.5 h based on participant availability. The interview was recorded to get the verbatim transcripts. The analysis began by assigning keywords to the line-by-line answers to identify the absence or limiting influence, their presence or driving influence, and their in-between presence or conditional influence. The coding continued by labeling keywords per related category and factor to pursue.

Table 2. Interview parts and questions list

Part	Reference category	Influential factors	Guiding questions
1	(Inter) Organizational	Current practices	How does your municipality communicate flood risks and adaptive measures to residents? How effective have these methods been?
2	Organizational	Culture and structure	How does your municipality currently adopt new technologies or innovations? What changes are needed to integrate the game into communication efforts?
3		Leadership and support	How do municipal leaders support the introduction of innovative tools and technologies?
4		Resources and Training	What resources (financial, personnel, technological) support adopting new technology in your municipality? How are staff trained to use these technologies?
5	Innovation	Technological integration	Would implementing a serious game like “WhereWeMove” face acceptance challenges? What technical factors would ease its integration?
6	(Inter) Organizational	Public Engagement and Co-Creation	How does your municipality involve citizens in solving local challenges? How could “WhereWeMove” improve residents’ involvement in flood risk management?
7	Innovation	Trialability and experimentation	What opportunities exist to pilot new technologies in your municipality? How can the game be adapted to fit your community’s needs?
8		Security and privacy	How does your municipality address security and privacy when implementing new technologies like “WhereWeMove”? Are there specific protocols in place?
9	Individual	Perceptions and enthusiasm	What is the general attitude of public servants towards adopting new technologies?

4 Results

Results are listed by participant and factor category, including a new “politics” category to reflect (inter)organizational influences beyond formal mandates.

4.1 Large Municipality

The environment-related factors are drivers considering the highly urbanized area with outer dike regions. The government offers subsidies; riverine and rainfall flood scenarios are relevant. Inter-organizational-related factors are also related to drivers. High collaboration is present through ongoing cooperation initiatives with (social) housing associations. There are also various (online) communication channels and seasonal dissemination. Two-way communication is present through visits on-site and planned workshops, incorporating flooding scenarios per neighborhood. Co-creation is possible through discussion events in the neighborhood and by supporting residents’ bottom-up initiatives. Inter-organizational learning was not mentioned as an influential factor.

Organizational-related factors are in-between or conditional to politically related factors. The municipality encourages responsibility and leadership with support. Adopting the game depends on outsourcing tasks and fitting costs within the budget. The culture favors clear plans, and short training is welcomed. Innovational-related factors are constraining or conditional. The municipality values equity and inclusivity, requiring the game to be accessible and meet data safety standards. It shouldn’t place full responsibility on residents without support. The game would be first for awareness raising, followed by co-creation. It should be tested internally before being shared with residents. Individual-related factors are driving. Enthusiasm depends on outsourcing and maintaining trust between residents and the municipality. With a diverse population and various activities, the game could be included if accessible. Politically related factors are in-between or conditional to the approval of, for example, the municipal councils. The organization must allocate capacity and justify the game’s strategic importance. A clear communication strategy and strong framing are needed to gain support.

4.2 Small Municipality

Environmental-related factors are constrained due to local relevance. Medium urbanization fits the socio-economic profile, but the game focuses on rainfall, not riverine flooding, and doesn’t address integrated drought and flood measures. It also overlooks residents’ priority of lowering energy costs. Good collaboration with water authorities and climate adaptation networks drives inter-organizational factors. Frequent newsletters cover floods, droughts, and national campaigns. Inter-organizational learning and co-creation are key despite communication challenges between departments, especially due to a new law requiring closer interaction with residents. Independent departments and limited resources constrain organizational factors. Leadership is needed to integrate efforts, and the municipal council’s support is crucial. The game could be used for internal training (pilot tests) to explore responsibility distribution.

Innovation challenges include ensuring accessibility for all residents, addressing data safety, and keeping implementation costs low due to budget cuts. Gaming offers a new approach but should better reflect local relevance. The interviewee has positive expectations, noting that the municipality has the skills to play the game, though it requires time from everyone. Even if the education level of players is relatively good, limiting complexity and follow-up information is needed. Politically, the priority for playing the game should be aligned with the plans at all government levels. By testing the game internally at first, support from the municipal council could follow for broader implementation.

4.3 Provincial Organization

Environmental factors are like those of a large municipality but constrained by local relevance. The recommendation is to expand the game settings and define whether it's open to all residents or a limited group. Inter-organizational communication with residents is limited, as the province focuses on summer workshops, joint projects with professional organizations, and co-creation with professional stakeholders. Organizational factors drive leadership and cross-collaboration, but the organization's size can slow implementation. Budget and capacity must be allocated, though training capacity may be available in the province. Having unclear the target group constrains innovation factors.

The game's monetary system does not make it playable with all residents. Yet, data safety is not a concern if anonymity is ensured. The game should focus on relevance, raising awareness as the top priority. In either case, a positive effect is expected in players' capacity to make more responsible decisions. The game seems highly versatile and possible to adjust to the context. Individual-related aspects are positive as long as an open community exists for implementation. There are different views on how to best communicate with residents that the game would have to bridge. Politically related factors remain challenging as long as there is no clear strategy behind or priority, and municipal awareness remains low.

4.4 Comparative Overview

Table 3 shows that according to the organization type and managing area, important factors for adoption were relevance and compatibility with government guidance, adequate targeting and game complexity for the intended players, and adequate data privacy management. Low resources may limit adoption. However, regardless of the available resources, all organizations consider it important to have a leader in the organization coordinating and supporting the adoption of innovation. Overall, a primary requirement that may limit or drive adoption is the extent to which the game design and play align with the priorities at all government levels and are supported by relevant decision-makers at a local level.

Table 3. Comparative keywords by category and factor: green (somehow present as drivers), red (lacking as constraints), orange (conditional or in-between influence).

Category	Antecedent factors	Key characteristics influencing adoption		
		Large municipality	Small municipality	Province
Environment	Socioeconomic characteristics	High urbanization and budget	Medium urbanization	Very dense area, Wealthy area
	Local relevance	Similar flooding scenarios	Lack of flood experience	Broaden game. Target players
Inter-Organizational	High levels of collaboration	Local cooperation.	Waterboard collaboration. Residents network	Municipal task, No citizen network.
	Frequent dissemination	Online information. Seasonal dissemination.	Newsletters distribution. National campaigns.	No active communication. Few tools.
Inter-Organizational	Inter-organizational learning		Difficult coordination, but there is a safety department.	Summer workshops for municipalities
	Two-way communication	Citizen feedback through on-site visits. Awareness workshops.	Citizen feedback through field visits. Evening events to simulate scenarios.	Joint projects with municipalities and professionals
	Co-creation	Discussion events. Bottom-up approach	Interest in activating residents. Legal compliance required.	Representatives of local stakeholders
Organization	Supportive Leadership	Responsible leadership	Need for a leader as efforts divided	Innovative leaders
	Organizational Structure	Decentralized by law but defined responsibilities	Decentralized implementation	Size slows down implementation. Interest in cross-collaboration
	Presence of slack resources	Outsourcing tasks. Reasonable costs if there is budget	Small budget. Need for staff	Large financial resources Capacity needs to be allocated
	Supportive culture	Concrete plans and expectations	Political dependence	Slow innovation adoption
	Easy training for employees	Short training necessary	Usage for internal training	Basic training for volunteers

(continued)

Table 3. (continued)

Innovation	High ease of use	High accessibility, Low complexity	Challenging game	Target group dependence
	Absence of security/privacy issues	Data safety & IT compliance	Data safety concerns	Need for anonymity
	Low implementation costs		Short budget	
	High compatibility	Support in responsibilities, equity/inclusivity	The game frame should fit the relevance	
	High perceived usefulness	First, raise awareness. Then, co-creation	Communicate local risks and actions to take	All three objectives, but awareness at first
Innovation	High relative advantage	High versatility	New working way	Positive effect on players. High versatility
	High trialability	Test possibility	Pilot tests	
Individual	Personality characteristics	Certain enthusiasm	Positive expectations	Positive acknowledgment High enthusiasm
	Public servant skills	Outsourcing	Present skills	
	Innovation resistance	Trust issues	Framing importance	Value conflict
	Demographic Aspects	A diverse population reach with various types of activities	Average education to play, but additional information needed	Open community
Political	Plan-based communication	Strategy importance	Prioritization need	Strategy importance
	Innovation program fit	Framing innovation	Main assignment	No priority

5 Discussion

Three main considerations for adoption emerged, based on which game prototype adjustments and diffusion should be planned. First, a new category emerged—politically related factors—which, despite overlapping with organizational factors, highlights the complexity of adopting innovations to meet social demands [25]. The politics category also shows that the innovation steps proposed by Rogers [23] are framed at the individual level. However, the decision process is more complex as organizations have

goals, regulations, and informal practices that shape the process [34]. In this context, WhereWeMove should align the gameplay with the wider guidelines of higher government levels. The gaming approach should further have the endorsement of provinces or large municipalities as early opinion leaders for further adoption. Overall, the municipal councils approve the strategies for communicating with residents and require coordination from municipality staff on the overall process, as supportive leadership, culture, and the internal provision of resources are necessary. Alternatives to experiment with the game and observe some of its effects were found in the learning communities set by the province across municipalities and for the internal training of municipal staff. Second, as much of a government support dependence, having concrete implementation plans was of utmost importance while managing expectations of what is possible (or not with the innovation). These plans should be tailored by the organization. In alignment with the needs for games in flood risk management [17], on one side, the game should include the integrated management needs of the municipality, not focusing only on floods. Conversely, suggestions were to reduce the complexity to make the game as inclusive as possible. This suggestion requires choices about what to include or not to keep the game relevant for the adoption context. Moreover, the game frame should consider strategies to support players in taking responsibility for acting and accounting for equity aspects. Third, interview results show the priority set by all management organizations on raising awareness over co-creation to envision strategies for strengthening residents' action capacities or exploring the effectiveness of possible policies. For such an aim, players are conceived as a limited group of professionals and resident representatives at the municipality or advisory organizations, and with students as future professionals.

6 Conclusions

This study allowed us to identify key factors that should be present or pursued for the WhereWeMove game adoption. There are three main antecedent factors to tackle. First, political support can be obtained through a plan-based communication strategy that aligns with the innovation needs of the municipalities. Second, organizational readiness is considered through the availability of resources to support the implementation or by offering the possibility to outsource when necessary. Lastly, fine-tune the game readiness by critically considering which adaptations can improve its relevance, manage the complexity, and ensure the effectiveness of the game play for players and coordinating organizations. Although the factors considered relevant in this study align with more recent meta-analyses [25], future research should verify their relevance by including more regions and interviewees per municipality, or examining how gameplay experience influences game adoption perceptions.

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