Tailoring open government data portals for lay citizens

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Tailoring open government data portals for lay citizens: A gamification theory approach

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ABSTRACT

Government policies focused on Open Government Data (OGD) often aim to stimulate the provision of public, interoperable data towards any user, including lay citizens, through online portals. However, these OGD portals are mostly developed for expert users. This hinders the realization of critical values such as transparency, empowerment, and equality of access. Following a Design Science Research approach, this study aims to examine how gamification can help tailor OGD portals for lay citizens. As a pre-condition to this goal, we identify requirements toward OGD portals through twenty interviews with experts and lay citizens. Compared to expert users, lay citizens expect an OGD portal with a more playful interface, vulgarized content, customized visualizations, and transparency-related datasets in a human-readable format. Second, we develop our research artifact, the OGD portal prototype, implementing fifteen design propositions using gamification theory to address lay citizens' requirements. Third, the evaluation with ten lay citizens reveals the perceived usefulness of the design propositions. Badges were evaluated as most useful to highlight portal relevance. This study contributes to OGD theory development by identifying lay citizens' requirements towards OGD use. Furthermore, this study is the first to reveal the usefulness of implementing notions from gamification theory into OGD portal design. Finally, practitioners can use our findings to make OGD portals more inclusive and thus contribute to attaining key OGD policy objectives.

1. Introduction

Open Government Data (OGD) policies often aim to stimulate the provision of public, interoperable data towards all potential users: lay citizens, developers, researchers, public agents, and other stakeholders. Governments publish this data through OGD portals. One of the key pillars of a digital government is the use of information and communication technologies (ICT) to improve the delivery of information to citizens, business partners, employees, and other government entities (Andersen & Henriksen, 2006; Layne & Lee, 2001; Mellouli, Luna-Reyes, & Zhang, 2014). Numerous portals have been developed worldwide for several purposes. For instance, Open Health Data New York, which was found to increase transparency for health researchers (Martin, Helbig, & Birkhead, 2015). Another example is the national Open Data Portal of

Singapore that stimulated the creation of innovative e-services internally and by external partners (Chan, 2013). Both OGD policies and scientific studies have identified various types of OGD re-users (Gonzalez-Zapata & Heeks, 2015; Safarov, Meijer, & Grimmelikhuijsen, 2017). Generally speaking, a division can be made into expert users, i.e., re-users having technical expertise and domain knowledge, and lay citizens, i.e., re-users not having this expertise or knowledge.

OGD portals are mostly developed for expert users such as developers or researchers (Lourenço, 2015). Janssen, Charalabidis, and Zuiderwijk (2012) consider that the entry barriers to portals are too high for lay citizens. This can hinder key drivers to release OGD: fostering transparency (Araújo, Reis, & Cardoso Sampaio, 2016; Lnenicka & Nikiforova, 2021), decreasing the information asymmetry between citizens and government (Murillo, 2015), and empowering citizens and ensuring

equal access to data to all citizens (Gonzalez-Zapata & Heeks, 2015). Furthermore, this problem is all the more important as citizens are willing to engage in OGD for different reasons, depending on the context (Jurisch, Kautz, Wolf, & Krcmar, 2015; Wirtz, Weyerer, & Rösch, 2018), and to become effective e-citizens in a digital community (Biasiotti & Nannucci, 2004). For instance, Purwanto, Zuiderwijk, and Janssen (2020) found that citizens were motivated to engage in OGD to deal with societal issues and to contribute to a better government.

Following the Design Science Research (DSR) process described in (Hevner, 2007), this study aims to examine how gamification can help tailor OGD portals for lay citizens through the development of a research artifact: a gamified OGD portal prototype. As a pre-condition to this goal, we first identify the requirements from lay citizens towards OGD portals. Previous research suggested, among others, intermediary tools (Thorsby, Stowers, Wolslegel, & Tumbuan, 2017) or vulgarized descriptions (Safarov et al., 2017) to decrease the entry barriers for lay citizens. Overall, these recommendations are cited as a way forward but not extensively described nor validated with lay citizens. Furthermore, these recommendations remain hypothetical, as they did not emerge from field studies with a clear identification of lay citizens' requirements. Additionally, Araújo et al. (2016) suggest that lay citizens' and experts' requirements for reusing data on OGD portals differ, and may even be conflicting. Furthermore, in order to design an OGD portal prototype, tailored for lay citizens, different approaches can be followed such as better social media integration (Alexopoulos, Zuiderwijk, Charapabidis, Loukis, & Janssen, 2014) or customized visualizations (Barcellos et al., 2017). In this paper, we draw from gamification theory. Gamification mechanisms can make tasks more attractive to users and to foster engagement with a system. This theory therefore constitutes a promising direction to design a prototype of an OGD portal that is easier to use and more attractive, and in turn more in line with lay citizens' requirements.

2. Research background

Our research objective is to examine how the implementation of gamification mechanisms can help tailor OGD portals for lay citizens. This section discusses previous research on the two parts of this objective: the understanding of lay citizens' requirements towards OGD portals (Section 2.1) and the usefulness of gamification theory to address these requirements (Section 2.2).

2.1. Lay citizens' requirements towards OGD portals

The most widespread way to share OGD is to publish it on online portals. In a comparison of 36 national portals, Sáez Martín, Rosario, and Pérez (2015) categorize the requirements of an ideal portal. The *functional* category refers to the utilities and functionalities of the portal through which the users can obtain and provide information (e.g., the data search techniques, the visualizations, and the feedback mechanisms). The *semantic* category refers to the arrangement of data on the portal to facilitate re-use (e.g., the level of metadata, the data format, the language of the portal). The *content* category refers to the website quality of the portal, and how it provides the data (e.g., the accuracy of data, number of datasets, availability of filters). Much of the previous research focuses on the exploitation of OGD on such portals by experts (Crusoe, Ahlin et al., 2019), the features portals should have (Sáez Martín et al., 2015), and the challenges they may face (Beno, Figl, Umbrich, & Polleres, 2017; Crusoe & Simonofski, 2019).

Several papers take the lay citizen perspective on OGD portal use. In his analysis of OGD portals, Lourenço (2015) concludes that typical portals such as 'data.gov' do not support ordinary citizens and fail to reach their transparency and accountability goals. Several authors also argue that the notions of transparency and openness are related but not both enabled by current municipal OGD portals (Araújo et al., 2016). They argue for the development of "transparency portals", in line with

OGD principles that are necessary to satisfy lay citizens (Corrêa, Corrêa, & da Silva, 2014). The development of OGD portals for lay citizens indeed entails several specificities. In an analysis of the content and functionalities of portals, Thorsby et al. (2017) conclude that portals are at an early stage of development, have the same overall structure and interface, and need to improve their analysis and support functionalities to help lay citizens to make sense of the data. Indeed, Alexopoulos et al. (2014) mention that current platforms provide basic functionalities such as searching and downloading but fail to deliver value to users. Gebre and Morales (2020) explore the users' comments on OGD datasets and conclude that the descriptions found on the portal were too limited. Dos Santos Pinto, Bernardini, and Viterbo (2018) examine the categories of datasets on portals and find that the high number of categories for datasets can hinder the access to information by users. Safarov et al. (2017) mention that intermediary tools for data analysis and exploration are critical for lay citizens to use OGD. Zuiderwijk, Janssen, and Dwivedi (2015) also recommend this support of end-users with demos, online courses, FAQs, or a helpdesk. Finally, Purwanto et al. (2020) identify several pre-conditions to increase citizens' intention to engage in OGD such as the perceived ease of engagement, the availability of feedback mechanisms, or the link with social media. In **Error! Reference source not found.**, we summarize the lay citizens' requirements identified in the literature according to the analytical categories of Sáez Martín et al. (2015). Table 1.

Several features of OGD portals have been discussed in the previous literature. However, they were merely cited as ways forward but hardly described in detail. In our DSR, we will first identify lay citizens' requirements towards OGD portals. This pre-condition is essential to achieve before understanding how gamification mechanisms can help address them.

2.2. Gamification theory for open government data

To implement lay citizens' requirements, some authors suggest to better integrate social media and open data (Alexopoulos et al., 2014). Others focus on custom visualizations to make sense of the data and foster transparency (Barcellos et al., 2017). In this paper, we suggest investigating gamification theory as a promising way forward, suitable with lay citizens' requirements. Gamification refers to "*a design approach of enhancing services and systems with affordances for experiences similar to those created by games*" (Koivisto & Hamari, 2019, p. 193). By using engaging elements found in games, gamification can increase users' motivation to perform some tasks by making them more fun and improving the user experience (Nacke & Deterding, 2017). Due to the lack of engagement of lay citizens with OGD, explained in Section 2.1, our proposal is to apply gamification to the tasks entailed by OGD use to improve citizens' experience on OGD portals and make the use process more attractive.

Gamification is increasingly used by diverse organizations (Vesa, Hamari, Harviainen, & Warmelink, 2017). **Error! Reference source not**

Table 1
Lay citizens' requirements towards OGD portals currently reported in the literature.

Type	Requirement	Source
Functional	Integration with social media	(Purwanto et al., 2020)
	Vulgarization of the data	(Thorsby et al., 2017)
	Intermediary tools to facilitate use	(Safarov et al., 2017; Thorsby et al., 2017),
	Feedback mechanisms	(Purwanto et al., 2020)
	Support and help tools	(Thorsby et al., 2017; Zuiderwijk et al., 2015)
Semantic	Clear descriptions of data	(Gebre & Morales, 2020)
Content	Clear categories	(Dos Santos Pinto et al., 2018)
	Datasets enabling transparency and accountability	(Lourenço, 2015)

found.**Error! Reference source not found.**Numerous mechanisms such as rewards, achievements, defining clear goals and progress paths, have been successful in engaging users in many domains such co-creation and innovation (Leclercq, Hammedi, & Poncin, 2018), healthcare (Hammedi, Leclerq, & Van Riel, 2017; Johnson et al., 2016), tourism (Moro, Ramos, Esmerado, & Jalali, 2019), and education (Majuri, Koivisto, & Hamari, 2018). In a systematic literature review, Koivisto and Hamari (2019) summarized the main gamification mechanisms reported in the literature: points, badges, leaderboards, quests, levels, timers, rewards, storytelling, dialogs, process, competition, quizzes and virtual helpers.

Gamification, Digital Government, and Open Data are three related research fields. **Error! Reference source not found.**On the one hand, a growing number of papers has focused on the use of gamification in a digital government for e-participation (Hassan & Hamari, 2019) or e-government services (Al-Yafi & El-Masri, 2016). On the other hand, open data and gamification have been combined for mainly two purposes in the literature. First, to encourage users to take part in data crowdsourcing (e.g., Arakawa and Matsuda (2016) have developed a gamified mobile application for urban sensing). Second, to create data games, which are "*games where gameplay and/or game content is based on real-world data external to the game, and where gameplay supports the exploration of and learning from this data*" (M. G. Friberger et al., 2013, p. 2). For example, Sugimoto (2018) proposed an age-guessing game based on Wikipedia and DBpedia data.

However, the use of gamification in the context of OGD remains scarce. Most studies rely on OGD to develop actual games intended to change the offline behavior of civil servants or citizens. For instance, (Kleiman, Janssen, Meijer, & Jansen, 2020) study the impact of a game intervention on civil servants' opinion towards OGD. Another example using OGD is a Monopoly-like game where the in-game values are computed from indicators about neighborhoods published by the UK government (Friberger & Togelius, 2012). While these games focus on educating to the content of the used datasets, Wolff, Barker, and Petre (2017) developed a board game to educate citizens to the benefits of open data more generally, making players aware of the questions open data can answer.

To the best of our knowledge and according to a recent literature review published by Hassan and Hamari (2019), only one study actually examines the use of gamification to improve the design of OGD portals. Blazhko, Luhova, Melnik, and Ruvinska (2017) use quizzes and a quest-like interface to foster communication between citizens and government by enabling citizens to give feedback on OGD datasets. However, the proposed solution only focuses on feedback features and does not undergo any user evaluation. This evaluation is critical as gamification does not automatically lead to positive outcomes (Hammedi, Leclercq, Poncin, & Alkire, 2021). Therefore, in our research, we will examine how several gamification mechanisms can help address lay citizens' requirements through an extensive evaluation.

3. Methodology

This section presents the research methodology (Section 3.1) as well as the data collection (Section 3.2) and analysis (Section 3.3) processes.

3.1. Design Science Research Process

We rely on the Design Science Research (DSR) approach (Hevner, 2007; Peffers, Tuunanen, Rothenberger, & Chatterjee, 2007) to iteratively build and evaluate our artifact, a gamified OGD portal tailored for lay citizens (Hevner, 2007; Peffers et al., 2007). This well-established approach within the information systems and management communities allows creating a technological artifact that serves human purpose by generating new knowledge for researchers but also by being usable by practitioners. DSR is relevant to explore new, as yet un-theorized areas (Kuechler & Vaishnavi, 2012), such as the intersection between

OGD portal design and gamification. According to the founding paper of Venable (2006), DSR approaches allow to iteratively build theory in three aspects: the problem diagnosis, the technology invention, and the technology evaluation. Kuechler and Vaishnavi (2012) later highlight that on top of the artifact developed, DSR approaches provide information systems design theory (e.g., meta-requirements indicating how the artifact should behave) and design relevant explanatory theory (e.g., explanations about why the artifact has the effects it has). Baskerville, Baiyere, Gregor, Hevner, and Rossi (2018) further explain that if an artifact is novel and useful, then it necessarily adds to design knowledge through generic design propositions.

This approach is thus well suited to our research objective as it will contribute to the theory building while having a direct impact on OGD practitioners' efforts to reach lay citizens. Furthermore, DSR has already been successfully applied to develop OGD portal proof-of-concepts (Alexopoulos et al., 2014; Zuiderwijk, Janssen, & Susha, 2016). Hevner (2007) formalized three research cycles to build the design artifact: the *Rigor Cycle* to theoretically underpin the problem from the knowledge base, the *Relevance Cycle* to identify the objectives of the artifact from the practical environment, and the *Design Cycle* to design and evaluate the artifact. The research communicated in this study complies with the seven DSR guidelines (Hevner, March, & Park, 2004):

1. "Design as an artifact": the artifact (the prototype of the gamified OGD portal) is an instantiation of design propositions.
2. "Problem relevance": we performed interviews with experts and lay citizens to elicit requirements for the artifact;
3. "Design evaluation": we performed interviews with lay citizens to gather feedback on our artifact;
4. "Research contributions": we identified the problem through an exploration of the literature to ensure a contribution to the theoretical knowledge base;
5. "Research rigor": the artifact is evaluated through a rigorous methodology;
6. "Design as a search process": the search for gamification mechanisms was performed in an exploratory manner to find the most relevant solutions to address citizens' requirements;
7. "Communication of research": the complete DSR process is explained in this paper and summarized in Fig. 1.

3.1.1. Relevance cycle: requirements identification study

The goal of the *Relevance Cycle* is to motivate the problem and to identify the objectives of the solution. In our contextual environment, the problem motivation evaluates if one OGD portal can address the requirements of both experts and lay citizens. As explained in Section 4.1, the identified requirements motivate the relevance of developing a dedicated portal for lay citizens, and to use gamification mechanisms to do so. The objectives of the solution relate to the identification of lay citizens' requirements. To identify the requirements of experts and lay citizens, we chose to perform semi-structured interviews. Due to the COVID-19 sanitary situation, the interviews were held remotely using Microsoft Teams. The interview process was the same for all interviewees to allow comparison and generalization. At the beginning of the interviews, we asked the participants open questions about their expectations on what an OGD portal should allow them to achieve. We chose to focus on municipal OGD portals, as they are the closest to the citizen level and have been studied in the context of lay citizens' OGD use before. After that, we showed the participants an existing OGD portal[4] and gave them the opportunity to freely explore it while performing think-aloud to understand their overall feeling. Then, we asked participants to perform predefined tasks. They consist in accessing and understanding a specific dataset (i.e., the evolution of the city's library

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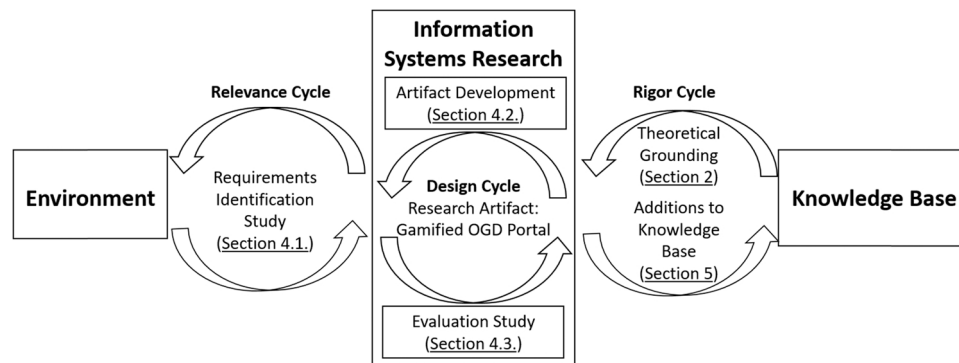[4] https://data.namur.be/pages/accueil/

Fig. 1. Design Science Research approach adapted from Hevner (2007)

budget over the years). Then, to complement the notes taken during the think-aloud, we asked the respondents additional questions from the interview guide that can be consulted in the supplementary material online[5] (Appendix 1). The questions are based on the process from Crusoe, Ahlin et al. (2019) that structures OGD usage into four steps: motivation to use the data, search for the data, access the data, and exploit the data. This process was validated with developers, yet the steps are generic enough to fit lay citizens' usage. To ensure that these steps match the reality of lay citizens, we pretested the guide with two lay citizens. The citizens found the model sufficiently complete and representative of their OGD use as they envision it. In any case, the semi-structured nature of the interviews gives the opportunity to discuss relevant elements that may not fit within the process. For each of the four steps, we asked questions about expectations and difficulties with the existing portal to extract requirements.

3.1.2. Design cycle – artifact development and evaluation study

To ensure the *Design Cycle* of DSR, we develop, demonstrate, and evaluate our artifact: the OGD portal artifact, composed of several gamification design propositions that address the identified requirements. The development followed the Analysis-Design-Prototyping-Evaluation iterative process recommended in the user experience literature (Hartson, Rex, 2012). Based on the identified requirements (*Analysis*), we formulate design propositions (Design) and implement them into a medium-fidelity interactive prototype modified from the current portal (*Prototyping*). We performed the development in collaboration with five university students in the context of a master's level software engineering course.

Then, we evaluated the artifact with lay citizens (Summative *Evaluation*) to assess our artifact. When applying the Technology Acceptance Model (TAM) to predict citizen engagement with digital government services (Cegarra, Navarro, & Pachon, 2014; Cegarra-Navarro, Garcia-Perez, & Moreno-Cegarra, 2014), ease of use and perceived usefulness are key elements to predict the intention to use. Ease of use measures the general usability and includes focused questions on specific features an OGD portal should offer (e.g. searching and visualizing data). Data about ease of use and usefulness of gamification was collected through individual interviews, combining think-aloud insights, open questions, and Likert questions as recommended by (Hartson, Rex, 2012). Like the requirements elicitation session, participants are first given time to freely explore the artifact and the different design propositions. We then asked respondents to execute the same predefined tasks as in the requirements elicitation interviews (Section 3.1.1.), allowing exploration of all features on the portal. Thereafter, we asked the interviewees to evaluate and rate the usefulness of the gamification mechanisms using five-point Likert statements with a scale ranging from "Strongly Disagree" to "Strongly Agree". Each statement evaluates the

extent to which users agree that a given gamification mechanism fulfills a given requirement. Participants were also asked to rate the ease of use of the artifact by answering 17 five-point Likert statements from (Zuiderwijk et al., 2016) The sets of questions can be found in the supplementary material[2] (Appendix 2).

We focus on an extensive standalone evaluation of the artifact instead of a comparison with existing OGD portals using experimental design for two main reasons. First, the requirements analysis already shows that the lay citizens are not satisfied with traditional portals and not capable to use them. Therefore, our research objective is to examine how gamification can help improve OGD portals for lay citizens, rather than compare our prototype to existing solutions. Second, regarding maturity, our artifact is a prototype whereas existing portals are professionally developed, which would bias the evaluation.

3.2. Data collection

3.2.1. Participants recruitment

To recruit participants, we adapted the approach of Graves and Hendler (2014) who, in the context of OGD visualization, recruited and separated experts from lay citizens after an online recruitment survey. This approach is summarized in Fig. 2.

We thus sent out a survey and recruited people who met our study's selection criteria. The survey consisted of questions related to ICT skills (e.g., using tables, exploring datasets, and using traditional technologies such as smartphones and computers), software development skills, awareness about OGD, interest in knowing more about OGD, and willingness to participate in our study. The survey questions are in the supplementary material[2] (Appendix 3). Using people's self-evaluated ICT use and development skills on a five-point Likert scale ranging from "Very Low" to "Very High", we differentiated experts from lay citizens. To be labelled as a lay citizen, neither development nor ICT use skills could be above the "medium" level. Then, amongst these two pools of possible respondents, we performed random sampling to contact interviewees in each group. As the inclusion criteria were predefined, random sampling is an efficient approach to select participants while reducing the influence of uncontrolled factors in the study (Robert Wall Emerson, 2015). For the evaluation stage of the design cycle, we solicited ten lay citizens randomly selected from the pool among those not interviewed for the requirements elicitation. The complete information about the participants to requirements elicitation and evaluation interviews can be found in the supplementary material[2] (Appendix 4).

3.2.2. Data saturation

The qualitative research literature gives no fixed evidence-based guideline on how many participants to interview but rather recommends to carry interviews until saturation is reached (Guest, Bunce, & Johnson, 2006; Lallemand & Gronier, 2015). Robinson (2014) reports that researchers conducting Interpretative Phenomenological Analysis should work with a sample size between three and sixteen. Guest et al.
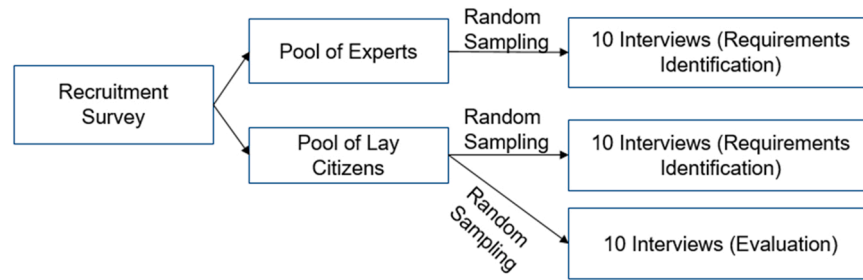
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[5] https://zenodo.org/record/5074487#. YOQCeugzY2w

Fig. 2. Participants Recruitment Process.

(2006) analyzed the transcripts of 60 interviews and reported reaching saturation at the twelfth transcript, having uncovered 88% of the codes derived from the whole transcript set. Francis et al. (2010) mention the 'ten+three criterion', that is, ten interviews followed by three consecutive interviews without new insight. Finally, Baccino, Bellino, and Colombi (2005) recommend to interview ten users when identifying requirements. Based on these recommendations, for the relevance cycle, we have conducted ten interviews (five with experts and five with lay citizens) to perform an intermediary analysis. We then carried out five extra interviews with both experts and lay citizens that allowed identifying two extra requirements and giving more depth to the requirements. The last five interviews confirmed the established findings. Therefore, the sample of twenty requirements elicitation interviews allowed reaching saturation in the requirements. Regarding the evaluation of the artifact, well-recognized studies show that four or five users are enough to detect 80% of issues in an interface, and that very few new insights emerge beyond ten users (Nielsen & Molich, 1990; Virzi, 1992). Others recommend to conduct evaluations with eight users (Rubin & Chisnell, 2008). Thus, to follow these recommendations and to reach saturation, a first round of five interviews was performed for the evaluation in the design cycle to gather feedback about the artifact. Then, a second round of five interviews was conducted and confirmed the trend of the five first interviews without new insight, suggesting that saturation was reached with the ten evaluation interviews.

3.3. Data analysis

The analysis of the requirements elicitation interviews was performed following the thematic content analysis method described in Anderson (2007) and Mayring (2004), using an inductive approach to define requirements.

First, the analysis started by summarizing the interviews and think-aloud transcripts before recording them manually in a data memo. In order to code the data, we skimmed the transcripts and highlighted relevant sentences based on the research objective using "initial coding" guidelines from Saldana (2009). When one of the two user groups made assumptions about the requirements of the other group, we did not consider them in our analysis. The created codes referred to requirements identified in the interviews. For each code, we linked a specific excerpt from the interview. This resulted in a list of codes, with a definition for each code and illustrative examples from the interviews. Several steps ensure the trustworthiness of the analysis. A rigorous audit trail was applied to the data. All material was carefully recorded manually, including interview transcripts to confirm the interpretations needed for the qualitative content analysis (Miles & Huberman, 2003).

Second, to give coherence to the coding of the first step, we performed axial coding (Strauss & Corbin, 1998). This resulted in grouping the codes into categories and sub-categories. The categories were mapped to the main phases of OGD use from Crusoe, Ahlin et al. (2019) and the functional analytical aspects from Sáez Martín et al. (2015). We ensured the validity of the data analysis in two ways. On the one hand, for each step of the data analysis, the author team adopted an insider/outsider coding method (Gioia, Corley, & Hamilton, 2013). An

"insider" author, who worked in the OGD field, coded the data, then one other author, who had not worked in the field, acted as "outsider" by reviewing and criticizing the schema during the coding process. The result of the data analysis consisted in a requirement (sub-category) belonging to two categories (the phase of OGD use and the type of requirement) linked to interviewees and excerpts from the interviews. The main improvements for this comparison stage reside in the detection of additional excerpts and the grouping of similar requirements in a broader sub-category. On the other hand, the research process allows a complete identification of requirements as we asked the respondents to give their insights about an ideal OGD portal in different ways: open expectation questions, free exploration of an existing OGD portal and oral overall feedback, suggestions of predefined tasks to guide the use, and specific questions related to the usage process. Thanks to the diversity in the profiles of the interviewees, the insider-outsider analysis performed by two authors, and the semi-structured interview process, we were able to limit the subjective perception in the data and ensure coding validity.

Regarding the evaluation of the artifact, we followed the same approach for the qualitative insights obtained through the questions and think-aloud. We also analyzed the data collected from five-point Likert-scale questions. Therefore, to obtain a central tendency measure, we computed the median for each statement and used it to draw conclusions on the usefulness of gamification in the research artifact.

4. Results

We first present the output of the relevance cycle of DSR: the lay citizens' requirements identified (Section 4.1). Then, we present the output of the design cycle: the prototype of the gamified OGD portal (the artifact) and its design propositions implementing gamification mechanisms (Section 4.2) as well as its evaluation with lay citizens (Section 4.3).

4.1. Identification of lay citizens' requirements

Following ten interviews with lay citizens and ten interviews with expert users, we have identified 26 requirements for both groups, including six shared requirements but also five conflicting ones. As experts' requirements are deeper established in the literature, we focus on the lay citizens' requirements in this section. However, all requirements are extensively described in a qualitative manner in the external report of the research[6] (Appendix 5). Table 2 summarizes the main requirements identified from lay citizens. For each requirement, the type and the key insights from the interview are mentioned.

The comparison between lay citizens' requirements and experts' requirements reveals five conflicts:

– Conflict 1 (R5): Lay citizens expect a playful interface to explore the datasets whereas experts expect a neutral interface. Indeed, lay

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Table 2
Lay citizens' requirements.

Type	Lay Citizens' Requirements	Insights from interviews
Functional	R1: Raising awareness	– OGD portal awareness should be stimulated through proactive campaigns, social media, TV ads, flyers, the city website, radio, or sensitization workshops; – Awareness campaigns should focus on successful reuses of OGD to show citizens concrete instances where OGD brings value.
	R2: Information relevance	- Relevance should be highlighted on the portal through success stories of reuse by other lay citizens, use scenarios for the portal formulated as "I search for …", or a "dataset of the day".
	R3: Search engine efficiency	- The search engine should explore titles, descriptions, and the content of datasets; - Keywords should be suggested automatically to users when typing in the engine.
	R4: Structured categories	- Datasets should be presented hierarchically through broad categories and (e.g., mobility, governance, health) and sub-categories (e.g., bike mobility) to allow an efficient browsing.
	R5: Playful interface	- Datasets should be presented in an attractive way that invites exploration through visual maps, interactivity features, logos, and colors.
	R6: Export feature	- Data should be exported directly in relevant applications (e.g., public arts datasets in Google Maps)
	R7: Feedback mechanisms	- Feedback should be sought proactively by the publishers, in a personalized manner on the portal or externally (e.g., through mails or dedicated workshops)
	R8: Customized visualizations	- Default visualizations (e.g., pie charts for budgets or maps for pathways) and additional buttons with clear labels such as "evolution over time" to have dynamic information should be included.
	R9: Additional information	- Clicking on a specific line of a dataset to have more information should be possible; - A responsible person for each dataset should be assigned and contactable.
	R10: Support	- Support should be provided with information points, chatbots, or blogs connecting the users' community.
Semantic	R11: Vulgarized content description	- Datasets should be described through examples and visual aid; - Datasets should be contextualized.
	R12: Quality indicators	- Information about data sources, number of updates, and possible missing data should be included; - Indicators should allow citizens to have trust in the data.
	R13: Human-readable format	- Data should include qualitative information and be included in known formats (Excel, PDF, or Word); - Citizens want to consult the data directly on the portal.
Content	R14: Wide variety of information	- Data should come from city's government, public organizations (e.g., schools, libraries, universities) but also private organizations.
	R15: Transparency datasets	- Data should relate to the city's functioning (e.g., budget, subventions, political reports) and transparency - Data should allow citizens to monitor the city and its representatives and to participate in public life.

citizens were discouraged by the presentation of datasets that seems destined to "*IT people*" whereas the experts prefer a presentation as a technical itemized list;

– Conflict 2 (R8): Experts are satisfied with a presentation as a table as it is structured and allows for a quick overview of the content and structure of the datasets. However, lay citizens expect customized visualizations depending on the datasets in order to actually interpret the data;

– Conflict 3 (R11): Lay citizens expect vulgarized content descriptions of the datasets whereas experts expect concise technical descriptions with information such as licenses, list of data attributes, or number of data entries;

– Conflict 4 (R13): Experts expect machine-readable formats such as CSV, JSON, or Shapefiles while lay citizens expect data in a human-readable format with qualitative information such as Excel, PDF, or Word. In most cases, lay citizens do not even expect to download a dataset but simply want to consult it on a webpage of the portal;

– Conflict 5 (R15): Experts tend to expect a wide variety of datasets without a real preference for a certain category if they are raw and exploitable. On the other hand, lay citizens are more interested in informing themselves and more specifically in consulting datasets related to the transparency of the city and its functioning (e.g., budget, subventions, political reports).

The requirements analysis shows that it is difficult to integrate all requirements on the same portal, since five are conflicting with additional requirements from the lay citizens. For example, it is not possible to provide a vulgarized content description and technical information at the same time without overloading the interface. Furthermore, most of the lay citizens were not capable of performing the predefined tasks on the existing OGD portals and required support from the interviewer. This underlines that traditional OGD portals are not tailored to lay citizens. Therefore, the relevance cycle underpins the need for designing an OGD portal tailored for lay citizens. Furthermore, the cycle already highlights that the requirements of lay citizens can be addressed through gamification.

4.2. Design artifact: gamified OGD portal

4.2.1. Design choices: selection of requirements and of gamification mechanisms

To tackle the lay citizens' requirements identified in Section 4.1, we first selected the ones affecting the design of the OGD portals and where gamification can provide an added value. Therefore, we discarded the "Content" requirements as they refer to the data found on the portal, no matter the portal design. When fueling our artifact with data, we focused on the transparency-related datasets, from the OGD portal of Namur (Belgium) to stimulate lay citizens' interest to address the fifth conflict. Furthermore, within the "Functional" and "Semantic" requirements, some relate to actions to be realized outside the portal and not directly related to its design (R1, R9). Some others consist in technical features where gamification is more difficult to apply (R3, R4, R6, R8, R12, R13). Indeed, gamification can hardly be applied to features such as a search bar, a dataset export, and offering a specific data format. As a result, we select five requirements as basis to develop the gamified OGD portal (R2, R5, R7, R10, R11). In the next section, the requirement R5 is not directly mapped to any gamification feature. This requirement is overarching to the global gamification approach and is therefore fulfilled by the combination of all the gamification mechanisms.

In order to address the selected requirements, we iteratively selected relevant gamification mechanisms from an extensive list provided in a recent literature review on gamification (Koivisto & Hamari, 2019). As gamification has not been widely used to improve OGD portals, the mapping between gamification mechanisms and lay citizens' requirements was exploratory and considered several criteria:

- Holistic coverage of the selected requirements: To be selected, the gamification mechanisms must have a direct impact on the selected requirements. This impact was not self-evident and was found through continuous brainstorming amongst the developers of the prototype. A matrix, presented in Table 3, was used to map gamification mechanisms to requirements.
- Technical feasibility: To be selected, the gamification mechanism must be technically integrated in an OGD portal. For instance, the 3D world mechanism was considered but dismissed due to its implementation complexity and the technical limitations of the development team.
- Harmonious integration within a single interface: A balance had to be found between the coverage of the requirements and the risk of overloading the interface. Therefore, as a design rule, we implemented the mechanisms that addressed the higher number of requirements in priority.
- Continuous feedback by users: five users (students with not technical expertise nor knowledge about OGD) were asked to give their feedback throughout the prototype development. This feedback allowed to facilitate decisions when the development team hesitated between alternatives.

To address the five Requirements (R) in our artifact, we selected the eight Gamification mechanisms (G) from (Koivisto & Hamari, 2019): Quiz (G1), Badges (G2), Voting (G3), Notifications (G4), Competition (G5), Collaboration (G6), Rewards (G7), and Storytelling (G8).

4.2.2. Design Propositions
The code of the prototype is freely accessible online under the MIT license.[7] It implements fifteen Design Propositions (DP) consisting in the use of one gamification mechanism 'Gi' to address one requirement 'Ri'. Some gamification features contribute to several requirements. Therefore, we have refined them into several design propositions because we study the contribution of each proposition to each individual requirement.The portal is composed of a welcome page, an exploration page referring to several dataset pages and to the search engine, a quiz page, a scoreboard, a notification button, and a profile page, all accessible from the navigation bar (see Fig. 3).

To demonstrate the relevance of the portal to lay citizens (R2), which breaks down to demonstrating the relevance of the available datasets, we introduced several gamification mechanisms, mainly on the welcome page.

- **DP1 – Using quizzes (G1) to increase relevance (R2)**: First, as shown in Fig. 4 (right), the introduction of *quizzes (G1)* on the welcome page can encourage the exploration of transparency datasets. The quiz presents a question (e.g., "Can you guess how much your city spent for public libraries in 2019?") where the user would be able to choose between different answers.
- **DP2 – Using competition (G5) to increase relevance (R2)**: After giving a response, the respondent is informed of the correct answer, the percentage of users who guessed the correct answer, and the average number of attempts. Each user can therefore compare his/her performance with others', in a *competitive manner (G5)*. Then, the user can consult the dataset on which the quiz was based or continue answering questions. Actions performed on the portal give points to a user. The overall points ranking of users can be accessed on the leaderboard through the navigation bar (Fig. 3), fostering competition as well.
- **DP3 – Using badges (G2) to increase relevance (R2):** Key exploration stages of the portal are rewarded by *badges (G2)*. For instance,

users will receive a badge (Fig. 5, left) when consulting a dataset, answering a quiz, or registering on the portal.
- **DP4 – Using rewards (G7) to increase relevance (R2)**: the badges can be transformed into offline *rewards (G7)* such as coupons for museums or stores. Consulting the gained badges and converting them into rewards is possible on the user profile page.
- **DP5 – Using collaboration (G6) to increase relevance (R2)**: Q*uizzes (G1)* and *collaboration (G6)* can be combined to allow users to ask questions they are interested in by signing in to the portal (Fig. 5, right). This demonstrates the citizens' real-life questions OGD can answer, and therefore the relevance of the portal.
- **DP6 – Using notifications (G4) to increase relevance (R2)**: *Notifications (G4)* appear on the portal to redirect citizens towards datasets matching a recent news topic, or popular datasets (e.g., most downloaded, most viewed). These datasets are also highlighted on the welcome page as shown in Fig. 4 (left). DP1 and DP6 can be combined by using these datasets as material for the quiz.

To increase the support during the use by lay citizens (R10), we implemented four design propositions:

- **DP7 – Using collaboration (G6) to increase support (R10)**: On the portal, there is the possibility to ask questions (DP5). Other users could find the answer on the portal and provide the answer to other citizens (G6).
- **DP8 – Using badges (G2) to increase support (R10)**: Relevant answers to questions from other users are rewarded by *badges (G2)*.
- **DP9 – Using rewards (G7) to increase support (R10)**: Similar to DP4, badges earned by answering other users' questions can be turned into *rewards (G7)*.
- **DP10 – Using voting (G3) to increase support (R10)**: Users can *vote (G3)* the answers from other users in the community to highlight the most relevant answers.

Furthermore, as lay citizens would like to have vulgarized content descriptions about the datasets (R11), we implemented the following design proposition:

- **DP11 – Using storytelling (G8) to vulgarize content (R11)**: We suggest users to investigate linked datasets with plain language and provide "data stories" explaining the content of the dataset in a reader-friendly and understandable manner, using examples as shown in Fig. 6. For instance, the users are encouraged to check the votes and composition of the municipal council after consulting the validated budgets of the city.

Finally, as lay citizens expect proactive and personalized feedback mechanisms (R7), we introduced four design propositions:

- **DP12 – Using voting (G3) to stimulate feedback (R7)**: the subscription to datasets is enabled through *voting (G3)* and allows portal developers to be aware of the datasets that users find the most interesting.
- **DP13 – Using notifications (G4) to stimulate feedback (R7)**: Furthermore, after registering to categories they find relevant, users proactively receive *notifications (G4)* to inquire them about the data they would like to see published.
- **DP14 – Using badges (G2) to stimulate feedback (R7)**: We give *badges (G2)* to citizens when they spot an error or give overall feedback about the data quality on a dataset page.
- **DP15 – Using rewards (G7) to stimulate feedback (R7)**: These badges can again be transformed into *rewards* (*G7*) linked to the theme of the obtained badge.

[7] Link hidden due to double-blind review process

Table 3

Usefulness of the fifteen design propositions with computed medians in parentheses (on the scale of 1–5, where 1 means not useful and 5 means extremely useful).

DP	Min	Max	Median	Average	St. Dev.	Distribution	DP	Min	Max	Median	Average	St. Dev.	Distribution
DP1	3	5	4	3.9	0.57		DP9	1	5	3	3.3	1.06	
DP2	1	5	4	3.5	1.08		DP10	2	5	4	3.6	0.84	
DP3	3	5	5	4.4	0.84		DP11	3	5	4	4.3	0.67	
DP4	1	5	4	4.1	1.20		DP12	1	5	4	3.6	1.35	
DP5	2	4	4	3.4	0.84		DP13	2	5	4	3.7	1.16	
DP6	1	5	4	3.7	1.16		DP14	2	5	4	3.7	0.95	
DP7	2	4	3	2.9	0.74		DP15	3	4	4	3.8	0.42	
DP8	3	5	4	3.8	0.79								

Fig. 3. Navigation bar of the portal prototype. It is composed of menus to explore datasets, access the quiz, consult the leaderboard (DP2), access notifications (DP13), and login to the portal.
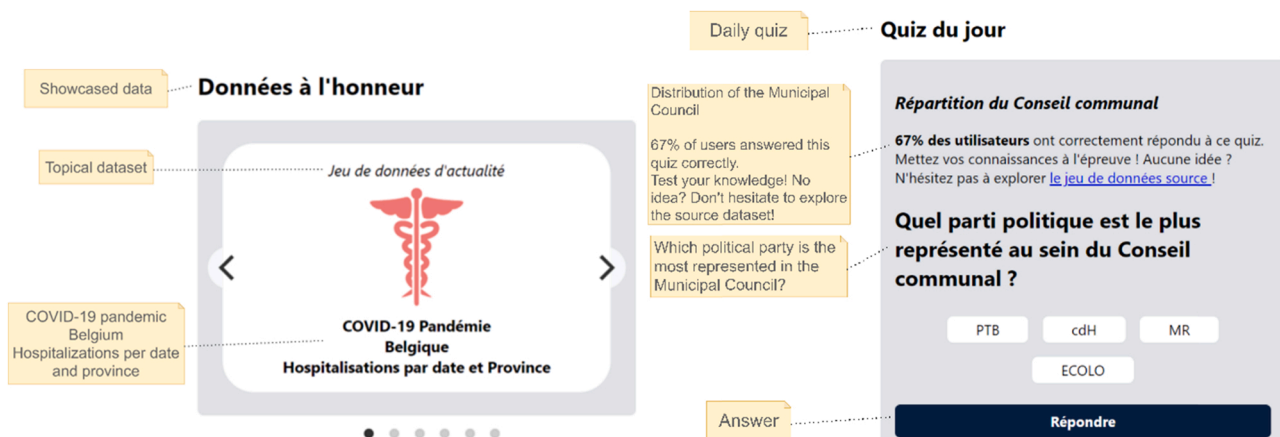

Fig. 4. Highlighted Datasets (DP6) (Left) and Data Quiz (DP1, DP10) (Right).

4.3. Design artifact evaluation

The overall evaluation participants gave during the interviews is highly positive. They reported that the portal is "*different from what they expect a government website to look like*", that they "*really like it*", that it "*makes you want to use it*", and that "*the gamification elements are awesome*". They found the interface "*very well done*", "*clear and uncluttered*", "*playful*", "*very legible*", and "*giving a feeling of modernity*". Being attractive and inviting are essential features for an OGD portal destined

to lay citizens. The participants' feedback suggests that it is the case for our prototype. Moreover, all participants stated that they would use such a portal if made available by their city. The following sections present the findings related to the ease of use of the portal and the usefulness of gamification mechanisms.

4.3.1. Ease of use

The first ease of use indicator is that nine out of ten lay citizens managed to perform the predefined tasks during the evaluation without
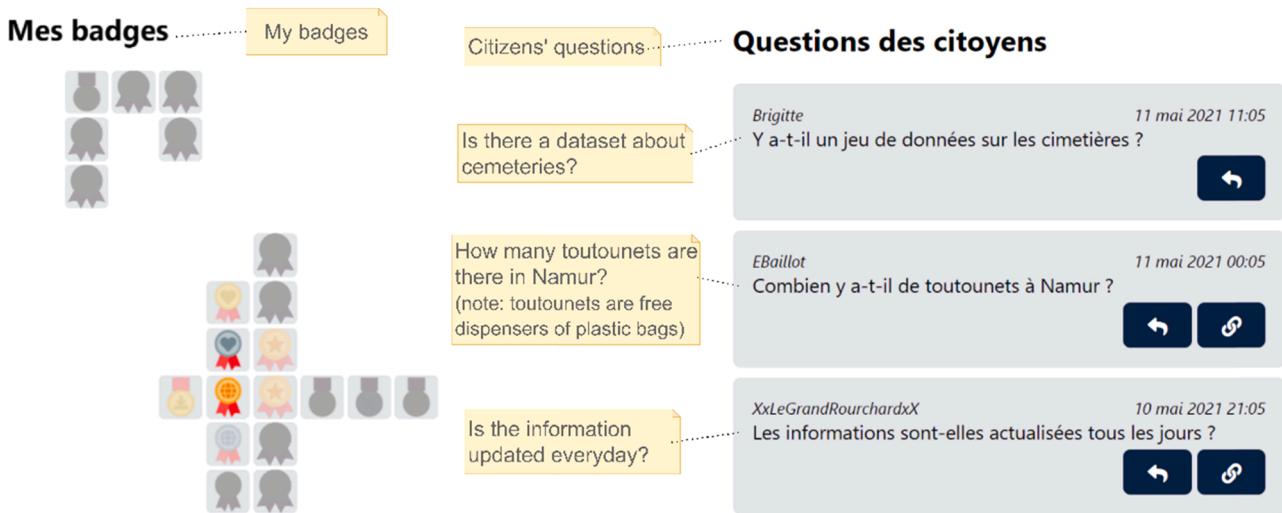
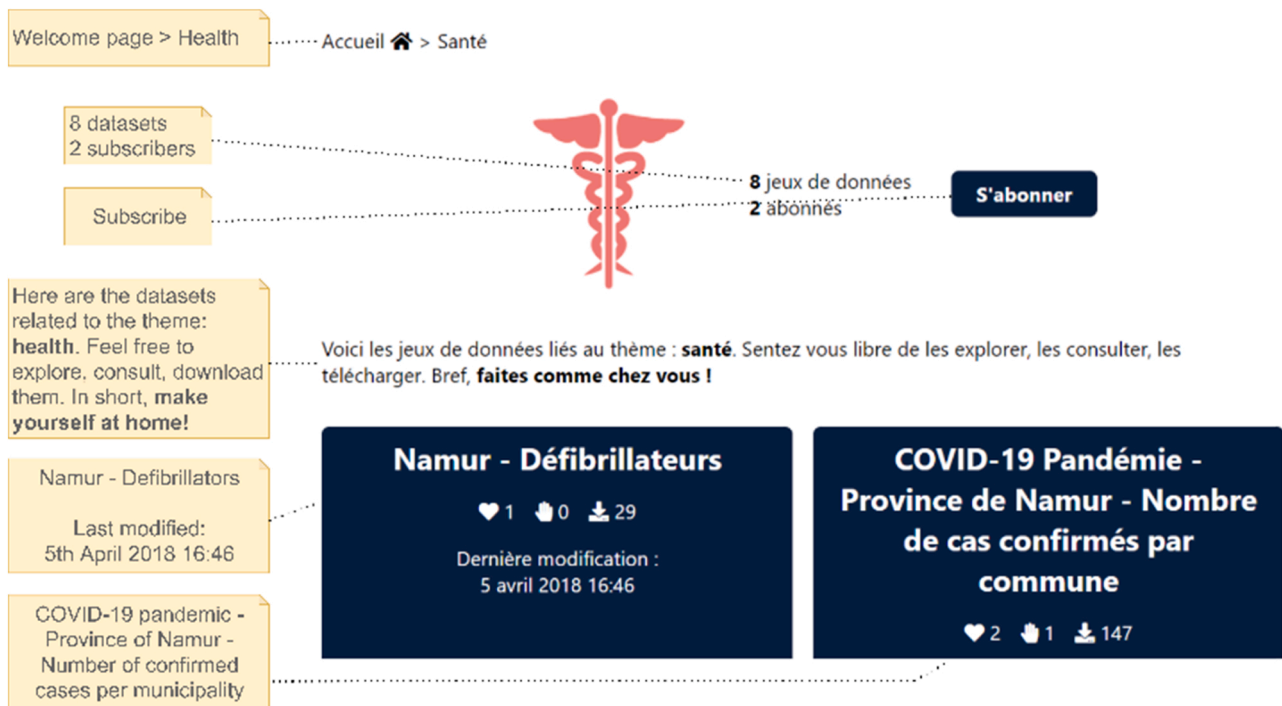**Fig. 5.** Badges (DP3, DP4, DP8, DP9, DP14, DP15) (left) and Citizens' questions (DP5, DP7) (right).

Fig. 6. Dataset presentation page (DP11, DP12).

the interviewer's support, a much higher rate than what we observed with the existing OGD portal which did not implement gamification mechanisms.

More specific aspects of the ease of use of the artifact were measured by the 17 statements from (Zuiderwijk et al., 2016) mentioned in Section 3.2.1. The complete list of these statements is provided in Appendix 2 in the supplementary material. There are five statements with which 2 respondents or more disagreed. While this confirms that the portal was found easy to use overall, this also shows that there are features to improve. Four additional statements were disagreed with by P6 (3 statements) or P8 (1 statement). No respondent disagreed with the 8 remaining statements. It is interesting to note that more than half of the disagreements were expressed by P6 and P8. In the qualitative feedback, they are the two respondents who raised the most concerns about the intuitiveness and usability of the interface. P6 stated "*what disturbed me*

the most was not being strongly guided at the beginning" and found that the welcome page was overloaded with information. P8 found the portal "*attractive but not always intuitive*" Indeed, issues regarding the understandability of button labels, data search, and retrieving read notifications were shared by P8.

4.3.2. Usefulness of gamification mechanisms

We evaluated the usefulness of gamification mechanisms by computing the median of Likert-scale statements. For instance, a median of five means that most participants totally agree about the usefulness of a particular mechanism to meet a requirement. Table 3 shows the usefulness computed for each DP. Most of the design propositions (13 out of 15) was found useful by the respondents, and the remaining two have a moderate usefulness. Therefore, none of the design proposition was found useless by the respondents, which is an encouraging result, and is

consistent with the enthusiasm towards the gamification features the participants showed during the evaluation. The best received gamification mechanism is badges (G2), which is the only one for which a design proposition has a median of five (DP3). This mechanism successfully addresses the three requirements it was implemented to fulfill. During the evaluation, several participants specifically highlighted the badges as their favorite aspect of the portal. Several participants even went beyond the number of badges required by the evaluation task to climb up the leaderboard.

Beyond the median, we also provide the average, standard deviation, minimum and maximum values, as well as the detailed distribution of answers for each design proposition. This information is summarized in Table 4.

Looking at these results from the requirements perspective, every requirement was successfully addressed by at least one gamification mechanism. However, the support requirement (R10) has mixed results. The design propositions for which a moderate usefulness was observed are related to the citizens' question feature. Indeed, two (resp. three) respondents found that DP5 (resp. 7) was not useful. DP5 and DP7 are the two design propositions related to the collaboration mechanism implemented by the citizen questions. It is the mechanism that received the highest number of disagreements. The qualitative feedback from the participants suggests that the citizen' questions feature has potential but should be improved. One respondent reported that he "*would not answer citizens' questions unless they are related to a dataset he has liked*" and another participant felt that the questions are "*random*" and should *"have a topic"*. This suggests that citizens' questions should be presented in a more structured way that is adapted to users' datasets and topics of interest. The other disagreements are isolated instances specific to one participant. For example, P6 found the interface "very clean in terms of design, quite sober" but reported it was bothering from a gamification perspective because the "spirit of game, competition" was felt less intensively. Therefore, P6 gave a low score to the competition design proposition. Another example is P8, who found the notification mechanism confusing and gave a low score to DP13 and DP14, for which notifications are mentioned in the related question in the survey. A few other low scores were given for the design propositions implementing voting and rewards. Such marginal instances were expected, since individuals' reaction to game mechanism differs according to the way they want to engage. Bartle (1996) defines player archetypes and shows that there is variability in the goals formulated by the players and the mechanisms they are willing to engage with to achieve them. We believe that this is reflected in our results, in a visible way through the standard deviations, and that it explains the isolated low scores observed for some design propositions. For example, P3 gave the lowest possible score to DP4, whereas every other participant gave a high score. Simply, P3 is not interested by the type of rewards offered on the portal.

5. Discussion

DSR also has a long tradition of building and evaluating theory, as the additions to the knowledge base are essential in the DSR process (Hevner, 2007). This paper provides various theoretical contributions to the existing literature by unpacking how gamification can help improve OGD portals for lay citizens. On one hand, the requirements of lay citizens towards OGD portals have not been identified in the current literature. On the other hand, the impact of gamification mechanisms on the design of OGD portals and their impact on lay citizens' OGD use was unexplored.

In the relevance cycle of DSR, we performed ten interviews with experts and ten interviews with lay citizens to understand their requirements towards OGD portals. These requirements contribute to the theorization of the problem diagnosis, as they are generic and can be implemented in several ways. Furthermore, additional requirements and qualitative insights are provided compared to previous studies. In total, fifteen lay citizens' requirements are identified. These requirements suggest that lay citizens expect a playful, attractive, vulgarized, and interactive OGD portal, inviting exploration. The requirements also include five key differences with the ones of experts: before even engaging on the portal, lay citizens expect transparency and information datasets on the portal whereas experts expect niche reusable datasets; when searching for a dataset, lay citizens expect a playful interface whereas experts expect a neutral interface; when they find a dataset, lay citizens expect vulgarized content descriptions whereas experts expect concise technical descriptions; when accessing a dataset, lay citizens expect data in a human-readable format whereas experts expect data in a machine-readable format; and in order to actually use the data, lay citizens seek information through visualizations whereas experts expect raw data. These key differences make it difficult for a single portal to satisfy both lay citizens' and expert users' requirements.

Therefore, in the design cycle of DSR, we built a prototype of a gamified OGD portal (the artifact) that implements fifteen design propositions using eight gamification mechanisms: quizzes, badges, voting, notifications, competition, collaboration, rewards, and storytelling. These mechanisms constitute an adequate and under-investigated lead to address lay citizens' requirements.

Table 4
Descriptive statistics for evaluation questions.

DP	Min	Max	Median	Average	St. Dev.	Distribution	DP	Min	Max	Median	Average	St. Dev.	Distribution
DP1	3	5	4	3.9	0.57		DP9	1	5	3	3.3	1.06	
DP2	1	5	4	3.5	1.08		DP10	2	5	4	3.6	0.84	
DP3	3	5	5	4.4	0.84		DP11	3	5	4	4.3	0.67	
DP4	1	5	4	4.1	1.20		DP12	1	5	4	3.6	1.35	
DP5	2	4	4	3.4	0.84		DP13	2	5	4	3.7	1.16	
DP6	1	5	4	3.7	1.16		DP14	2	5	4	3.7	0.95	
DP7	2	4	3	2.9	0.74		DP15	3	4	4	3.8	0.42	
DP8	3	5	4	3.8	0.79								

5.1. Theoretical Contributions

We distinguish three theoretical contributions to the research field of OGD:

Problem diagnosis. The first area of theoretical contributions of DSR concerns the problem diagnosis (Venable, 2006), the understanding of a practical problem in the environment domain (Hevner, 2007), and its consequently related requirements (Kuechler & Vaishnavi, 2012). We contribute to contribute to solving the lack of understanding of lay citizens' requirements (research gap 1). Our findings confirm the previously cited requirements for lay citizens summarized in Section 2.1 and compare them with experts' requirements to elicit five conflicts. Table 5 provides a mapping between the requirements of lay citizens from the literature and our findings. Moreover, it depicts the new requirements that we derived from our study. To the best of our knowledge, these new requirements have not yet been mentioned in the literature.

Artifact and technology invention. Following Baskerville et al. (2018) and Venable (2006), the second area of theoretical contributions of DSR corresponds to the artifact and technology invention and the design propositions. The novelty of our design propositions has theoretical implications as they allow bridging the gap between gamification and OGD literatures by suggesting the introduction of eight gamification mechanisms to improve OGD portal design. As shown in Section 2.2, only one paper reported the use of gamification in OGD portals (Blazhko et al., 2017) but it only focused on feedback features and was not evaluated. The research reported in this paper thus describes a new application domain for gamification theory. Furthermore, even though we suggest an implementation in this paper, the propositions are generic enough to be tackled alternatively in future research.

Technology evaluation. The third area of theoretical contributions discussed by (Hevner, 2007; Kuechler & Vaishnavi, 2012; Venable, 2006) concerns technology evaluation and its contribution to explanatory theory. The findings from the evaluation unpacks the usefulness of gamification to address the requirements (research gap 2). More specifically, we highlight the gamification mechanisms found relevant by the citizens. Badges showed the most promise to highlight portal relevance whereas collaboration mechanisms were less effective to increase support on the portal.

5.2. Implications for practice

DSR approaches allow designing an artifact relevant for researchers and practitioners. Our artifact (the prototype of the gamified OGD portal) is directly relevant for practitioners (i.e., portal developers, public servants, political representatives) willing to use it as a basis to develop or improve their OGD portals.

Furthermore, we provide qualitative descriptions for each

Table 5
Theoretical positioning of lay citizens' requirements.

Lay Citizens' Requirements	Reference
Raising awareness (R1)	(Purwanto et al., 2020)
Structured categories (R4)	(Dos Santos Pinto et al., 2018)
Feedback mechanisms (R7)	(Purwanto et al., 2020)
Customized visualizations (R8)	(Safarov et al., 2017; Thorsby et al., 2017)
Support (R10)	(Thorsby et al., 2017; Zuiderwijk et al., 2015)
Vulgarization content description (R11)	(Gebre & Morales, 2020; Thorsby et al., 2017)
Transparency datasets (R15)	(Lourenço, 2015)
Relevance information (R2), Efficient search engine (R3), Playful presentation of datasets (R5), Export feature (R6), Additional Information (R9), Data Quality Indicators (R12), Human Readable Format (R13), Wide variety of information (R14)	Additional findings

requirement. These qualitative insights were missing from previous research and allow a better understanding of what users expect. We also provide alternatives for the concrete implementation of the identified requirements (e.g., examples of visualizations, different feedback mechanisms, publicity channels, leads for playful interfaces). Finally, the comparison reveals five novel conflicts between the OGD portal requirements of lay citizens and experts. These findings are directly relevant for OGD portal developers. as they could improve the use of traditional OGD portals by implementing the lay citizens' requirements uncovered in this study.

Moreover, through our design propositions, we show that gamification can effectively tackle some of lay citizens' requirements such as highlighting the relevance of the portal or introducing proactive feedback mechanisms. Practitioners can use these findings, as well as our open-source solution, as a basis to improve their portal and to examine a list of design propositions using gamification to make their portal more attractive to lay citizens.

Lastly, the evaluation findings constitute a first theoretical basis to test and improve ease of use and relevance of OGD portals for lay citizens. Through this evaluation, practitioners can identify which gamification mechanisms are effective to meet the lay citizens' requirements. Therefore, depending on the requirements that practitioners choose to address in priority, they can select the most appropriate mechanisms accordingly.

5.3. Limitations and research directions

This study has inherent limitations that open new research directions. First, the data collection for the requirements identification could be improved. Indeed, we based our division between experts and lay citizens on ICT and development skills. More fine-grained divisions are possible, such as those based on previous experience, political involvement, and other dimensions. Furthermore, the skills were self-evaluated through an online questionnaire to recruit participants. Using existing and validated scales about digital literacy, such as the one proposed in Hargittai and Hsieh (2012), would allow a more detailed evaluation but, as it is time-consuming, it might discourage participants to enter the study. The participants in the study were volunteers. Indeed, it was essential to discuss with citizens interested in OGD and willing to take the time to participate. However, a larger scale study with quotas for different profiles would be a promising way forward. Second, only some requirements of lay citizens were addressed through gamification in this paper, leaving the "content" requirements aside. For instance, as lay citizens focus primarily on transparency datasets, we recommend portal developers to use indicators from the Digital Transparency Index (as described in Araújo et al. (2016) that suggest specific transparency information to be displayed to citizens such as government decisions, payrolls, administrative data, and policy monitoring. A comprehensive survey aiming to identify the content expectations of lay citizens would be promising. Third, the evaluation study reported in this paper focuses on the usefulness of gamification mechanisms to achieve certain requirements. However, as identified in the Technology Acceptance Model (Cegarra-Navarro et al., 2014; Marangunić & Granić, 2015), other factors such as ease of use are essential to predict intention to use and citizen engagement with digital government services. As it is not uncommon in DSR publications to leave out the extensive evaluation of the research artifact for future research (Angelopoulos et al., 2021; Costa, Soares, & de Sousa, 2020), we suggest leads to perform this extensive quantitative study.

To further bridge the gap between the gamification literature on the one hand and the OGD literature on the other hand, we recommend four research directions, directly relevant for practitioners as well:

1. **Enable the transition from gamified to traditional OGD portals:**
   Openly sharing data is already a time-consuming task for governments with limited resources. Developing a new portal can thus be a

burdening extra task. Our gamified OGD portal constitutes an entry point for the lay citizens on the portal. Ultimately, through continuous learning, citizens could move towards the regular interface on the portal (Hartson, Rex, 2012). Future research should investigate how this transition can be implemented through continuous learning, using the adaptive difficulty (or "levels") gamification mechanism for instance.

2. **Investigate alternative implementations of gamified OGD portals**: The gamification mechanisms we implemented were selected from an exploratory mapping, and other mechanisms could prove valuable. Therefore, we encourage researchers to investigate alternative implementations for the identified requirements and to evaluate them using experimental design. Alternative implementations should particularly focus on requirements that were not addressed successfully in this paper such as support mechanisms. Future portal developments should focus on a comprehensive mapping between the portal exploration steps and the badges, with progress relationships between the badges, attractive and dynamic representations and exploration mechanisms, and collaborative and competitive interactions between users on the portal. Promising leads can be found in the literature listing other gamification mechanisms such as levels for portal exploration, virtual helpers for support, and 3D worlds for the playful interface design. An aspect that we did not study is whether two gamification mechanisms are exclusive. For example, there is a strong negative correlation between DP8 and DP13. DP8 asks whether badges motivate users to answer citizens' questions, and DP13 asks whether notifications asking questions motivate citizens to give feedback about the portal. The two respondents who did not find DP13 useful gave the maximum score to DP8, and all respondents who gave a neutral score to DP8 (which is the lowest score observed for this design proposition), found DP13 useful. This could be explained by the reported usability issue about notifications, or by the fact that asking users to give feedback and answer questions is too much, and that they would be willing to contribute only for one. The sample size does not allow to formulate any robust conclusion, but it suggests a potentially interesting point of attention for future work. Other leads stem from the inconsistency between the sobriety of the interface and the playful mechanisms that were detrimental to the experience of one of the participants.

3. **Evaluate holistically the benefits and drawbacks of gamification for OGD portals**: Gamification is a hyped phenomenon, but the research devoted to its concrete benefits and possible drawbacks remains scarce. Recently, Hammedi, Leclercq, Poncin, and Alkire (Née Nasr) (2021) unpacked the dark side of gamification in the workplace and revealed it can have a negative impact on job satisfaction and engagement. Drawing from the research design of Zuiderwijk et al. (2016), the benefits and drawbacks should be compared with large scale experiments involving a control group of citizens using a traditional portal and treatment group using the gamified portal(s). In these experiments, constructs from the Technology Acceptance Model (TAM) could be used to evaluate the perceived usefulness of the gamification mechanisms but also the perceived ease of use of the portal. Besides the TAM, other IS success models include key dimensions such as self-efficacy (Balapour, Reychav, Sabherwal, & Azuri, 2019) and information quality (Rai, Lang, & Welker, 2002) that should also be included in a future holistic evaluation of a gamified OGD portal.

4. **Investigate the relationship between ease of use and gamification**: An interesting aspect to evaluate in future work is the link between ease of use and gamification. On the one hand, some studies report a positive, even mutual, relationship between the two. For example, Rodrigues, Oliveira, and Costa (2016) found that ease of use and enjoyment have a positive influence on each other in the context of e-banking. Also, Lallemand and Gronier (2015) emphasize how users' confirmation bias affect their perception of the interface. The elements that are first noticed on the interface, which are related

to aesthetics and emotions, and thus to gamification, will influence users' opinion throughout their interaction with the interface, when they will experience the elements related to the ease of use. This means that a more enjoyable interface will be perceived as easier to use. Although the sample size of this study does not allow reporting sound findings on the matter, this is consistent with the answers given by P6, who explicitly stated that the gamification was not intensively felt on the artifact and gave the lowest ease of use ratings among all participants. On the other hand, the usability literature recommends to keep design as minimal as possible (Nielsen & Molich, 1990), which implies removing every element that is not useful for users to reach their primary goal. In this line of thought, gamification elements could be seen as a distraction. Although the ease of use of OGD platforms has been previously studied (Zuiderwijk et al., 2016), little is currently known about the gamification on OGD platforms. Literature and, to a certain extent, our findings suggest that the interplay between ease of use and gamification is important.

6. Conclusion

The objective of this paper is to examine how gamification can help tailor OGD portals for lay citizens. Traditional portals are designed for expert users and therefore fail to attain key goals of OGD policies. To reach our objective, we applied a Design Science Research approach to build and evaluate a design artifact, the prototype of an OGD portal tailored to lay citizens through implementing mechanisms from gamification theory. In the rigor cycle of DSR, we ensure that our research objective was addressing key gaps in the existing literature related to OGD portals use (lay citizens' requirements towards OGD portals have not been properly identified) and OGD portal design (the impact of gamification mechanisms on the design of OGD portals and their impact on lay citizens' use remain unexplored).

The novelty of the design propositions allows us to contribute to OGD developments by providing the first evaluated OGD portal drawing from gamification theory. This study is the first to reveal the usefulness of implementing various notions from gamification theory into OGD portal design. Furthermore, the evaluation of the artifact reveals that lay citizens found gamification useful and that badges constitute an appreciated mechanism that successfully addresses citizen's requirements. Practitioners can use our findings to make OGD portals more inclusive and thus contribute to attaining key OGD policy objectives. As a way forward, we suggested four research directions to further bridge the gap between gamification and OGD.

CRediT authorship contribution statement

Simonofski Anthony: Conceptualization, Methodology, Writing – original draft, Investigation, Project administration. **Anneke Zuiderwijk**: Conceptualization, Methodology, Writing – review & editing, Supervision. **Antoine Clarinval:** Conceptualization, Methodology, Writing – original draft, Validation. **Wafa Hammedi:** Conceptualization, Writing – review & editing, Supervision.

Declaration of Competing Interest

None.

Acknowledgement

Appendix A. Supporting information

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