Thomas Rehder

Enhancing Municipal Flood Risk Communication and Community Adaptability Through Serious Gaming

A Case Study of the 'WhereWeMove' Game

TU Delft

Enhancing Municipal Flood Risk Communication and Community Adaptability Through Serious Gaming

A Case Study of the 'WhereWeMove' Game

by

Thomas Rehder

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TU Delft

Acknowledgments

As this university adventure draws to an end, I want to express my sincere thanks to everyone who supported me throughout this journey. The past two years in the Management of Technology program have been both challenging and rewarding. While the first year taught me the basics, the second allowed me greater freedom, particularly in the selection of my thesis topic. As I was interested in the country's geographical aspects, the subject of flood risk management, based on the use of a serious game, seemed both interesting and tangible to me. Working on this thesis presented its own set of challenges, particularly in integrating theoretical concepts with practical applications. The organization of game sessions and interviews also proved complex and required methodological and time-related readjustments to suit everyone's schedules. However, these challenges were also opportunities to deepen my understanding of both flood risk management and the innovative use of serious games. The process taught me the importance of flexibility and creativity in problem-solving.

First and foremost, I want to thank my supervisors, Dr.ir. V.J. Cortes Arevalo and Dr.ir. G. Bekebrede, for their guidance, encouragement, and insightful feedback throughout this research. I especially appreciate the time they took to help me steer this project in the right direction. I also express my gratitude to the municipal and provincial staff for taking the time to answer my questions and support me in this project.

Finally, I would like to thank my family and friends, who have been there for me through the good and difficult times over the last few months. Working with all these people has shaped me, helping me grow and see things in new ways that I will take with me into the future.

Thomas Rehder
Delft, August 2024

Executive Summary

The Netherlands is exposed to fluvial and pluvial flooding aggravated by the subsidence of the land, which pose significant threats to the population. Flood risks due to climate change are a growing concern, especially in urban and riverine areas. The responsibility for the consequences of extreme weather events lies unidirectionally on the shoulders of the state, which can no longer guarantee the safety of its inhabitants. This thesis explores the use of serious games as a tool to enhance municipal flood risk communication and community adaptability in order to achieve a shared responsibility.

The research is carried out using the "WhereWeMove" serious game case study, developed to simulate flood scenarios and the homeowner's decision-making process involved in flood risk management. The thesis seeks to answer the following research questions: *How can municipalities use gaming, such as "WhereWeMove," to communicate with residents about the flood risks and related house adaptive measures? What are the implications of using such a gaming approach for the municipality? How can municipalities better involve citizens in co-creating flood risk management strategies through gaming?*

To meet the research objective, a theoretical framework was used as a reference to identify key influential categories for the adoption of innovations by government organizations. The reference framework outlines five categories, with a focus on the organizational, individual, and innovation categories. The environmental category was primarily used as criteria for selecting the area of interest for this study, while the inter-organizational category was narrowed down to communication and co-creation practices, aligning with the focus of the WhereWeMove game.

To explore the way and extent in which the WhereWeMove game could be used as a communication tool, this thesis addresses the research questions through a dual qualitative analysis. The first step aimed to identify the extent to which co-creation is facilitated, based on results from a preliminary WhereWeMove session with students, conducted prior to playing the game with residents. The second step involved conducting interviews with municipal staff involved in planning adaptation strategies, to explore the perceived drivers and barriers to adopting the WhereWeMove game in their current practices.

In conclusion, the thesis demonstrates the potential of serious games as a transformative tool in municipal flood risk communication. By using the model resulting from the practice and theory, organizations can identify the key influential factors and transform barriers into drivers in order to use serious games within their institutions. Engaging citizens through interactive debriefing and collaborative gaming experiences allows co-creation with municipalities, enabling them to work together to test and refine policies, ultimately fostering a culture of preparedness and shared responsibility.

Table of Contents

List of Figures

List of Tables

1. Introduction

The climate emergency has taken on an increasingly important role in our society in recent years. This term refers to the urgent need to address climate change and its widespread impacts, including rising temperatures, extreme weather events, and sea-level rise. In this context, communication is a key measure to help people understand the severity and immediacy of these issues (Goldberg et al., 2022). More and more people will face challenges in protecting their property. Particularly concerned are those living in urban and suburban areas during river and rainfall floods. These events are becoming not only more frequent but also more damaging, causing significant property losses and even endangering lives. Therefore, it is crucial to establish a shared responsibility between municipalities and residents.

The flooding of July 2021 in the province of Limburg in the Netherlands, demonstrated that despite public defense infrastructures such as natural protection, vegetation and dikes, individual safety cannot always be guaranteed by the state in the event of a natural disaster (Koks et al., 2022). For this reason, residents need to become aware of their exposure to riverine and pluvial flooding as well as having a more active role in implementing private adaptive measures or reconsidering their living location. It is therefore necessary to find an intermediary to raise awareness of these potential events, which could be handled by the province or, more specifically, the municipality. The active involvement of these government institutions is crucial, as they need to take the initiative in coordinating and combining necessary strategic communication efforts. These institutions oversee various aspects of societal functioning for their inhabitants, ranging from quality of life to transportation, but most importantly, they ensure the safety of their citizens (Moustakas, 2023).

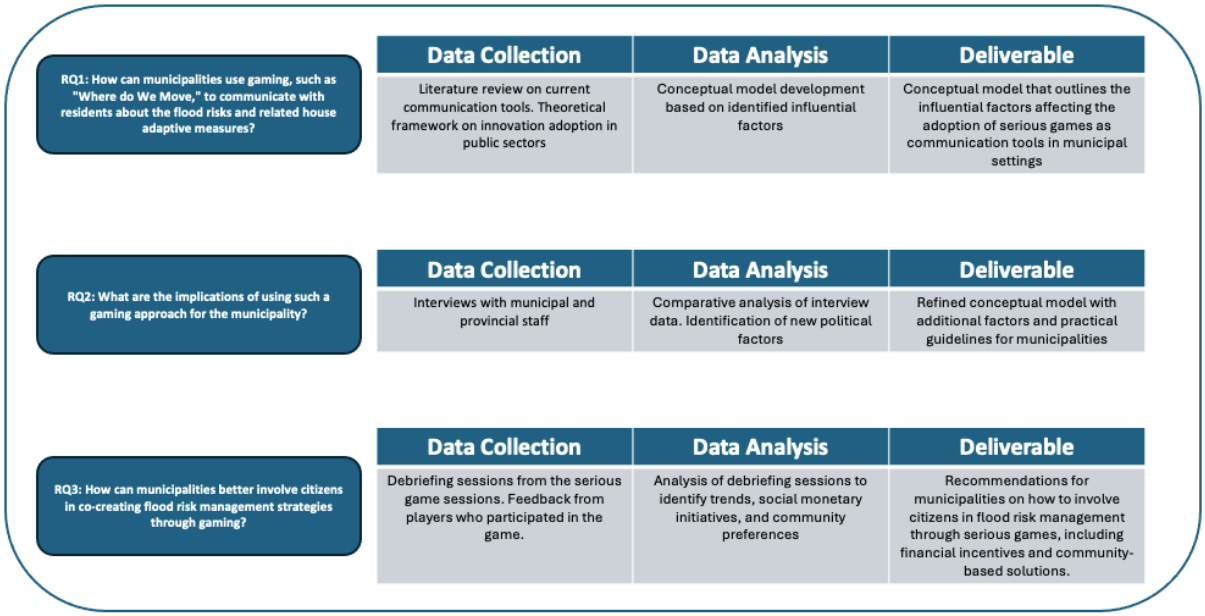
Municipalities face significant challenges in promoting a shared responsibility for flood preparedness. These include a limited understanding of residents' motivations to take action, a lack of effective proactive measures, and insufficient awareness among residents about their risks and options (Kuhlicke et al., 2020) Encouraging a shift towards more adaptive behaviors requires effective communication. However, current communication strategies often fall short in several key areas. They primarily focus on response and preparedness measures rather than encouraging residents to adapt their individual practices and properties. They do not adequately consider that most people have not yet experienced severe flooding and therefore cannot fully imagine its consequences, and they fail to sufficiently explore the social norms, attitudes, and preferences that drive people to take adaptive actions (Forsyth et al., 2023). In order to communicate and prepare residents as effectively as possible, it is therefore of major importance to find a way to raise awareness of possible flooding events, as well as to support the homeowner's decision-making process in these circumstances. One innovative approach addressing this need is through the use of serious games. In theory, serious games can help raise awareness and educate players about

problems they might face in the real world, enabling them to be proactive in both policymaking and implementing practical protective measures. In practice, such games need to be adopted and customized by relevant organizations to better serve their purpose (Flood et al., 2018).

Scientific Relevance: The factors influencing the adoption of serious games have been extensively studied in educational (Malaquias et al., 2018) and corporate environments (Azadegan et al., 2012). However, there is a significant research gap into the factors influencing the adoption of serious games in a public organizational setting.

Societal Relevance: The WhereWeMove game development started in 2023 with a preliminary design that was first assessed via an MSc thesis study. Challenges in their usability were addressed by developing a game website. Further adaptation of the game to better fit the needs for communication of municipal organizations are planned. However, the focus of the next development stages are to be informed based on the priorities identified from these study.

The thesis is structured as follows: The second chapter addresses the problem statement, outlining the various challenges and providing a comprehensive overview of the research objectives and research questions. The third chapter delves into the theoretical background and discusses the theoretical framework to be used and its application to the main core concepts and existing literature of the research. In chapter 4, the focus shifts from the theory to the practical methodology, outlining the systematic steps and procedures to be followed to validate the theoretical influential factors, providing a detailed description of the research design and data collection methods used to ensure the robustness and reliability of the collected results. Chapter 5 looks at the data analysis, outlining the results derived from the qualitative research data, followed by a discussion and reflection of the results in chapter 6, considering their relevance and significance within the broader context of flood risk management. Chapter 7 is a conclusion, summarizing the key findings of the study, reflecting on the research process, and suggesting potential areas for future research.



2. Problem Statement

The municipality faces a set of technical, institutional, and social challenges that need to be addressed. Technically, there is a need to improve infrastructure resilience and implement advanced warning systems (Perera et al., 2020). Institutionally, municipalities must balance public infrastructure needs with private adaptations, engaging residents and navigating regulatory and resource challenges in a collaborative way. Socially, it is essential to promote a shared responsibility in taking into account the residents' perceptions and capacities (Van Der Graaf et al., 2021). Addressing these challenges would enable the implementation of common infrastructures and the establishment of policies and incentives for individuals. All of this must be carried out within a defined legal and ethical framework that meets the community's need for access and fairness. To get support in addressing these challenges, municipalities have an interest in changing the adaptive behavior of residents, from inaction to a sense of urgency and the ability to protect and prepare for riverine and pluvial flooding (Endendijk et al., 2023). Changing behaviors requires effective communication. The balance lies in communicating effectively to inform residents without inciting unnecessary fear or panic.

2.1 Technical challenges

Climate change has taken on increasing proportions in the past few decades. In addition to constant rising temperatures, which could increase by 1.1 to 5.4 degrees by 2100 according to Climate.gov (2024), violent metrological events such as floodings are also becoming more frequent (Najibi & Devineni, 2018). The study revealed that the frequency and duration of long-lasting floods have increased worldwide. This trend is particularly evident in the tropics (equatorial region), where the flood frequency has quadrupled since the 2000s, and in the northern mid-latitudes (European continent), where it increased by a factor of 2.5. The Netherlands is one of the countries that is particularly affected by these metrological variations with more than a third of its territory below sea level, at depths of up to 6.7 meters (Ugc, 2024). The negative altitude on its own is not the main threat faced by the country. In fact, Death Valley in US Nevada lies up to 86 meters below sea level and does not experience a flood risk of this kind (Ecology of Death Valley National Park, 2024). The risk arises mainly from the country's high population density, latitude and proximity to the sea with large river deltas stretching far into the country.

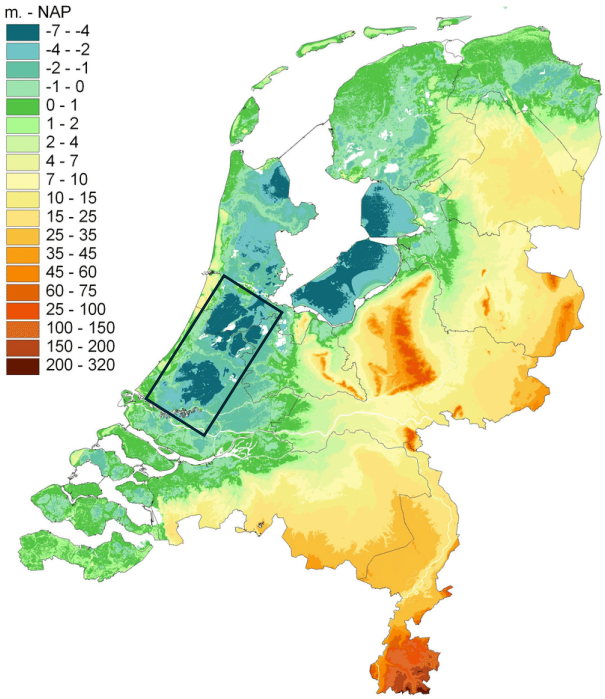


Figure 2.1: Topographic map of the Netherlands elevation (Blom-Zandstra et al., 2009)

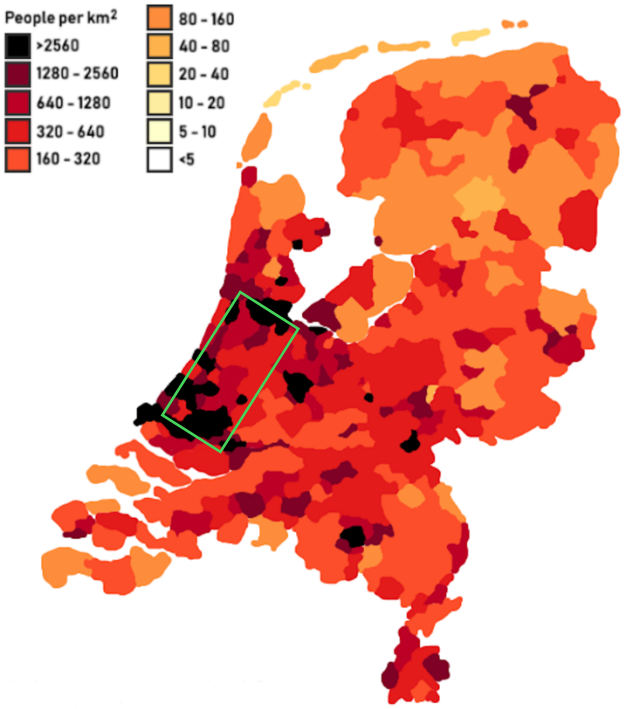


Figure 2.2: Population density map of the Netherlands (Citypopulation, 2020)

The two figures (2.1) and (2.2) provide an overview of the flood risks faced by the country, largely due to its geography and density. A large part of the Dutch population is located within the rectangle shown above, encompassing parts of the two provinces of Zuid and Noord Holland, with more than 6 million inhabitants or 35% out of a total population of 17 million (Netherlands: Number of Inhabitants, by Province 2023 | Statista, 2023). This densely populated area poses a threat to the population due to its proximity to the sea and negative altitude of between 0 to -7 meters (Figure 2.1). In addition to the melting ice cap and rising sea levels that the country will have to contend with over the next several years due to global warming, there are two other types of floods which poses a greater risk in the short term. Fluvial and Pluvial flooding are interconnected and are often the cause of natural disasters in the Netherlands arising from climate disruption.

2.1.1 Fluvial flooding

Fluvial flooding, also known as river flooding, occurs when excessive water fills river channels and overflows their banks. This phenomenon is mainly due to factors such as heavy rainfall, melting ice and snow, upstream water flow changes, flow obstruction, and dam failure (Kundzewicz & Pińskwar, 2022). This specific type of flooding is a significant concern, due once again to the geographical aspect of the country. Located near the delta of three major European rivers (the Rhine, the Meuse, and the Scheldt), the Netherlands faces a major risk

in the event of severe metrological conditions. The figure 2.3 below highlights the flood prone areas, in particular riverine flooding which can be identified in light blue along the rivers and around the red circle marking the delta. River flooding typically develops more slowly, in the sense that the water rises on a moderate scale, whereas in the opposite situation the evacuation is equally slow, taking anywhere from a few days to a few weeks (Tanaka et al., 2020).

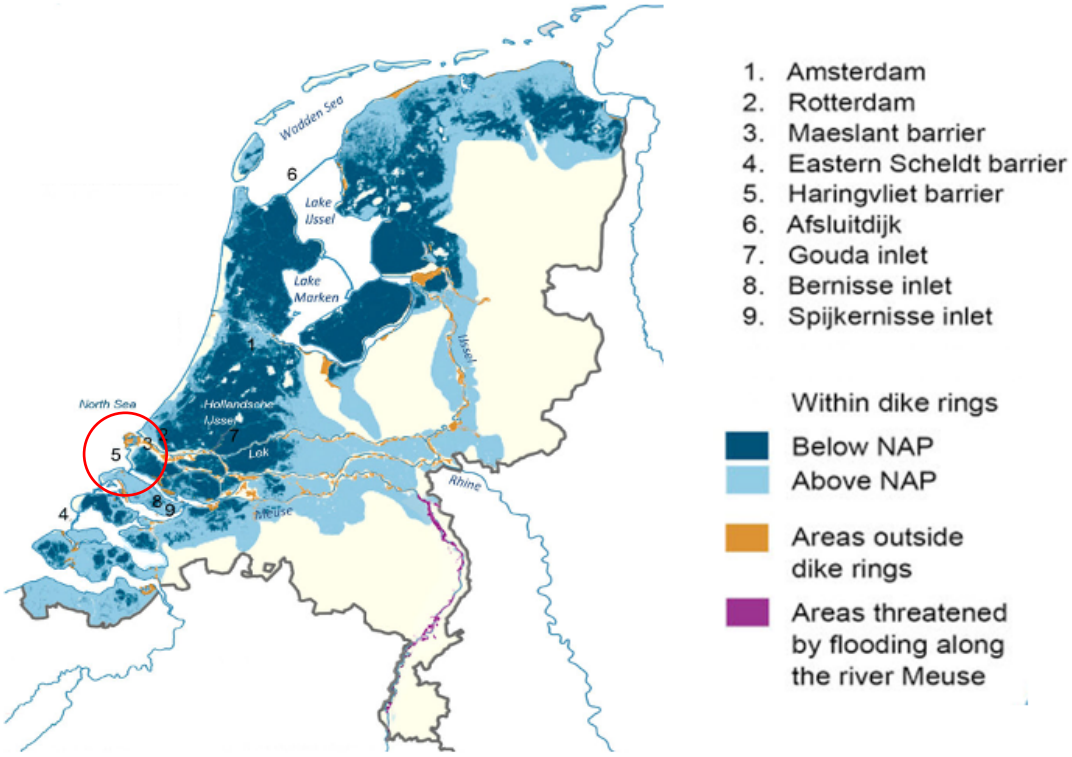


Figure 2.3: Map of the Netherlands showing flood prone zones (Haasnoot et al., 2020)

Throughout its history, the country has had to face challenges and carry out colossal infrastructure projects to ensure the security of its land and residents. The Dutch national and provincial government turned to floods risk management strategies that have been based on reducing the probability of coastal and riverine flooding by dividing the country into dyke-ring areas (Ritzema & Van Loon-Steensma, 2017). These areas are protected through a closed system of dykes, dunes, dams, barriers, and natural high ground, also known as the polder approach. This approach not only involves protection but also active management of water levels in these areas using pumps, canals, and flood defenses (Nillesen & Kok, 2015). While protective measures can be implemented along large rivers, their implementation is limited in smaller tributaries and channels, necessitating localized measures to protect private property, such as private houses that might be exposed. As a result of large public protection, the risk perceptions of citizens in the Netherlands about this type of flood are low. Expensive measures, such as raising or adapting the ground level to accommodate potential floods, might be necessary but cannot be implemented universally without private support (Dillenardt et al., 2021). The difficulty in this kind of gigantic project lies in finding the right

balance to evacuate the accumulated water inland, so as not to cause a "bathtub" effect where the accumulated water cannot drain away. The underground water drainage and the increasing construction of new buildings lead to a phenomenon known as subsidence, which causes the ground to sink, thus leading to an increased vulnerability (Stouthamer et al., 2020).

2.1.2 Pluvial flooding

Pluvial flooding occurs when the amount of rain exceeds the drainage capacity, leading to an accumulation of water on the surface that cannot be discharged properly (Guerriero et al., 2017). The cause of such events is due to many factors but can be summed up in four key points as far as the Netherlands are concerned. The first factor is climate change, which has led to a change in rainfall patterns in Europe in the recent times. Over the past 50 years, the intensity of the precipitation, such as heavy rain events, has increased and these events are becoming more frequent (Vrac et al., 2022). This is partly attributable to the warming of the earth's atmosphere, which results in greater moisture retention, leading to heavier precipitations. Future rain precipitations are expected to evolve in a non-linear way and will be more intense. It is estimated that in 50 years' time, periods of heavy precipitation will double, or triple compared with today, resulting in more significant pluvial floods (IPCC, 2024). The second cause can be attributed to the urbanization and densely populated area that covers much of the country. To understand how this affects the risk of rain flooding, one must first look at the surface on which the infrastructure are build. The ground is a natural absorbent due to its soft permeable nature which makes water drainage easier. Conversely, increased urban development with insulating materials such as concrete, asphalt and metal covering a large surface of urban areas results in a greater difficulty in absorbing the excess rain water (Costa et al., 2021). The third factor derives from the second and is based on infrastructure limitations. A large number of drainage and sewage systems are outdated and not adapted to this kind of climate phenomenon. This factor can also be accentuated by the historical aspect of cities, erected centuries ago, with their ancient buildings and city plans making water drainage management more challenging. The fourth cause is related to the terrain's topography. The natural low-lying areas of the Netherlands are prone to water accumulation. As mentioned above, the accumulation of this water will be trapped just as in a fluvial flooding event with the bathtub effect and will have difficulty being redirected out of the land, given that the country is protected by dikes higher than the country's average altitude.

2.1.3 Subsidence

Both types of flooding are further intensified by a phenomenon briefly discussed in the previous sections known as subsidence, A process influenced by both natural and human activities, resulting in a downward vertical movement of the Earth's surface. The importance of this phenomenon is often underestimated, yet it causes major material damages and is a

vector that fosters the flooding retention and intensity. Human factors are the main cause of this type of phenomenon and result from the extraction of liquids, gases and materials from the soil (Candela et al., 2022). The primary cause is the lowering of the groundwater level in order to dry out the soil and make it habitable. In addition to this, the extraction of gas, oil, and salt plays a significant role, as it creates a cavity and causes the weight of the soil to pile up, filling the void.

Another less significant but nonetheless pervasive cause is a natural phenomenon known as the glacial isostatic adjustment. GIA is a geological process that has been affecting ground elevation for thousands of years. Also known as post-glacial rebound, it is driven by the redistribution of land mass in response to the melting of the Ice Age glaciers (Simon et al., 2021). The enormous weight of the ice cap has pushed down the European continental landmass, causing the ground level to fall and leading to an increase in land level around the glacier's periphery, compensating the vertical movement. The Netherlands, at the edge of the ice cap, therefore experienced a rise in land level over a period of 100,000 years. The ice cap's disappearance freed the land from the pressure exerted by the frozen surface, leading to a reverse movement that resulted in a rise in elevation of the continental land, and a fall in elevation of the land around the edge of the cap, explaining the natural phenomenon of subsidence in the Netherlands (Figure 2.4). The subsidence associated with this natural phenomenon occurs at a slower rate than human activity but cannot be prevented in the long term.

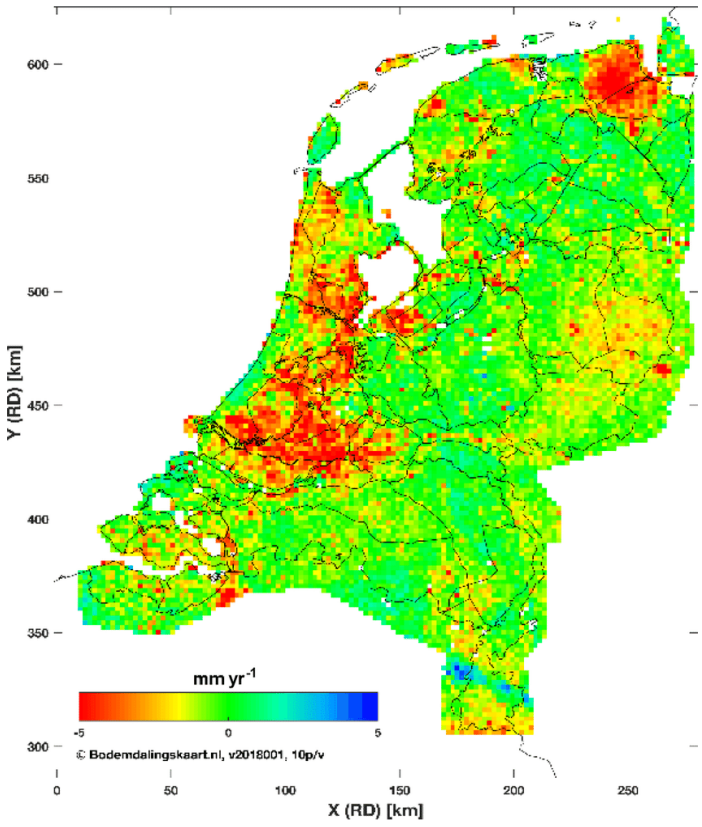


Figure 2.4: Annual land subsidence rates in the Netherlands (Van Gils et al., 2020)

Despite public protection measures such as dams, polders and advanced warning systems, the risk of flooding is set to increase due to the combined effects of rising sea levels, land subsidence and increased river discharges, presenting a threat to the environment (Ritzema & Van Loon-Steensma, 2017). In response to such major climate-related events, municipalities are exploring various strategies to communicate and manage flood risk effectively. It is their responsibility to ensure the well-being and safety of their citizens. To tackle such crucial issues, there is a growing need for innovative approaches that engage the community and individual responsibility alongside municipal effort.

2.2 Institutional challenges

Municipalities face several institutional challenges in managing and communicating flood risks, particularly as they try to balance responsibilities between public infrastructure (technical) and encouraging private property-level adaptations (social). These challenges results from the need to engage effectively with residents, navigate complex regulatory frameworks, and manage the distribution of resources. Institutions need to understand their residents' expectations to come up with solutions (policies/infrastructures) that are both economically and socially viable. It is a balancing act of negotiation that can only be achieved within a collaborative framework. Such a setting can be established with the help of a co-production model, which aims to tackle these challenges through different prisms between the stakeholders.

2.2.1 The Co-production Model

The co-production model in local government put forward by Van Der Graaf et al. (2021) can be applied to this study and emphasizes a structured yet dynamic approach to collaboration between stakeholders. This model is tailored to address the institutional and social challenges in flood risk management through the components of Context, Process, Codification, Capacity and Outcomes.

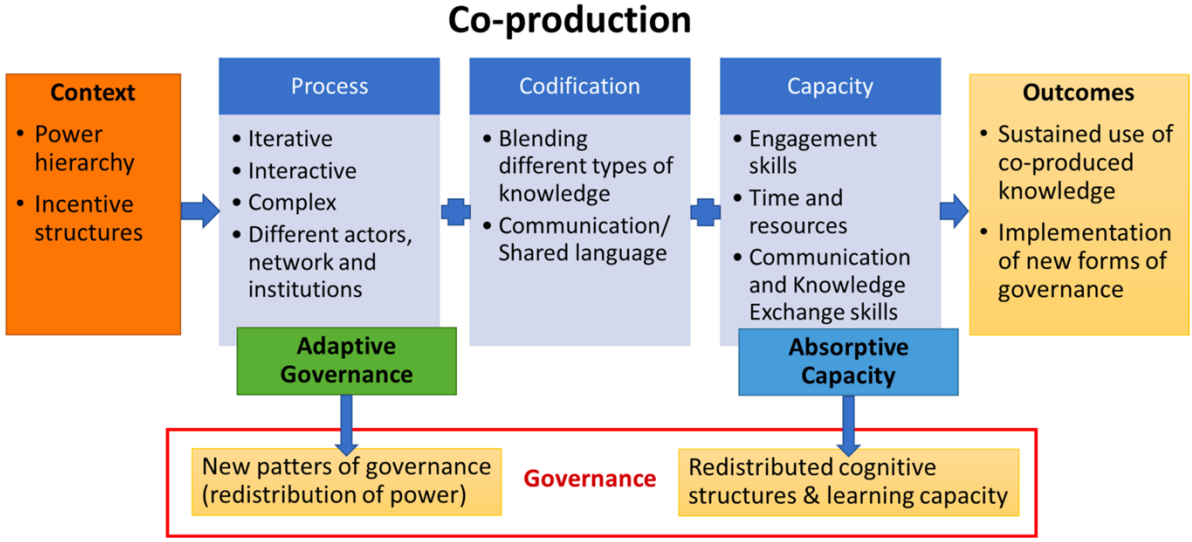


Figure 2.5: Co-production Model (Van Der Graaf et al., 2021)

Context:
The local context provides the foundation for understanding the technical, social and institutional dynamics of communities. This ensures that flood management strategies are tailored to the unique needs and characteristics of the community, making them more relevant and effective. A contextual understanding of the situation enables the identification of the communities' strengths and vulnerabilities.

Process:
The process component involves iterative and interactive engagement among all stakeholders. This ensures that the collective knowledge and experiences of community members (including residents, governments) are systematically integrated into flood management approaches. The high degree of interactive engagement drives a strong sense of ownership and commitment among all stakeholders which is fundamental for an effective implementation of flood management initiatives.

Codification:
Codification is a step leading to the organization and transformation of insights and experiences gathered from stakeholders into structured, actionable knowledge that can be effectively utilized by municipalities and communities. This step can be seen as a funnel that organizes knowledge into concrete plans, such as new policies and practices.

Capacity:
Capacity building is also crucial in the co-production process as it involves enhancing the skills and knowledge of the stakeholders, enabling them to engage more effectively between each other or in a particular situation like floodings.

2.3. Social challenges

2.3.1 Perceptions and Capacities of Citizens

Flood risks are not just a technical or institutional issue but also a social one, deeply influenced by the perceptions and capacities of the citizens affected. The perception of flood risk is not the same for everyone and varies according to factors such as past experience, media exposure and level of trust in local or government authorities. These perceptions significantly affect how individuals prepare for and respond to flood warnings. For instance, communities that perceive a high risk of flooding are more likely to engage in proactive measures, whereas those with a lower perceived risk may be less prepared (Lechowska, 2021). The citizens' capacity to respond optimally encompasses their risk awareness (overall knowledge), information on a disaster response plan, evacuation route when advised by local authorities, and access to resources such as emergency supplies (National Center for Disaster Preparedness, NCDP, 2024). A study by Steratore et al. (2023) highlights the importance of a tailored risk communication strategy to enhance understanding and adherence to protective actions. In contrast, the capacity of these groups to respond to flooding is lower among vulnerable populations, such as the elderly, people with disabilities, low-income households, and households in climate sensitive areas. These disparities in vulnerability may continue during the flood itself, increasing the risks for these populations.

2.3.2 The Role of Co-production in Addressing Social and Institutional Challenges

According to the study carried out by Van Der Graaf et al. (2021) the risk perception and capacities of the citizens and institutions can be positively influenced through co-production. Van Der Graaf et al states that “Creating collective spaces for reflection in between government departments allows for iterative, interactive processes of co-production with external partners that support emergence of new governance structures to socially action the co-produced knowledge in context and build capacity for sustained evidence use.” (p.1). Given the similarity of the study carried out, having a joint collaboration between government and citizens can effectively address the institutional and social challenges associated with flood risks. The benefits of co-creation are numerous and translate into trust building and engagement, inclusive planning, capacity building and adaptive governance between residents and governments.

The use of a co-production communication mechanism fosters engagement with the communities involved and thus strengthens links between parties while also building trust, ensuring that local knowledge and concerns are integrated into flood management strategies. The definition and perception of flood risk can then be argued and aligned between residents and government bodies, leading to more effective and balanced communication.

The co-production exercise involves various community members in planning joint solutions. It ensures that the needs and capacities of all groups are considered. This is particularly important for the vulnerable population. This inclusion can lead to the development of tailored interventions that enhance overall community resilience.

The work carried out collectively between residents and governmental organizations leads to a phenomenon of capacity building, improving residents' ability to respond to flood risk. Educating the community about flood risks and response strategies empowers individuals and fosters a culture of preparedness.

Co-production promotes an adaptive governance that emphasizes a shared responsibility between the two parties, creating an iterative, interactive process of knowledge production. This enables governmental organizations to keep up to date with stakeholder expectations and refines their strategies based on community feedback.

2.4 Serious games as communication tool

Serious games are not just about being entertaining, they also serve a primary educational and communicative purpose. In the context of flood risk management, serious games serve as an innovative communication tool that can bridge the gap between technical knowledge and public understanding. This communication tool seems theoretically suited to the co-production model, given that it allows for the integration of different building blocks (process, codification and capacity). The "WhereWeMove" serious game is designed to address the various challenges mentioned above, with an approach that leads to the co-creation process further elaborated in the discussion.

2.5 Research objective

Municipalities struggle with informing their citizens about flood risks. The aim of this research is to assess the current communications approaches and evaluate the process and impact of integrating the "WhereWeMove" serious game into municipal flood risk communication strategies. This research aims to identify the organizational, technological, and communicative challenges and opportunities municipalities face in utilizing the serious game technology to improve public communication and engagement on flood risk management. In this research context, "WhereWeMove" is seen as a tool designed not only to communicate about flood risks to residents, but also to support the implementation of public/municipality risk management practices as well as monetary incentives. The game offers the municipality a safe environment to explore possible policies for strengthening resident's action capacities. The research will be carried out in accordance with the MOT criteria, taking into account the entrepreneurial aspect considered here as governmental institutions (provinces, municipalities) and the technological aspect with the use of serious games.

2.6 Research questions

The research objective leads to three research questions that the study seeks to answer:

RQ1: How can municipalities use gaming, such as "WhereWeMove," to communicate with residents about the flood risks and related house adaptive measures?

RQ2: What are the implications of using such a gaming approach for the municipality?

RQ3: How can municipalities better involve citizens in co-creating flood risk management strategies through gaming?

3. Theoretical Background

This chapter addresses the theoretical framework and the existing literature on the research subject. The literature review will be divided into three core concepts, notably communication tools, municipal organization, as well as serious games in disaster management. Analyzing these concepts from the conceptual framework's point of view will lead to the identification of theoretical barriers and drivers that will be assessed in the following chapters.

3.1 Theoretical framework

The framework to be used derives from a meta-synthesis article of literature about the diffusion and adoption of innovations in the public sector (De Vries et al., 2018). It is based on the theory developed by Everett Mitchell Rogers in 1962 on the adoption and diffusion of Innovation, which seeks to explain how, why, and at what rate new ideas and technology spread. De Vries et al. (2018) provides a comprehensive synthesis of the existing literature to give a wider overview of what has been researched in terms of models until now and refers to "what" are the categories and influential attributes for the diffusion and adoption of an innovation.

Roger's theory is based on the assumption that adoption is a social process, strongly influenced by social interactions between individuals within a society. Adoption is defined as "the sequence through which an individual (or other decision-making entity) transitions from initial awareness of an innovation, to forming an attitude about it, to deciding whether to adopt or reject it, to implementing and using the new idea, and finally to validating this decision" (Rogers, 2003). Influential factors can both promote or hinder the diffusion of innovation and vary according to the sector of application in which diffusion takes place. In other words, the private and public sectors have different influential factors/variables which must first be identified. In this article the writings and theories are divided into three subfields of analysis: public management, public policy and e-government. These three components are based on partly different factors. The e-government literature is based primarily on technological innovation processes, while the public policy literature is primarily based on governance innovation and conceptual innovation. The public management component is more general and encompasses elements of both governance innovation and technological innovation. Together, these three components constitute the public sector.

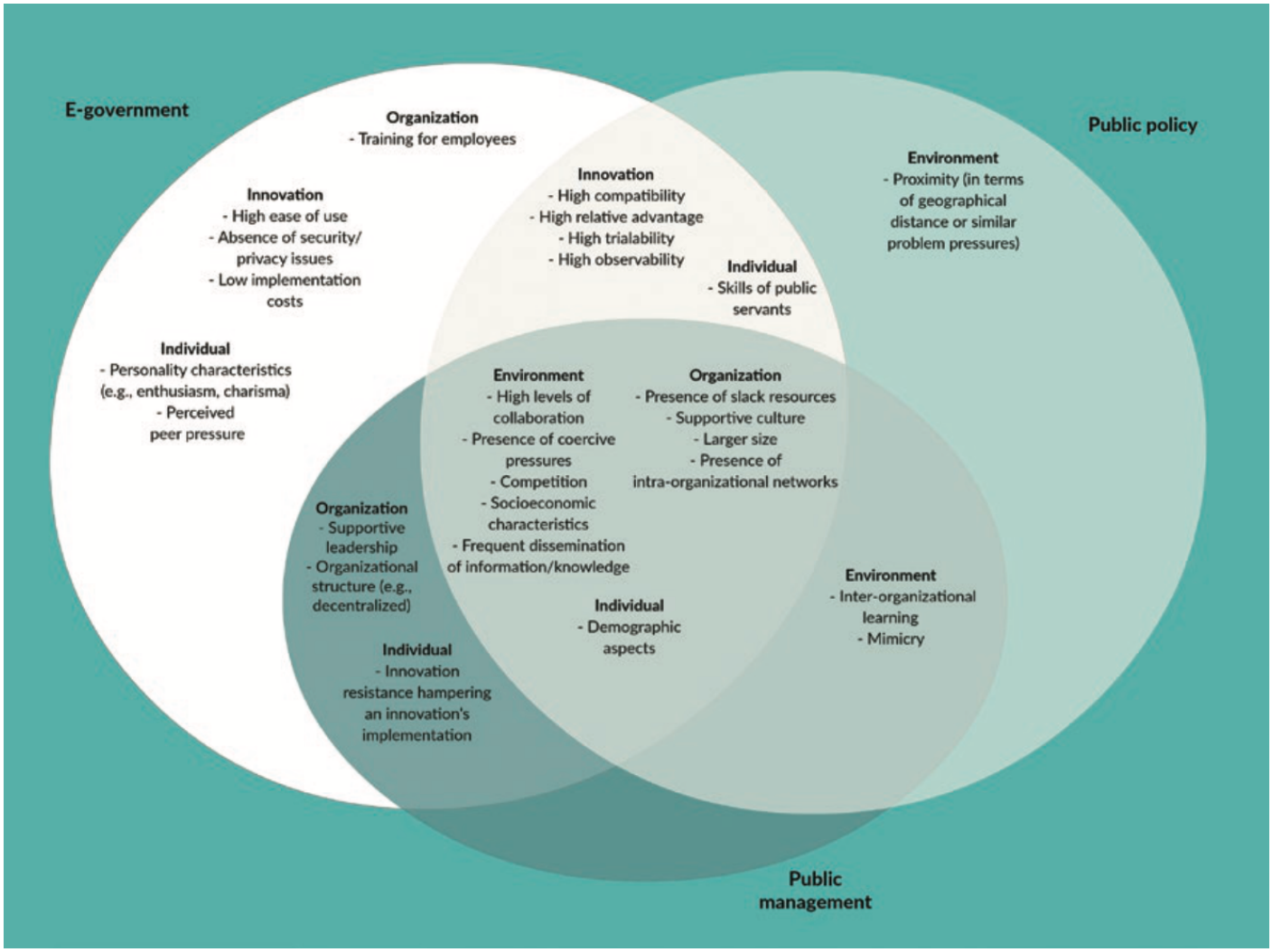


Figure 3.1: Theoretical framework featuring the complete range of influential factors, leading to an increase in innovation adoption (De Vries et al., 2018)

The framework is based on the assumption that the three subfields of analysis form a whole that represents the public sector. The literature has identified the variables, also known as influential factors, that enable the diffusion of innovation in the public sector. These variables are grouped into categories (aspects) known as Environmental, Inter-organizational, Organizational, Innovation and Individual.

3.2 Conceptual framework

Search Strategy

The above-mentioned framework forms the foundation and starting point of the research. Compatible with the MOT criteria and given the relevance of this framework in the field of study, it has been adapted to answer the research questions and focuses on the diffusion and adoption of serious games (a form of technological innovation) within a municipal context

(public organization). The variables or influential factors leading to the diffusion and adoption have been identified in the literature encompassing the three core concepts, namely communication tools, municipal organization, as well as serious games. The identification of relevant variables required a rigorous approach to ensure the validity of the academic literature review.

To achieve this, the literature research was conducted across a wide range of databases, including Google Scholar, Scopus/Elsevier, JSTOR, and Web of Science. The search terms used have been selected to ensure an extensive coverage of a wide range of peer-reviewed articles in order to determine the patterns or influential factors that most often emerged, as well as those that simply weren't there. Keywords such as “flood risk communication”, “flood mitigation strategies”, “flood risk awareness”, “effective communication”, “(Dutch) flood risk communication tools”, “(Dutch) flood risk communication strategies”, “two-ways approach”, “(Dutch) municipal responsibilities” “(Dutch) municipal organization”, “(Dutch) municipal communication strategies”, “serious games as communication tool”, “serious games and flood risk awareness”, “co-creation in serious games”, “serious games in municipal organizations”, “social learning outcomes of serious games" were employed to capture both broad and specific literature with the primary aim of determining the state of the art in terms of communication tools, municipal organization and serious games, as well as establishing the variables relevant to the resulting model. The selected articles resulting from the search terms were based on the last 10 to 15 years. Some articles, however, have a seminal function, laying the foundations on which future concepts or models are built, such as the Mitchell Rogers model developed in 1962 and still relevant today. The sources have been peer-reviewed and published in English, aiming to provide academic rigor and support the relevance of the research results.

3.2.1 Communication

Flood risk communication

As climate change is causing increasingly severe damages due to its growing frequency and intensity, government institutions have had to turn their attention to flood risk communication strategies in order to mitigate the situation (Rainear & Lin, 2021). De Boer et al. (2015) state that effective communication about climate change and related risks is complicated by the polarization between ‘‘climate alarmists’’ and ‘‘skeptics.’’ The implementation of climate risk communication strategies must therefore strike a balance between alarming the public and trivializing the situation. Before looking more closely at existing strategies, it is important to clarify what is understood by the term flood risk communication. According to Da Fonseca et al. (2022), it involves an information and experience exchange among different social actors. Flood risk communication is intended to identify high-risk areas and reach as many people as possible living in these conditions,

notably the most vulnerable. This is done in order to gather knowledge about the phenomenon so as to develop appropriate strategies to be prepared for future flooding events.

Flood risk communication is a critical component of managing the increasing threat posed by climate change-induced flooding. Lindell and Perry (2011) provide a crucial perspective for understanding the cognitive and behavioral mechanisms that determine individuals' responses to flood risk. Their approach explains how individuals process threat information, assess their vulnerability, evaluate the effectiveness of protective measures, and ultimately make decisions to protect themselves against environmental risks. This perspective underscores the importance of clear, credible, and actionable information in motivating individuals to adopt protective measures. Additionally, it offers a way of assessing the risk profile of residents and evaluating how municipalities can communicate the danger without causing undue fear or discomfort among their population.

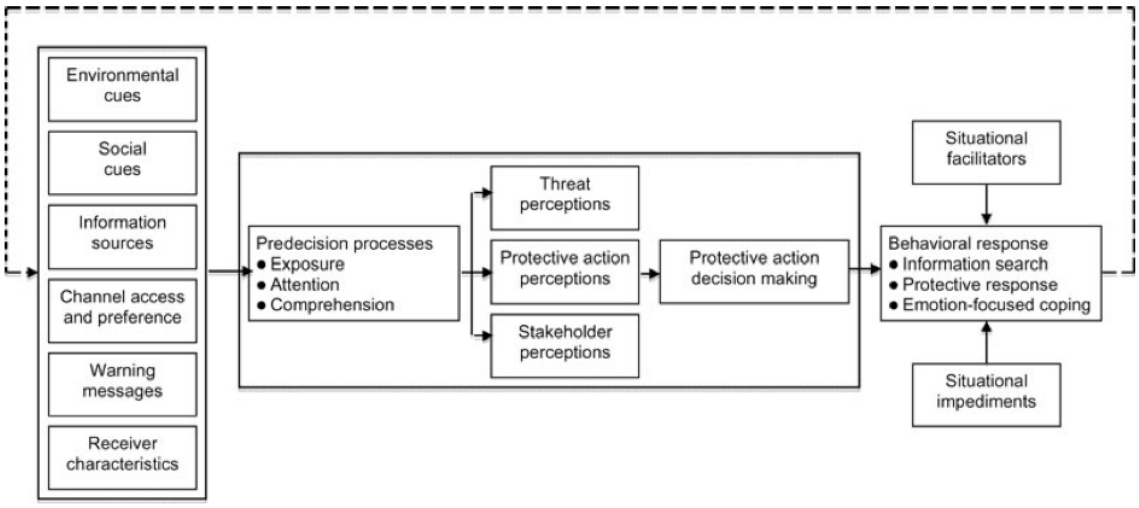


Figure 3.2: Information flow in the PADM (Lindell & Perry, 2011)

Moreover, demographic aspects of individuals, such as their educational level and tenure, play a crucial role in the effectiveness of flood risk communication and the adoption of protective measures. These factors can either act as barriers or drivers in the adoption and diffusion of innovative technologies designed to mitigate flood risks. For instance, higher educational levels may facilitate a better understanding of risk information and increase the likelihood of adopting recommended protective actions. Conversely, certain demographic characteristics, such as lower income or short tenure in a community, may hinder the adoption of new technologies due to lack of awareness.

Communication strategies

Municipalities often employ several strategies for flood risk communication that have proven moderate efficacy. In 2004, following the devastating earthquake and tsunami in the Indian Ocean, which killed 250,000 people, a framework was put in place to mark the beginning of a new strategy for disaster risk reduction efforts with a ten-year plan (2005-2015). 165 members of the United Nations, including the Netherlands, have decided to implement the measures under the Hyogo framework (UNDRR World Conference on Disaster Reduction, 2005). The country launched a national project based on this framework, known as the Delta program (Ministerie van Infrastructuur en Waterstaat, 2023). In addition to supporting the construction of public infrastructure, the project also focuses on shared responsibility, commitment and communication between residents and governmental organizations (Sanders, 2018). Municipalities are responsible for developing communications strategies to ensure the safety of their citizens. The province subsequently ensures that these municipal plans are aligned with national strategies. For the context of this study, it is important to distinguish between two types of strategies: short and long term. Short-term strategies are not the main focus but are nonetheless relevant in raising public awareness of an upcoming flood event. According to Lopez et al (2017), early warning systems (FEWS) like audio and media alerts play a crucial role in raising public awareness, but their effectiveness will strongly depend on social preparedness, which is the ability to construct an image of the danger and to prepare oneself over the long term rather than the short term. The long-term strategies used by municipalities are varied but are often in the form of visualization communication tools. The content of the communication practices are not standardized, but generally offer a local risk description and danger level, susceptibility as well as a spatial extension of the hazard. They are usually translated into a flood map that can be found on the websites of institutions such as municipalities or provinces. According to the research of Charrière et al. (2012), the phase of risk management in which communication takes place is at the level of prevention and preparedness. However, there are very few flood maps that encompass both, as some focus more on the communication of flood warning for preparedness and others on the representation of flood extents for prevention. The multi-purpose aspect is therefore lacking in these communication strategies, even if this tool remains the most widely used, ahead of video clips, images or objects such as flood marks. A widely used communication tool is nevertheless an advantage. According to Zhang et al. (2015) the adoption and diffusion of a technology also depends on its compatibility with those who use it. Their study focuses on Using diffusion of innovation theory to understand the factors impacting patient acceptance and use of consumer e-health innovations. The results suggest that the factors contributing least to the adoption rate were, among others, the incompatibility of the new service with the patients' preferences, suggesting that the communication tool should present a high compatibility to the citizens. Kjellgren (2013) delves into the effectiveness of flood maps and draws some critical conclusions about it. Although a very practical visual tool at first glance, its drawback lies in its unidirectional communication, which hinders public

adoption. Although unidirectionality is useful in raising awareness in certain conditions, such as short-term possible crisis situations (Kuhlicke et al., 2011), according to the communication theory, the introduction of hazard maps made accessible to the general public is unlikely to lead to attitudinal or behavioral effects, given the need for a two-way communication structure to trigger such effects. Active engagement is therefore needed to raise awareness about flood risks. Finding a means of dialogue between the municipality and residents has proven to raise the willingness of the target audiences to become more risk aware and to learn about appropriate risk management measures. Studies have also shown that dialogue is a major factor in organizations, improving the relationship between stakeholders and thus leading to a more successful project outcome (Bond-Barnard et al., 2018). The municipality must therefore ensure that its organizational structure allows for the implementation of participatory projects, in order to support the adoption of a suitable communication tool. According to Brockhoff et al. (2019) the two ways approach is a fundamental step, yet communication or simple information transfer is not enough to guarantee the successful completion of a project between two stakeholders. The co-creation of a project can only be guaranteed through some form of engagement. Co-production is an iterative and highly interactive process that involves shifting roles and power balances between local government staff and academic researchers. It codifies different types of knowledge at various stages, requiring local governments to build capacity to absorb this co-produced knowledge and embed it into their cultures by creating a shared language (Van Der Graaf et al., 2021). This can take the form of citizen science projects, where commitment is needed to bring reflection and group work into the process. Engagement will have an effect on the communication effectiveness mentioned above. De Boer et al. (2015) highlights results showing that it is also possible to increase participants' perception of local climate risk in combination with an increased motivation for flood risk prevention through tools of local relevance to citizens with information on local climate-related flood risks. The use of a serious game for municipal purposes as a communication tool might be able to bring these parameters and factors together and present a high relative advantage by offering an interactive and engaging learning experience, which could increase public understanding and motivation regarding local climate risks and preparedness strategies. Using serious games as a communication tool also encourages experimentation, for instance by developing pilot projects set up by both parties.

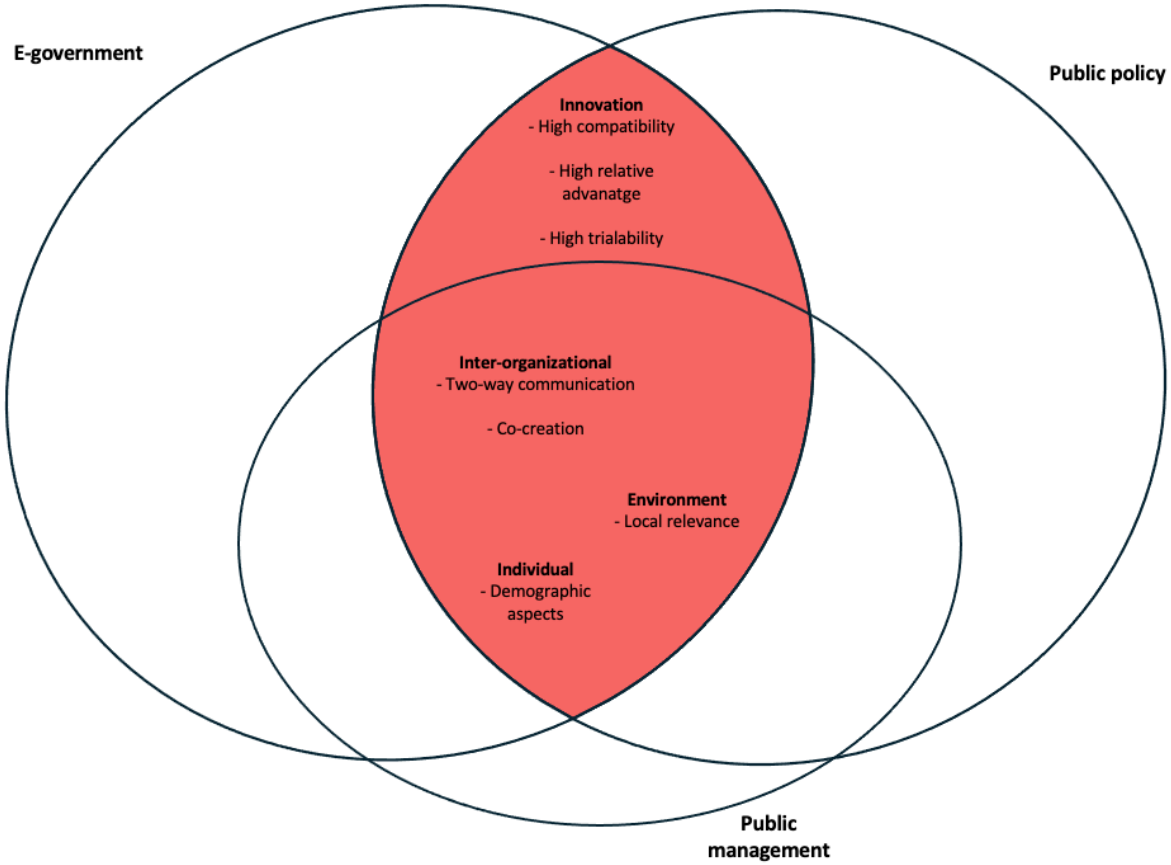


Figure 3.3: Conceptual framework featuring the communication influential factors, leading to an increase in innovation diffusion

3.2.2 Municipal institutions

Municipalities participatory project implementation

Implementing a successful public participation project is not an easy task and requires focusing on the organizational aspect of the municipality. This will enable the identification of important variables that may act as barriers or drivers for the organization. Identifying and implementing them maximizes the probability of success, based on the theoretical framework. According to Wanyama and Zheng (2010), successful implementation in both the private and public sectors depends on the organization's culture and structure. their study looks at financial management reforms and the problems they face during the implementation process. It is revealed that time, norms, and rules aspects are interconnected and hamper innovation. Bozeman and Kingsley (1998) go even further, arguing that the problem in implementing innovative projects in the public sector might lie in the risk culture. Public organizations often have a more cautious approach to risk, due to their public accountability and government oversight, than private organizations, where risk-taking is

encouraged. The Dutch municipal structure is fixed given that the last constitutional modification of its hierarchical form was introduced in 1848 (Local Government in the Netherlands, 2017). Having a steep or fixed hierarchy is often associated with little change and little risk-taking, however risk-taking is a necessary part of the innovation cycle, hence the importance of having a supportive culture in the organization. Another closely related concept that influences project performance within the municipal framework is leadership. The research carried out by Bronkhorst et al. (2013) highlights how transformational leadership in Dutch municipalities can boost motivation at work by focusing on effective goal setting and minimizing procedural constraints. Good leadership not only clarifies objectives, but also reduces obstacles to achieving them, thus fostering an environment conducive to motivation and, by extension, improving the chances of project success. The results therefore suggest that a form of supportive leadership is essential to navigate and take advantage of the fixed hierarchical structures to be found in Dutch municipalities, which could lead to greater innovation and adaptability in public sector participatory projects. If the implementation of such a project is envisaged within the organization in terms of structure, culture, and leadership, this does not yet mean that it can be achieved. The fundamental aspect on which this kind of initiative relies is the aspect of community engagement. According to De Weger et al (2018) Community involvement is increasingly seen as essential to achieving high-quality, efficient, and collaborative care. The study is based on the public sector and highlights several action-oriented barriers and enablers to engage the community in project planning. The presence of slack resources is needed to set up a working framework and the use of communication tools between citizens and municipalities. Wei et al. (2022) put forward this assertion in the research on the effect of slack resources on innovation performance in the public medical setting. The results suggest that having a certain number of slack resources helps organizations adapt to environmental changes or policy reforms by providing a margin of error allowing them to take risks and thus stimulate innovation. This variable depends mainly on the financial and personnel resources available in the municipalities. According to the Times (2021) newspaper, more than a third of Dutch municipalities are in financial difficulties. Of the 336 in existence, 120 were in deficit in 2021, and 12 of these have been placed under guardianship by the province because they will not be able to submit a balanced budget until 2024. This deficit arises mainly from social obligations such as youth care and social assistance to their citizens. Slack resources are therefore closely linked to the socio-economic characteristics in which the municipality operates. Since monetary funds are distributed on a provincial scale, municipal resources will depend on the geographical region and the number of inhabitants (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, 2016). This socio-economic variable is therefore not fixed and can represent an inequality in the implementation of such projects (OECD, 2022). This can also influence the amount of information/knowledge disseminated around the project. The project and its communication tool need to be promoted in order to attract participants, which means that the municipality needs to focus on one or more channels in order to target and find respondents. If the preceding variables are met by the municipality

and do not form barriers to the project, it is now important to ensure a high level of collaboration between citizens and municipal representatives. Weger et al (2018) highlight the importance of fostering a safe and trusting environment enabling citizens to provide input, invest in citizens who feel they lack the skills and confidence to engage as well as ensuring citizens' early involvement. This will be achieved through the communication method adopted by the municipality enabling this kind of environment. However, it is important to critically evaluate the allocation of resources to participatory processes. The municipality need to determine whether the engagement will have a real influence on policy outcomes, or simply allow economically motivated vested interests to influence decisions. Irvin and Stansbury (2004) highlight the need for careful examination of such participatory efforts, particularly in the field of environmental management, where the balance between local interests and regulatory success is delicate. In addition, policymakers should consider potential inefficiencies and resource expenditures that may not lead to substantial improvements in the environment or public well-being. Ultimately, the effectiveness of dialogue and citizen involvement must be weighed against the tangible benefits they bring to the implementation of environmental policy. Both citizens' and organizations' motivations have to be taken into account. If the commitment is not assumed in the same way on both sides, a power imbalance could arise, which could represent a treat to the project's implementation. Constructive citizen participation is only possible if organizational processes are adapted to ensure that they are inclusive, accessible, and supportive of citizens as much as municipal organization. The implementation of a participatory project within the municipality aims to foster a collaborative environment where knowledge and practices can be exchanged and improved. A key objective of this approach is to encourage inter-organizational learning, a process in which organizations (citizens/municipalities) learn from each other to improve their practices and results. Hartley and Allison (2002) explore this variable in their research on Inter-organizational learning in a network of local authorities. The research explores a program that aims to serve as a practical model of how participatory projects can promote inter-organizational learning. Workshops, seminars, and collaborative projects provided an opportunity for local authorities to share their tacit and explicit knowledge. While explicit knowledge can be formally documented and shared in visual or written form, tacit knowledge operates in the consciousness and manifests itself in the way we think and handle a situation. Local authorities have reported improvements in their policymaking, thanks to better understanding gained through network activities and collaborative work. The study highlights that participatory projects underline potential structural improvements to enhance the capacity and effectiveness of organizations, leading to more informed decision-making and the adoption of innovative practices. It highlights as well, the need for participatory projects to not only focus on the theoretical exchange of ideas but also on the practical application and operationalization of shared knowledge. Inter-organizational learning is a two-way process. On the one hand, it would enable citizens to raise awareness and acquire a knowledge of floods-risk and the consequences in terms of measures to be taken in the event of flooding. On the other hand, it would provide

constructive feedback on citizens' needs in terms of implementing municipal measures to ensure their protection. This study therefore suggests that the municipality should turn to an innovative, practical communication tool to stimulate inter-organizational learning and propose common solutions.

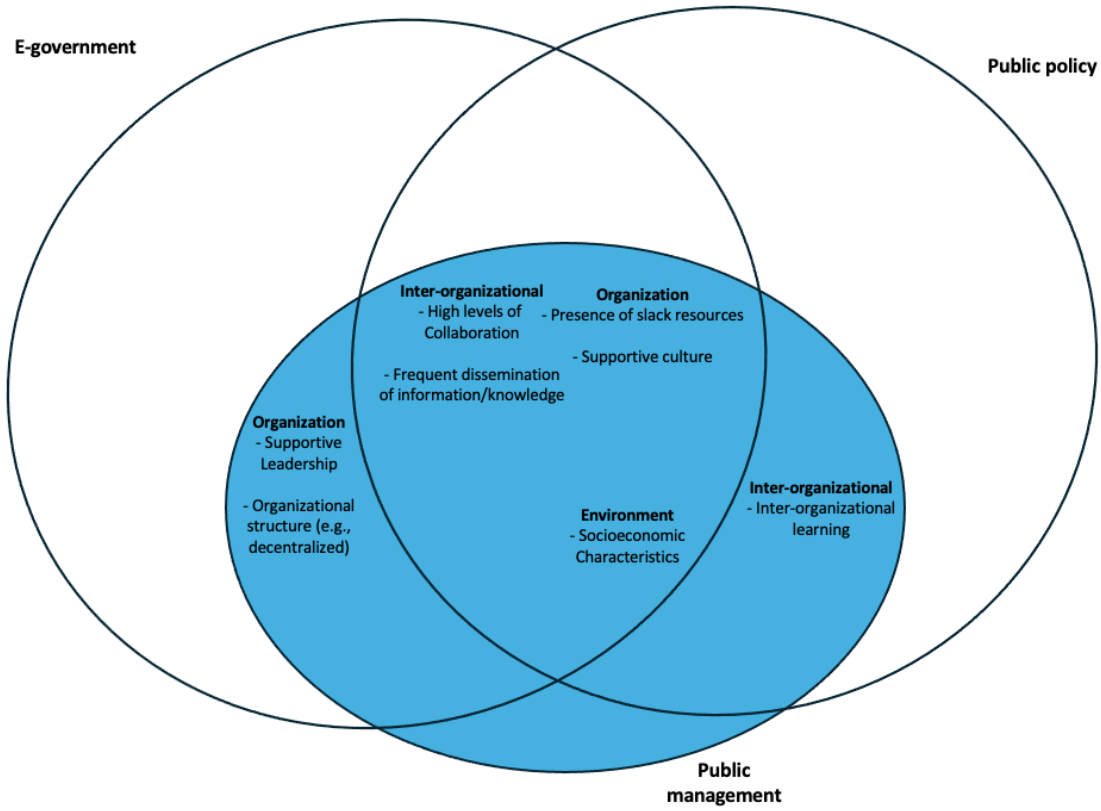


Figure 3.4: Conceptual framework featuring the municipal influential factors, leading to an increase in innovation diffusion

3.2.3 Serious games

Serious games as communication tool

The serious game is the chosen communication tool for this participatory project. This follows from the literature findings in the first paragraph, which highlighted the variables important to the diffusion and adoption of a communication tool, most of which are also present in this tool, as the following paragraph will demonstrate. A serious game is a type of game that is not solely designed for entertainment purposes, but rather to fulfill a specific educational, training, or therapeutic objective (Michael & Chen, 2006). These games are communication tools used in various fields such as education, public organization, defense, and corporate training to promote exchange and user involvement in order to improve learning and skill development through interactive and often immersive experiences. Gaming is known for the value of communication, learning and commitment to action, however, according to the

framework, the literature, and the case study, it is important to ensure the presence of a number of variables in order to promote its diffusion and adoption within an organization and among citizens. The Meta-Review of Damaševičius et al. (2023) gathers a large number (53) of articles highlighting different aspects of gamification in the development of serious games. The article suggests that serious games have a high trialability as they can be easily experimented in different organizations and educational settings. This trialability is supported by their digital nature, which allows them to be accessed and tested across multiple platforms with minimal risk and investment. The use of mobile phones and computers increases the ease with which different situations can be tested, promoting the adoption of these kinds of communication tools among the general public. The “WhereWeMove” game allows the administrator to create scenarios or implement certain constraints on the website, thus offering the possibility of experimenting with the game's variables. The adoption and wider use of serious games is only possible if it offers a high level of compatibility within the organization. The variable of compatibility between municipality and serious games is related to the last paragraph and can only take place if the municipal structure offers a two-way participatory approach. In addition to a two-ways approach, the literature emphasizes the importance of a co-creation process that the communication tool must offer in order to foster player engagement and reflection. Haan and Van Der Voort's (2018) literature review on the Social Learning Outcomes of Serious Games emphasizes the critical role these tools play in promoting co-creation within municipal planning through increased citizen involvement. The study demonstrates how social learning is accelerated by serious games, creating a setting where community members work together and take an active role in urban planning. In the context of watershed governance research, Jean et al. (2018) reinforce and broaden the argument by pointing out that using serious games as boundary objects promotes knowledge co-creation and cooperation. Their results show that using games as a means of interaction gives stakeholders from different backgrounds a dynamic platform to communicate and discuss difficult social issues. As a result, stakeholders are encouraged to bridge boundaries in expertise, ideology, and jurisdiction, changing perspectives among individuals and encouraging cooperation between different organizations. The “WhereWeMove” serious game allows this type of exchange and knowledge sharing in its operation, particularly at the end of the game during the debriefing. Players and organizers can discuss the decisions taken and the future expectations of both parties, encouraging shared responsibility and the implementation of joint measures. The demographic aspect (level of education or tenure) was also taken into account when designing the game, as was its local relevance given that it simulates flooding events taking place on a larger or smaller scale in the country. The demographic aspect (level of education or tenure) was also taken into account when designing the game, as was its local relevance given that it simulates flooding events taking place on a larger or smaller scale in the country (see Appendix A). The presence of these variables favors the adoption of the serious game, given the familiarity of the players with the topic.

Looking in more detail at the technical aspects of serious games, there are a number of variables that need to be taken into account in order to ensure the widespread adoption of such a tool. The first variable concerns the skills of public servant. If the technology is implemented within the municipal context, the public servant will have to be able to understand the technology. According to the research of Arnab et al (2012) it is believed that the use of serious games provides a multifaceted view of a subject offering a fruitful way of gaining a more global understanding. After addressing the collaborative, game-building and engagement aspects of the tool, the research looks at the key points that a serious game must have in order to ensure its adoption. The study argues that a large number of logistical and technical variables are often overlooked and need to be adapted to users and players, such as better training for practitioners, simpler tools for authoring educational game activities and web-based communications, more institutional support as well as the resources needed for practitioners. Barragán-Pulido et al. (2023) conducted his research on the Development of Students' Skills through Gamification and Serious Games with similar arguments, although 11 years after Arnab et al (2012). The research highlights the need for a digitization of education, or in other words the importance of teachers knowing these tools properly in order to pass on knowledge to students effectively. “WhereWeMove” requires a good understanding of technology and a minimum knowledge of IT. The tool offers an administrator interface that can adapt game scenarios to a certain degree. If the organization wants to add or remove features to adjust to its needs, it will need staff who can program or outsource this task to an external entity. As the game requires a certain level of computer literacy, it is necessary to train facilitators in a municipal context to supervise sessions and help players in need. This influential factor may be perceived as secondary but is nonetheless the backbone of the technology's diffusion and adoption. For facilitators, being able to align game mechanics with municipal objectives is crucial. Their enthusiasm is key, enabling them to perceive a higher degree of innovation acceptance, as well as guiding participants appropriately and ensuring that the learning objectives have been met. Municipalities requires between 1 and 5 facilitators per session, depending on the exact number of participants, as the game can be played in different configurations (see Appendix A). The game will therefore be played according to the number of staff available within the municipality, as well as in a wide or short setup, depending on the number of participants. Training time and difficulty can also have an impact on facilitators' technology acceptance and must therefore be taken into account. These factors can also influence how the technology is perceived by those involved in the implementation process. The study carried out by Spil et al. (2021) tackles the issue of tool usability and asks whether serious games are too serious. Three major arguments emerge from this medically oriented public-sector analysis as being relevant in a municipal context. According to the study, a serious game must be easy to use if it is to be adopted. Despite the game's social relevance, it can't bring users knowledge if they find it too difficult to engage with. The effectiveness of a serious game will depend on the balance between its educational content, such as the knowledge it provides, and its engaging gameplay. This can be translated into incentives for gamers, such as a

competitive format, as in the case of the serious game “WhereWeMove”, where the player with the most satisfaction points wins the round. Finally, the study also stresses that while this type of tool should be fun and entertaining, it is essential to ensure that privacy and security concerns are taken into account. Individuals, in this case players, put their trust in an organization that must safeguard the anonymity of participants, especially in a municipal/governmental context. McCall and Baillie's (2015) research, Ethics, Privacy and Trust in Serious Games, highlights the ethical issues that can arise from game designs and establishes concepts and guidelines to provide a method by which practitioners and researchers can consider ethical and privacy issues in their own systems.

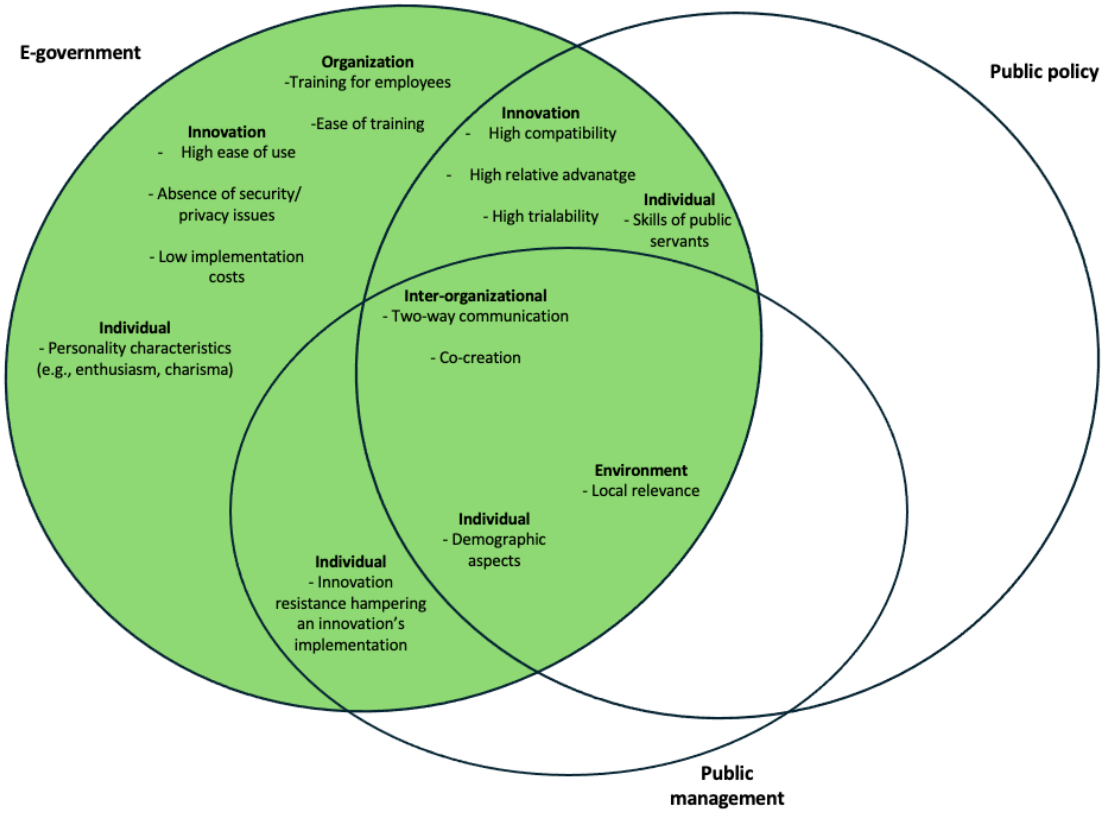


Figure 3.5: Conceptual framework featuring the serious game influential factors, leading to an increase in innovation diffusion

3.2.4 Conceptual framework overview

While numerous studies have explored flood risk communication and potential strategies within public environments, there is a notable scarcity of research examining the implementation of serious games within municipal contexts. The integration of serious games as a structural intervention necessitates organizational changes, including adjustments in human resources, functions, and infrastructure. Moreover, the outcomes of such games, such as increased citizen awareness, may require subsequent actions from the municipality to effectively address the high public engagement and ensure sustainable flood risk management.

The main points to be retained from this literature review are that, in order to communicate effectively, it is necessary to ensure a balance between informing and alarming the public, to use communication tools that are compatible with the audience, and to foster a two-way communication structure that promotes active engagement. It is also crucial to incorporate local relevance and co-creation processes to enhance the adoption and diffusion of the communication tool. What has been identified is that up until now, municipalities have relied solely on one-way communication approaches such as flood maps to warn the population of potential flood risk. This way of communicating hinders the shared responsibility that can take place via a co-creation tool. In order for municipalities to enable a co-creation process, it is essential to adapt the municipal organization structure to foster the implementation of participatory projects, enabling the two-ways communication approach. The success of the two-ways approach and thus of the diffusion and adoption of the communication tool (serious game) depends on multiple influential factors such as the intra-organizational readiness level, culture, structure, leadership and resources.

In addition to structural/organizational factors, the diffusion of the innovation is also based on the technical aspects of the communication tool (serious game). It has been documented that serious games, used for educational and training purposes, can promote commitment and learning, and that their adoption and diffusion depends on their trialability, compatibility, and the co-creation process they facilitate. Technical aspects such as public servant skills, training, and ease of use are critical. Serious games should balance educational content with engaging gameplay while ensuring privacy and security.

All things considered, the successful spread and use of serious games in municipalities will depend on both the technical features of the games themselves and the organizational factors within the municipalities that can either help or hinder their adoption.

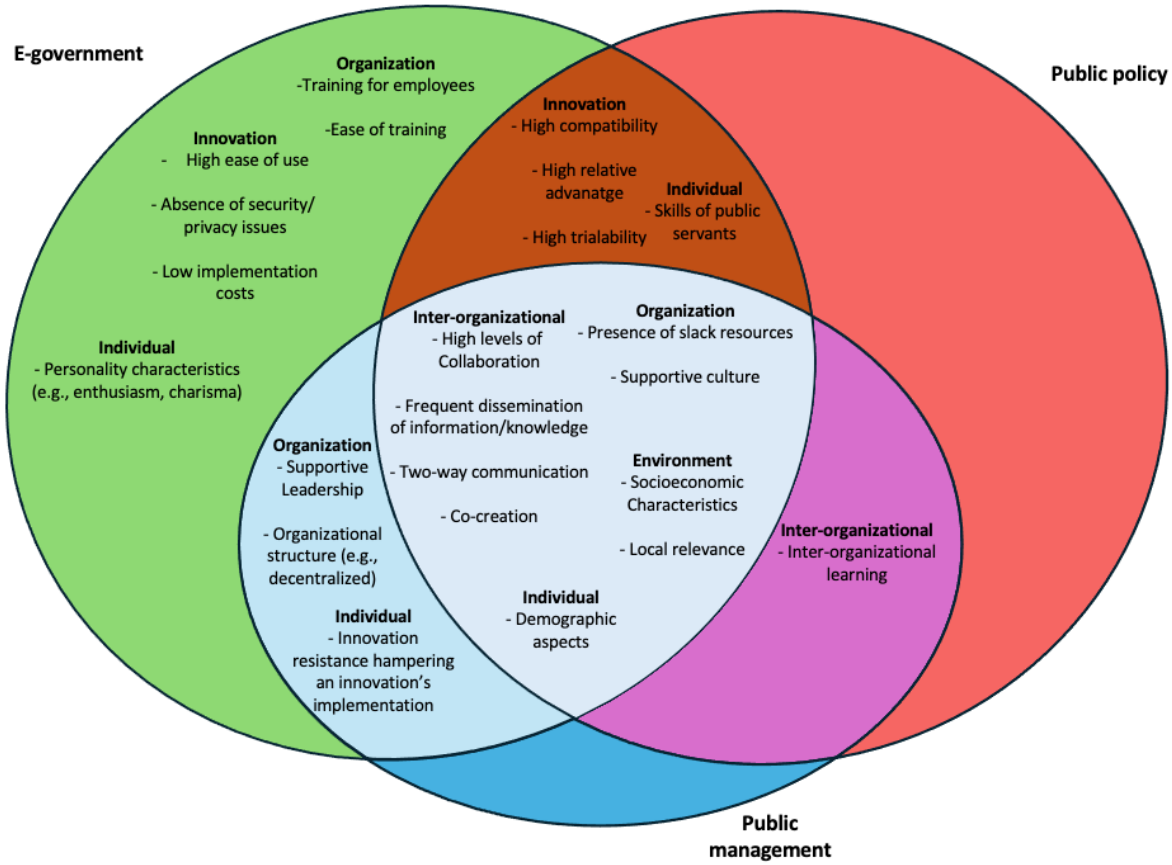


Figure 3.6: Conceptual framework featuring all the influential factors, leading to an increase in innovation diffusion and adoption of the serious game in a municipal context

3.2.5 Influential factors definition list

Influential factors corresponding to the municipal organizational aspect of the diffusion and adoption of a serious game according to the literature review (Figure 3.4)

Characteristics Levels	Factors	Description
Environment	Socioeconomic characteristics	Socioeconomic characteristics of a certain area, such as a state (e.g., wealth of an area, urbanization)
Inter-organizational	High levels of collaboration	Close collaboration with, or involvement of, external stakeholders such as civil servants, citizens, patients and politicians
	Frequent dissemination of information/knowledge	Frequent dissemination of information about an innovation
	Inter-organizational learning	Significant learning across organizations through inter-organizational networks

Organization	Supportive leadership	Leader support for an innovation's implementation process
	Organizational structure (e.g., decentralized)	The organizational structure which can facilitate or hinder an innovation's implementation (decentralization is often assumed to foster innovation diffusion)
	Presence of slack resources	The availability of resources inside an organization, such as money, staff, and ICT facilities
	Supportive culture	The dominant risk culture of an organization since this can hinder or support innovation diffusion/ adoption (for instance, a dominant risk-averse culture hinders)

Influential factors corresponding to the innovation's technological aspect of the diffusion and adoption of a serious game according to the literature review (Figure 3.5)

Characteristics Levels	**Factors**	**Description**
Environment	Local relevance	Fit community with local needs and contexts for greater adoption and diffusion
Inter-organizational	Two-way communication	Involves stakeholders in participatory projects, ensuring balanced and effective communication
	Co-creation	Promotes active engagement and compatibility with the audience, integrating their feedback.
Organization	Training for employees	Training (can ensure a higher degree of innovation acceptance by employees)
	Ease of training	Ensures innovations are simple to learn, increasing employee acceptance and use

Innovation	High ease of use	The degree to which an innovation is perceived as easy to understand and user friendly
	Absence of security/privacy issues	Concerns about security and privacy issues related to the use of governmental websites or other electronic applications, with perceptions of a lack of security and privacy resulting in a decrease in innovation diffusion/adoption
	Low implementation costs	Costs of an innovation's implementation, with high costs decreasing an innovation's diffusion/adoption
	High compatibility	The extent to which the innovation is in line with existing ways of working in the organization
	High relative advantage	The perceived usefulness and benefits of an innovation relative to current tools or procedures
	High trialability	Possibility to experiment (e.g., use of pilot projects)
Individual	Personality characteristics (e.g., enthusiasm, charisma)	Personality (e.g., autonomy, enthusiasm, charisma) of the individuals involved in an innovation's implementation process, which can positively or negatively influence innovation diffusion/adoption
	Skills of public servants	Necessary individual skills, often ICT-related
	Innovation resistance hampering an innovation's implementation	Positive or negative perceptions about an innovation which can positively or negatively influence innovation diffusion/ adoption
	Demographic aspects	individuals, such as their educational level or tenure, which can positively or negatively influence innovation diffusion/adoption

4. Methodology

The methodology chapter provides an overview of the research design, data collection methods as well as data analysis methods used in the project. This section discusses in detail how and why the data was collected and analyzed from the game session debriefings as well as from the interviews conducted with the various participants. The selection of representative stakeholders such as student, municipal and provincial authorities will be explained in order to understand the underlying rationale behind the adopted research methods and their relevance to the research objectives and research questions. This project is based on a case study-led qualitative research aimed at exploring the factors leading to the adoption and dissemination of a serious game focusing on flood risks in a municipal-citizen context. This approach is suited to a more detailed understanding of the needs and constraints of the various stakeholders at their respective levels in the implementation of a shared responsibility. After examining the results of the debriefing sessions and interviews, the research aims to identify key issues in order to give actionable recommendations to government bodies such as municipalities and provinces for using serious games in their institutions.

The study is based on a qualitative analysis of the debriefing sessions and interviews, as mentioned above. The advantage of a qualitative analysis in this context is that it allows to go into detail and depth in the face of nuanced answers and lends itself well to an interview approach in order to understand the motivations, and emotions of the actors when the answers are not black or white. The subjective experiences of the interviewees also offer an opportunity to determine crucial information that has not been addressed in the theoretical Background, allowing emerging themes and patterns to be identified, providing an excellent way of locating potential problems and solutions. The second strong point is that qualitative research is fundamentally flexible and can adapt to emerging themes and models during the research process. This allows the framework supporting the research to be verified and refined, so as to have a more global overview encompassing both practical and theoretical aspects (Hammarberg et al., 2016). The case study used for this qualitative analysis is the serious game "WhereWeMove" which has been developed within the university and whose mechanism is explained in more detail in Appendix A. Its role is to evaluate the possibility of implementing the use of serious games in a municipal or provincial setting as a means of enhancing community engagement and co-creation in flood risk management.

The qualitative data gathered from the interviews and debriefings were not analyzed in the same manner, given their different formats (employing text analysis for the paper-based data and audio transcription analysis for the recordings). Despite these methodological differences, the objectives remained consistent, as both data sources underwent a thematic content analysis to identify recurring themes (Mutisya, 2019). The function and importance of the two data streams are not the same. The debriefing seeks to analyze the players'

expectations and present the results to the municipal/provincial representative in order to affirm the possibility of co-creating with the help of the game, and therefore does not have the primary aim of answering the research question. Its function is therefore secondary, whereas the interviews have the primary function of answering the research question and rely on the debriefing to do so.

4.1. Serious game of reference

The choice of the “WhereWeMove” serious game is essential for this study, as it has been developed in previous studies in which various aspects have already been explored. My research is partly based on the game's existing functionalities, in order to determine new information, such as implementation stages, for the next phases of its development. "WhereWeMove" employs a hybrid format combining a central game board combined with the use of a technology (computer/phone) to follow the evolution of the player's choices throughout the game. It can be played by 6 to 40 participants, each of whom is assigned to a table of 6 to 8 players. Each player is given a homeowner goal with a different salary and living expenses. With these inputs, the player can decide to buy a house according to his means at different locations. On the game board, there are three distinct housing areas: the first is a neighborhood separated by a nature-based solution such as a forest between the houses and the river, followed by a neighborhood protected by a dike next to the river and a neighborhood directly next to the river. In each round (3 in total) it will have to pay his mortgage, taxes, and flood damage if applicable. Flood damages occur in two forms: Rain flood and River flood. The probability of either of these scenarios occurring depends on the dice roll and the protection offered by the area in which the player's home is located. The three areas offer advantages specific to one of the two scenarios. The aim of the game is to achieve the highest possible personal satisfaction score that can be obtained from the player's purchases and strategic choices. In fact, satisfaction points can be obtained by purchasing flood adaptive measures to better protect their homes in the case of a flooding event, as well as by directly purchasing satisfaction points representing a real-life situation, such as investing in vacations, or buying products that make us satisfied, such as clothes, cars or technologies that have nothing to do with flooding events. The player can also decide to sell his house and move, as well as save his income for future rounds. All these parameters represent real human behaviors and choices under a simplified form in this serious game. At the same time as playing on the game board, players can follow their income, news, decisions, consequences, and satisfaction points on the website in real time from their connected devices. In fact, it is from the website that they have all their personal information and can decide on their investments and follow the outcome of their decisions. Game parameters can be influenced and adjusted by a facilitator on the website. The facilitator can decide on the player's income and role in its entirety, as well as changing game situations via news. The facilitator can also influence players' knowledge by displaying or not the price of private protective measures in order to influence the individual's choices.

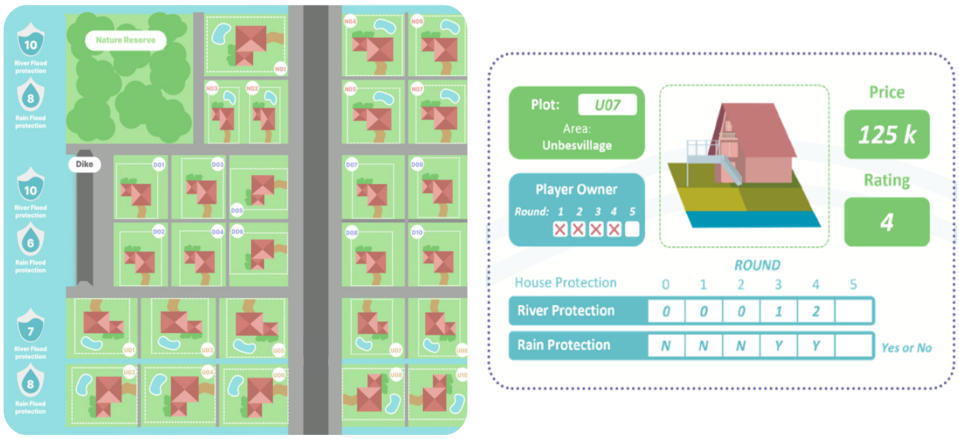


Figure 4.1: "WhereWeMove" game board and house options

4.2 Debriefing sessions

4.2.1 Selection of participants

Two game sessions and debriefings were organized with two different organizations bringing together students from a water management related course to analyze the co-creative nature of the serious game and to draw out insights that could be used to demonstrate the value of such a tool to municipalities/provinces. Both institutions were willing to test the game with their students, which resulted in a good number of participants. During the gameplay sessions, students were able to engage with each other and with the game board (smartphone) in a playful way, making personal choices leading to an understanding of flood management. Targeting students is a logical step, given that they represent future residents who will have to cope with extreme weather events such as extreme rainfall or river flooding. Playing this game is therefore beneficial for both the study and the students, as it raises awareness around the issues they'll soon be facing. During the debriefing session, participants were asked to share their experiences and feelings about the game sessions, providing insight into the effectiveness of the game. Data was collected through questionnaires and an audio recording, as well as a map of the game with the players' locations. The audio recording is nevertheless unusable for this part of the analysis, given the noise pollution making it impossible to distinguish between the voices.

4.2.2 Data collection procedure

The debriefing methodology used in the two educational organizations is differing slightly in terms of questions but gathers the same type of information relevant to the research. The first gaming session with the first organization took place in early April and lasted one afternoon with two tables of 6 to 7 students participating in this research. The game sessions provided them with the knowledge required to complete the debriefing, which took place at the end of the game and lasted a total of 30 minutes. The debriefing takes the form of an A3 questionnaire addressed to the entire table where the players are asked to write on the sheet and pass it around the table. The open-ended questions addressed the gaming experience and real-world scenarios. The first set of questions explored what they liked most and least about the game, as well as a follow-up question on missing or potential additions. The second

set of questions focused on the adaptive measures they were prepared to implement in a real-world setting and a justification for these, as well as a question on community protection. The answers provided an insight into players' motivations and gave a good idea of what marked their gaming sessions. The debriefing ended with a debate during the last 10 minutes, in which the aim was to divide the table between the municipality and the citizens, in order to identify the needs of both sides.

DEBRIEFING	SESSION 1	SESSION2	TOTAL
PARTICIPANTS	12	36	48

Table 4-1: Debriefing participants

The second gaming session with the second organization took place in mid-April and lasted one afternoon as well, with 6 tables of 6 players. The debriefing was carried out by 6 facilitators over a period of 30 minutes, asking slightly different open-ended questions to the previous IHE game session. The questions were presented under an A3 paper format and were divided in three blocks, starting with interactive storytelling to introduce players to the subject by asking them to recount their game sessions decisions, outcomes and emotions. This allowed the participants to be more involved in the discussion and to transition from the game session into the working section. The second block focuses on real word decisions and is of particular importance as it provides answers that can be of great use to municipalities in implementing policies or citizen incentives. Finally, a role-playing exercise consisting of four questions was conducted, with participants taking on the roles of residents and municipal representatives, during which the needs of each were explored and established.

4.2.3 Data analysis procedure

The debriefing data analysis took place in three steps. The first step was to collect all the A3 debriefing sheets and convert them into digital format, as well as translating them into English for the tables that had carried out the game sessions and debriefings in Dutch. The second step was to progress question by question in order to determine the common patterns and keywords emerging from the answers to the same questions across the different tables. This was done using a color code for each keyword found in the question, for all 6 questions. The color code made it possible to categorize the keywords with the number of iterations across the different tables, highlighting the most important answers for the majority of participants. The answers to the 6 questions were represented graphically to enable the interviewee to visualize the predominated debriefing findings. The role-play discussion analysis was carried out on the same basis as the questions, by determining which key words on both sides (municipalities/residents) were the most resounding. The results were presented graphically, although the number of responses from municipalities was lower than those from residents, given the students' lack of knowledge of municipal or provincial capabilities. The game map with the player’s locations was created by aggregating the different individual maps according to the tables and is represented digitally with different colored hexagons representing the individual players per table.

4.3 Semi-Structured Interviews

4.3.1 Selection of participants

A list of municipalities affected by flooding (rain or river) has been set up in order to target the organizations to be contacted for the interviews. The inclusion and exclusion criteria were based on the geographic aspect of the region and the size of the municipality. As Zuid Holland is a densely populated area with a large number of organizations, it was possible to identify 15 suitable municipalities that corresponded to the selection criteria, which were initially contacted by e-mail. After a week of no response, it was clear that active participation was necessary to improve the chances of obtaining an interview. This was confirmed by some negative returns mentioning the lack of resources and priority at the moment, to carry out interviews in certain municipalities. The second phase therefore consisted in contacting the municipalities by telephone to seek a correspondent who could refer me to the communications or climate advisor team. No member of the secretariat connected me directly to these teams, but they did refer me to them internally, which resulted in three positive responses from the municipalities and one positive response from the province through a contact. One of the three meetings scheduled with the municipalities was nevertheless cancelled for personal reasons one day before the interview, resulting in a total of three interviews and game demonstrations with two municipalities and large provincial organization. Before conducting the interviews, I approached the serious game designer for the province, to discuss and validate the theoretical framework. The reason behind it is that he is in a very good position to evaluate the work and that the interviews are a way of verifying and extending the theoretical framework previously put in place. The importance of having a solid base is therefore paramount. The framework's validation brought credibility and enabled the drafting of interview questions to better align the theoretical and practical aspects. The interview questions were aimed at understanding the willingness and capacity of municipalities/provinces to adopt serious games in their communication systems. Interviewees' responses were recorded, transcribed and coded in order to determine influential factors, patterns and iterations resulting in barriers or drivers in the organization.

4.3.2 Data collection procedure

The three interviews took place in person at the respective organizations. While online interviewing offers flexibility and convenience, face-to-face interviewing allows for a more dynamic and spontaneous discussion, which I personally value. The interviews took place over a three-week period, starting with a large municipality (<650.000 inhabitants), followed by a smaller municipality (<65.000) and a large provincial organization. Semi-structured questions were asked to the various institutions over a period ranging from 1h to 1h30. The semi-structured question format allows for a balance between validating existing information derived from the literature and exploring new information of importance to municipalities, which corresponds to this type of study.

The questionnaire consists of 9 main questions. The first set of questions deal with the current practices in order to establish a baseline of what the municipality/province is already undertaking in terms of communication. Once the organization's functioning methods have been elaborated, the interviewee is introduced to the game, where he or she is shown a PowerPoint demonstration of the game's main mechanisms, as well as the three objectives it is able to cover:

OBJECTIVE1: For players to learn about floods and choices among possible adaptation measures. OBJECTIVE2: For players and government organizations to envision strategies based on their game experience. OBJECTIVE3: For government organizations to explore the effectiveness of possible policies for strengthening resident action capacities

Objectives two and three are backed up by the data analysis carried out from the students' debriefing feedback to reinforce the argumentation's credibility and feasibility. The questions that follow the demonstration are more specific and seek to determine indirectly whether or not the variables set out in the literature are present in the organization in question. The intention of structuring the interview in this way is to avoid influencing the respondent and to obtain new information. The structure can therefore be seen as a funnel, with very general questions at the beginning, followed by more specific ones until the end.

Section	Question	Key Influential Factors Covered
1. Current Practices (Context)	How does your municipality currently communicate flood risks to residents? What does the municipality communicate about flood risks and adaptive measures? How effective have these tools been so far?	Two-way communication, High levels of collaboration, Inter-organizational learning
2. Organizational Culture and Structure	Can you describe the current culture and structure within your municipality regarding the adoption of new technologies or innovations? What changes would be necessary to use the "WhereWeMove" in communication efforts?	Supportive culture, Organizational structure, Risk culture
3. Leadership and Support	How do leaders within your municipality support the introduction and implementation of innovative tools and technologies?	Supportive leadership, Supportive culture
4. Resources and Training	What resources (financial, personnel, technological) are available within your municipality to support the adoption of new technologies? How do you ensure that employees are adequately trained to use these technologies?	Presence of slack resources, Training for employees, Ease of training
5. Technological Integration	Would the implementation of a serious game like "WhereWeMove" within the municipality be a challenge in terms of acceptance? What other technical factors would facilitate the integration of this game?	High compatibility, High ease of use, Innovation resistance
6. Public Engagement and Co-creation	How does your municipality involve citizens in co-creating solutions for local challenges? How could "WhereWeMove" enhance citizen involvement and co-creation of flood risk management strategies?	Co-creation, High relative advantage
7. Trialability and Experimentation	What opportunities exist within your municipality to pilot new technologies or projects before full-scale implementation? How can the game be designed or modified to meet the needs of your community?	High trialability, Local relevance, Low implementation costs
8. Security and Privacy	How does your municipality address security and privacy concerns when implementing new technologies like the "WhereWeMove" game? Are there specific protocols or practices in place?	Absence of security/privacy issues
9. Perceptions and Enthusiasm	What is the general perception and enthusiasm among public servants towards adopting new technologies?	Personality characteristics, Positive or negative perceptions

Table 4-2: Interview protocol questions

4.3.3 Data analysis procedure

The interview data analysis is the heart of the research and took place in a cycle over a longer period of time and at a higher level of complexity than the debriefing. The thematic analysis was carried out using a mixed-method approach starting with an inductive process followed by a deductive one. This was necessary as the empirical research seeks to achieve three objectives: to establish new themes, to identify variables previously defined in the literature, and to determine whether these variables are barriers/drivers for the organization.

4.3.4 Coding process

The first step was to transcribe the interviews from audio to written format, which was done using Microsoft word. As the software transcription was not completely accurate, a second listening, reading and cleaning of the data was necessary before it could be used for coding. The cleaned document was coded with a line-by-line granularity where first-order codes were assigned to sentences of significant importance to the research. These initial codes enabled an inductive approach to the creation of new second-order codes not found in the literature. The coding process did not take place directly in Word, but in Excel, where the first-order codes with their sentences were categorized in a table under second-order codes (axial coding). This coding approach made it possible to determine the number of first-order codes iterations under the second-order codes, in order to gain an overview of the variables that were mentioned several times and may have been of greater importance to the interviewee. The majority of first-order codes were nevertheless classified with second-order codes that had been mentioned in the theoretical background.

The excel table grouping the first and second-order codes in detail fulfils the first two objectives mentioned above but cannot be used as such in the research report for confidentiality reasons. A second excel table grouping first-order codes of the same meaning (without supporting sentences), as well as second- and third-order codes, has been set up to provide an overall view of the variables emerging from the interviews. This table is specific to each interview and indicates with a color code whether the variables are considered barriers or drivers according to the organization. A triangulation was then made between the interviews and the emerging answers. By comparing the codes of the different stakeholders, new and consistent patterns were identified, supporting the credibility and validity of the research and the theoretical framework. Finally, the data were interpreted in the context of the research questions and theoretical background at individual and aggregated levels, in order to explain the results in a structured way.

4.4 Ethical Considerations

Participants were provided with a consent form ahead of the game and interview sessions outlining how their data would be managed and processed within the project. The form ensures the anonymity of both players and interviewees and indicates that their data will only be used internally within the TUDelft University for research purposes such as this thesis or related project. Participants were fully informed about the nature of the study, including the purpose, procedures, and their rights. The voice recording and transcript took place via the MS Teams university account, with subsequent migration of the data to SURF drive, a server compliant with the human research ethics criteria's to which this project is committed. The names of the governmental organizations will not be given and will be substituted by their characteristics in order to preserve the anonymity of the interviewees given the use of quotes from them.

The analyzed data will be presented in the next section, which is based on the outcomes of the interviews and debriefings. The graphical results of the debriefing and the codebooks of the three interviews will be elaborated and individually justified to provide a complete understanding of the practical circumstances and the barriers and drivers faced by the organizations.

5. Data Analysis

The data analysis section will be divided into four parts, corresponding to the different data collected during this research. In the first part, the results of the debriefings will be analyzed, along with their significance with regard to the game outcome. The second part of the data analysis will cover the three individual interviews, starting with the larger municipality, followed by the small/medium-sized municipality and concluding with the provincial organization. The analysis will focus on the three objectives mentioned in the methodology, namely exploring and classifying new, existing and important influential factors for the municipality, as well as identifying whether these variables are barriers or drivers for these organizations. A summary of the important points emerging from the interviews will also be provided in order to understand the context in which the organization is evolving and to understand their own needs in order to use the "WhereWeMove" serious game at a municipal or provincial level.

5.1 Debriefing data analysis

The importance of having a debriefing translates into demonstrating to governmental organizations the potential for achieving a shared responsibility through the use of a serious game as a communication tool. The data analysis will follow a chronological order, starting with the questions and game map living locations, before moving on to the role-play debate. The most frequently mentioned points will be discussed and analyzed.

1) *What actions would you take in the real world?*

The first question allowed the identification of nine key words from the six tables. Figure 5.1 illustrates the frequencies of the different actions participants would take in real life.

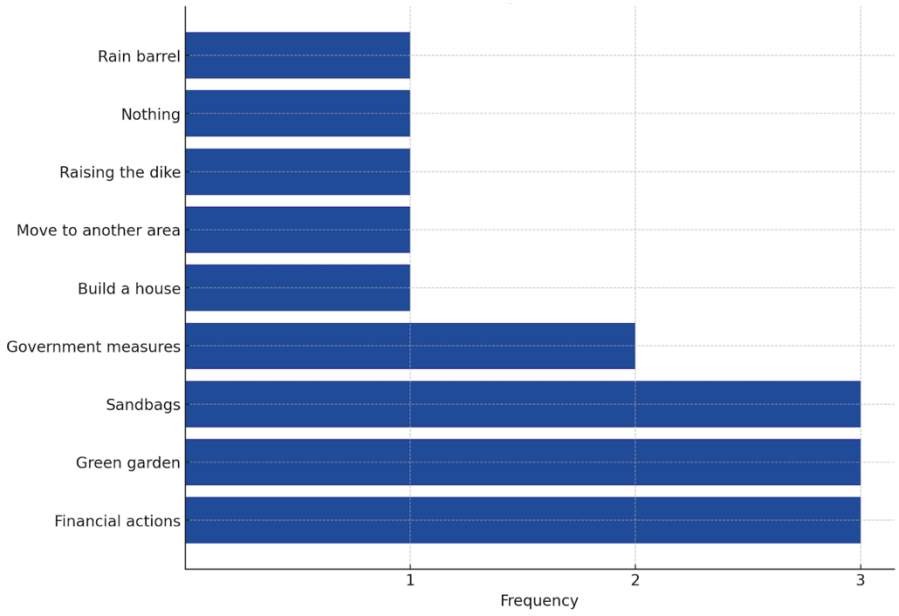


Figure 5.1: Frequency of different actions participants would take in real life

The measures that were mostly refer in the tables were about financial actions, green garden and sandbags.

Financial action translates into financial aid or tax incentives for residents. This implication recognizes the importance of the economic aspect in the implementation of private protective measures in the event of flood risks. The financial aspect is a key concern, since in this case it translates into personal expenditure.

Green garden and sandbags corresponds to two of the eight personal protections available, chosen by players in a real-life scenario. This implies that the players value simple, inexpensive measures such as sandbags as much as more expensive, proactive environmental measures over the longer term.

2) How do these choices differ from the game and why?

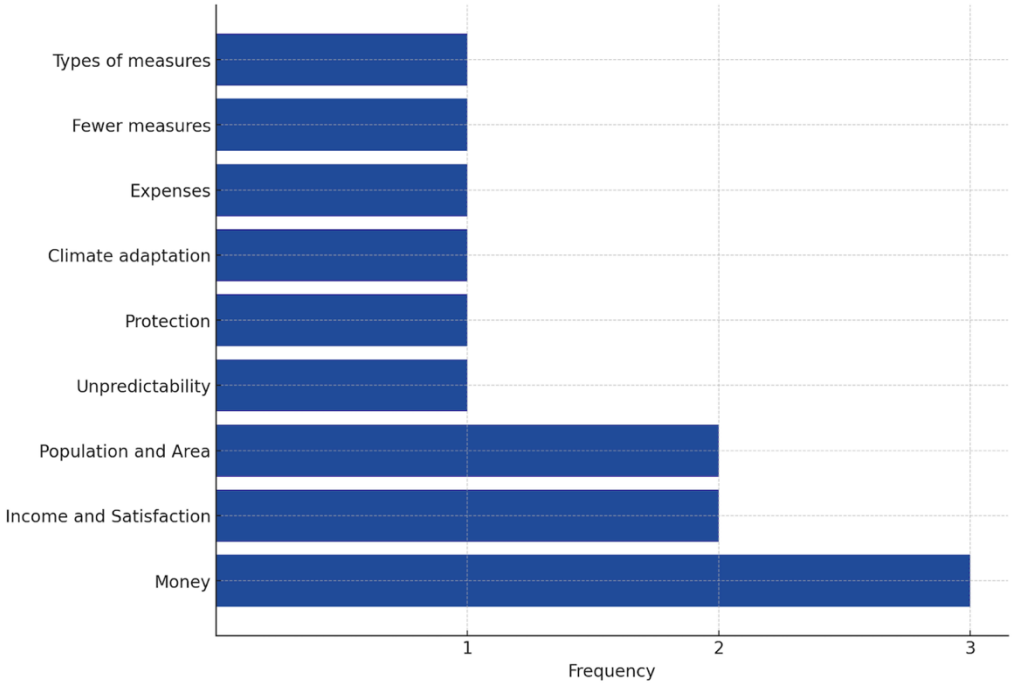


Figure 5.2: Differences between game choices and real-life decisions

The first two factors *Money, Income and Satisfaction* have been the most frequently mentioned and address the same overall theme and are therefore grouped together. As for the previous question, they address the importance of the financial aspect, which plays a crucial role in real life as opposed to games. Participants find it easier to make financial decisions in a fictional context than in a real one. Those with resources to spare in real life will therefore tend to invest less in high-cost personal protection measures: “In the game, you only have money available for measures. In reality, you have many different expenses. Many other cost items”.

The second most-mentioned factor is the geographical and demographic aspect (*Population and Area*) of the serious game. Players argue that the real estate situation in the Netherlands encompasses a large number of additional constraints that may force residents to make certain decisions at the expense of others, hence the need for a tailored solution to the game board depending on the context in which the session takes place.

3) In which of the three residential areas would you prefer to live?

This question addresses the urban aspect of the game board. Establishing the preferences of players' residential areas is important, as this information provides municipalities with insights into potential future flows of residents in terms of housing demand. With more such information, pro-active measures could be taken by government institutions to support prospective homeowners.

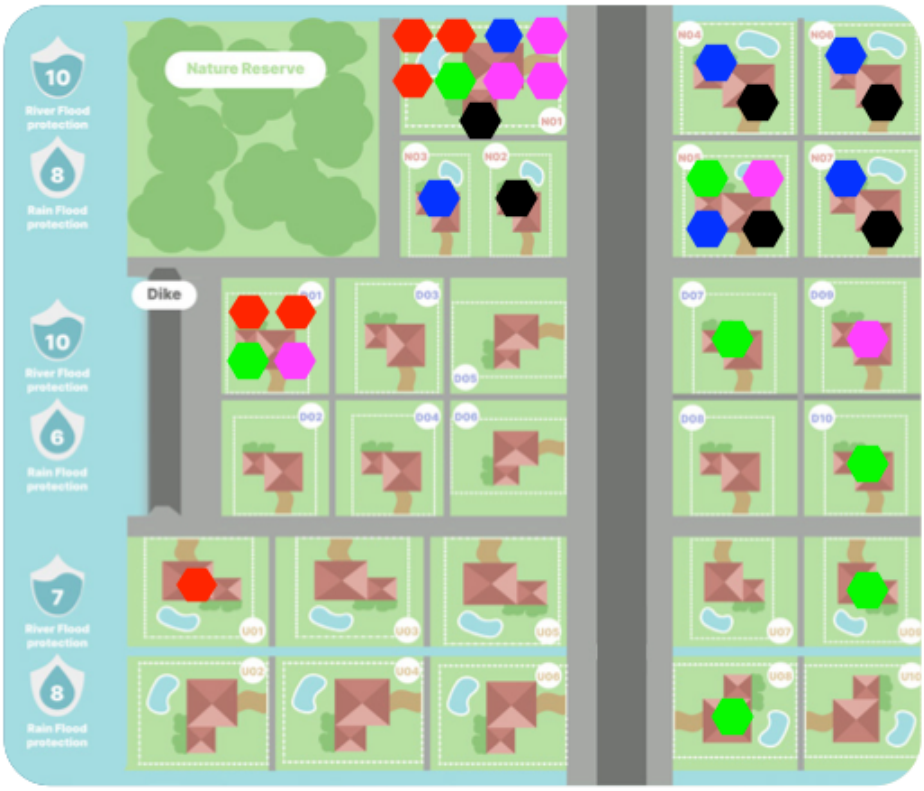


Figure 5.3: Player preferences for residential areas

Figure 5.3 illustrates an overall preference among players to live in a setting such as Natucity, with significant vegetation and a nature reserve as overarching protection. The factors influencing such preferences are often of a personal affinity, but may translate into a desire for a sustainable, green living environment in conjunction with a strong overall protection that the area offers.

4) Would you be interested in community protection, and if so, in which?

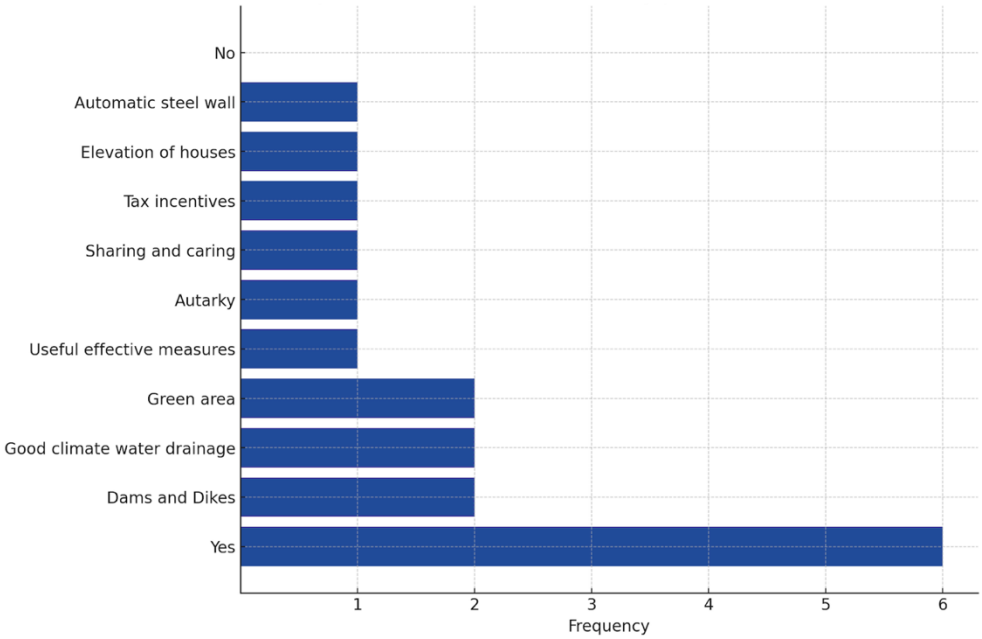


Figure 5.4: Interest in community protection measures among participants

The figure 5.4 reveals a clear motivation for all players to have community protection, with a frequency of six corresponding to all the tables taking part in the game session. This suggests that players attach a great importance toward sharing private measures that have been adopted by the majority for a global good capable of protecting an entire living area. The private protective measures to be used as community protection are not set in stone, with most players suggesting simple measures such as water drainage and green gardens, which were also mentioned in the first question.

5) What non-structural measures (other than policy measures or individual protective measures) do you think are important to consider?

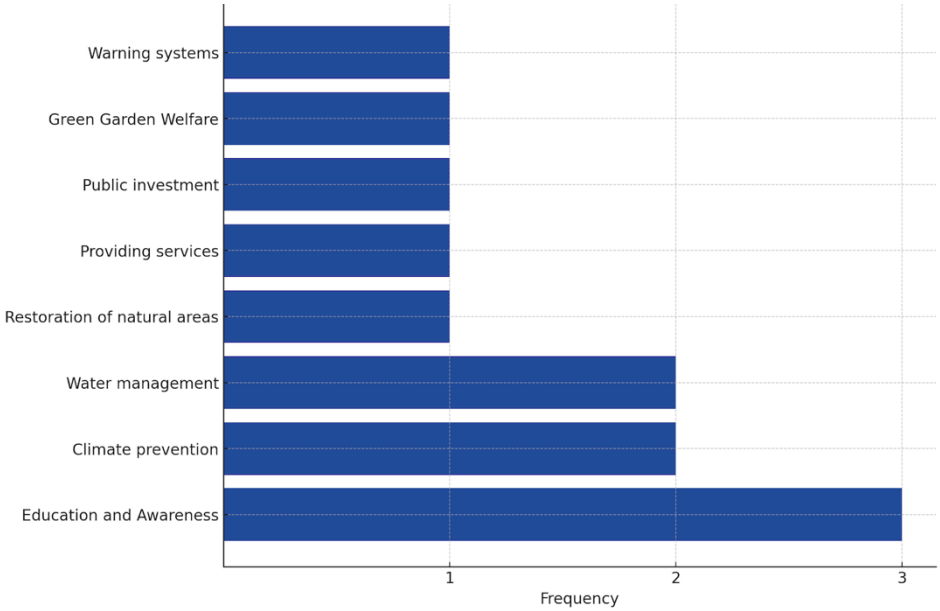


Figure 5.5: Importance in non-structural measures

Figure 5.5 reveals the importance of *education and raising awareness* regarding flood risks and private protective measures. Three mentions out of the six tables suggest that participants realize that there is a global lack of knowledge about this topic as outlined in the literature. This factor gives an indication to municipalities and provinces of a need for education and communication about this topic, as well as demonstrating a willingness to learn if a suitable communication tool was put in place.

The second factor focuses on a more global *Climate prevention & Water management*, which could provide information not only on rainfall and flooding events, but also on heat waves, droughts as well as information on the current water management, such as water pump options, rain water reservoirs, etc.

6) would you rather be interested in: education campaigns, warning systems, insurance and financial instruments or environmental management (restoring natural areas)? please rank them

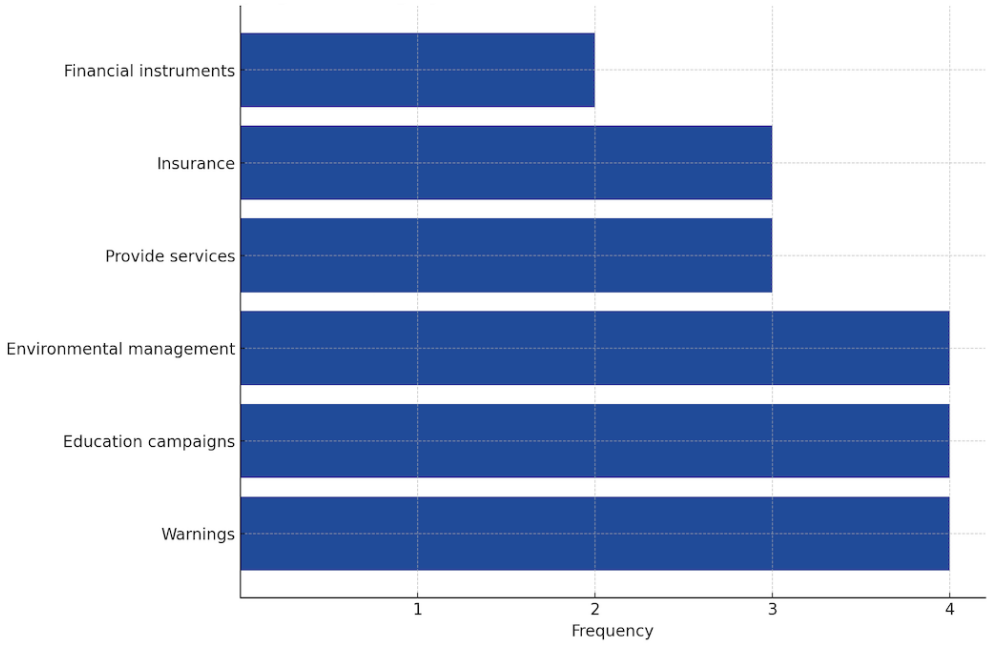


Figure 5.6: Ranking of interests in non-material measures

Figure 5.6 highlights the primary interests of players among the different types of non-material measures and proposes a ranking system that can be used by municipalities or provinces to experiment with certain measures or actions on residents and obtain their feedback or allow them to vote on flood management-related choices. In this scenario, players were mainly interested in warning systems, education campaigns and a better environmental management.

The role-play between municipality and residents recapitulates the needs expressed in the previous questions in a more entertaining and interactive way and creates a balanced and constructive debate between the two parties, even though the municipal part is played by students.

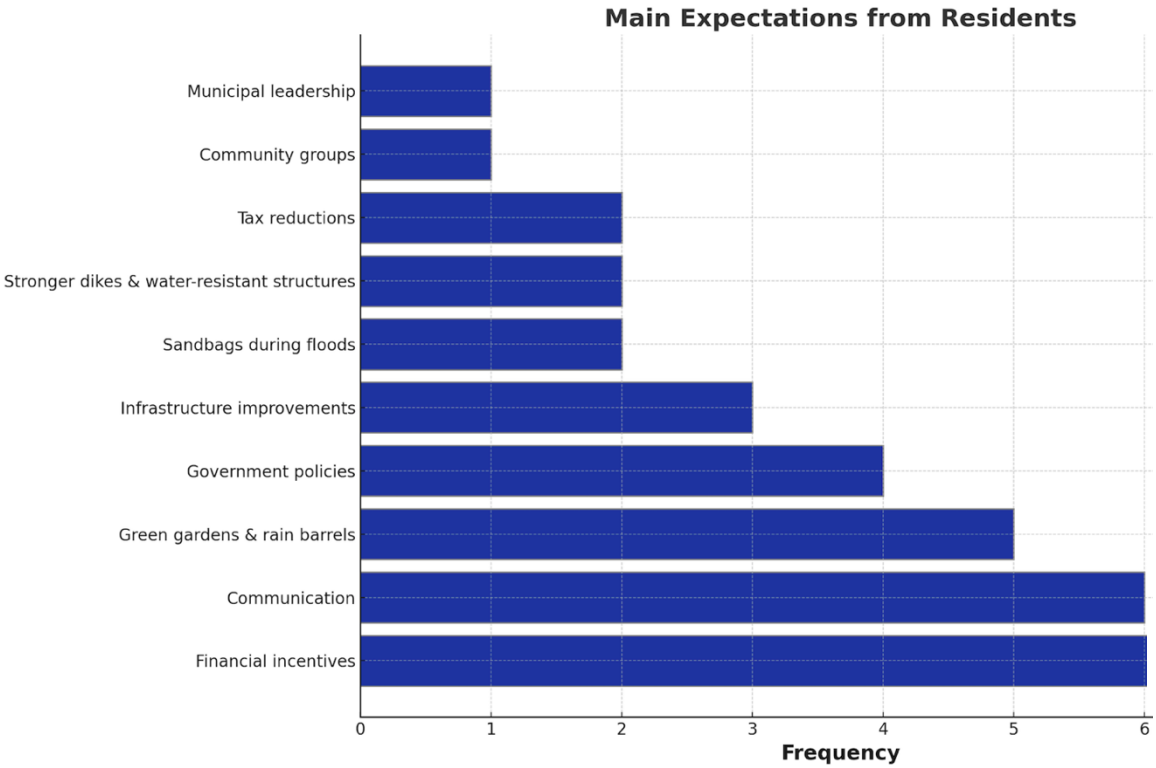


Figure 5.8: Role-play residents arguments

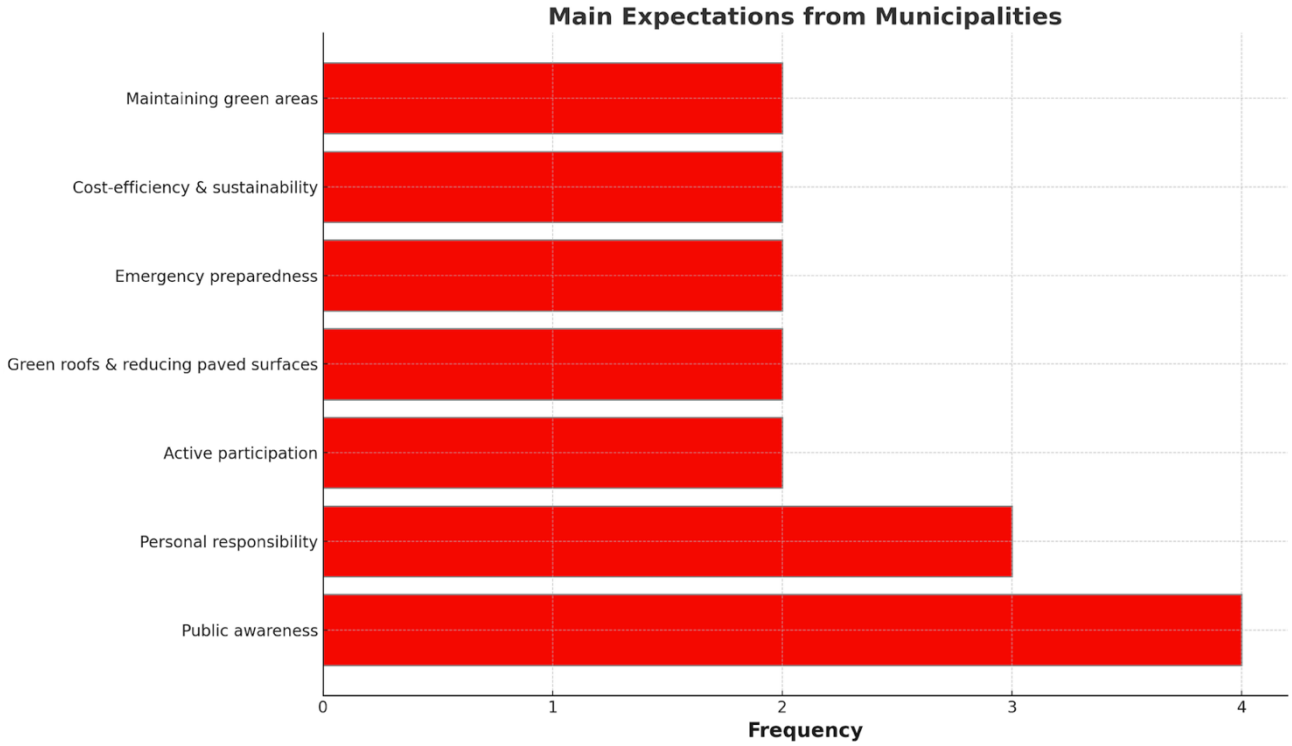


Figure 5.8: Role-play municipalities arguments

Residents' needs remain mainly financial, mentioned a total of seven times, followed by the need for effective communication and common protection measures such as green gardens & rain barrels. On the municipal side, expectations are mostly in terms of better public awareness, mentioned a total of four times, thus meeting the residents' second argument, followed by the expectation of residents to have greater personal responsibility and active participation.

Conclusion:

To conclude this debriefing analysis, residents have a multitude of expectations that manifest primarily in the form of financial incentives (financial aid, tax reduction) followed by a desire for community protection with private protective measures such as green garden and rain barrel. The analysis also shows a preference for future residents to live in an area protected by a nature reserve, as well as a need to be better informed about flood risks overall, and for organizations to find ways to raise public awareness through education and prevention.

5.2 Interview data analysis

5.2.1 Large Municipality Interview Context (Interview One)

The interview with the municipality took place with a water safety advisor and discussed the current flood risk communications methods used by the organization, as well as the requirements and needs for introducing a serious game such as "WhereWeMove" as a new communications tool.

According to the interviewee, the large municipality has important responsibilities towards its residents in terms of flood risk prevention and protection. While the rain and river flooding responsibilities are shared between departments and waterrecht, the municipality has a duty to inform and communicate flood risks to residents. For the time being, this is done via a number of channels, including government, provincial websites, social networks and local networks such as WhatsApp groups as well as local contacts in high-risk areas around Noordereiland. Communication is achieved not only digitally, but also in person, through a range of events organized by the municipality, or through climate adaptation programs involving residents in climate initiatives aimed at making the city greener and more sustainable.

The interview continued with a PowerPoint presentation outlining the mechanics, benefits and co-creation potential of serious gaming, before moving on to more specific questions about the various aspects to be taken into account within the organization in order to be able to use this communication tool.

If this specific municipality were to use this kind of communication tool, its aim would be to raise awareness in the first place by playing game sessions with residents. The secondary and tertiary objective would indeed be to have a co-creation work with resulting common ideas and policy trials, although this would be more of a longer-term solution. While the game is a good initiative and its use may be considered in the near future, there are nonetheless some important points to bear in mind that could prove challenging when it comes to implementing such a tool. According to the interviewee, equity and inclusivity are of great importance to the municipality, which requires the game to be accessible to most of its residents, both intellectually and socially. The safety aspect must also meet government criteria when used in a real-life scenario and must be compatible with the organization's internal software. The organization also needs to provide capacity that is not currently available. The use of this game would require staff resources that are currently occupied with other administrative tasks. One solution would be to outsource facilitators for the game sessions. Lastly, the municipality sees the potential and acknowledges the importance and willingness to use such a game in its organization but stresses the importance of integrating this communication tool into a more overarching program in order to give greater purpose to its use.

Influential Factors:

From the interview responses it was possible to classify first-order codes into second-order codes (influential factors) emerging from the theoretical background (*Deductive approach)*.

First Order Codes	Second Order Codes	Third Order Codes
High urbanization	Socioeconomic characteristics	Environment
Monetary initiatives		
Similar scenario	Local relevance	

Table 5-1: Environmental aspect of the large municipality

Socioeconomic characteristics (2 iterations):

The city's large size (high urbanization) implies that the municipality has considerable resources (monetary initiatives) at its disposal for social projects offering a wide range of subsidies for its residents as stated during the interview. The socio-economic factor is a driver in this regard.

Local relevance (1 iteration):

The local relevance of the game is very much present, given that it is a large city encompassing residence areas similar to those of the serious game, and faces heavy rainfall combined with overflowing rivers (Similar scenario).

Environment

The environmental aspect includes two influential factors, both of which drive the implementation of serious gaming in the organization.

First Order Codes	Second Order Codes	Third Order Codes
Local contacts	High levels of collaboration	Inter-organizational
Social cooperation		
Online information	Frequent dissemination of information/knowledge	
Seasonal dissemination		
Spontaneous communication	Two-way communication	
Awareness workshops		
Discussion events	Co-creation	
Bottom-up approach		

Table 5-2: Inter-organizational aspect of the large municipality

High levels of collaboration (4 iterations):

At the start of the conversation, the interviewee mentions that the organization has a good local communication via social networks or events with residents (Local contacts) "*We have contacts for example people who live there and host WhatsApp groups from the neighborhood"* as well as a good social cooperation between people in need and housing association (Social cooperation). The municipality therefore has a high level of collaboration and can consider this influential factor as a driver.

Frequent dissemination of information/knowledge (3 iterations):

The organization has a good dissemination of information and knowledge through its online communication channels which are updated on a regular basis (Online information) as well as through social networks and the hosting of regular events (Seasonal dissemination.

Two-way communication (8 iterations):

According to the interviewee, two-way communication is already present in the municipal setting, as employees interact with residents, particularly during spontaneous actions, to discuss and ask questions (Spontaneous communication). The organization also offers awareness workshops incorporating flooding scenarios for different types of neighborhood, in which both professionals and residents can take part (Awareness workshops).

Co-creation (4 iterations):

In this organization, co-creation is possible and takes place on a medium scale. The neighborhoods can discuss their problems with the municipalities, who are able to propose long-term solutions, although this is not systematic (discussion events). A bottom-up approach is nonetheless possible in the sense that citizens can approach the municipality to propose a change. If the reasoning is reliable, there is a good chance that the suggestion will be implemented (Bottom-up approach). Co-creation is therefore a driver, despite the fact that it takes place on a spontaneous and not yet regular basis.

Inter-organizational

Although the Inter-organizational learning influential factor has not been addressed by the municipality during the interview, suggesting that it plays a secondary role in the implementation of a serious game in this organization, the broader environmental aspect is a driver for the organization in this case and favors its implementation.

First Order Codes	Second Order Codes	Third Order Codes
Framing dependence	Supportive leadership	Organization
Responsible leadership		
Decentralized with waterrecht	Organizational structure (e.g., decentralized)	
Outsourcing ICT	Presence of slack resources	
Dependent presence of money		
Managing expectations	Supportive culture	
Handling new tools	Training for employees	
Short training	Ease of training	

Table 5-3: Organizational aspect of the large municipality

Supportive leadership (3 iterations):

The interviewee emphasizes the importance of framing the serious game in a context where leadership support is possible. For them, the need is not present, and taking responsibility for introducing such a game if there are expectations is risky (Framing dependence) "*You have to frame it a certain way where you can also not have the responsibility all just on your shoulder*". This factor is not entirely a barrier. Leadership can accept the introduction of such a game if there is an underlying motive (Responsible leadership). This variable will therefore be classified as "dependent" between driver and barrier, which can be both depending on the context.

Organizational structure (e.g., decentralized) (1 iteration):

The large municipality has a very broad and complex organizational structure, with well-defined responsibilities between departments and institutions such as the waterrecht. This clear separation of tasks enables more efficient and faster project management, favoring the implementation and dissemination of a serious game (Decentralized with waterrecht).

Presence of slack resources (2 iterations):

The interview mentions that the large municipality brings together a important number of resources, whether monetary, personal or ICT facilities. The organization would have no problem outsourcing staff and spending capital on this project if required. Outsourcing is a necessity, according to the interviewee, given the large workload for the various employees already on board, who would be unable to manage such a project internally. The main issue or challenge is the allocation of resources to certain projects. For this communication tool to be selected, it needs to be placed within a more global communication plan "*Let's say I hire a private organization who can facilitate, then it cost me like 5,000 euros. Maybe that will be expensive already for one evening. That's not a problem*". This influential factor is therefore also considered to be "dependent" on underlying factors and may be a barrier or driver dependent on the context.

Supportive culture (1 iteration):

The culture is supportive in the implementation of projects when they are well laid out with a concrete plan to manage expectations. As long as responsibilities are well defined and taken into account, the organization allows the introduction of innovative projects (Supportive culture).

Training for employees (1 iteration):

Training employees is not an issue, as this is already done internally. The organization mentions the need to train employees in the use of existing and new tools (Handling new tools).

Ease of training (1 iteration):

The interviewee acknowledges that the game would be easy to train and points out that it could be done in half a day (Short training).

Organization

Unlike the environmental aspect, the organizational aspect cannot be considered a driver nor a barrier, since some of its influential factors are dependent on elements that are beyond the control of the municipality.

First Order Codes	Second Order Codes	Third Order Codes
Importance in high accessibility	High ease of use	Innovation
Session low complexity		
Security concerns	Absence of security/privacy issues	
IT support		
Compatible through inclusivity	High compatibility	
High versatility	High relative advantage	
Test possibility	High trialability	

Table 5-4: Innovation aspect of the large municipality

High ease of use (3 iterations):

This influential factor may present a problem for the organization. The game requires a lot of planning to be able to play it with residents, which is already a challenge, but above all the municipality is focusing enormously on accessibility, inclusivity and ensuring that it can be played by everyone (Importance in high accessibility) "*For us accessibility would be very important that if we would organize sessions with inhabitants, it should be accessible for most people*". The serious game must therefore have more accessible mechanics for everyone, as it could be considered a little too difficult for residents to play from an intellectual point of

view (Session low complexity). Please note that this observation has only been made with regard to the serious game "WhereWeMove" and that this precedent can therefore not be generalized to all serious games and their mechanics.

Absence of security/privacy issues (2 iterations):

Security is also a concern mentioned by the interviewee. The municipality has to comply with important government safety regulations and must therefore be able to use this game in the organization by applying its rules and regulations (Security concerns) "*A lot of games are developed with the idea that governments are going to work with it but that means that we have to implement these kind of systems also from a security perspective*". The organization therefore needs to ensure that it is in compliance when using a serious game such as "WhereWeMove", and therefore requires more information on internal IT and administrative mechanisms in order to make a safe decision on whether to use this game with residents (IT support).

High compatibility (1 iteration):

The municipality organizes events and is open to new projects with dedicated budgets. Compatibility is therefore well within reach if this kind of innovative initiative is to be implemented. If the game is compatible with the organization's guidelines such as inclusivity and accessibility, it will be implemented (Compatible through inclusivity).

High relative advantage (1 iteration):

The use of a serious game such as "WereWeMove" is seen as very versatile as it can be implemented in a variety of contexts such as a governmental organization, but also in the private sector or as an educational tool in universities, high schools or elementary schools, depending on the difficulty of the game. This tool is very flexible and offers a distinct advantage over other conventional means of communication (High versatility).

High trialability (1 iteration):

This influential factors is also present according to the interviewee, as this game can be tested internally before being used with residents. The organization also has enough connections to pilot this tool in a trial setting.

Innovation

The innovation aspect is currently a barrier to the implementation of the serious game. Two influential factors need to be modified and overcome to allow the introduction and diffusion of this communication tool.

First Order Codes	Second Order Codes	Third Order Codes
Certain enthusiasm	Personality characteristics (e.g., enthusiasm, charisma)	Individual
Outsourcing	Skills of public servants	
Trust issues	Innovation resistance hampering an innovation's implementation	
All levels communication	Demographic aspects	

Table 5-5: Individual aspect of the large municipality

Personality characteristics (e.g., enthusiasm, charisma) (2 iterations):
The arrival of a serious game is seen in a positive and enthusiastic light. The municipality welcomes new, innovative projects to help residents (Certain enthusiasm).

Skills of public servants (2 iterations):
Public servant skills are not a problem either, as the organization aims to outsource the workforce to facilitate the gaming experience (Outsourcing).

Innovation resistance hampering an innovation's implementation (2 iterations):
Citizens are open to new solutions proposed by the municipality. There may, however, be concerns about the level of trust between the state and its citizens, which has become increasingly apparent in recent times (Trust issues). The innovation and its mechanisms need to be presented in a transparent way, with clear data management guidelines, ensuring the security and integrity of the users.

Demographic aspects (2 iterations):
The large city's demographic aspect is diverse with a population of average educational standards on a global scale. This influencing factor is by no means a problem, given that the game and its functioning are intended to reach a broad audience in order to bring knowledge and a means of exchange to as many people as possible (All levels communication).

Individual

The individual aspect can be considered as a driver and does not pose a problem in the implementation of a serious game in the organization. All the influential factors are present, yet the trust between citizens and municipality remains an important component.

Inductive approach

Two further influential factors emerge from the interview and form together an additional third-order category/code which is the political dimension in governmental organizations.

First Order Codes	Second Order Codes	Third Order Codes
Strategy importance	Plan based communication strategy	Politics
Framing innovation	Innovation program fit	

Table 5-6: Political aspect of the large municipality

Plan based communication strategy (10 iterations):

Among the most important influential factors in the implementation of a serious game is the strategic political importance it brings to the organization, justifying its use. The interviewee affirms that while the vast majority of the above-mentioned factors can be dealt with and resolved internally, it is essential to have a plan-based communication strategy in order to gain political support. This variable is therefore dependent on underlying political endorsement and is therefore neither a barrier nor a driver (Strategy importance) "*It should fit within the targets of the program because else why should you do it if it doesn't fit in your strategy?*".

Innovation program fit (4 iterations):

Projects implemented within the municipality depend largely on an innovation program fit. It is essential to frame this communication tool as a necessity in order to have the underlying political support to enable the implementation of this technology. Just like the communication strategy influential factor, the innovation program fit depends on political ambitions and requires a solid framing and argumentation (Framing innovation) "*That's why the framing is important. sometimes it's also about raising expectations, which you cannot meet*".

Politics

The political aspect is not yet present. It does, however, play a key intermediary role in unlocking influential factors that the organization cannot control. The four variables highlighted in orange depend therefore on the political aspect in this municipal organization.

Overview table interview one

First Order Codes	Second Order Codes	Third Order Codes
High urbanization	Socioeconomic characteristics	Environment
Monetary initiatives		
Similar scenario	Local relevance	
Local contacts	High levels of collaboration	Inter-organizational
Social cooperation		
Online information	Frequent dissemination of information/knowledge	
Seasonal dissemination		
Spontaneous communication	Two-way communication	
Awareness workshops		
Discussion events	Co-creation	
Bottom-up approach		
Framing dependence	Supportive leadership	Organization
Responsible leadership		
Decentralized with waterrecht	Organizational structure (e.g., decentralized)	
Outsourcing ICT	Presence of slack resources	
Dependent presence of money		
Managing expectations	Supportive culture	
Handling new tools	Training for employees	
Short training	Ease of training	
Importance in high accessibility	High ease of use	Innovation
Session low complexity		
Security concerns	Absence of security/privacy issues	
IT support		
Compatible through inclusivity	High compatibility	
High versatility	High relative advantage	
Test possibility	High trialability	
Certain enthusiasm	Personality characteristics (e.g., enthusiasm, charisma)	Individual
Outsourcing	Skills of public servants	
Trust issues	Innovation resistance hampering an innovation's implementation	
Strong overall commitment	Demographic aspects	
Strategy importance	Plan based communication strategy	Politics
Framing innovation	Innovation program fit	

5.2.2 Small Municipality Interview Context (Interview Two)

The interview with the municipality took place with a sustainability climate adaptation advisor and discussed the current flood risk communications methods used by the organization, as well as the requirements and needs for introducing a serious game such as "WhereWeMove" as a new communications tool.

The interviewee begins by describing her specific role in the smaller-sized municipality. The focus is on spatial adaptation, which involves four main themes: heat, drought, flooding and rainwater management. Her main role is to implement strategies to support residents in dealing with these four themes. The division of responsibilities is clear: the waterboard covers river flooding, the safety region handles communication in imminent crisis situations, and the municipality is responsible for long-term risk communication. The organization uses a multitude of communication strategies to connect residents with local information via digital means such as social networks or weekly newsletters, as well as through local events to inform residents directly on-site. Although these means of communication work very well in theory, the interviewee highlights the lack of commitment and recalls having received feedback indicating a significant lack of knowledge among residents about climate adaptation.

The interview continued with a PowerPoint presentation outlining the mechanics, benefits and co-creation potential of serious gaming, before moving on to more specific questions about the various aspects to be taken into account within the organization in order to be able to use this communication tool.

As in the case of the larger municipality, this one sees itself using this serious game to achieve the three objectives of raising awareness, co-creation and policy testing. The most important element, according to the interviewee, is first and foremost to provide people with knowledge around the local flood risk and actions they could take. Although co-creation is possible, the municipality is focusing more on the information transmission for the time being, mainly because of a lack of urgency around the subject and issues deemed as "more important" such as energy prices that need to be tackled first. The organization is nevertheless open to new innovative solutions, even though implementation requires overcoming significant monetary and inter-organizational constraints. The interviewee discusses the need to get innovative projects of this kind onto the political agenda in order to win their support. The organization has both inherent and independent drivers and barriers that need to be addressed and overcome.

Influential Factors:

From the interview responses it was possible to classify first-order codes into second-order codes (factors) emerging from the theoretical background (*Deductive approach).*

First Order Codes	Second Order Codes	Third Order Codes
Medium urbanization	Socioeconomic characteristics	Environment
Lack in relevance	Local relevance	

Table 5-7: Environmental aspect of the small municipality

Socioeconomic characteristics (1 iteration):
The municipality is medium-sized, with a moderately urbanized area and a population of over 60,000. The infomercial factor is not a problem in this instance.

Local relevance (3 iterations):
Although the use of a serious game is relevant to the organization, the usefulness of this particular game is questionable as it does not fully correspond to the problems faced by the small municipality. In order to use the game, the interviewee suggests that rain floods should play a more significant role than river floodings, which do not occur on a scale such as Limburg, for instance (Lack in relevance) "*We haven't had a large flowing here like in in Limburg*". The lack of a tailor-made game board can therefore be seen as a current barrier to the implementation of the serious "WhereWeMove" game.

Environment

The environmental aspect is a barrier due to the local relevance, which is not perceived as suitable for the local community.

First Order Codes	Second Order Codes	Third Order Codes
Waterboard collaboration	High levels of collaboration	Inter-organizational
Important network		
Newsletters distribution	Frequent dissemination of information/knowledge	
National campaigns		
Difficult coordination	Inter-organizational learning	
Citizen feedback	Two-way communication	
Evenings events		
Action stimulation	Co-creation	
Legal enabler		

Table 5-8: Inter-organizational aspect of the small municipality

High levels of collaboration (3 iterations):

The small municipality has a good collaboration between different departments in the sense that responsibility is clearly defined, and they can rely on each other (Waterboard collaboration). The same applies to cooperation between residents and the municipality. The multiple communication channels, both digital and face-to-face, available enable the discussion and understanding of each other's needs (Important network).

Frequent dissemination of information/knowledge (2 iterations):

As already mentioned in the previous paragraph, the interviewee emphasizes that the information flow is not a problem between municipality and residents. The weekly newsletter keeps residents up to date and informed about the local situation (Newsletters distribution). Twice a year, they also participates in external national campaign events, using this channel to communicate with citizens (National campaigns).

Inter-organizational learning (1 iteration):

Although communication is difficult between the various departments given their strong independence, the inter-organizational leaning is still present (Difficult coordination). The municipality's role is to listen and learn from residents' needs, as well as communicating them internally to find common solutions.

Two-way communication (3 iterations):

The organization communicates directly with the local population and receives feedback through spontaneous meetings and events (Citizen feedback). Workshops are also organized between residents and municipal representatives, with simulated scenarios involving different neighborhoods (Evenings events).

Co-creation (3 iterations):

From the two-way communication influential factor emerges co-creation on a limited scale. The interviewee mentions the willingness to stimulate residents on subjects such as climate adaptation rather than limiting their interactions to symmetrical communication (Action stimulation). Co-creation should be a way to go. The municipality also has to comply with a new law requiring the intensification of constructive interaction with residents. It encourages the use of communication tools such as a serious game to interact with citizens in order to get to know what their priorities are (Legal enabler).

Inter-organizational

The environmental aspect is a driver for the municipality. The various influential factors are present and are not problematic in the implementation of a serious game such as "WhereWeMove".

First Order Codes	Second Order Codes	Third Order Codes
Leadership division	Supportive leadership	Organization
Need for a leader		
Decentralized system	Organizational structure (e.g., decentralized)	
Small budget	Presence of slack resources	
Need for staff		
Political dependence	Supportive culture	
Possible training	Training for employees	

Table 5-9: Organizational aspect of the small municipality

Supportive leadership (2 iterations):

The interviewee mentions the difficulty of having a supportive leadership in the way the municipality is structured. The organizational structure is flat, and the departments work independently, and this game would require different groups such as the policy, safety and communication teams to work together (Leadership division). A project leader is therefore needed to harmonize the tasks between departments and implement the game (Need for a leader) "*I think I need somebody in my department on like maybe management level who will say we're going to prioritize this topic*". This influential factor is therefore not a barrier or driver in the strict sense of the term but is rather dependent on a higher authority enabling a leader to be put in place at management level.

Organizational structure (e.g., decentralized) (3 iterations):

The organizational structure, though less complex than the large municipality, is well defined between departments, and technology adoption does take place within the organization. For current projects, it is the departments in charge of management of the public space that are responsible for implementation, but this could be changed with the arrival of a serious game with the help of a newly defined leadership (Decentralized system).

Presence of slack resources (5 iterations):

The municipality is quite small with a small number of personnel and an average budget, says the interviewee. Monetary resources are not currently available (Small budget) to implement this kind of tool, and there is a crucial shortage of staff (Need for staff). The interviewee is alone in her department at the moment and has already a very heavy workload "*We would need more personnel to do this*." Without the recruitment of new personnel, the tool cannot be implemented, making this influential factor a difficult barrier to overcome.

Supportive culture (2 iterations):

As with supportive leadership, supportive culture is dependent on a higher authority taking responsibility for implementing such a project. Although the organizational culture is supportive in the work of the various departments, the implementation of this communication tool could not be implemented without overarching support (Political dependence) "*It is also part of the local politics*".

Training for employees (1 iteration):

Employee training is a driver and can be done internally within the organization between different departments to get an overview of how the organization works.

Organization

The organizational aspect is a barrier to the implementation of serious gaming so far. It includes influential factors that depend on higher authorities as well as more pragmatic barriers such as the lack of personnel faced by the municipality.

First Order Codes	Second Order Codes	Third Order Codes
Security concerns	Absence of security/privacy issues	Innovation
Short budget	Low implementation costs	
New working way	High relative advantage	
Pilot tests	High trialability	

Table 5-10: Innovation aspect of the small municipality

Absence of security/privacy issues (1 iteration):

The interviewee mentions the need to integrate the game into a secure software system and to follow strict guidelines that have been put in place nationally for governmental organizations (Security concerns) "*Because you have a lot of information about the inhabitants, so there's always safety and security concerns*". As the game is currently presented, it could only be played internally within the organization but could not be used at official events until it complies with security expectations. This influential factor is therefore a barrier for the time being.

Low implementation costs (1 iteration):

As mentioned above, the budget is limited at a municipal level. Each year a budget is allocated within the organization for projects. However, this allocation is voted by the council, which sits and votes on the distribution of the funds. In 2026, Dutch municipalities will have to face a cut in their budgets, for which they are already preparing. Obtaining funding to implement this game will therefore depend on the costs and perceived potential of the game on a more global scale. This influential factor is therefore dependent on a higher authority and is neither a barrier nor a driver (Short budget) "*Low implementation costs are important because of the budget cut 2026*".

High relative advantage (1 iteration):

The advantage of this communication tool is that it is innovative and could help the community in a new way, introducing a playful side to a serious subject like flood risk (New working way).

High trialability (1 iteration):

Using a pilot would be possible with the agreement of the respective departments, enabling the game to be tested internally before being used in a real-life scenario (Pilot tests).

Innovation

The innovation aspect is an obstacle for the organization. The security/privacy influential factor is a barrier at this stage, as are implementation costs, which depend on a higher authority and are considered neither a driver nor a barrier. The last two factors, on the other hand, allow for the implementation of the game.

First Order Codes	Second Order Codes	Third Order Codes
Positive expectations	Personality characteristics (e.g., enthusiasm, charisma)	Individual
Present skills	Skills of public servants	
Framing importance	Innovation resistance hampering an innovation's implementation	
Average education	Demographic aspects	

Table 5-11: Individual aspect of the small municipality

Personality characteristics (e.g., enthusiasm, charisma) (1 iteration):
The interviewee shows a certain enthusiasm for the serious game and recognizes the need to use innovative communication channels to teach residents about new aspects such as finance, types of protection and different types of risks (Positive expectations).

Skills of public servants (1 iteration):
Facilitating the game doesn't require any specific personnel and shouldn't pose a problem for the organization. Mastering the game is feasible but requires time to be freed up for the employees (Present skills).

Innovation resistance hampering an innovation's implementation (1 iteration):
The resistance faced by the municipality if the game is implemented will depend on how it has been communicated to the residents. It is important to have a framing strategy to introduce the game by explaining its potential and benefits without causing a sense of fear amongst the player that might make them reluctant to play an anxiogenic game. This shouldn't be a problem for the municipality, given that they already communicate sensitive subjects with residents (Framing importance).

Demographic aspects (1 iteration):
The overall demographic aspect is a driver. The average level of education is relatively good on a national scale, as is the local financial situation.

Individual

The Individual aspect is a driver to the "WhereWeMove" serious game. The four factors do not pose a threat to the implementation of this communication tool.

Inductive approach

Two further influential factors emerge from the interview and form together an additional third-order category/code which is the political dimension in governmental organizations.

First Order Codes	Second Order Codes	Third Order Codes
Prioritization need	Plan based communication strategy	Politics
Main assignment	Innovation program fit	

Table 5-12: Political aspect of the small municipality

Plan based communication strategy (2 iterations):

As already mentioned by the large municipality, one of the most important influential factors for this municipality is the communication strategy around the game. The interviewee stresses the importance of promoting the value of the game so that it becomes a priority for residents and politicians (Prioritization need) "*I think what's necessary is that people know why it's important and that it needs to get prioritized*". This factor is dependent on and interlinked with the political aspect and may influence their decisions on the use of this communication tool.

Innovation program fit (3 iterations):

According to the interviewee, if the innovation corresponds to a more global political program, a main assignment could be triggered to implement this communication tool in the municipality through a bottom-down approach following a traditional pyramidal hierarchy. "*Main assignment from politics to play this game*", "*The use of the serious games is due partly also just local politics*". As with the previous factor, it depends on the underlying political aspect, and thus for the moment neither a driver nor a barrier.

Politics

The political aspect is not yet present. It does, however, play a key intermediary role in unlocking influential factors that the organization cannot control. The five variables highlighted in orange depend therefore on the political aspect in this municipal organization.

Overview table interview two

First Order Codes	Second Order Codes	Third Order Codes
Medium urbanization	Socioeconomic characteristics	Environment
Lack in relevance	Local relevance	
Waterboard collaboration	High levels of collaboration	Inter-organizational
Important network		
Newsletters distribution	Frequent dissemination of information/knowledge	
National campaigns		
Difficult coordination	Inter-organizational learning	
Citizen feedback	Two-way communication	
Evenings events		
Action stimulation	Co-creation	
Legal enabler		
Leadership division	Supportive leadership	Organization
Need for a leader		
Decentralized system	Organizational structure (e.g., decentralized)	
Small budget	Presence of slack resources	
Need for staff		
Political dependence	Supportive culture	
Possible training	Training for employees	
Challenging game	High ease of use	Innovation
Security concerns	Absence of security/privacy issues	
Short budget	Low implementation costs	
New working way	High relative advantage	
Pilot tests	High trialability	
Positive expectations	Personality characteristics (e.g., enthusiasm, charisma)	Individual
Present skills	Skills of public servants	
Framing importance	Innovation resistance hampering an innovation's implementation	
Average education	Demographic aspects	
Prioritization need	Plan based communication strategy	Politics
Main assignment	Innovation program fit	

5.2.3 Province Interview Context (Interview Three)

The interview with the province took place with a water safety policy officer and discussed the current flood risk communications methods used by the organization, as well as the requirements and needs for introducing a serious game such as "WhereWeMove" as a new communications tool.

The interview begins with a contextualization of the differences between the responsibilities of municipalities and provinces. Although the two governmental bodies are similar in organizational terms (working methods, internal networks, government obligations), they are very different in their functions. The purpose of the province is to communicate the needs of municipalities to the government and vice versa. It is an intermediary between municipalities and ministries. The municipality, on the other hand, is an intermediary between citizens and the province (politics). The separation between entities is designed to facilitate communication between stakeholders. The interviewee mentions that they don't communicate directly with residents and that it is a task that municipalities take on for them. The province works on a national scale, compiling and calculating flood risk maps and communicating this data to ministries and politicians to implement new measures, incentives or legislation in the Netherlands as a whole. The information gathered is generally not disclosed publicly, although what is disclosed is available on the government website. The organization also provides guidelines and suggestions for private adaptive measures. In particular, for residents living in flood prone areas, who may find out what is available to them. These guidelines are intended as information and are not legally enforced.

The interview continued with a PowerPoint presentation outlining the mechanics, benefits and co-creation potential of serious gaming, before moving on to more specific questions about the various aspects to be taken into account within the organization in order to be able to use this communication tool.

As with the smaller municipality, the interviewee stresses that awareness of climate adaptation and flood risks is low among residents. The will is there to use this game to achieve the three objectives, but raising awareness would be the most important for the moment. Offering immediate incentives at this stage is less feasible, as residents prioritize other issues. The province is far from residents, which makes it difficult to organize game sessions or to find an event where this could be done. The interviewee mentioned that the organization would have to work together on a larger scale if they wanted to set up such a program, and that the province supports innovative projects with consequent means, but that implementation would be a slow process requiring to overcome a multitude of barriers.

Influential Factors:

From the interview responses it was possible to classify first-order codes into second-order codes (factors) emerging from the theoretical background (*Deductive Approach*).

First Order Codes	Second Order Codes	Third Order Codes
Very dense area	Socioeconomic characteristics	Environment
Wealthy area		
Broaden game	Local relevance	
Target players		

Table 5-13: Environmental aspect of the province

Socioeconomic characteristics (2 iterations):

The Provinciehuis encompasses a large region of almost four million inhabitants with significant resources and can be considered as the political heart of the Netherlands, making this influential factor a driver.

Local relevance (4 iterations):

The relevance of the serious game "WhereWeMove" is not optimal and could be broadened according to the interviewee "*You could broaden it so not only flood risk, but also like really climate adaptation*". It would be interesting to add a sea flooding aspect and to make the game more general about a multitude of climate phenomena (heat stress, droughts...) that could lead to a house relocation. The game map could also be modulated with the same game mechanics, with the aim of targeting players in the outer dikes areas, which are more at risk and less protected.

Environment

The environmental aspect is a barrier due to the local relevance, which is not perceived as suitable for the province.

First Order Codes	Second Order Codes	Third Order Codes
Low citizen collaboration	High levels of collaboration	Inter-organizational
No citizen network		
No active communication	Frequent dissemination of information/knowledge	
Few tools		
Summer workshops	Inter-organizational learning	
Participation projects	Two-way communication	
Local stakeholders approach	Co-creation	

Table 5-14: Inter-organizational aspect of the province

High levels of collaboration (3 iterations):

There is a high level of collaboration with the political sphere, but very little collaboration between residents and the province. As mentioned above, the organization does not actively communicate flood risks to local inhabitants (Municipal task) "*We don't actively communicate flood risk to residents.*" The problem also lies in the lack of a dedicated communication network. The province doesn't use local news or events to actively communicate but relies mainly on governmental websites (No citizen network) "*Municipalities they have like these networks, we don't*". This influential factor is therefore a barrier, given that the main focus of this project is to play this game with residents, rather than politicians.

Frequent dissemination of information/knowledge (3 iterations):

Given the lack of communication network and the often confidential or not publicly disclosed data, the dissemination of information is not frequent and can be considered uncommon (No active communication) "*We have like all these maps but. We don't actively communicate them*". The rare information that is communicated is concise and often refers to the municipal institutions that take the lead in terms of communication (Few tools). This influential factor is therefore an obvious barrier.

Inter-organizational learning (2 iterations):

The province has set up a system for exchanging knowledge between departments through summer workshops. Given the large size of the organization, it hosts an in-house event each year between the 1,600 employees (Summer workshops). Each unit can learn from the others what they do through this interorganizational network.

Two-way communication (1 iteration):

Two-way communication exists within the province as it organizes participatory projects between departments and professional stakeholders. These projects do not focus on flood management or risk communication (Participation projects). This influential factor is therefore a driver.

Co-creation (2 iterations):

As with two-way communication, co-creation is also carried out in-house. Joint solutions are found with local farmers, for example. Co-creation between individuals is rare, given that it more often involves projects between the province and outside companies/organizations, on a more global scale (Local stakeholders approach).

Inter-organizational

The inter-organizational aspect is a barrier because of the two missing influential factors: high level of collaboration and frequent dissemination of information.

First Order Codes	Second Order Codes	Third Order Codes
Innovative leaders	Supportive leadership	Organization
Large structure	Organizational structure (e.g., decentralized)	
Cross-collaboration		
Capacity problem	Presence of slack resources	
Large financial resources		
Slow innovation adoption	Supportive culture	
Training volunteers	Training for employees	
Basic training	Ease of training	

Table 5-15: Organizational aspect of the province

Supportive leadership (1 iteration):

The interviewee emphasizes that the organization offers employees a considerable degree of freedom and that the leadership is supportive overall (Innovative leaders). As with the other government organizations, the problem lies with the upper political sphere, which can affect whether projects are implemented or not. "*I think they're all really pro innovation technologies and I think our Superior here that if she could, she would have like a lot of innovation. But that's just not happening. We are not a fast-moving governmental layer*" Leaders at provincial level are willing to play their part, but a higher level of authority is needed which makes this influential factor dependent.

Organizational structure (e.g., decentralized) (4 iterations):

The provincial organizational structure is, like the two municipalities, well defined. The interviewee mentions the imposing size which can hinder collaboration, hence the importance of a substantial effort from the various departments on this project (Large structure). Another disadvantage of the large size is that it slows down the introduction of joint projects (Cross-collaboration). This influential factor is nonetheless a driver, given that, although slower, the implementation of projects is still manageable.

Presence of slack resources (2 iterations):

This influential factor is also considered to be dependent in this case, given that the province has sufficient monetary resources (Large financial resources) "*We actually do have quite a lot of money as regional governments*" and potentially the capacity to carry out the project, but that these resources are made available in a higher level and are not automatically available (Capacity problem) Whether this factor is a barrier, or a driver will depend on the priority of the superordinate authority.

Supportive culture (1 iteration):

Like the supportive leadership factor, the supporting culture is present but would really endorse the implementation of the project if a hierarchically superior order were given. "*I think that the province like to be innovative but because we are a regional government, things go quite slow* ". This influential factor is therefore considered to be dependent.

Training for employees (1 iteration):

The interviewee mentions that if there are volunteers within the provincial organization, training sessions could be carried out without any problem. To play this game, the province requires employees with a basic understanding of flood risk, which is why staying with people from the organization has priority over outsourcing (Training volunteers).

Ease of training (1 iteration):

The game is seen as easy to train and could be played in real conditions after some practice. This influential factor is a driver (Basic training).

Organization

The organizational aspect is not a barrier nor a driver at the moment but can be seen as dependent on an external factor that cannot be controlled within the provincial organization.

First Order Codes	Second Order Codes	Third Order Codes
Target group dependence	High ease of use	Innovation
Need for anonymity	Absence of security/privacy issues	
Positive effect	High relative advantage	
High versatility		

Table 5-16: Innovation aspect of the province

High ease of use (1 iteration):

The game is not seen as easily playable. The province must be able to play with people from all backgrounds and from different social or intellectual situations. According to the interviewee, the game mechanics could be adapted to suit the player group. "*I think it's not an easy game to play*". It would be possible to replace the complex monetary system with a substitute such as a simple trading or coin system, for instance. The factor is seen as a barrier.

Absence of security/privacy issues (1 iteration):

Unlike the two municipalities, the interviewee sees no privacy issue in the implementation of this game in a live scenario, given that the players' identities are already preserved by assigning them a player and table number. The important point is to ensure that the player's

name cannot be traced so as not to breach anonymity. This influential factor is therefore seen as a driver (Need for anonymity).

High relative advantage (2 iterations):
The province sees the use of this type of game as positive. This is something that hasn't been done before and brings an innovative aspect to creating awareness (Positive effect). The interviewee mentions that it is important to introduce this kind of tool now in view of future natural disaster occurrences where this game could have an impact and help the local population to make responsible decisions (High versatility). Another advantage is the game's versatility. Sessions can be set up quickly and played in different contexts, such as in an inter-organizational setting, which is highly appreciated.

Innovation

The innovation aspect is a barrier due to the perceived difficulty of the game. The other two factors (security) and (relative advantage) are considered to be drivers for the organization.

First Order Codes	Second Order Codes	Third Order Codes
Positive acknowledgment	Personality characteristics (e.g., enthusiasm, charisma)	Individual
High enthusiasm		
Value conflict	Innovation resistance hampering an innovation's implementation	
Large community	Demographic aspects	

Table 5-17: Individual aspect of the province

Personality characteristics (e.g., enthusiasm, charisma) (2 iterations):
As with high relative advantage, the interviewee expresses her enthusiasm for the game. The fun aspect will particularly appeal to young public servants (High enthusiasm), who are increasingly turning to this new kind of learning tools that combine fun and work (Positive acknowledgment).

Innovation resistance hampering an innovation's implementation (2 iterations):
It is possible to encounter resistance to the introduction of this communication tool. This will depend on the value that people place on it, which will vary according to colleagues and their vision of communicating with residents (Value conflict). More generally, the serious game should be well received according to the interviewee.

Demographic aspect (1 iteration):
The demographic aspect is not a problem in broad terms and reflects the demographic situation faced by the two municipalities. The interviewee mentioned that the community is on average open to change, which makes this factor a driver (Open community).

Individual

The three influential factors are drivers, which makes the individual aspect a driver as well in the implementation process of serious gaming within the province.

Inductive approach

Two further influential factors emerge from the interview and form together an additional third-order category/code which is the political dimension in governmental organizations.

First Order Codes	Second Order Codes	Third Order Codes
Strategy importance	Plan based communication strategy	Politics
No priority	Innovation program fit	

Table 5-18: Political aspect of the province

Plan based communication strategy (3 iterations):

For the province, the strategic communication factor remains a central and decisive aspect in the implementation of the communication tool. According to the interviewee, government organizations follow regulations and prioritizations that have been put in place in previous years indicating which tasks are considered important and should be prioritized first. Immediate prevention is a priority task at the moment, which excludes this type of tools. A management shift is needed to ensure that passive communications tools are put in place to raise awareness and ensure shared responsibility (Strategy importance) "*When a strategy is being decided, then is the time to really involve inhabitants and give them incentives*". This factor is therefore still dependent on a higher authority for the time being.

Innovation program fit (3 iterations):

In addition to prioritizing this communication tool, it has to be matched with an existing program. The game therefore needs to be adapted to the current system or made to fit in with the existing prevention program (No priority) "*I think maybe the game is useful for the long run but not for right now because we are very well protected. Cities are working in climate adaptation*". The important point is to have a solid argument to justify why this game is really necessary and that it fits in with the broader agenda and political direction. The influential factor is also dependent on a higher authority that the province does not control.

Politics

The political aspect is not yet present. It does, however, play a key intermediary role in unlocking influential factors that the organization cannot control. The five variables highlighted in orange depend therefore on the political aspect in this municipal organization.

Overview table interview three

First Order Codes	Second Order Codes	Third Order Codes
Very dense area	Socioeconomic characteristics	Environment
Wealthy area		
Broaden game	Local relevance	
Target players		
Municipal task	High levels of collaboration	Inter-organizational
No citizen network		
No active communication	Frequent dissemination of information/knowledge	
Few tools		
Summer workshops	Inter-organizational learning	
Participation projects	Two-way communication	
Local stakeholders approach	Co-creation	
Innovative leaders	Supportive leadership	Organization
Large structure	Organizational structure (e.g., decentralized)	
Cross-collaboration		
Capacity problem	Presence of slack resources	
Large financial resources		
Slow innovation adoption	Supportive culture	
Training volunteers	Training for employees	
Basic training	Ease of training	
Target group dependence	High ease of use	Innovation
Need for anonymity	Absence of security/privacy issues	
Positive effect	High relative advantage	
High versatility		
Positive acknowledgment	Personality characteristics (e.g., enthusiasm, charisma)	Individual
High enthusiasm		
Value conflict	Innovation resistance hampering an innovation's implementation	
Open community	Demographic aspects	
Strategy importance	Plan based communication strategy	Politics
No priority	Innovation program fit	

5.2.4 Comparative Analysis of the three governmental institutions

This section presents a comparative analysis between the three organizations: The discussion will focus on the six key aspects (Environment, Inter-organizational, Organizational, Innovation, Individual, and Politics) highlighting their similarities and differences for a comprehensive comparison.

First Order Codes	Second Order Codes	Third Order Codes
High urbanization	Socioeconomic characteristics	Environment
Monetary initiatives		
Similar scenario	Local relevance	
Local contacts	High levels of collaboration	Inter-organizational
Social cooperation		
Online information's	Frequent dissemination of information/knowledge	
Seasonal dissemination		
Spontaneous communication	Two-way communication	
Awareness workshops		
Discussion events	Co-creation	
Bottom up approach		
Framing dependence	Supportive leadership	Organization
Responsible leadership		
Decentralized with waterrecht	Organizational structure (e.g., decentralized)	
Outsourcing ICT	Presence of slack resources	
Dependent presence of money		
Managing expectations	Supportive culture	
Handling new tools	Training for employees	
Short training	Ease of training	
Importance in high accessibility	High ease of use	Innovation
Session low complexity		
Security concerns	Absence of security/privacy issues	
IT support		
Compatible through inclusivity	High compatibility	
High versatility	High relative advantage	
Test possibility	High trialability	
Certain enthusiasm	Personality characteristics (e.g., enthusiasm, charisma)	Individual
Outsourcing	Skills of public servants	
Trust issues	Innovation resistance hampering an innovation's implementation	
Strong overall commitment	Demographic aspects	
Strategy importance	Plan based communication strategy	Politics
Framing innovation	Innovation program fit	

First Order Codes	Second Order Codes	Third Order Codes
Medium urbanization	Socioeconomic characteristics	Environment
Lack in relevance	Local relevance	
Waterboard collaboration	High levels of collaboration	Inter-organizational
Important network		
Newsletters distribution	Frequent dissemination of information/knowledge	
National campaigns		
Difficult coordination	Inter-organizational learning	
Citizen feedback	Two-way communication	
Evenings events		
Action stimulation	Co-creation	
Legal enabler		
Leadership division	Supportive leadership	Organization
Need for a leader		
Decentralized system	Organizational structure (e.g., decentralized)	
Small budget	Presence of slack resources	
Need for staff		
Political dependence	Supportive culture	
Possible training	Training for employees	
Challenging game	High ease of use	Innovation
Security concerns	Absence of security/privacy issues	
Short budget	Low implementation costs	
New working way	High relative advantage	
Pilot tests	High trialability	
Positive expectations	Personality characteristics (e.g., enthusiasm, charisma)	Individual
Present skills	Skills of public servants	
Framing importance	Innovation resistance hampering an innovation's implementation	
Average education	Demographic aspects	
Prioritization need	Plan based communication strategy	Politics
Main assignment	Innovation program fit	

First Order Codes	Second Order Codes	Third Order Codes
Very dense area	Socioeconomic characteristics	Environment
Wealthy area		
Broaden game	Local relevance	
Target players		
Municipal task	High levels of collaboration	Inter-organizational
No citizen network		
No active communication	Frequent dissemination of information/knowledge	
Few tools		
Summer workshops	Inter-organizational learning	
Participation projects	Two-way communication	
Local stakeholders approach	Co-creation	
Innovative leaders	Supportive leadership	Organization
Large structure	Organizational structure (e.g., decentralized)	
Cross-collaboration		
Capacity problem	Presence of slack resources	
Large financial resources		
Slow innovation adoption	Supportive culture	
Training volunteers	Training for employees	
Basic training	Ease of training	
Target group dependence	High ease of use	Innovation
Need for anonymity	Absence of security/privacy issues	
Positive effect	High relative advantage	
High versatility		
Positive acknowledgment	Personality characteristics (e.g., enthusiasm, charisma)	Individual
High enthusiasm		
Value conflict	Innovation resistance hampering an innovation's implementation	
Open community	Demographic aspects	
Strategy importance	Plan based communication strategy	Politics
No priority	Innovation program fit	

Table 5-19: Comparative Analysis of the three governmental institutions

Environmental (Large Municipality: Driver, Small Municipality Barrier, Province Barrier)

Common Points:

The three organizations are located in close geographical areas with high levels of population density and developed infrastructures and have very similar socio-economic characteristics. These characteristics are high in the Netherlands compared to other parts of the world and include comparatively high standards of living, with the majority of residents having access to quality education, healthcare, and employment opportunities (OECD Better Life Index, 2024).

Differences:

The relevance of the game is not perceived in the same way. Although close to each other, the organizations do not evolve around the same local constraints and have different visions of the game's use. The larger municipality sees relevance in the game as such, as its geographical position is perfectly suited to the game board. The smaller municipality and province, on the other hand, see a lack of customization, as they don't face certain scenarios highlighted in the game or would like to see other aspects such as heat stress and droughts added to the game.

Inter-organizational (Large Municipality: Driver, Small Municipality Driver, Province Barrier)

Common Points:

All organizations have inter-organizational communication mechanisms and are actively involved in co-creation. Each organization actively engages in collaborative processes across different departments, ensuring that flood risk communication strategies are not developed in isolation but are instead the result of integrated efforts involving multiple stakeholders.

Differences:

Both municipalities are very often in contact with citizens proposing time-limited co-creation activities in the form of events or special activities, while the province mainly collaborates with ministries and municipalities. While some use social networks or newsletters to communicate, others only disseminate information passively via government websites.

Organization (Large Municipality: Dependent, Small Municipality Barrier, Province Dependent)

Common Points:

The organizational structure is well organized and similar between the three institutions. Given that they depend on the same ministry in the same province, the operating system is more or less standardized between bodies. The three organizations also have a supportive leadership that is conditionally present on higher-level political support. Finally, trainability is possible within the institutions that have the facilities for it.

Differences:

The differences between the three organizations lie in their slack resources. Both the province and the large municipality have important personnel and resources that depend on greater authority to be unlocked. Conversely, the smallest municipality lacks the staff and money to implement the project even in the case of a green light from above.

Innovation (Large Municipality: Barrier, Small Municipality Barrier, Province Barrier)

Common Points:

Overall acknowledgement of the importance and benefits of using a serious game as a communication tool. Although appreciated by the interviewees "WhereWeMove" presents complex mechanisms that can be restrictive for institutions, given that their duty is to play with people from all backgrounds. According to the interviewees, the game is too complex to be played by all residents and so should be developed in a more affordable version.

Differences:

Not all organizations have the same concerns about privacy issues arising from the game. The two municipalities emphasize the security aspect of gaming and the need to adapt it, whereas the province doesn't see any urgency around this factor. According to European regulations the game must be compliant with the General Data Protection Regulation (Regulation - 2016/679 - EN - GDPR - EUR-Lex, 2016). This includes ensuring that all personal data collected during gameplay (such as names, contact details, or location data) is processed lawfully, transparently, and for a specific purpose. In addition to this regulation, which can be found in universities or companies, governmental institutions follow stricter rules specific to the Netherlands. The department in charge of the organization's cyber-security will have to make the game compliant with the Baseline Informatiebeveiliging Overheid (Digitale Overheid, 2024). The BIO is the Dutch government's standard for information security across all government organizations. It provides a comprehensive set of guidelines and controls to ensure the confidentiality, integrity, and availability of government information.

Individual (Large Municipality: Driver, Small Municipality Driver, Province Driver)

Common Points:

The three organizations show a strong enthusiasm for using serious games with residents to promote a shared responsibility. As with the socio-economic characteristics, the demographic aspect is common between institutions with a good average level that encompasses a wide variety of individuals. Municipalities and provinces have qualified servants with skills in a wide range of fields (communication, IT) who are able to disseminate the serious game without encountering too much innovation hampering.

Differences:

The individual aspect is present and doesn't really differ between the three governmental bodies.

Politics (Large Municipality: Dependent, Small Municipality Dependent, Province Dependent)

Common Points:

The three governmental organization are in agreement on the major importance of the political role when it comes to implementing a serious game in house. In their view, the key is a plan-based communication strategy with a corresponding innovation program fit. If these two factors are present, there is a greater likelihood of political agreement to implement the project.

Differences:

The degree of political dependence and the need for strategic framing vary across organizations. Smaller-sized municipalities require more support to implement the use of this tool due to constraints such as financial, personnel, and hierarchical limitations that large organizations do not face.

6. Discussion

The discussion section will be divided into three parts, starting with the main findings that will address current practices and challenges in the implementation of serious games in municipalities/provinces. Two spheres of influence known as Level 1 and 2 will be presented in order to understand the full range of influential factors and their interrelated mechanisms. The important factors (dependent and barriers) will be addressed in order to provide potential solutions that could lead to the adoption of this communication tool. The second part addresses the positioning in relation to the literature and the theoretical background. Although the theoretical and empirical parts are similar, there are some differences in terms of the priorities and factors that will be discussed. The third part considers the limitations of this study and provides recommendations for further research on this complex and interconnected topic.

6.1 Main findings

6.1.1 Debriefing and co-production

The important points to take away from the debriefing data analysis are not solely the factors and measures that emerge from it, but mainly the fact that it is possible to create an environment for co-production with the help of a debriefing between the two parties at the end of the session. According to the building blocks highlighted by Van Der Graaf et al. (2021) and the data analysis of the debriefing, the use of the serious game "WhereWeMove" does indeed lead to a phenomenon of co-production.

Process: The debriefing sessions are inherently iterative, interactive, and complex. These characteristics as described in the co-production model are essential to the process. For example, during the debriefing, participants were encouraged to reflect on their experiences, challenge each other's views, and collaboratively explore the implications of their actions within the game. This iterative dialogue ensures that knowledge is not just shared but actively co-constructed, allowing for a deeper understanding and fostering a shared sense of ownership over the outcomes. In addition to the playfulness of the game, the role play at the end of the session also offers an interactive way of interacting between the various institutions and actors involved.

Codification: Debriefing sessions contribute to the codification of knowledge. The knowledge and needs of players/residents can be brought forward as well as the knowledge of municipal organizations on potential measures, both material and monetary. The debriefing session helps to create a shared language among participants. This codification process is crucial for translating the game experience into actionable insights that can inform real-world

governance practices. Players can identify problems they face in the game in relation to real life, and thus let organizations know about previously unknown needs. The pooling of these problems or initiatives highlights a shared responsibility.

Capacity: Throughout the debriefing, players are engaged and learn from each other. The debate at the end of the questions allows them to present their arguments, which have been determined by the questions beforehand. The communication and exchange of knowledge enables further learning and results in capacity building.

Outcome: The results of the debriefing highlighted that it is possible to co-create between municipalities, provinces and residents on measures or policies to be implemented, and therefore to work as a team on a larger or smaller scale on common solutions enabling a shared responsibility. The use of a serious game is therefore, according to this analysis, suitable for co-creation between organizations.

6.1.2 Interviews

The three governmental organizations illustrate a spectrum of practices and challenges in the implementation of a serious game as a communication tool for flood risk management. Due to the nature of the organizations (municipalities and provinces) each operates in a unique context with its own constraints as well as shared challenges. The influencing factors and operational challenges vary from one organization to another and make a standardized implementation unfeasible.

Dependent influential factors

Before addressing the barriers that organizations must overcome to use a serious game as a communication tool in the governmental body, it is important to define what is understood by the term "level 1 and 2" and "dependent" influential factor. In order to answer the research questions how can municipalities use gaming, such as "Where do We Move," to communicate with residents about the flood risks and related house adaptive measures and what are the implications of using such a gaming approach for the municipality? a conceptual framework was used with the help of an extensive literature providing a model with a number of barrier and drivers to overcome. The practical aspect of this research was to determine the presence of factors that have been elaborated in the literature as well as to determine factors that have not yet been addressed in the literature and that are of importance to the organizations. The factors were then to be classified as barriers and drivers. What emerged uniformly from the three interviews is very interesting: ***The political aspect is central to the implementation of a participative project for all three organizations.*** To simplify the understanding of this research, the political aspect will be considered as a higher level "Level 2" taking priority over the "Level 1" influential factors in the implementation process of a serious game. This means

that if the influential factors are not resolved and transformed into drivers in the higher level, the game cannot be set up despite the presence of the "Level 1" or independent influential factors. A factors belonging to the higher level or level 2 are indicated in orange in the analysis and are “dependent” on a higher authority. They are considered to be dependent when it is beyond the control of the organization in question to turn it into a driver. Another characteristic of higher-level factors is their implementation time. If the political aspect provides the necessary stimulus, the orange “dependent” variable is immediately transformed into a driver.

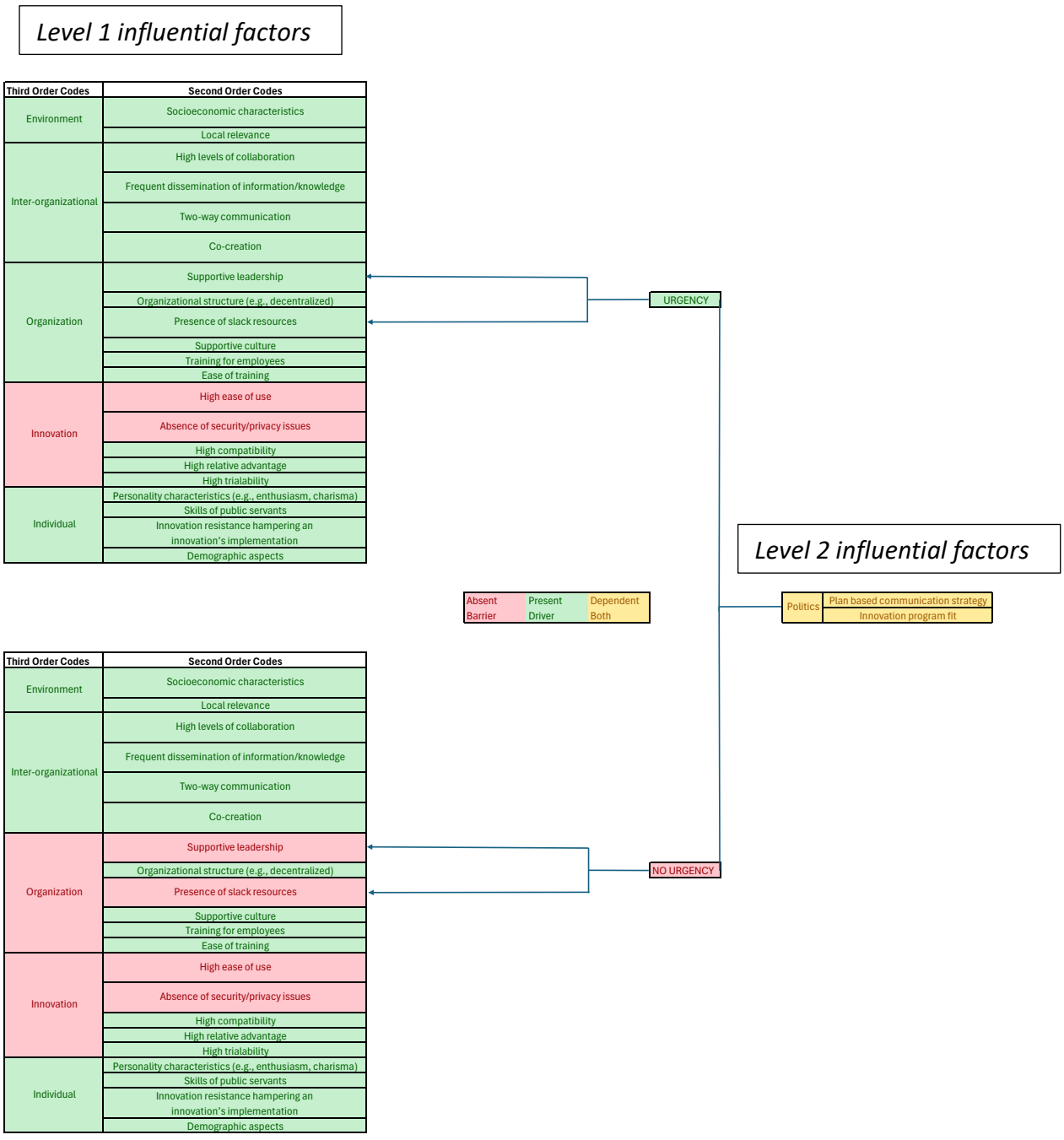


Figure 6.1: Influence of level 2 on level 1 large municipality

Figure 6.1 illustrates graphically what the two levels correspond to side by side. For the large municipality to be able to use this communication tool, the first step is to integrate the game into a plan-based communication strategy in order to contextualize its use. Secondly, it needs to be included into the wider political program to give it credibility. Once these prerequisites have been met, the serious game is then presented to the local or national political authorities (this can be done through the province) in order to gain their approval. If the political sphere deems that there is an urgency in the use of this game, the dependent factors will therefore be unlocked and will represent a driver as visible in the top left of figure 6.1. If approval is given on a higher authority for the large municipality, this would mean that the supportive leadership would be present during the implementation of the project, given that responsibility would no longer lie solely with the municipality. Staff and financial resources (slack resources) would be made available for the purpose, making the project possible from an environmental, organizational, inter-organizational and individual perspective.

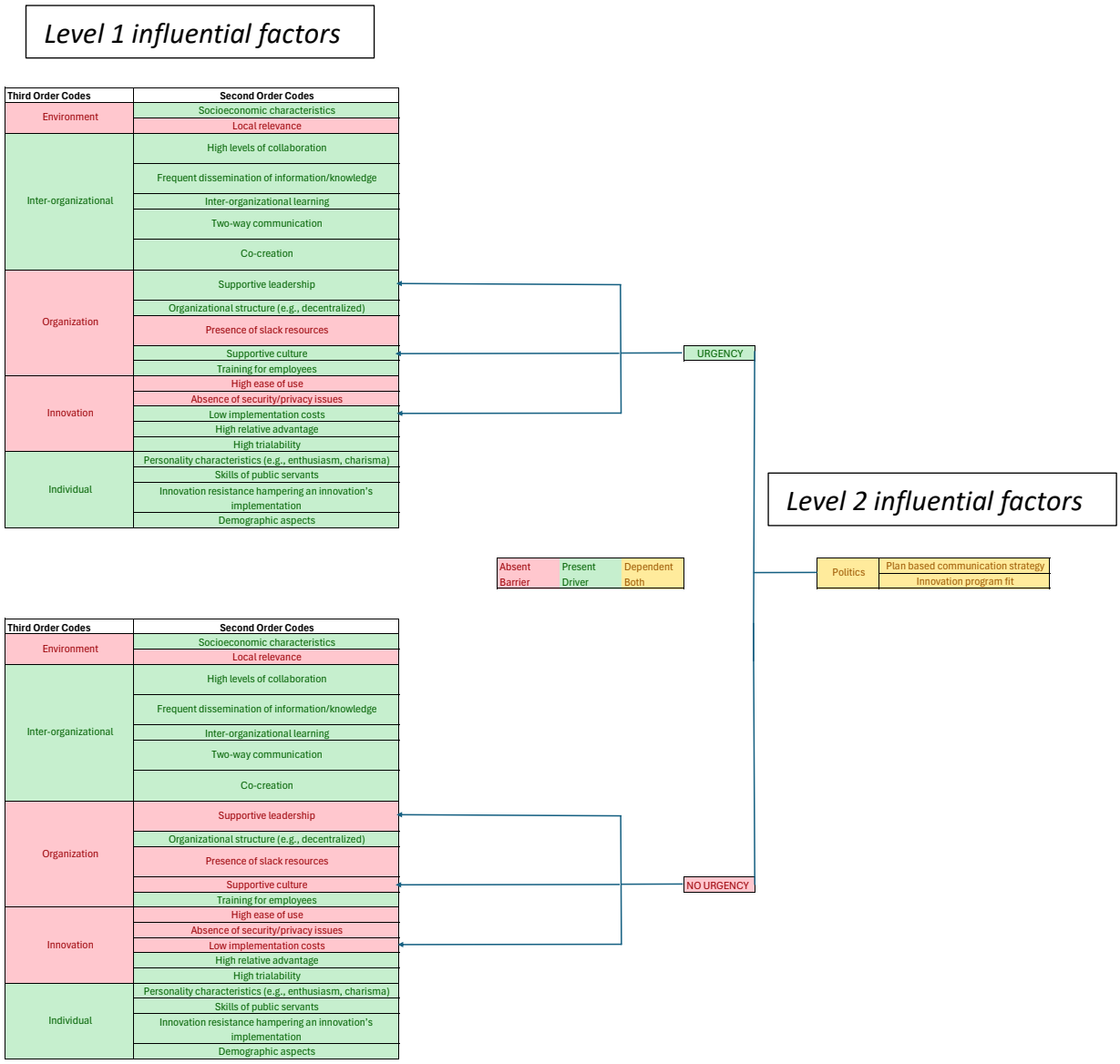


Figure 6.2: Influence of level 2 on level 1 small municipality

Figure 6.2 shows the political influence (Level 2) on the three first-level factors for the small municipality. As with the large municipality, if the local or national political sphere recognizes an urgency through the plan-based communication strategy and innovation program fit to the use of gaming, there is a strong chance of securing approval which, if present, would enable the organization to have the supportive leadership, supportive culture and a sufficient level of funding necessary for this medium-sized municipality to organize gaming sessions and offer incentives to local residents.

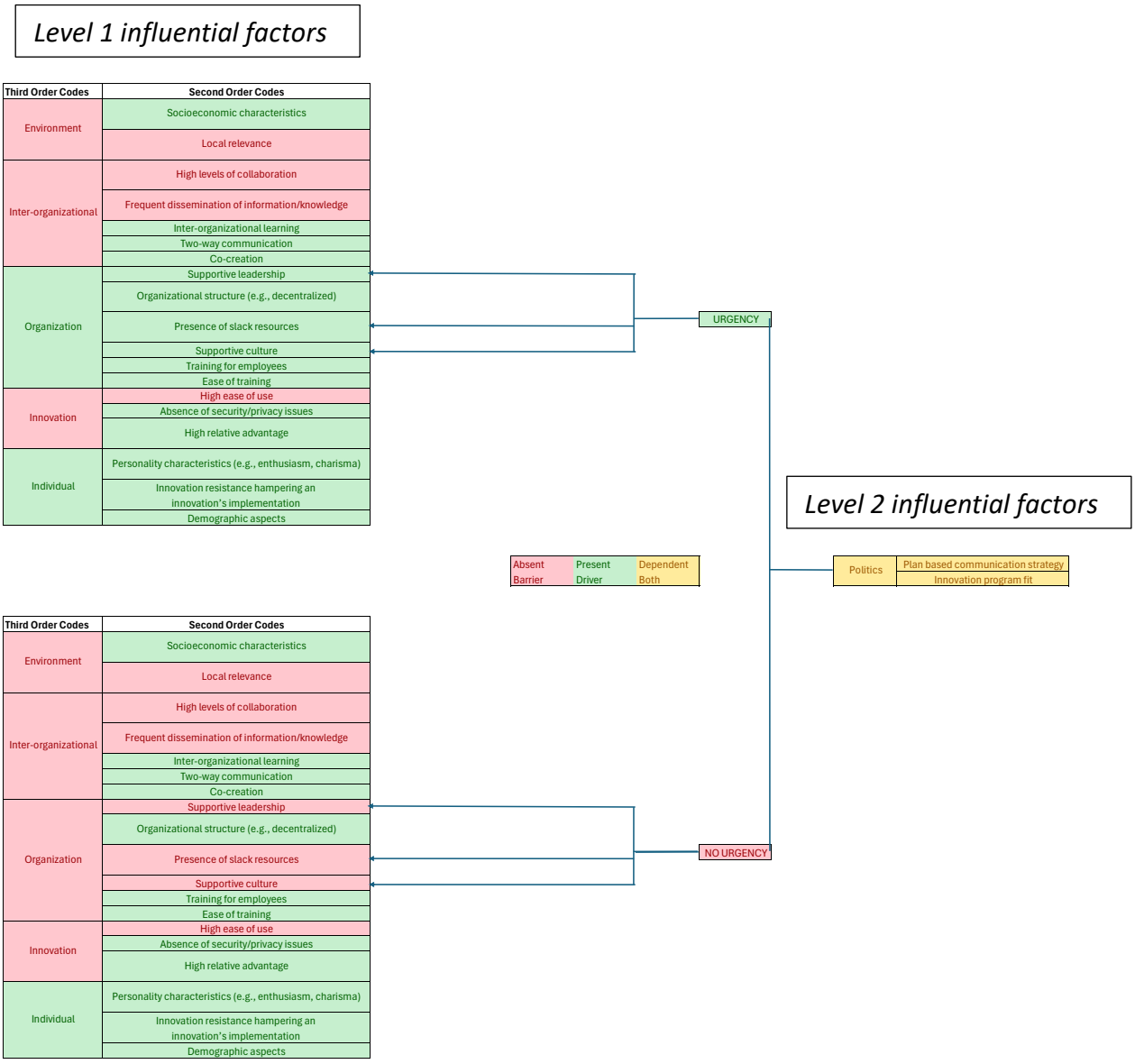


Figure 6.3: Influence of level 2 on level 1 province

With the necessary political support, the province (Figure 6.3) would also be provided with supportive leadership, supportive culture and the internal provision of resources such as personnel and financial means.
The majority of the dependent factors are consistent across the three organizations, almost always involving responsibility, staff availability and monetary resources. They can be regarded as common necessities for the implementation of a participatory project on a political scale. The interviewees distinguished two types of political scales: local politics and national politics.

6.1.3 Local politics

A local way of obtaining political approval is through the municipality's local council. Council endorsement is crucial for legitimacy and gaining a broader support. Members can publicly endorse the project, helping to raise awareness and encourage community participation. The council can allocate municipal funds to support the project, covering expenses like materials, marketing, and personnel. They also provide access to municipal facilities and venues where the game can be held and where debriefing sessions can take place (Wat Doet De Gemeenteraad? 2024).

6.1.4 National politics

The project of using a serious game within a municipality/province could be submitted with a plan-based strategy and innovation program fit to a political party with a keen interest in this kind of initiative as well as to the Ministry of the Interior and Kingdom Relations (Ministerie van Binnenlandse Zaken en Koninkrijksrelaties, BZK) which is directly responsible for municipal affairs that can promote participatory governance and encourage citizen involvement.

Province:

The province plays a central intermediary role between municipalities and ministries, which implies that if the province shows an interest in using the game, as mentioned during the interview, it becomes easier to promote the communication tool to the national political scene. Regular emphasis and communication can be put in place to raise awareness around the project to encourage its implementation. Figure 6.4 bellow illustrates how a political approval of the project could take place for municipalities and for the province.

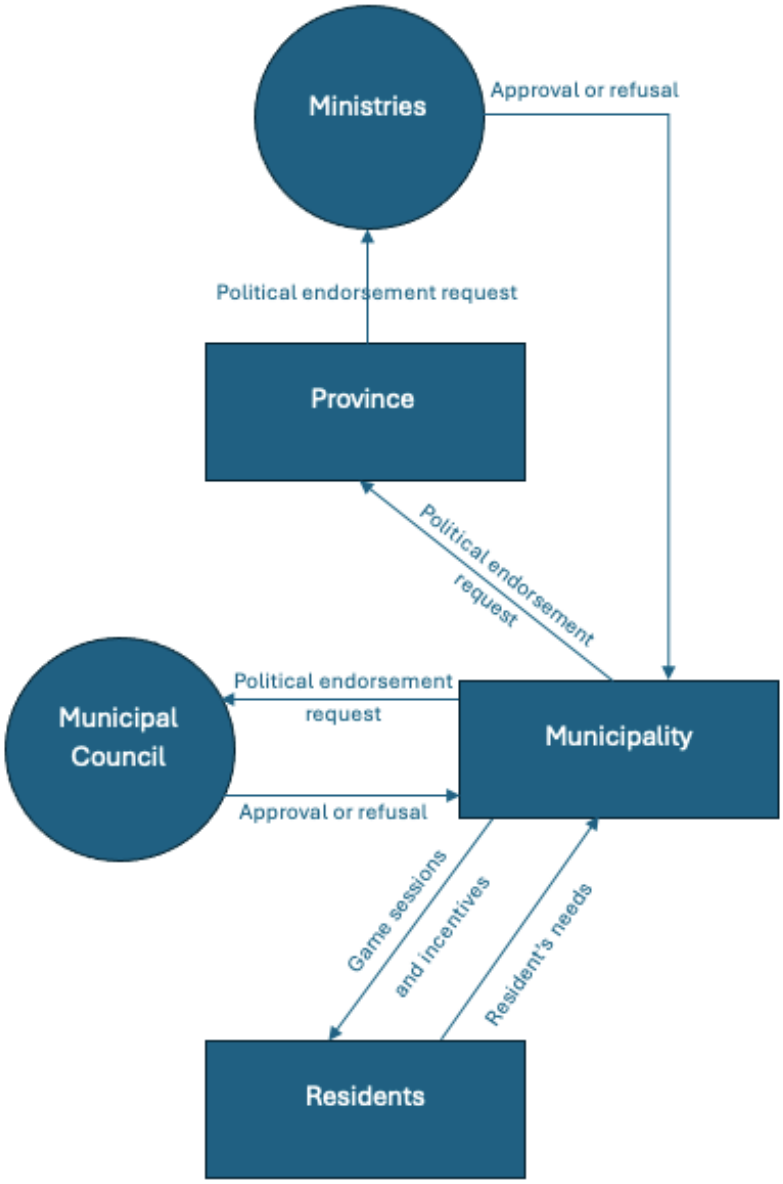


Figure 6.4: Political spheres and game approval

6.1.5 Independent influential factors

Once the political aspect has been addressed and all level 2 influential factors have become drivers, it is not yet possible to implement the game, as the level 1 factors within the organization, also known as independent factors, need to be addressed. Independent influential factors are specific to each organization with respect to local constraints. These barriers do not depend on a higher authority to be transformed into drivers. Independent barriers are shown in red in the data analysis, and their transformation into drivers is to be carried out within the organization (municipality or province). In comparison with dependent influential factors, their implementation takes longer, and the barrier does not become a driver immediately.

Large Municipality:

With a favorable political aspect, the municipality now faces only 2 barriers out of a total of 21 influential factors. These barriers are directly linked to the innovation aspect and include (high ease of use as well as absence of security privacy issues). As the problem is mentioned in more detail in the data analysis, the solution to the usability challenges encountered with the "WhereWeMove" game lies in the work between the municipality and the university (TUDelft) to find a balance in the desired mechanisms and the need to remain as close to reality as possible, while combining simple understanding to enable the game to be played by a maximum number of residents. The game will also have to be adapted from a security point of view between the two institutions in order to comply with the municipal IT security measures. **Once these two factors have been resolved, the game can be successfully implemented in the municipality, according to the theoretical and practical model.**

Small Municipality:

With a favorable political aspect, the municipality faces 4 barriers before being able to implement the game (local relevance, presence of slack resources, high ease of use and absence of security privacy issues). The solutions for the last two barriers have already been mentioned for the large municipality and are the same for the smaller one. To address the local relevance, the game will have to be adapted to the local context of the municipality, as it does not face river flooding. This can be done in partnership with the two institutions (TUDelft, Municipality) to develop a suitable game board. Another problem that needs solving is the lack of personnel. With funding being put in place by the political aspect, the municipality must at least attract and find new staff with the right skills, which is not easy to do, as mentioned by the interviewee in the data analysis. Overcoming these barriers is feasible but may take some time. **Once these four factors have been resolved, the game can be successfully implemented in the municipality, according to the theoretical and practical model.**

Province:

With a favorable political aspect, the province faces 4 barriers before being able to implement the game (local relevance, High levels collaboration, Frequent dissemination of information/knowledge and high ease of use). The solutions for the first and last barrier were already mentioned earlier with the two municipalities. In order to overcome the barriers and establish communication with residents, the province must turn to its municipalities to take over their networks and use their communications channels. This can be done but requires a major campaign and a managerial shift that is difficult to achieve. **Once these four factors have been resolved, the game can be successfully implemented in the province, according to the theoretical and practical model.**

Feasibility:

The model derived from theory and practice with the two levels can therefore be used to identify barriers and drivers and act as a guide for municipalities/provinces. Feasibility varies from one Institution to another. In this instance, the municipality with the least problems and the greatest feasibility of adopting the game is the larger one. The municipality has wide-ranging capacities and, if it wants to, can introduce the game with a clear plan. The smaller one, on the other hand, has more challenges that can be solved, but which require greater organizational effort. Lastly, although the province is a large entity with a wealth of resources, it is simply not designed to work with citizens on the same scale as municipalities. This is not its role. Changing the working culture would require a major managerial effort that seems difficult to achieve at the moment.

6.2 Positioning in literature

The theoretical background and its conceptual model deal with a large majority of the key elements enabling the diffusion and adoption of a technology. Some important elements for the organizations, however, have not been addressed in the literature, just as some factors have been addressed in the literature and considered irrelevant to the specific organizational context. Reality is somewhat more complex than theory. The practical aspect of the interviews is therefore complementary and has helped to highlight the differences between these two worlds.

6.2.1 Common and contextual influential factors

The vast majority of influential factors identified in the literature and elaborated in the model are of common relevance to all the organizations interviewed. These factors are general and range from local relevance to slack resources to supportive leadership and ease of use. Other influential factors, however, were not addressed by all interviewees due to the context in which the institutions operate. The factors considered as contextual are: Ease of training, High compatibility, Low implementation costs, High trialability, skills of public servants as well as inter-organizational learning. Not all the above factors were mentioned in each interview. This may be linked to the context being too similar or not relevant, such as "Low implementation costs", which is not relevant for the large municipality or the province, which can cover the costs without too much difficulty, and Ease of training, which may be a little too close to training for employees, for instance. Of the 25 influential factors elaborated from theory and practice, 20 can be considered indispensable independently of the context, given their recurrent mentions across the three organizations and literature.

6.2.2 Main influential factors for implementation

Political Support: As mentioned more in detail in the main findings, the political aspect as well as the two influential factors (Plan based communication strategy and Innovation program fit) emerged from the three interviews and complete the literature. This complex aspect is at the heart of the implementation process and must be tackled first before moving on to the following influential factors.

Organizational Readiness: The presence of slack resources is a factor that can be considered as a main one from a staff point of view. The lack of personnel immobilizes the implementation of the project. One way to remedy this is to outsource personnel, as indicated by the large municipality. This is done, however, with the help of substantial funding from the underlying organization.

Game Readiness: The three major factors associated with serious gaming are ease of use and relevance, as well as security and privacy. The game must be adapted internally between the municipality and the TUDelft Gamelab, outlining the needs, difficulties and relevance of each party in order to find a common solution that will lead to the use of the game in the municipality. Although this aspect is mainly a task for the Gamelab, the security aspect will have to be handled by the municipality (cybersecurity department) and, as mentioned above, will have to comply with European and National regulations in terms of data management.

6.3. Limitations and recommendations

Data Collection Methods:

The qualitative approach to this research has both advantages and disadvantages. The two types of data collected (debriefing sessions and interviews) are based on participants' self-reported experiences and perceptions, which are influenced by memory recall, social desirability, and individual interpretations. These insights are fundamental to understanding the complexity of the attitudes and motivations of both governmental organizations and residents. On the other hand, none of the results derive from existing publicly available material resulting in novel data that is not always easy to process and interpret. The presence and interaction of facilitators (see Appendix A) during debriefing sessions can inadvertently influence participants' responses. Facilitation should be as clear-cut as possible during the debriefing, so as not to lead participants towards certain topics or answers that could affect the authenticity of the data collected. The debriefing was audio record with the intention of coding the players' discussions. After reviewing the sessions, however, it was very difficult to distinguish between the players, given the high level of background noise among all the tables and mixed players/facilitators. The research therefore opted to analyze the players' written feedback, which may have led to a lack of depth in the findings. Some of the written responses from the Dutch facilitated tables had to be translated into English, which may have altered

the meaning of certain sentences. For this study, the lack of depth was not a problem, as the debriefing was used primarily to show that co-creation is possible. A future recommendation is to have better preparation for audio recording during the debriefing sessions or using video recordings to capture both audio and visual cues. This could mean spacing the tables further apart to minimize noise pollution and using a professional microphone into which the players can speak when they take the lead.

Sample size:

The sample size used for the study may not capture the full diversity of perspectives and experiences within the broader population. The generalizability of the results is based on the responses of the three stakeholders from the three municipalities/province which can be considered limited. Although the unanimities of the stakeholders' responses on a multitude of questions indicates a generalizable tendency to a larger number of governmental organizations, a larger and more diverse sample, including public servants from various departments, governmental bodies (provinces, ministries, municipalities), would provide a more comprehensive understanding of the community's needs and responses to the serious game. Interviewing two people per municipality in four municipalities of varying character (location, size, positions...) could give a more complete picture of the needs. The difficulty lies in finding an exact number from which a generalization can be achieved, as the needs, although close, are always somewhat different. Playing the debriefing sessions with residents is also a future recommendation in order to see the expectations and needs of this stakeholder group. Up to now, the gaming sessions have only taken place with students in an educational setting. Random municipality stapling including other provinces experiencing flood risk would reduce selection bias and increase sample representativeness. Working with a mixed method (qualitative and qualitative) through the use of surveys could complement the interviews and debriefing sessions, providing a richer and more complete dataset that may lead to answering other underlying research questions.

Temporal Constraints:

The research provides a snapshot of the immediate reactions and feedback from participants following the 'WhereWeMove' game sessions. Long-term changes in attitudes, behaviors, and municipal policies may not be evident within the study's limited timeframe. As mentioned in the methodology, the practical part of the stakeholder interviews was difficult to carry out, given the lack of responses to the large number of messages sent and calls made. The municipalities were in the middle of the European elections period and didn't necessarily have the time to spare. The late responses therefore narrowed the already limited timeframe, limiting the depth of the practical aspect of this research. The results were nonetheless conclusive and could be used and generalized. One recommendation for temporal contains would be to target governmental organizations in advance and contact them at convenient times. If written answers are inconclusive, the next step is to contact them by telephone or attempt to go physically for direct enquiries.

7. Conclusion

This research aimed to explore the potential of using serious games, specifically the “WhereWeMove” game, to enhance municipal flood risk communication and community adaptability. The study focused on three main research questions to determine how municipalities can leverage gaming to communicate flood risks, understand the implications of this approach, and involve citizens in co-creating flood risk management strategies. The findings from the literature, interviews, and game debriefings provide valuable insights into these areas.

RQ1: How can municipalities use gaming, such as "Where do We Move," to communicate with residents about the flood risks and related house adaptive measures?

The research began to look at the tools currently used in governmental organizations to communicate with residents about potential flooding events. It was found that governmental bodies are not actively communicating flood risks and their implications to citizens but rely mainly on one-way communication tools for short term emergency scenarios, such as flood maps and warning messages. One-way communication certainly helps to raise awareness in the given moment (emergency) but does not result in long-term attitudinal or behaviors effect leading to resilience and community adaptability. The literature therefore explored a tool for two-way communication and co-production between residents and governmental organizations. Theory has revealed that the use of a serious game as a communication tool for municipalities/provinces is well suited to building a shared responsibility and raising awareness around flood risks and possible private protective measures among the residents. The use of a theoretical framework based on the adoption and diffusion of an innovative technology in the public sector resulted in a conceptual model tailored to this study, with the aim of answering the research question "*How can municipalities use gaming, such as "Where do We Move," to communicate with residents about the flood risks and related house adaptive measures?”* To enable government institutions to effectively integrate a serious game within their organizations, the conceptual model outlined all the influential factors that affected the adoption of this communication tool. 23 influential factors have been identified in the literature and theoretical framework and constitute drivers or barriers for organizations that need to be identified and overcome.

RQ2: What are the implications of using such a gaming approach for the municipality?

The conceptual model derived from the theoretical framework has been tested in practice with two municipalities and one province. What emerged is that practice is often somewhat more complex than theory. The implications of using such a gaming approach for municipalities are numerous. The results of the interview data analysis revealed a new political aspect and new influential factors to complement the conceptual model. In practice, to enable a municipality or province to use a gaming approach, it is imperative to seek approval from the political authority on a higher governmental level (Level 2) in order to be able to work on the implementation within the organization (Level 1). As pointed out in the discussion, the higher political aspect influences the supportive culture, leadership and slack resources representing fundamental elements in the establishment of a participatory project. The second step for the organization is to address the dependent influential factors and to work on the barriers in order to transform them into drivers. This operating procedure is intended to seek guidance and provide an overview to all governmental organizations wishing to integrate serious gaming into their communication strategy. The conceptual model, complimented by the practical aspect, presents a solid foundation and guideline to address the research objective and provide a real solution to a complex problem.

RQ3: How can municipalities better involve citizens in co-creating flood risk management strategies through gaming?

The use of serious games, such as “WhereWeMove” has shown potential in facilitating co-production between municipalities and residents (Van Der Graaf et al., 2021). The debriefing sessions from these games reveal that they can serve as effective communication tools, fostering shared responsibility and collaboration. Governmental organizations can envisage collaborative strategies with the players based on their game experiences, as well as testing the effectiveness of potential policies on residents in order to strengthen their action capabilities. The debriefing session analysis allows to identify trends and patterns in the players choice preferences, and thus to find community-based solutions for the greater good. The notable points emerging from the debriefing data analysis are mostly related to social monetary initiatives. Participants expressed a strong preference for financial aid or tax incentives as key motivators for engaging in flood risk management. Municipalities should consider offering financial support to encourage the adoption of protective measures. Players are also turning to straightforward measures such as green gardens and sandbags, showing an interest in community protection. Debriefing sessions are a way of raising awareness of local issues and proposing tailored solutions when considering strategy development. The proximity between governmental organizations and municipalities through the use of a serious game offers a framework that is both playful and reassuring, where the development of common solutions is encouraged. By leveraging the insights gained from serious gaming and incorporating these strategies, municipalities can enhance citizen involvement in the co-creation of effective and sustainable flood risk management strategies.

8. Reference List

Arnab, S., Berta, R., Earp, J., De Freitas, S., Popescu, M., Roméro, M., Stănescu, I. A., & Usart, M. (2012). Framing the adoption of serious games in formal education. United States Department of Education, 10(2), 159–171. https://eric.ed.gov/?id=EJ985419

Azadegan, A., Riedel, J. C. K. H., & Hauge, J. B. (2012). Serious games adoption in corporate training. *In Lecture notes in computer science (pp. 74–85)*. https://doi.org/10.1007/978-3-642-33687-4_6

Barragán-Pulido, S., Barragán-Pulido, M. L., Alonso-Hernández, J. B., Sánchez, J. J. C., & Rabazo-Méndez, M. J. (2023). Development of students' skills through gamification and serious games: An exploratory study. *Applied Sciences, 13(9)*, 5495. https://doi.org/10.3390/app13095495

Blom-Zandstra, M., Paulissen, M., Agricola, H., & Schaap, B. (2009). How will climate change affect spatial planning in agricultural and natural environments? Examples from three Dutch case study regions. *IOP Conference Series Earth and Environmental Science*, *8*, 012018. https://doi.org/10.1088/1755-1315/8/1/012018

Bond-Barnard, T. J., Fletcher, L., & Steyn, H. (2018). Linking trust and collaboration in project teams to project management success. *International Journal of Managing Projects in Business, 11(2)*, 432–457. https://doi.org/10.1108/ijmpb-06-2017-0068

Bozeman, B., & Kingsley, G. (1998). Risk culture in public and private organizations. *Public Administration Review, 58(2)*, 109–118. https://doi.org/10.2307/976358

Brockhoff, R. C., Koop, S., & Snel, K. a. W. (2019). Pluvial flooding in Utrecht: On its way to a flood-proof city. *Water, 11(7)*, 1501. https://doi.org/10.3390/w11071501

Bronkhorst, B., Steijn, B., & Vermeeren, B. (2013). Transformational leadership, goal setting, and work motivation. *Review of Public Personnel Administration, 35(2)*, 124–145. https://doi.org/10.1177/0734371x13515486

Candela, T., Chitu, A. G., Peters, E., Pluymaekers, M., Hegen, D., Koster, K., & Fokker, P. A. (2022). Subsidence induced by gas extraction: A data assimilation framework to constrain the driving rock compaction process at depth. *Frontiers in Earth Science, 10*. https://doi.org/10.3389/feart.2022.713273

Charrière, M., Junier, S., Mostert, E., & Bogaard, T. (2012). Flood risk communication: Visualization tools and evaluations of effectiveness. *TU Delft*. http://resolver.tudelft.nl/uuid:02a043cd-69a9-4e37-b719-145ccaf1c924

Climate change: Global temperature projections. (2012, March 6). *NOAA Climate.gov*. https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature-projections

Costa, S., Peters, R., Martins, R., Postmes, L., Keizer, J. J., & Roebeling, P. (2021). Effectiveness of nature-based solutions on pluvial flood hazard mitigation: The case study of the city of Eindhoven (The Netherlands). *Resources, 10(3)*, 24. https://doi.org/10.3390/resources10030024

Da Fonseca, M. N., Da Silva, L. P., & Garcias, C. M. (2022). Flood risk communication. *Mercator, 21(2)*, 1–14. https://doi.org/10.4215/rm2022.e21027

Damaševičius, R., Maskeliūnas, R., & Blažauskas, T. (2023). Serious games and gamification in healthcare: A meta-review. *Information, 14(2)*, 105. https://doi.org/10.3390/info14020105

De Boer, J., Botzen, W., & Terpstra, T. (2015). Flood risk and climate change in the Rotterdam area, The Netherlands: Enhancing citizen's climate risk perceptions and prevention responses despite skepticism. *Regional Environmental Change, 16(6)*, 1613–1622. https://doi.org/10.1007/s10113-015-0900-4

De Vries, H., Tummers, L., & Bekkers, V. (2018). The diffusion and adoption of public sector innovations: A meta-synthesis of the literature. *Perspective on Public Management and Governance, 1(3)*, 159–176. https://doi.org/10.1093/ppmgov/gvy001

De Weger, E. J., Van Vooren, N., Luijkx, K., Baan, C. A., & Drewes, H. W. (2018). Achieving successful community engagement: A rapid realist review. *BMC Health Services Research, 18(1)*, Article 3090. https://doi.org/10.1186/s12913-018-3090-1

Digitale Overheid. (2024, May 16). Baseline informatiebeveiliging overheid cybersecurity - digitale overheid. https://www.digitaleoverheid.nl/overzicht-van-alle-onderwerpen/cybersecurity/bio-en-ensia/baseline-informatiebeveiliging-overheid/

Dillenardt, L., Hudson, P., & Thieken, A. H. (2021). Urban pluvial flood adaptation: Results of a household survey across four German municipalities. *Journal of Flood Risk Management, 15(3)*. https://doi.org/10.1111/jfr3.12748

Endendijk, T., Botzen, W. J. W., De Moel, H., Aerts, J. C. J. H., Slager, K., & Kok, M. (2023). Flood Vulnerability Models and Household flood damage Mitigation Measures: An econometric analysis of survey data. *Water Resources Research, 59(8)*. https://doi.org/10.1029/2022wr034192

Flood, S., Cradock-Henry, N. A., Blackett, P., & Edwards, P. (2018). Adaptive and interactive climate futures: *Systematic review of 'serious games' for engagement and decision-making. Environmental Research Letters, 13*(6), 063005. https://doi.org/10.1088/1748-9326/aac1c6

Forsyth, W., Roberts, T., & Brewer, G. (2023). Conceptualising risk communication barriers to household flood preparedness. *Urban Governance*, *3*(2), 116-129. https://doi.org/10.1016/j.ugj.2023.02.001

Goldberg, M. H., Gustafson, A., Van Der Linden, S., Rosenthal, S. A., & Leiserowitz, A. (2022). Communicating the scientific consensus on climate change: Diverse audiences and effects over time. *Environment and Behavior, 54(7–8)*, 1133–1165. https://doi.org/10.1177/00139165221129539

Guerreiro, S., Glenis, V., Dawson, R., & Kilsby, C. (2017). Pluvial flooding in European cities—A continental approach to urban flood modelling. *Water, 9(4)*, 296. https://doi.org/10.3390/w9040296

Haan, R. D., & Van Der Voort, M. C. (2018). On evaluating social learning outcomes of serious games to collaboratively address sustainability problems: A literature review. *Sustainability, 10(12)*, 4529. https://doi.org/10.3390/su10124529

Haasnoot, M., Kwadijk, J., Van Alphen, J., Bars, D. L., Van Den Hurk, B., Diermanse, F., Van Der Spek, A., Essink, G. O., Delsman, J., & Mens, M. (2020). Adaptation to uncertain sea-level rise; how uncertainty in Antarctic mass-loss impacts the coastal adaptation strategy of the Netherlands. *Environmental Research Letters*, *15*(3), 034007. https://doi.org/10.1088/1748-9326/ab666c

Hammarberg, K., Kirkman, M., & De Lacey, S. (2016). Qualitative research methods: When to use them and how to judge them. *Human Reproduction, 31(3)*, 498–501. https://doi.org/10.1093/humrep/dev334

Hartley, J., & Allison, M. (2002). Good, better, best? Inter-organizational learning in a network of local authorities. *Public Management Review, 4(1)*, 101–118. https://doi.org/10.1080/14616670110117332

Heavy precipitation and pluvial floods. (2024). *IPCC*. https://www.ipcc.ch/report/ar6/wg1/chapter/chapter-11/

Irvin, R. A., & Stansbury, J. (2004). Citizen participation in decision making: Is it worth the effort? *Public Administration Review, 64(1)*, 55–65. https://doi.org/10.1111/j.1540-6210.2004.00346.x

Jean, S., Medema, W., Adamowski, J., Chew, C., Delaney, P., & Wals, A. (2018). Serious games as a catalyst for boundary crossing, collaboration and knowledge co-creation in a watershed governance context. *Journal of Environmental Management, 223*, 1010–1022. https://doi.org/10.1016/j.jenvman.2018.05.021

Kjellgren, S. (2013). Exploring local risk managers' use of flood hazard maps for risk communication purposes in Baden-Württemberg. *Natural Hazards and Earth System Sciences, 13(7)*, 1857–1872. https://doi.org/10.5194/nhess-13-1857-2013

Koks, E., Van Ginkel, K., Van Marle, M., & Lemnitzer, A. (2022). Brief communication: Critical infrastructure impacts of the 2021 mid-July western European flood event. *Natural Hazards and Earth System Sciences, 22(12)*, 3831–3838. https://doi.org/10.5194/nhess-22-3831-2022

Kuhlicke, C., Seebauer, S., Hudson, P., Begg, C., Bubeck, P., Dittmer, C., Grothmann, T., Heidenreich, A., Kreibich, H., Lorenz, D. F., Masson, T., Reiter, J., Thaler, T., Thieken, A. H., & Bamberg, S. (2020). The behavioral turn in flood risk management, its assumptions and potential implications. *Wiley Interdisciplinary Reviews Water, 7(3)*. https://doi.org/10.1002/wat2.1418

Kuhlicke, C., Steinführer, A., Begg, C., Bianchizza, C., Bründl, M., Buchecker, M., De Marchi, B., Di Masso Tarditti, M., Höppner, C., Komac, B., Lemkow, L., Luther, J., McCarthy, S., Pellizzoni, L., Renn, O., Scolobig, A., Supramaniam, M., Tapsell, S., Wachinger, G., & Faulkner, H. (2011). Perspectives on social capacity building for natural hazards: Outlining an emerging field of research and practice in Europe. *Environmental Science & Policy, 14(7)*, 804–814. https://doi.org/10.1016/j.envsci.2011.05.001

Kundzewicz, Z. W., & Pińskwar, I. (2022). Are pluvial and fluvial floods on the rise? *Water, 14(17)*, 2612. https://doi.org/10.3390/w14172612

Lechowska, E. (2021). Approaches in research on flood risk perception and their importance in flood risk management: a review. *Natural Hazards, 111(3)*, 2343–2378. https://doi.org/10.1007/s11069-021-05140-7

Lindell, M. K., & Perry, R. W. (2011). The protective action decision model: Theoretical modifications and additional evidence. *Risk Analysis, 32(4)*, 616–632. https://doi.org/10.1111/j.1539-6924.2011.01647.x

Local Government in the Netherlands. (2017, December). *VNG International*. https://www.vng-international.nl/wp-content/uploads/2017/12/Local-Government_in-the-Netherlands.pdf

Lopez, M. G., Di Baldassarre, G., & Seibert, J. (2017). Impact of social preparedness on flood early warning systems. *Water Resources Research, 53(1)*, 522–534. https://doi.org/10.1002/2016wr019387

Madhuri, M., Tewari, H. R., & Bhowmick, P. K. (2014). Livelihood vulnerability index analysis: An approach to study vulnerability in the context of Bihar. *Jàmbá, 6(1)*. https://doi.org/10.4102/jamba.v6i1.127

Malaquias, R. F., Malaquias, F. F., & Hwang, Y. (2018). Understanding technology acceptance features in learning through a serious game. *Computers in Human Behavior, 87, 395–402*. https://doi.org/10.1016/j.chb.2018.06.008

McCall, R., & Baillie, L. (2015). Ethics, privacy and trust in serious games. In *Springer eBooks* (pp. 1–30). https://doi.org/10.1007/978-981-4560-52-8_37-1

Michael, D. R., & Chen, S. (2006). Serious games: games that educate, train, and inform. In ResearchGate. https://www.researchgate.net/publication/234812017_Serious_Games_Games_That_Educate_Train_and_Inform

Ministerie van Binnenlandse Zaken en Koninkrijksrelaties. (2016, June 14). Provinces, municipalities and water authorities. *Public Administration | Government.nl*. https://www.government.nl/topics/public-administration/provinces-municipalities-and-water-authorities

Ministerie van Infrastructuur en Waterstaat. (2023, October 4). Flood risk management. *Three Topics | Delta Programme*. https://english.deltaprogramma.nl/three-topics/flood-risk-management

Moustakas, L. (2023). Social cohesion: Definitions, causes and consequences. *Encyclopedia, 3(3)*, 1028–1037. https://doi.org/10.3390/encyclopedia3030075

Mutisya, F. (2019). Qualitative Data analysis The NIHR Research Design Service for Yorkshire & The Humber. www.academia.edu.

Najibi, N., & Devineni, N. (2018). Recent trends in the frequency and duration of global floods. *Earth System Dynamics, 9(2)*, 757–783. https://doi.org/10.5194/esd-9-757-2018

National Center for Disaster Preparedness, NCDP. (2024, April 26). Vulnerable Populations. https://ncdp.columbia.edu/research/vulnerable-populations/

Netherlands: Number of inhabitants, by province 2023. (2023, September 4). *Statista*. https://www.statista.com/statistics/753196/total-number-of-inhabitants-in-the-netherlands-by-province/

Nillesen, A. L., & Kok, M. (2015). An integrated approach to flood risk management and spatial quality for a Netherlands' river polder area. *Mitigation and Adaptation Strategies for Global Change, 20(6)*, 949–966. https://doi.org/10.1007/s11027-015-9675-7

OECD Better Life Index. (2024). https://www.oecdbetterlifeindex.org/countries/netherlands/

OECD. (2022). Regions and cities at a glance [Report]. *OECD*. https://www.oecd.org/regional/nld-rcg2022.pdf

Perera, D., Seidou, O., Agnihotri, J., Mehmood, H., & Rasmy, M. (2020). Challenges and technical advances in Flood Early Warning Systems (FEWSS). *In IntechOpen eBooks*. https://doi.org/10.5772/intechopen.93069

Rainear, A. M., & Lin, C. A. (2021). Communication factors influencing flood-risk-mitigation motivation and intention among college students. *Weather, Climate, and Society, 13(1)*, 125–135. https://doi.org/10.1175/wcas-d-20-0016.1

Regulation - 2016/679 - EN - *gdpr* - EUR-*Lex*. (2016). https://eur-lex.europa.eu/eli/reg/2016/679/oj

Ritzema, H., & Van Loon-Steensma, J. (2017). Coping with climate change in a densely populated delta: A paradigm shift in flood and water management in The Netherlands. *Irrigation and Drainage, 67(S1)*, 52–65. https://doi.org/10.1002/ird.2128

Rogers, E. M. R. (2003). *Diffusion of innovations* (5th ed.). https://open.ncl.ac.uk/theories/8/diffusion-of-innovations/

Sanders, F. (2018). Dutch Delta resiliency by societal learning: Introducing the intertwined process of daily practice and theory development. *ResearchGate*. https://doi.org/10.20944/preprints201811.0392.v1

Simon, K. M., Riva, R. E. M., & Vermeersen, L. L. A. (2021). Constraint of glacial isostatic adjustment in the North Sea with geological relative sea level and GNSS vertical land motion data. *Geophysical Journal International, 227(2)*, 1168–1180. https://doi.org/10.1093/gji/ggab261

Spil, T., Romijnders, V., Sundaram, D., Wickramasinghe, N., & Kijl, B. (2021). Are serious games too serious? Diffusion of wearable technologies and the creation of a diffusion of serious games model. *International Journal of Information Management, 58*, 102202. https://doi.org/10.1016/j.ijinfomgt.2020.102202

Statistics Netherlands. (2020). *Population density in the Netherlands* [Map]. citypopulation.de. https://upload.wikimedia.org/wikipedia/commons/1/18/Population_density_in_the_Netherlands.png

Steratore, R., Clark-Ginsberg, A., Shelton, S. R., Malika, N., Leuschner, K. J., & Reese, T. (2023, May 8). Community and Individual Disaster Resilience for Floods: Options for improving Protective Action guidance. RAND. https://www.rand.org/pubs/research_reports/RRA1770-1.html

Stouthamer, E., Erkens, G., Cohen, K., Hegger, D., Driessen, P., Weikard, H., Hefting, M. M., Hanssen, R. F., Fokker, P., Van Den Akker, J., Groothuijse, F., & Van Rijswick, M. (2020). Dutch national scientific research program on land subsidence: Living on soft soils – Subsidence and society. *Proceedings of IAHS, 382*, 815–819. https://doi.org/10.5194/piahs-382-815-2020

Tanaka, T., Kiyohara, K., & Tachikawa, Y. (2020). Comparison of fluvial and pluvial flood risk curves in urban cities derived from a large ensemble climate simulation dataset: A case study in Nagoya, Japan. *Journal of Hydrology, 584*, 124706. https://doi.org/10.1016/j.jhydrol.2020.124706

Third of Dutch municipalities in financial trouble: Report. (2021, March 1). *NL Times*. https://nltimes.nl/2021/03/01/third-dutch-municipalities-financial-trouble-report

Ugc. (2024, March 13). Laagste punt van Nederland (Lowest point in the Netherlands). *Atlas Obscura*. https://www.atlasobscura.com/places/laagste-punt-van-nederland-lowest-point-netherlands

UNDRR World Conference on Disaster Reduction. (2005). *Hyogo framework for action 2005-2015: International strategy for disaster reduction*. https://www.unisdr.org/2005/wcdr/intergover/official-doc/L-docs/Hyogo-framework-for-action-english.pdf

Van Der Graaf, P., Cheetham, M., Redgate, S., Humble, C., & Adamson, A. (2021). Co-production in local government: Process, codification and capacity building of new knowledge in collective reflection spaces. *Health Research Policy and Systems, 19(1)*, Article 6772. https://doi.org/10.1186/s12961-021-00677-2

Van Gils, M., Stouthamer, E., & Groothuijse, F. (2020). Towards a legal strategy fitting today's challenge of reducing impacts of subsidence in the Netherlands. *Proceedings of the International Association of Hydrological Sciences*, *382*, 825–829. https://doi.org/10.5194/piahs-382-825-2020

Vrac, M., Thao, S., & Yiou, P. (2022). Changes in temperature–precipitation correlations over Europe: Are climate models reliable? *Climate Dynamics, 60(9–10)*, 2713–2733. https://doi.org/10.1007/s00382-022-06436-5

Wamsler, C. (2020). Education for sustainability. *International Journal of Sustainability in Higher Education, 21(1)*, 112–130. https://doi.org/10.1108/ijshe-04-2019-0152

Wanyama, T., & Zheng, Q. (2010). Organizational culture and information systems implementation: A structuration theory perspective. In *2010 2nd IEEE International Conference on Information and Financial Engineering* (pp. 507–511). https://doi.org/10.1109/ICIFE.2010.5609410

Wat doet de gemeenteraad? (2024). Nederlandse Vereniging Voor Raadsleden. https://www.raadsleden.nl/het-raadslid/wat-doet-de-gemeenteraad/

Wei, L., Song, X., Hou, C., & Zhu, J. (2022). The effect of slack resources on innovation performance and the environmental adaptability of public hospitals: The empirical evidence from Beijing of China. *Frontiers in Public Health, 10*. https://doi.org/10.3389/fpubh.2022.904984

Wikipedia. (2024, March 13). Death Valley. *Wikipedia*. https://en.wikipedia.org/wiki/Death_Valley

Zhang, X., Yu, P., Yan, J., & Spil, I. T. a. M. (2015). Using diffusion of innovation theory to understand the factors impacting patient acceptance and use of consumer e-health innovations: A case study in a primary care clinic. *BMC Health Services Research, 15(1)*, Article 72. https://doi.org/10.1186/s12913-015-0726-2

9. Appendix

Appendix A

Game process

The game begins with the player reading and signing a data collection and analysis consent clause. This clause allows results to be compared between game tables and sessions, as well as the sharing of results in open-access publications and the reuse of data for research purposes in the field of climate action and education. Once this formality has been completed, the player is invited to go to the website provided by the facilitator to complete a pre-survey. The purpose of this questionnaire is to assess the players' flood risk knowledge and attitudes before starting the game. Once these two steps have been completed, the gameplay begins, with 5 rounds to play. As mentioned in more detail in the previous paragraph, this part leaves freedom to the players to make decisions and choices according to the scenario, with the aim of winning the game. The whole process is supervised by a facilitator, who keeps an overview of the progress and provides support to the players when needed. The facilitator's role is to check that all parameters are respected and can also take on the role of the bank when buying or selling a house. At the end of the game, players will have a post-survey to analyze their progress or learning curve acquired during the session from the experiences they've made. This questionnaire reflects on the relationship between real life (pre-survey) and game experience (post-survey). Finally, players are invited to discuss their game experiences and give their opinions as well as feedback on possible scenarios to strengthen their ability to take action. All these elements can be used to create a game post analysis, providing a comparison of sessions and an overview of choices made.

Game mechanics table

Category	**Mechanics**	**Explanation**
Player Actions	Housing choice	players may purchase a house with the means given at the beginning of the round as well as decide on its location.
	Funds handling	Players manage their income by paying taxes and potential flood damage.
	Purchase of private protective measures	Players can purchase a variety of projective measures to use during flood events.
	Purchase of Satisfaction Points	Players can invest in satisfaction that has nothing to do with flood protection.

External Factors	Flood events	Flood impact determined by the 3 dice rolls and house location
	Scenario and news updates	Changes in the game due to news updates
	Facilitator	Influence the game by setting the income and living expenses.
Scoring	Satisfaction score	The goal is to maximize the satisfaction score in order to win the game. This is achieved through investment strategy, a certain percentage of luck (dice) and good management of your houses and financial capital.
Win Condition	Most	Player with most satisfaction points over the 5 rounds
Asymmetry	Different start resources	Players start with different incomes/economic backgrounds in order to simulate an economic diversity.
	Flood risks	The possibility of a flooding event depends also on the house location.
Knowledge And Understanding	Pre-survey	Assess the players' flood risk knowledge and attitudes before starting the game
	Post-survey	Reflects on the relationship between real life (pre-survey) and game experience (post-survey)
	Open discussion	Feedback on possible scenarios to strengthen their ability to take action

Appendix B

Previous debriefing

Interactive Storytelling:

Have participants (1 or 2) narrate their game decisions/outcomes experienced and emotions felt during the game. This little introduction session can serve as the introduction to the debriefing, making participants feel more invested in the discussion

Questions for the group:

Game Experience

1) What did you like the most about the game?
2) What didn't you like about the game?
3) What do you think is missing in the game that could be added?
4) If you would play again, would you take other actions?

Real world

1) What actions would you take in the real world?
2) How do these choices differ from the game and why?
3) In which of the three housing areas would you like to live and why?
   Visual Mapping: (Have them turn over a game map and draw a point where they would like to live)
4) Would you be interested in community protection (tragedy of the commons)?
5) Do you have any other private adaptive measures you'd like to see implemented?

Roleplay exercise: *(audio recorded)*

Half of the participants are in the shoes of the municipality (municipal decision-makers), and the other half in the shoes of the population (residents affected by flooding). This leads to a debate and a sense of involvement.

Municipality

1) What are your expectations of government institutions in terms of support?
2) What are the most important points you think the municipality should take into account?
3) would you implement private adaptive measures if the municipality would support you in doing so?
4) What policies or incentives would motivate you to implement home adaptation measures discussed in the game?
5) How would you describe your willingness to engage with the municipality on flood risk management initiatives after participating in this game session?

Updated debriefing

Interactive Storytelling. (5 Min): *(audio recorded)*

Have participants (1 or 2) narrate their game decisions/outcomes experienced and emotions felt during the game. This little introduction session can serve as the introduction to the debriefing, making participants feel more invested in the discussion

Questions for the group: (10 Min): *(audio recorded)*

Real world:

1) What actions would you take in the real world?
2) How do these choices differ from the game and why?
3) In which of the three housing areas would you like to live and why?

Visual Mapping: (Have them turn over a game map and draw a point where they would like to live)

4) Would you be interested in community protection, if so, in which one would you be interested?
5) What non-structural measures (other than policies or private protective measures) do you think are important to consider?
6) would you rather be interested in: Education Campaigns, Warning Systems, insurance and Financial Instruments or Environmental Management (restoring natural areas)? **Please rank them.**

Roleplay exercise (30 min): *(audio recorded) (Cut the A3 sheet in the middle for the role play)*

Half of the participants are in the shoes of the municipality (municipal decision-makers), and the other half in the shoes of the population (residents affected by flooding). This leads to a debate and a sense of involvement.

	Residents about the municipality	**Municipality** about residents
1. What type of support do you expect from each other? *(incentives)*		
2. What actions would you take about flood risk if you had the necessary support?		
3. What are the necessary considerations or requirements for implementing actions to mitigate flood risk?		
4. How do you want to work together to better adapt to the increasing flood risk?		

Appendix C

Municipalities and province interview

1. **Current Practices (context)**

How does your municipality currently communicate flood risks to residents?
What does the municipality communicate about flood risks and related house adaptive measures?
How effective have these tools been so far?

POWERPOINT SLIDES (explain the three objectives here)

- What do you intend to get out of using a serious game for citizen engagement?

OBJ1: For players to learn about floods and choices among possible adaptation measures
OBJ2: For players and government organizations to envision strategies based on their game experience
OBJ3: For government organizations to explore the effectiveness of possible policies for strengthening resident action capacities

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2. **Organizational Culture and Structure**

Question: Can you describe the current culture and structure within your municipality regarding the adoption of new technologies or innovations?
What changes would be necessary to make within your municipality to use the "WhereWeMove" in the communication efforts?

3. **Leadership and Support**

Question: How do leaders within your municipality support the introduction and implementation of innovative tools and technologies?

4. **Resources and Training**

Question: What resources (financial, personnel, technological) are available within your municipality to support the adoption of new technologies?
How do you ensure that employees are adequately trained to use these technologies?

5. **Technological Integration**

Question: Would the implementation of a serious game like "WhereWeMove" within the municipality be a challenge in terms of acceptance?
What other technical factors would facilitate the integration of this game?

6. **Public Engagement and Co-creation**

Question: How does your municipality involve citizens in co-creating solutions for local challenges?

How could “WhereWeMove” enhance citizen involvement and co-creation of flood risk management strategies?

7. Trialability and Experimentation

Question: What opportunities exist within your municipality to pilot new technologies or projects before full-scale implementation?
How can the game be designed or modified to meet the needs of your community?

8. Security and Privacy

Question: How does your municipality address security and privacy concerns when implementing new technologies like the “WhereWeMove” game?
Are there specific protocols or practices in place?

9. Perceptions and Enthusiasm

Question: What is the general perception and enthusiasm among public servants towards adopting new technologies?