Game Over or Jumping to the Next Level? How Playing the Serious Game 'Mobility Safari' Instigates Social Learning for a Smart Mobility Transition in Vienna

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Abstract Serious games and gaming are increasingly considered as the magic bullet for improved stakeholder involvement and citizen engagement in urban planning and governance. They are also discussed as means to instigate learning and capacity building and to raise the awareness of citizens and stakeholders about various urban topics. These learning processes can unfold in various different formats, such as social or game-based learning. This chapter investigates if playing the serious game prototype 'Mobility Safari' supports such processes. Mobility Safari is a serious-game prototype developed for the City of Vienna. The game is targeting Vienna's ambition to become a smart city. One focal point of this ambition concerns the change towards a more sustainable mobility system. Our analysis illustrates that the serious game indeed evokes learning processes during the gameplay and the debriefing, covering a broad range of learning activities and social interaction. Incomplete rule-sets and un-governed situations trigger discussions in which players confront the game experience with their actual real-world practices. Our analysis suggests that games are indeed suitable means for informing citizens and supporting capacity-building processes in participatory-planning approaches. However, they need a careful design, facilitation and sufficient time for a debriefing so that players can reflect on the game experience. This reflection is crucial to transform the game experience into a deeper learning experience that is meaningful for real-world contexts.

Keywords Serious games · Urban governance · Civic learning
Sustainable mobility · Smart city · Vienna

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1 Introduction

Serious games, digital tools and gamified environments are increasingly utilized in a broad variety of different sectors related to planning, such as health, urban and community planning, mobility, or energy related issues (e.g., Kleinhans et al. 2015; Mohammed and Pruyt 2014; Poplin 2014). The reason is that they can represent complex 'real-world' situations and allow players to engage with these in explorative and experiential ways. In the field of planning, serious games and gamelike approaches were first introduced in the 1960s. More recently, the proliferation of mobile devices (e.g., smart phones), the broad availability of Wi-Fi, modelling and simulation technologies (e.g., GIS, ABM)—but also the emergence of the smart city discussion—have resulted in a new wave of gamified tools, serious games and digital technologies in the field of planning (e.g., Gugerell et al. 2017; Tan 2014). Serious games and gamified environments are considered valuable because they enable the exploration of various pathways, support experimentation with various behaviors and the manipulation of system components (Cumming et al. 2012). The immediate response of the game system to decisions taken is one of the assets for the players. Consequently, playing games instigates various formats of experiential learning, such as knowledge creation, finding common ground, conflict resolution, experimenting with rules or institutions and motivating goal achievement (e.g., Bluemink et al. 2010; Devisch et al. 2016; Guzzetti et al. 1993; Hämäläinen 2011; Poplin 2014).

The game Mobility Safari targets Vienna's ambition to shift towards a more sustainable mobility system and to encourage 'greener' behavior by its citizens. Vienna is growing by 30,000 inhabitants per year, corresponding to a proportional increase in the number of trips. The current modal split shows a distribution of 39% public transport, 7% bicycles, 27% pedestrians and 27% motorized individual traffic (MA23 2016). Hence, CO_2-free modes such as walking and cycling should be strengthened to progressively lower the MIT to 15% by 2050. Also, with new propulsion technologies for non-motorized types of PT and MIT, the entire commercial traffic (source and destination traffic) should run CO_2 free by 2050 (City of Vienna 2016). The city stakeholders are aware that this policy's success is dependent on the citizens' daily mobility behavior and their involvement in mobility projects. Thus, the city administration stresses the importance of: (i) awareness rising among the various actor groups; (ii) informing these actor groups which resources are needed for 'green' and 'shared' mobility projects; (iii) supporting networking and trust-building to set up sharing initiatives and citizen collectives; (iv) informing citizens of existing mobility initiatives and upcoming mobility projects run by the city; and (v) integrating underrepresented groups into these activities. The city's ambition is also characterized by urgency: the mobility and transport sector accounts for approximately 27% of global energy consumption and CO_2 emissions and 33% in the European Union (IPCC 2014). Also, mobility is causing significant urban noise and air pollution and can pose a major constraint on the quality of urban life (Batty et al. 2015; Banister and

Thurstain-Goodwin 2011). Thus, cities are important units for policies and practices addressing sustainability issues and aiming at strong environmental benefits (e.g., Bulkeley and Castan Broto 2013). This is because cities play two important roles: (1) of actors regarding local transport; and (2) of loci and provider of low-carbon innovation and services (Geels 2011a, b; Nevens et al. 2013). Hence, experimentation with alternative social and mobility practices questioning and disrupting existing, and envisioning, novel policies are—along with technological, market, policy and institutional questions—important tiers for urban sustainability transitions. In particular, local action is crucial for major sustainability-related changes. Still, modal choice and mobility practices are a consequence of a mix of values, attitudes and perceptions (e.g., Hunecke et al. 2010; Klinger and Lanzendorf 2016; Lesteven 2014; Thøgersen 2009), and/or economic viability (e.g., Van Exel and Rietveld 2009). Thus, however, sustainability transitions are not only about content or technology, but they rest on process- and practice-related matters and local action. Sustainability transitions are long-term processes of fundamental changes in practices, culture and structure (e.g., Avelino et al. 2016). In this article we raise the questions if: (i) the serious game 'Mobility Safari' can trigger civic learning and experimenting for sustainability (e.g., Lozano 2007, 2014; Gugerell and Zuidema 2017), together with alternative practices that might contribute to such transformations; and (ii) if the learning outcomes correspond with the ambitions stated in Vienna's smart city strategy. To better understand the links between games and learning, we briefly introduce the academic debate on the topic in the following section. In Sect. 3, we explain the game prototype 'Mobility Safari' and our research methodology. Section 4 contains the main findings, and finally in Sect. 5 we come back to our objectives in the conclusion. There we suggest that games can indeed evoke civic learning and can act as the onset of process-oriented sustainability transitions, but in more ambiguous ways than initially expected.

2 Games as Blissful Learning Environments for Sustainability Transitions

Playing is the most basic form of learning, and imaginative and social forms of play are crucial for conceiving and making sense of the external world (Piaget 1962; Huizinga 1999; Papert 1987). Learning through play is currently undergoing a renaissance with the rise of digital tools and the increasing popularity of (digital) games and serious games. In planning, more gameful (rule-based) and playful (free-form) participatory tools and digital models have emerged over the previous 25 years, many of them with the purpose to support participatory processes, decision making and a better understanding of the environment. Especially GIS and simulation technologies have experienced a certain "gamification", implementing gameful elements for improved participatory engagement (e.g., Schauppenlehner et al. 2016). Citizens are often considered as sensors but also as supporters for

research and solving complex scientific problems by playing games such as 'Fold-It' (protein folding, Cooper et al. 2010) or 'Quantum Moves' (moving quantum atoms, Center for Community Driven Research). Research argues that serious games have advantages over traditional learning formats. They allow players the discovery and reconstruction of knowledge and skills (Papert 1980, 1987) by active engagement with the game, receiving immediate feedback to actions and decisions taken in the gameplay, and support the understanding of complex systems by representing complex real-world matters in an artificial game environment (Mayer et al. 2005; van Bilsen et al. 2010; Medema et al. 2016; Tan 2014). The game as artifact prepares and guides the discovery and exploration path of the players (Marzano 2007), makes possible the taking of risks and manipulation or exploration of extreme pathways without facing the real consequences of failing or causing damage (Devisch et al. 2015; Juul 2016; Raphael et al. 2010). Games are pleasant and entertaining learning environments because they offer a balanced mix of progressing challenge, foster social interactions, provide feedback loops and rewards, ideally encourage replay and thus divest the player of the feeling of being wrong or having misunderstood (Papert 1980; Gee 2005; Lieberman 2006). Common criticisms against serious games suggest that players might get so immersed in the gameplay that they fail to achieve the initial learning objectives or that 'serious games' are sometimes too serious. Hence, the challenge is to integrate learning into the game without spoiling what is enjoyable and fun (Ke 2016) to keep the players blissfully engaged.

Research suggests that games support the development of improved cognitive and social learning (e.g., Erhel and Jamet 2013; Gee 2005; Granic et al. 2014; Hamari et al. 2016; Prensky 2006; Shaffer et al. 2005). Consequently, as 'serious learning technologies', games are expected to deliver benefits such as teaching problem solving, enhancing spatial sense and visual thinking, reflecting on complex problems, raising awareness, increasing media literacy, educating target audiences on specific topics and skills and building coalitions and networks (Ventura et al. 2013; Erhel and Jamet 2013; Gee 2005; Hamari et al. 2016; Prensky 2006; Crookall 2010). If such learning actions take place in group settings, where players interact with each other (i.e., in negotiating strategies, knowledge sharing, praising each other's achievement), the process is associated with social learning (e.g., Hummel et al. 2011). Multiplayer games, such as 'Mobility Safari', merge individual and social learning. Various different learning concepts (e.g. behaviorism, constructivism) promote different views on the importance of social interaction, but agree on the benefits of group interaction for learning in general (e.g., Doise et al. 1976; Grusec 1992; Piaget 1981). Within gameplay, social interaction helps to unlock joint knowledge, linking to already established practices or tacit knowledge to produce a new one. More recently, learning, exploration and experimentation have also been positively associated with action and actors engaged in sustainability transitions (e.g., Nevens et al. 2013; Frantzeskaki et al. 2014; Wittmayer et al. 2014). Lozano (2007, 2014) proposes an integrated concept that merges various learning approaches (i.e., adaptive, anticipatory, action-based) with the scheme of single-, double- and triple-loop learning (see Fig. 1). Lozano argues that learning

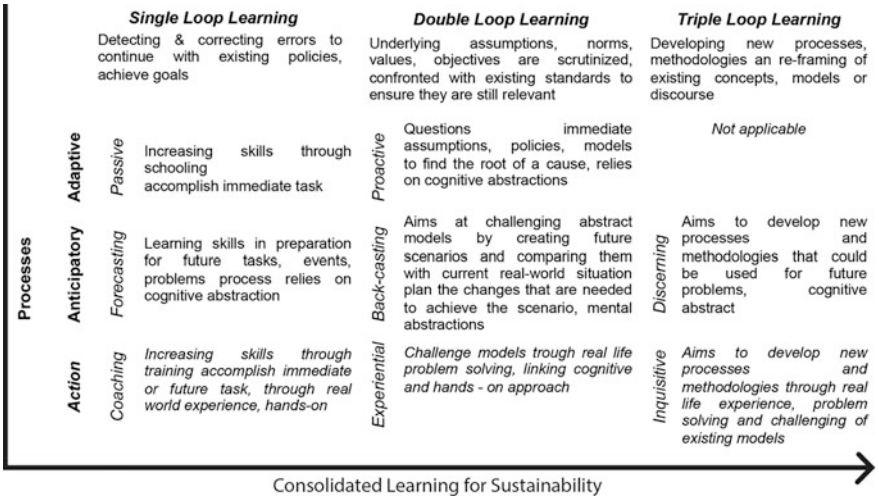

Fig. 1 Consolidated learning processes range from single-loop to more complex forms of learning, such as action-based triple learning. Illustration based on Gugerell and Zuidema (2017), Lozano (2014)

for sustainability requires consolidated learning processes that cover the range from single-loop knowledge learning to complex inquisitive forms of triple-loop learning that scrutinizes conceptual models and develops alternative ones. Especially the more complex learning formats align well with Papert‘s and Piaget’s learning concepts, focusing on actively challenging, questioning and constructing new mental models, concepts and processes to make sense of the game and the real world surrounding it. If, by playing a game, players reflect on their civic practices and actions, conceptualize them within a wider context, and can apply the learning outcomes (e.g., knowledge, skills) outside the game in a real-world context, this learning process becomes associated with civic learning (Gordon and Baldwin-Philippi 2014; Raphael et al. 2010). Thus, consolidated civic-learning processes are crucial to respond sufficiently to complex societal challenges, such as the pursuit of a sustainable mobility system. In our analysis, we ask whether playing ‘Mobility Safari’ unlocks various forms of learning, ranging from single-loop knowledge acquisition to more complex modes of social learning, including of double- and triple-loop learning.

3 Methods and Game Prototype ‘Mobility Safari’

The research follows a mixed method approach, combining: (a) a standardized questionnaire (n = 78); (b) participatory observation during gameplay; and (c) a debriefing at the end of each playing session (n = 16). Before and during the test

phase, various methods for recruiting voluntary players were used, including social media (e.g., Facebook, Twitter, LinkedIn) and snowball sampling. The standardized questionnaire is literature based, querying: (a) sociodemographic data; (b) knowledge and attitudes towards environment, mobility, energy and participation; (c) player types and game preferences; (d) gaming experience and strategy; and (e) gaming/learning impact. 'Learning impact' was sampled by the players' self-evaluation of their learning experience. The completed questionnaires were coded with SPSS and analyzed by descriptive statistics (see Table 1). The analysis was complemented by qualitative data on the playing processes, player interaction and decision-making processes in the game, which were collected through participatory observation. Mapping player interaction is crucial to identify learning actions associated with collective and social learning (Medema et al. 2016; Wendel and Konert 2016; Dörner et al. 2016). The debriefing was organized as a focus-group discussion moderated by a facilitator, where the players jointly reflected on the gameplay, strategies and decisions taken and linked the gaming with their real-world experience. Serious gaming literature stresses the importance of debriefing to transform the gaming experience into a deeper learning experience (Lederman 1992; Crookall 2010). The debriefings were recorded, transcribed and coded, and a content analysis was performed (Gläser and Laudel 2010; Mayring 2015). The sample is skewed towards higher levels of education and female participants. Most players are between 19- and 30-years old, which represents the project's focus group of young adults. The sample is balanced regarding gaming abundance: 36% play games rarely to never, 25% occasionally and 39% play games frequently, but with rather modest experience in serious games.

3.1 Serious Game 'Mobility Safari'

'Mobility Safari' is a co-located, serious board game for four to six players (see Fig. 2). The aim of the game is to increase the literacy of citizens about sustainable urban mobility options, experiment with different mobility choices, e.g., how to set up mobility cooperatives, and let players experience the community and environmental impact of their in-game choices. The game narrative is embedded in the local mobility narrative and the city's ambition for a sustainable urban mobility system (City of Vienna 2014, 2016; Mobilität—STEP 2025). The game board represents the city of Vienna and is divided into colored tiles that correspond to the main tiers of the city's policy (purple: innovation and learning; green: active and healthy; yellow: flexible and connected, red: fair and safe). Dicing drives the players to move their playing figure on the game board. Arriving at a tile, the player can decide on implementing a project determined by the color of the tile. Players can prioritize their target tiers and personal goals. The project cards are presented face-up, so the players can deliberate which project suits them most by checking its value and the requirements and resources needed to implement it. These requirements mirror a limited number of institutional, financial and social rules:

Table 1 Survey results on the players' perceived learning outcomes and learning effects

Statements	Relative frequency in %				
	Strongly disagree	Disagree	Neither	Agree	Strongly agree
Single-loop learning/knowledge learning					
I was curious to learn something new from the game	6	8	29	33	24
Through the game, I am inspired to learn more about the mobility transition in my region	10	26	29	28	7
Through the game, I understand more about implementing urban development projects	14	18	37	28	3
I obtain and explore new perspectives on the topic of mobility	6	37	31	22	4
Through the game, I learned something new about the mobility transition in my city	18	30	31	18	3
Social learning/double- and triple-loop learning					
Playing the game demonstrated that by cooperation with others environmental problems can be solved	8	17	31	32	12
The game shows various options for participation and civic involvement	10	20	36	27	7
Playing the game raised my interest and awareness regarding mobility projects	12	21	32	24	11
Through the game, I have a better understanding of possible projects in my city that contribute to the mobility transition	13	19	33	32	3
After playing 'Mobility Safari', I would like to engage more in mobility initiatives	19	28	31	19	3
Social learning/co-located learning by observation					
Through the game, I learned more about other players	7	14	31	34	14
Watching the strategies of other players helped me to understand the game better	7	24	36	22	11
I learned things I didn't know about the mobility transition from other players	23	28	29	14	11
The game offered me a new perspective on the interests and concerns of other players	17	31	34	14	4
Total	72 (100%)				

Fig. 2 Serious game prototype 'Mobility Safari', co-created in the play!UC project by various stakeholders, planners and researchers in Vienna (Austria) and Groningen (Netherlands)

(a) creating networks; (b) obtaining a permit (either by rolling a dice or answering a multiple-choice quiz question); and (c) paying the implementation and realization costs. Each implemented project provides the player's network with a certain number of coins (financial aspect), community points (social aspect) or CO_2-reduction points (environmental aspect). Players have to settle annually, increasing mobility costs at the end of each game round, paying with the coins they collected when implementing projects. At the end of each of the five rounds, an activity card is played: activity cards are single events that introduce external impacts on mobility, such as oil crisis, elections, increasing population or floods. At the end of the game, there are three possible winning conditions: players with the highest number of coins, community or CO_2-reduction points.

4 Consolidated Civic Learning with 'Mobility Safari'

Civic learning for sustainability should ideally cover all three formats of learning: single-, double- and triple-loop learning. The players evaluate 'Mobility Safari' as 'fun-to-play': "It was great fun playing it" (77%), "The game is well constructed" (62%) and "The game is interesting and diverse" (44%). Favorable feedback on the fun-factor and a high willingness to replay the game (73%) illustrate that 'Mobility Safari' works well as a game. Players that are active in community and participatory projects were even slightly more positive about the value of the game and the gameplay. Approximately one third of the players agreed that the game inspired them to learn more about sustainable urban mobility.

Learning actions in the ambit of single-loop learning occurred in the game via the quiz questions. The questions targeted at instruction in the field of sustainable urban mobility, such as providing information on bike-sharing, sustainable service providers, PT, CO_2 emissions and the urban carbon footprint. The wording of the multiple-choice quiz questions included some pieces of additional information. Thus, it was not necessary for players to know the correct answer: they could reconstruct it by using these bits of information. The various answer options facilitated approximating the correct answer. More than half of the players stated that during the gameplay they have learned something 'new' and that they have

obtained new knowledge on urban initiatives and new perspectives on mobility: "I've learned about sustainable projects and ideas I had no idea about" (G17). One fourth of the players perceived that they had learned about the environmental and community dimension of mobility choices: "The game shows that every project has a sustainable influence on the environment" and "[What I enjoyed was] setting up a joint venture and not executing projects on my own—and seeing the common benefit from implementing these projects". Even though learning actions occurred and the players actively reconstructed knowledge together by working on the quiz questions, their self-perception of learning remained moderate. That might be due to: (a) the slight overhang of well-educated people who are already well informed; and (b) given the better education, the set of quiz questions was perhaps a bit too easy and not sufficiently challenging for that player group.

The quiz questions linked single-loop learning with more complex forms of learning by triggering social interactions such as knowledge sharing or group discussions. The experience of social learning is twofold and stems both from getting acquainted with other players and their perceptions and from observing other players. Concerning getting to know other players, the game delivered effects above average. More elaborated effects, e.g., learning about other players' perspectives (48%)—"Now I know how you really tick" (G17) or anticipating other players' knowledge (25%) also occurred but on more moderate levels. The quiz questions were an important source of interaction. To approximate or calculate the answer, the groups confronted the quiz questions with their game experience and individual mobility and social practices in everyday life. In the resulting discussions, the players actively engaged in the debate about individual practices, shared their information about mobility options and other real-world experiences. Real-world experiences paired with individual values and norms played an important role in the discussions on the project selection: "No, I don't support electromobility projects. That's not solving any traffic and mobility issues of the city" (G14). The players actively linked the debate with the socio-spatial context of the various districts of Vienna: "No, for *Lobau* (district in Vienna, N/A) a promenade does not fit—so I'll choose another tile and topic." (G12) or "(…) the most important point of the strategy is to choose the right neighborhood for urban development (…) to enjoy the multiplier effects of neighboring projects" (G15). Hence, our work aligns with the prior work of Medema et al. (2016) showing that the gameplay delivers social-learning activities in the ambit of double-loop learning. We also observed that, apart from rules, also values and norms transgress the boundaries, in consequence linking the game and the real world (Juul 2011).

In addition to the content-specific group discussions, indications for institutional learning and capacity building occurred. Players indicated that they appreciated "negotiating and cooperating with other players" and the "process of gathering a team of project members". Contrary to standard game-design theory, we left some situations in the game ungoverned, such as coalition building or who should answer, and how, the quiz questions. We observed various strategies how groups dealt with this matter. In some cases, rules were actively negotiated, but more often norms were subliminally accepted. An example was the creation of a project

coalition, where the spectrum of different motives covered altruistic ("Nobody is left behind", G6), redistributive ("(…) you have almost no implemented projects yet", G6) or regulatory, normative motives, stressing that "Players who already collected many points were not considered anymore later in the game" (G13). However, less discursive formats for coalition building were also used, such as random selection or 'first-come first-served' options. These norms and subliminally accepted game rules were then re-introduced in the debriefing by the facilitator. At this stage, players often were surprised, arguing that "that was a rule" and eventually admitting that they actually just accepted something they did not always fully agree with. Some players complained about the lack of predefined rules to govern such situations. Experimenting with alternative institutions in the game also occurred, and it included resource sharing, gifting resources to other players or reasoning in favor of players who were struggling. Nevertheless, players also used active bribery, corruption or usury as informal game institutions. During the gameplay and in the debriefing, players addressed and discussed such practices, as well as institutional tensions, alternative institutional formats and the changeability of institutional designs. We interpret these activities as modest indications of anticipatory triple-loop learning. However, the discussion on alternative or new institutional formats and practices occurred much less often and in less obvious form than it happen with social and mobility practices and other real-life experiences.

5 Conclusions

In this article we argue that playing the serious game 'Mobility Safari' triggers learning activities and processes. The game delivers benefits that are associated with social learning addressed in the academic debate on sustainability transitions, such as evoking group discussions, spatial sensitivity, spatial sense or coalition building (e.g. Nevens et al. 2013; Neef et al. 2017). Hence, the game also works as a supportive tool in the implementation of Vienna's smart city strategy by raising awareness, informing actors on green mobility, and sharing projects and existing intitatives, as well as supporting networking (City of Vienna 2016).

While the game indicates promising results within the scope of single and partly double-loop learning, it falls short in the more complex ambit of the consolidated learning scheme (see Fig. 1). Hence, the anticipated consolidated learning process to support sustainability transitions remains moderate. Though the gameplay and the debriefing show moderate indications of more complex forms of learning (i.e., action-based triple loop), the players do not actively perceive them as learning processes. In consequence, the learning results, also those stated in the questionnaire, were rather modest. However, the players' perception that the activity is 'playing a game' and less a 'learning experience' confirms that the serious game works as a game without players noticing too much that they are learning. Nevertheless, in future research, a stronger focus on institutional learning in the

debriefing would be worth exploring. In the testing period, we also learned that the incomplete rule-set created added value to the more complex formats in the scope of double- and triple-loop learning: ambigous, ungoverned situations forced the players into the experience of institutional tensions. These situations motivated them to actively engage and explore various options for how to deal with or solve problems. The game, as the general structure, guides the players through their learning experience. Gaps and ungoverned spaces in the rule set of the game support active engagement and discovery learning (Papert 1980) of players. Hence, regarding gameful learning for sustainability transitions, consolidated civic learning is the ambition. Incomplete and ambigous rule-sets might be a suitable option to trigger active engagement and different modes of learning activites, such as exploring new rules, questioning institutions and discussing, negotiating and deciding on institutional formats. This finding adds to the traditional gaming literature that outlines unambiguous, fixed and binding rule sets as fundamental conditions for games (Salen and Zimmerman 2004; Juul 2011). To deliver a challenging learning experience, we suggest developing customized 'combat levels' (i.e., easy, moderate, hard), not only for entertainment but also for serious games. Player groups might differ significantly; to ensure a challenging experience, the players need the opportunity to select their game level. While this option is quite common in entertainment games, in serious games it is almost entirely missing. With differentiated levels, the players can experience progressive challenges over a longer time period or while playing the game more often. This will keep them interested and motivated and make the gaming experience more fun and enjoyable.

We also learned that the debriefing is the crucial moment to transform the gaming experience into a deeper learning experience by discussing and reflecting, e.g., institutional questions which are not obvious to the players in the gameplay. Thus, the debriefing and its design should be carefully considered and sufficiently addressed in the serious game design (Winn 2009; Hunicke et al. 2004). The debriefing activity is crucial to consciously link the gameplay and game experience to real-world circumstances, practices and local action and to contextualize their meaning. This reflection is the conceptual and procedural bridge that is required to facilitate serious games and gamified environments as sources and tools in participatory processes and collaborative action for the governance of sustainability transitions.

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