PARTICIPATORY VISIONING FOR BUILDING DISRUPTIVE FUTURE SCENARIOS FOR TRANSPORT AND LAND USE PLANNING

Abstract

Participatory visioning in transport scenario building can be particularly useful to anticipate and examine unexpected outcomes over long-term future timelines, providing broad legitimacy to today's decision-making processes. However, the strategic value of participatory approaches is increasingly being contested due to the difficulty to operationalize non-linear thinking, resulting in long-term visions similar to business-as-usual projections. To address this challenge, we developed and implemented a novel participatory visioning approach based on using semi-structured interviews that incorporate two types of wild cards – low probability and high impact processes – as disruptive visioning triggers: imaginable and unimaginable processes. A group of experts evaluated the level of disruptive thinking in the generated future visions. The Henares Corridor in the Metropolitan Area of Madrid, Spain provided the empirical focus. The results present a total of seven 2050 visions: one desired common vision plus six wild card visions. Higher levels of disruptive thinking were mainly present in those future visions generated by unimaginable processes, as such processes initiate highly diverging participant future views. It was also noted that smaller and specific groups of participants can visualize 2050 futures more disruptively. Conclusions and reflections on the strengths and weakness of the presented approach are drawn.

Key words: participation; stakeholders; strategic; scenario analysis; planning

1. Introduction

Cities and transport systems are changing faster than ever, which is a fertile ground for the emergence of sudden and low predictable processes (Barber et al., 2006; Dammers, 2010). As a result, transport planning is greatly challenged, with attacks on instrumental rationality (Innes and Booher, 2018) and calls for the inclusion of deep uncertainty in decision-making processes (Lyons and Marsden, 2019; Marchau et al., 2019; Navarro-Ligero et al., 2019). Bounded rationality – based on recognising cognitive limitations of human decision-makers (Simon, 1957)- offers alternative descriptions of decision-making (Alexander, 2000; Lyons et al., 2008), but the management of low predictable processes (e.g. the impact of smart phones on mobility patterns) still remains a challenge that limits the options for non-linear policy pathways. Those low predictable processes are here called wild cards: sporadic or long-lasting processes that are assumed to be improbable, but would have large consequences for cities, transport systems, and social trends (Mendoça et al., 2004; Smith and Dubois, 2010). Car dependency and its impact on urban form would have been considered a wild card in early 19th century. Another example is the COVID-19 pandemic, which is drastically altering how people use transport systems and experience cities.

Transport scenario building is a well-established methodology that can effectively address the challenge of incorporating wild cards in decision-making (Hickman and Banister, 2014; Soria-Lara and Banister, 2017b; Van Drunen et al., 2011). It investigates strategic and long-term futures marked by considerable uncertainty (e.g., the role of street space in cities) and/or situations where business-as-usual is no longer appropriate (e.g., transport emissions). Transport scenario building is distinguished by the approach of taking explorative/normative endpoints in the future, and then examining the means and policy pathways that can lead to these outcomes (Akerman and Höjer, 2006; Banister et al., 2000; Lyons and Davidson, 2016). The visioning phase is a crucial methodological step in transport scenario building, where a series of explorative and/or normative visions are constructed about the city's future and its transport systems (Banister and Hickman, 2013). This methodological phase is seen as a democratic exercise where the widest variety of actors should be engaged (Soria-Lara and Banister, 2017a; Tuominen et al., 2014; Wangel, 2011).

Although there has been a burgeoning application of participatory visioning approaches in the transport field (Zimerman et al., 2012; Wangel, 2011; Hickman et al., 2011; Schade and Schade, 2005; Olsson et al., 2015), limited attention has been paid to deal with non-linear thinking. First, the implementation of participatory visioning has usually followed consensus-based techniques (e.g. Delphi methods), which limits the capacity to add outlier views into future visions (Shiftan, 2003; Melander et al., 2019). Second, experts-guided processes have predominated, and those experts are usually trained to visualise futures linearly (Hickman and Banister, 2014). Third, visionary participants are heavily influenced by current social and technological trends, making outside-the-box thinking a challenge (Soria-Lara and Banister, 2018b). If those barriers persist, the democratic value of visioning processes will be curtailed, and their strategic value for decision-making will be reduced. Linear thinking will dominate, reducing the usefulness of transport scenario building in dynamic contexts.

To address these challenges, this paper explores the following research question: *To what extent can the use of wild cards stimulate a more disruptive thinking in participatory visioning?* A specific region in the Metropolitan Area of Madrid (the Henares Corridor) provides the empirical focus. A total of 129 participants were engaged via semi-structured interviews to construct a desirable future vision on transport and land use by 2050. Then, the same participants were asked

to distort their desired future vision according to six context-based wild cards ("what if" conditions), guiding participants to visualise additional endpoints outside of their comfort zone. The visioning exercise resulted in seven 2050 visions: one desired vision plus six wild card visions. The level of disruptive thinking reached was evaluated by a group of 21 experts, with expertise on fields related to innovation, strategic decision-making, and creative thinking.

The remainder of the paper is organised as follows. Section 2 outlines the theoretical background and the working hypothesis. Section 3 provides details on the research design, including a description of the case study. Section 4 summarizes the main results. Finally, Section 5 closes with concluding remarks and reflections.

2. Theoretical background and working hypothesis

2.1. Barriers blocking disruptive visioning processes

Current participatory approaches in transport scenario building have difficulties to generate low predictable visions. To address that, a first group of authors (Banister and Hickman, 2013; Hickman and Banister, 2007; Hickman et al., 2009) used workshops and focus groups, rather than implementing more-restricting methods (e.g. questionnaires). However, the obtained visions are still very close to the business-as-usual (BAU) projection. For example, one of the generated visions focused on higher oil prices, suggesting a decrease of motorised trips (Hickman and Banister, 2007). The participants engaged, mainly experts and stakeholders, were strongly biased by their professional domains and trained to visualise futures linearly. To overcome this limitation, Tuominen et al. (2014) involved young participants (15 to 17 years old) during the visioning stage (they are not part of the establishment and will be the adults of tomorrow), resulting in more "original" visions. One example is what Tuominen et al., (2014) called the "Urban Beat" vision, a radical future image based on compact cities and a high use of ICT. Soria-Lara and Banister (2017a) also noticed the higher capacity of younger and non-expert participants to visualize disruptive visions compared to highly experienced professionals, adults, and seniors.

Another reason impeding the construction of disruptive future visions is related to the type of participatory methods used and their operationalisation. The dominance of a consensus-based approach limits the chance to incorporate outliers and divergences (i.e. long-term visions are constructed on agreement of the participants' thoughts, but divergent ways of thinking are not previously stimulated). For example, Delphi techniques usually build future visions by carrying out several rounds of questions, where experts are informed about the main agreements reached in past participatory rounds (Mason and Alamdari, 2007; Melander et al., 2018; Shiftan, 2003; Zimmerman et al., 2012). When other more open participatory methods are used (e.g. in-depth interviews and workshops), only highly frequent and common thoughts remain in visions, limiting the incorporation of "outside-the-box" thinking (Soria-Lara and Banister, 2018a). For example, Soria-Lara and Banister (2018a) constructed a 2050 future vision for Andalusia, Spain mostly based on public transport promotion and urban compactness, which draws a scenario highly expected for that particular geographical context. Other aspects impeding disruptive thinking are: the use of BAU projections to orient visionary participants stimulates linear thinking (Julsrud and Uteng, 2015; Piecyk and McKinnon, 2010; von der Gracht and Darkow, 2016); the construction of a single long-term vision instead of a wide range of options reduces the space for exploring divergent futures (Mason and Alamdari, 2007; Schuckmann et al., 2012; Trolley et al., 2001); people are highly influenced by context and dominant trends (e.g. technological innovations) (Soria-Lara and Banister, 2017a).

2.2. Working hypothesis: wild card for thinking disruptively

The use of wild cards –low probability and high impact processes- in participatory visioning processes can break down the abovementioned barriers and stimulate inventive visioning outcomes. It must be accepted that accurate predictions are not possible about wild cards (Makridakis and Taleb, 2009; Taleb, 2007). However, their (qualitative) consideration in decision-making can deal with bounded rationality (Wright and Goodwin, 2009), anticipating certain (un)desired strategic pathways (e.g. car free cities in Western world). Different types of wild cards can be distinguished according to the level of surprise that can originate in societal structures, but in all cases large impacts would be expected. For example, a long-term future in

which autonomous vehicles predominate in Western cities would be less surprising than the prohibition of individual car ownership, but both aspects would be turning points in the evolution of cities and transport systems. Wild cards are both scale and context-based, which triggers the need for determining specific wild cards for each particular place. For example, overpopulation is expected in urban context on an European scale, but unexpected in rural contexts on a local scale (United Nations, 2019; OECD, 2015; European Union, 2015). Another example can be the impact of massively influential events like pandemics, with different levels of severity across countries.

Wild cards have been traditionally used to analyse unexpected future trends (Barber et al., 2006) as well as to test the stability of future visions in light of external and internal interferences (Steinmuller, 2004). For example, four different wild cards are used to test the robustness of long-term visions in the framework of the European Spatial Planning Cohesion Policies (Dammers, 2010). Hauphman et al. (2015) explore fourteen technological, geopolitical, and societal wild cards, analysing their likelihood of occurrence and potential effects. Walsh et al. (2015) also use wild cards as a destructive test to evaluate the behaviour of future transportation infrastructure systems. Von der Gracht and Darkow (2010) extract wild cards from a Delphi process and deploy them to visualise long-term transport logistics futures. However, the mentioned authors do not test the level of disruptive thinking reached for each vision.

The basic hypothesis underlying this paper is that wild cards can be used to stimulate thinking outside of the BAU zone during participatory visioning processes. Wild cards could be useful for interrupting linearity in the participants' visioning, resulting in more-disruptive outcomes (Figure 1). The confirmation of this hypothesis –even partially- can show useful and practical lessons for decision-making.

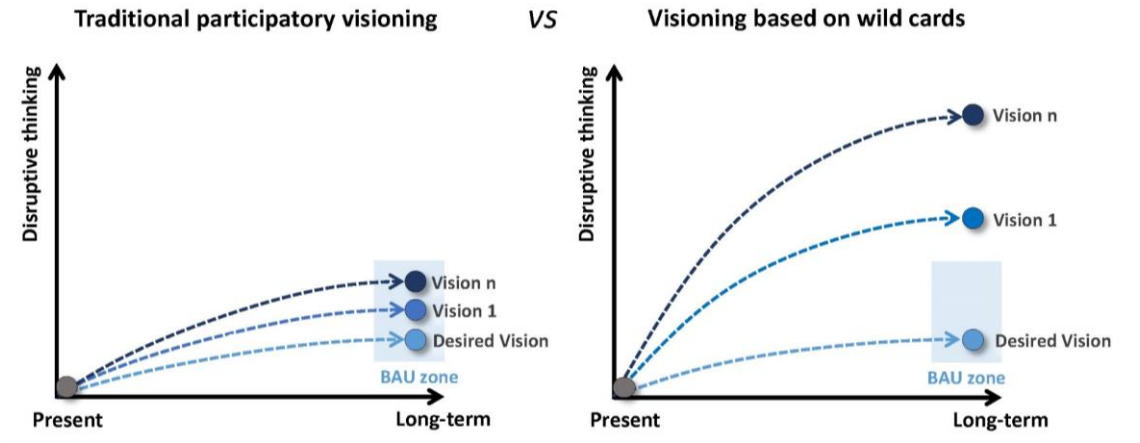

Figure 1. Working hypothesis. Conceptual scheme

3. Research design

Our participatory visioning approach entailed three-stages: (i) Case study and wild cards selection; (ii) Construction of 2050 visions and sample characteristics; (iii) Evaluation of disruption of 2050 visions.

3.1. Case study and wild cards selection

The Henares Corridor (approx. 50 km) is located in the east part of the Metropolitan Area of Madrid (MAM) in Spain, connecting the cities of Madrid (3,223,334 inhabitants) and Guadalajara (255,336 inhabitants) (Figure 2). More than a million people live in the 17 municipalities located in the Henares Corridor (INE, 2019). It is one of the most industrialised places in the MAM, originating a relevant number of commuters (Barreira-González et al., 2019; Cantergiani and Gómez-Delgado, 2018).

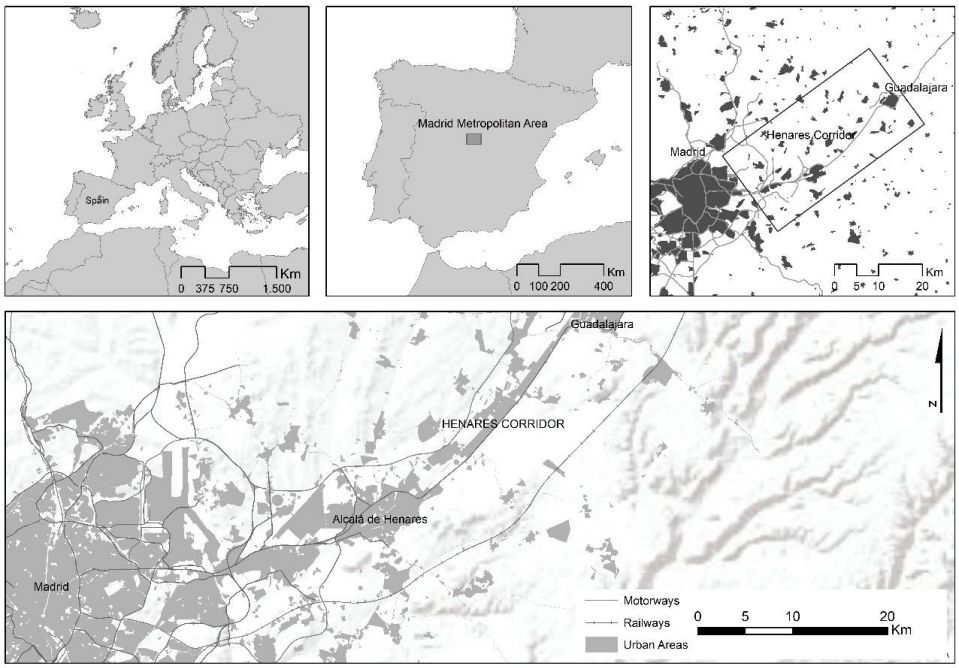

Figure 2**.** Case study location

To address particular problems and expectations on transport and land use in the Henares Corridor, the Madrid regional government and local authorities have been focused on three main drivers that will be addressed over the longer term, and this provides us with a 2050 business-as-usual (BAU) projection:

- *Decarbonization and air quality*. A strong reduction of car traffic is expected. The policies implemented by the Regional Mobility Plans[1] aim to reduce transport GHG emissions by 10%, limiting the transit of fuel-based vehicles in specific areas of city

[1] Plan MUS: Plan de Movilidad Urbana Sostenible de la Comunidad de Madrid: https://planmus.com; Plan Estratégico de Movilidad Sostenible de la Comunidad de Madrid: www.crtm.es

centres during sporadic events of high levels of air pollutants concentration[2]. That is consistent with some initiatives at local level[3], focused on pedestrianizing a relevant number of streets in city centres.

- *Travel behaviour and energy savings*. The objective of governments[1] is to reach an evenly distributed modal split in the mid-term – 33% by personal vehicles, 33% by public transit services, and 33% by active modes. Spurred on by the 2008 financial crisis, the plan "Activa Henares"[4] is also implementing policies to foster new business strategies impacting on travel behaviour and energy savings. For example, placing high priority on attracting technological companies with more flexible working conditions. However, no specific measures related to e-working are taken. Logistics platforms are also promoted, operating at national and international levels[5].

- *Demography, economics, and social inequalities.* Demographic projections by 2033[6] estimate an increase of population between 12% (high scenario) and 5% (low scenario). In all cases, the population >65 years old will increase from 17% in 2018 to around 23% in 2033. Migratory flows will decrease, as population will be more concentrated in coastal areas. The Madrid regional government has also developed a strategic plan to decrease social inequality levels[7], fundamentally focused on improving the access to dwellings and jobs for low-income population. Both crime and robbery rates are not expected to increase.

Based on the described BAU projection, a set of context-based wild cards have been identified to confirm/deny our working hypothesis. The research team identified a total of 20 wild cards that would disrupt BAU projections in official planning documents, being aligned with the three main drivers previously described. Those wild cards were discussed during several rounds, ultimately arriving at six (Table 1). The level of context-based surprise originated by the six wild cards was analysed, identifying two different types: (i) imaginable processes: possible surprises in the short and long term; and (ii) unimaginable processes: highly improbable surprises in both the short and long term.

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[2] Decreto 140/2017, de 21 de noviembre, del consejo de gobierno, por el que se aprueba el protocolo marco de actuación durante episodios de alta contaminación por dióxido de nitrógeno (NO2) en la Comunidad de Madrid: http://www.madrid.org/rlma_web/html/web/FichaNormativa.icm?ID=4141

[3] Estudio diagnóstico de movilidad peatonal de Alcalá de Henares: http://www.ayto-alcaladehenares.es/portalAlcala/RecursosWeb/DOCUMENTOS/1/0_17168_1.pdf; Plan de Movilidad Urbana Sostenible de San Fernando de Henares: http://www.ayto-sanfernando.com/plan-de-movilidad-urbana-sostenible/

[4] Plan Activa Henares: https://www.madridactiva.es/plan-activa-henares/

[5] Plan de Infraestructuras Logísticas de la Comunidad de Madrid: http://www.madrid.org/cs/Satellite?blobcol=urldata&blobheader=application%2Fpdf&blobheadername1=Content-Disposition&blobheadervalue1=filename%3D1_Modelo_actual_plano.pdf&blobkey=id&blobtable=MungoBlobs&blobwhere=1271799433420&ssbinary=true

[6] Instituto de Estadística Comunidad de Madrid: https://www.madrid.org/iestadis/fijas/estructu/demograficas/censos/estructu_procp.htm; Instituto Nacional de Estadística: https://www.ine.es/dyngs/INEbase/es/operacion.htm?c=Estadistica_C&cid=1254736176953&menu=resultados&idp=1254735572981

[7] Estrategia de inclusión social de la Comunidad de Madrid: http://www.madrid.org/bvirtual/BVCM013999.pdf

Table 1. Wild cards selected

Henares Corridor: 2050 (BAU)		**Wild cards**		
Driver	**Description**	**Label**	**Description**	**Level of context-based surprise**
Decarbonization and air quality	-Car-oriented society -Consolidation of electric public buses -Medium implementation level of electric vehicles -Pedestrianization of the biggest streets in city centres -Higher accessibility levels brought by active modes -Daily travel distances will not decrease	Zero-emission vehicles	Fossil fuel–powered vehicles will be fully prohibited, including individual and collective modes.	Low: Imaginable process
		Non-motorized city centres	City centres will be exclusively limited to active mobility (walking and cycling) and certain collective modes. Access to city centres by car will be fully prohibited.	Low: Imaginable process
Travel behaviour and energy savings	-Higher diversification of activities -Higher accessibility levels brought by collective transport modes -Number of daily trips will decrease weakly -Individual and car trips will predominate -Number of freight transport trips will increase -Working conditions will be more flexible -Low implementation of e-working	E-working dominates	E-working will be implemented for all jobs where physical presence is not required.	Medium: Imaginable process
		Shared motorized mobility dominates	Individual car ownership will be fully prohibited, and only shared motorized mobility can be used.	High: Unimaginable process
Demography, economics, and social inequalities	-No drastic variations of population are projected -Low-income people will easily access to dwellings and jobs -The maintenance and improvement of the existing transport infrastructures will predominate -Social inequalities will decrease -Crime and robbery rates will decrease	Overpopulation	Natural disasters triggered by climate change will originate strong migratory movements from other geographical latitudes to European countries, resulting in a 200% population increase.	High: Unimaginable process
		High level of insecurity in urban areas	The public space will become very insecure due to high social inequality rates. Walking, cycling, and motorbiking are not advisable actions.	High: Unimaginable process

3.2. Construction of 2050 visions and sample characteristics

Semi-structured interviews were conducted to construct 2050 visions on transport and land use, totalling 129 valid interviews. The choice of semi-structured interviews -rather than other open formats (e.g. participatory workshops)- is based on the need for obtaining larger sample sizes. Such larger sample sizes would increase the likelihood to engage people that prioritize different wild cards during the visioning process, triggering higher divergences between participants. Semi-structured interviews offer a participatory visioning process where the interviewer not only had a series of general guiding questions, but also latitude to ask more detailed questions in response to significant replies (Bryman, 2016). Each interview session was designed to take about 30 minutes. The empirical work was completed during June and July 2018.

Each semi-structured interview consisted of the following four-time blocks (Figure 3):

- First block: Socio-economic details: age, gender, educational level, work status, frequent transport mode, household composition, real-estate properties, and travel frequency along the Henares Corridor.

- Second block: Participants shared their desired 2050 vision on transport and land use. They were asked to visualise an ideal work day in 2050. They had to openly respond to the following questions: (i) How do you see covering your daily travels to work, leisure, and shopping on this imaginary day? (ii) Which transport modes would you prefer to use? (iii) Are you visualising any technological innovations that reshape transport and land uses by 2050? (iv) How does the neighbourhood you live in look like? (v) Are you visualising places where jobs, shops, and leisure are mixed with residential places, or not? (vi) Could you visualise how public transport stations look like in your neighbourhood by 2050? (vii) Could you visualise how open and green areas look like in your neighbourhood by 2050?[8]

- Third block: This portion focused on distorting the 2050 desired vision generated in the second block of the survey, by using the imaginable processes detailed in Section 3.1. First, participants had to select the most disruptive of the three imaginable processes (Table 1), according to their individual opinion. Second, participants had to respond to the same questions from the second block of the interview, but the imaginable process acts as a "what-if" condition for all the questions (e.g., "How do you see covering cover your daily travels to work, leisure, and shopping on this imaginary day if e-working dominates employment by 2050?").

- Fourth block: This portion focused on distorting the 2050 desired vision generated in the second block of the survey, by using the unimaginable processes detailed in Section 3.1. First, participants had to select the most disruptive of the three unimaginable processes previously presented (Table 1), according to their individual opinion. Then, participants had to respond to the same questions from the second block, but the unimaginable process act as a "what if" condition for all the questions (e.g., "How do you see covering your daily travels to work, leisure, and shopping on this imaginary day if there is high level of insecurity in urban areas by 2050?").

[8] These interview questions are a translation into English from the Spanish language original.

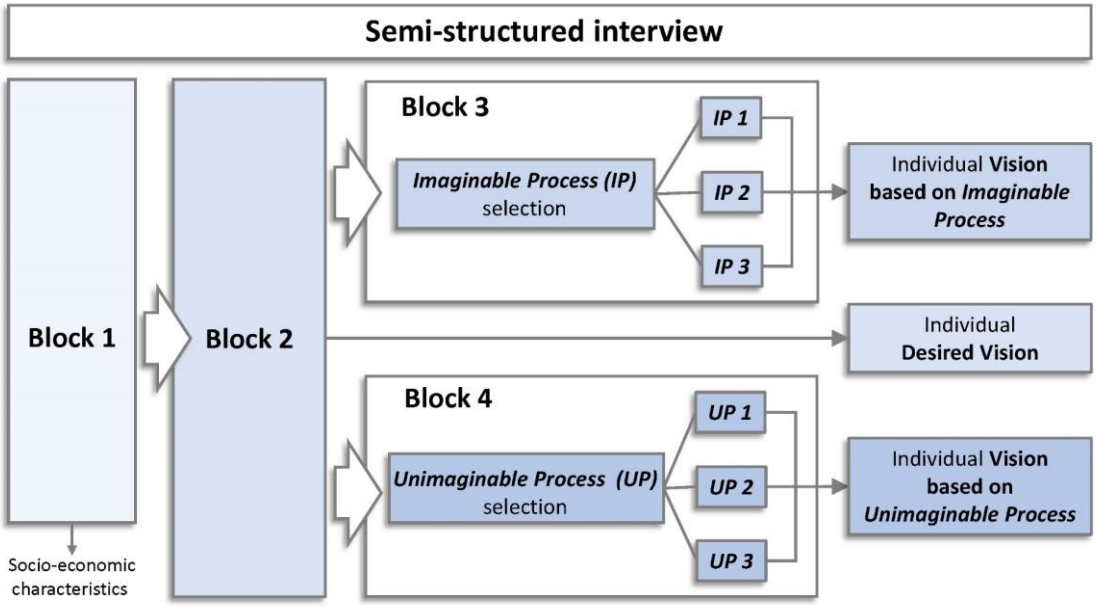

Figure 3. Outline of semi-structured interviews

In summary, each semi-structured interview provides a total of three individual visions per participant: desired vision (Block 2); desired vision based on one imaginable process (Block 3); desired vision based on one unimaginable process (Block 4). Then, those individual visions are codified and added to other individual visions to obtain collective 2050 visions. All those views from participants who selected a particular wild card are aggregated to produce a collective vision. Each collective vision was translated into a specific narrative (Sections 4.1; 4.2; 4.3), with seven narratives in total: the 2050 desired vision (based on the Block 2 portion) plus six 2050 wild card visions (three visions based on imaginable processes from the Block 3 and three visions based on unimaginable processes from Block 4). Each semi-structured interview was analysed through a systematic process of transcribing individual statements and several rounds of inductive coding (Figure 4). A total of 10,286 statements were identified, and then grouped and translated into 5,861 codes. For example, statements with a similar message (e.g., decreasing NO_x emissions, healthier ambient air) were grouped under the same code (e.g., improving local air quality). It uses descriptive statistics to analyse such codes, resulting in 2050 visions. The construction of each narrative used at least 75% of codes originated by the respondents for this specific vision. The other 25% of codes (e.g., contradictory aspects) were not always removed, but most of them were further present in some of the reminder visions.

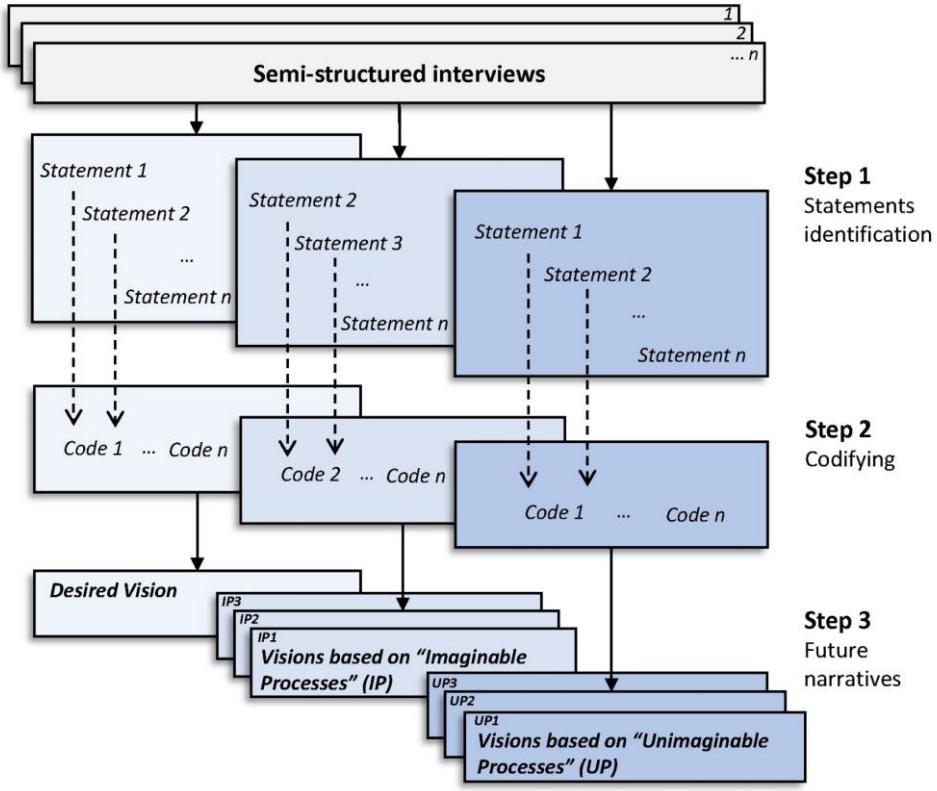

Figure 4. Construction of 2050 visions from semi-structured interviews

The sample target included members from both the general public and professionals from a wide range of sectors (Wangel, 2011). Since the research´s objective is to explore to what extent the use of wild cards stimulates a more disruptive thinking, the study sought to engage those participants proven to have more open and imaginative minds. That would increase the probability to find significant variations of disruptive thinking levels between the constructed 2050 visions. All selected participants were younger than 32 years old, i.e. those who would be at most 65 years old by 2050, the visioning horizon. This narrow age cohort was selected based on previous academic findings that revealed that young people usually have more open minds to visualise unconventional futures. For example, Soria-Lara and Banister (2017a p.122) compared the future views obtained by different cohorts of participants, revealing that the most radical future visions came from the youngest participants. Another example comes from Tuominen et al., (2014), who compared the future visions obtained by experts and young participants in transport visioning processes. Authors evidenced the importance to include views from younger people against experts´ guided processes, as they are not part of the transport establishment, but they can provide a "fresh" vision. In the present case, the selection of this group of participants -younger than 32 years old- is also possible because of this research is not formally connected to planning processes in the case study, which increases the freedom to "experiment" with a group of participants that initially seems more able to think non-conventionally.

Interviewees were recruited by handing out flyers with a brief description of the research. The selection of the engagement locations guaranteed the right variability of the sample (e.g., popular squares, university campuses, town centres, technological centres, workplaces, and suburban transit stations). All participants consented to recording the interview. Main sample characteristics can be consulted in Table 2.

Table 2**.** Socio-economic characteristics of the sample

% participants (n=129)			
	%		**%**
Gender		***Place of residence***	
Male	45	In the Henares Corridor	75
Female	55	Outside	25
Educational level		**Travel frequency**	
Low (basic)	1	Daily	60
Medium	21	Weekly	22
High (University)	78	Occasionally	18
Age (in years)		***Employment status***	
15-19	10	Student	42
20-24	45	Employed student	6
25-29	34	Employed	44
30-35	11	Unemployed	8
Regular transport mode		**Household type**	
Car (own)	28	Living with parents (on property)	54
Car-sharing	8	Living with parents (for rent)	4
Bus	22	Living independently (on property)	5
Train/metro	32	Living independently (for rent)	37
Bicycle	1		
Walk	7		
Moto	1		
Taxi/VTC	1		

3.3. Evaluation of disruption of 2050 visions

To analyse to what extent wild cards stimulate non-linear thinking, the seven 2050 visions were evaluated by a group of 21 experts in innovation, strategic decision-making, and creative thinking. It was ensured that all the selected experts were aware of existing planning documents and BAU projections in the case study. A total of 5 experts worked in technological innovation, 9 came from departments of innovation in the transport sector, 3 belonged to department of innovation in the urban planning sector, and the remaining 4 were researchers. The evaluation aimed to grade the seven 2050 visions according to their disruptive thinking level. The experts were informed about the meaning of "disruption", ensuring a common understanding. That is "significant divergences with BAU projections on transport and land use for the case study". The evaluation was completed via an on-line questionnaire, based on dividing the seven 2050 visions into 36 statements that encapsulated the essential components of the visions. Each 2050 vision was characterised by 13 to 14 statements, where one statement could be used in representing several 2050 visions, when appropriated. Each statement was rated on a Likert scale, asking the expert to indicate whether the statement was: (1) non-disruptive; (2) somewhat disruptive; (3) disruptive; (4) very disruptive; (5) highly disruptive. The answers for all statements that characterised each 2050 vision were grouped and processed, providing the experts assessment of the disruption potential of each 2050 vision.

4. Results: 2050 visions and level of disruptive thinking

4.1. The desired collective vision for 2050

This vision was generated by asking participants to visualise their desired ideal 2050 workday, without considering any wild cards. The narrative for the desired vision could be formulated as follow (Table 3):

> *It relies on decreasing the level of transport emissions; however, the daily modal split remains largely unaltered. Cleaner private vehicles dominate work commutes, while fossil fuel–powered vehicles are not fully replaced. E-working is seen as a marginal option, and walking and cycling are the preferred modes for shopping and leisure activities. A relevant percentage of vehicles are autonomous. Cities have reduced the distances between residential, shopping, and leisure places – by high levels of mixed use planning and by connecting amenities in a dense network of green corridors. However, workplaces are far away from residential areas and are still mainly located in the city's periphery. Both residential and work areas are connected by car infrastructures and efficient public transport services.*

4.2. Visions based on imaginable processes

According to participant responses, the most disruptive imaginable process is "zero-emission vehicles" (50%), followed by "e-working dominates" (30%), and finally by "non-motorized city centres" (20%).

The 2050 vision based on high penetration of zero-emission vehicles was mostly selected by participants that travel by car daily; it was the only vision where personal vehicles dominate (Table 3). These participants held views very closely aligned to the desired collective vision (Section 4.1), underlying that most would prefer to continue using motorized modes to reach work destinations. The narrative for the "zero-emission vehicles" 2050 vision could be formulated as follows:

> *It relies on a fundamental technological change – the prohibition of motorized vehicles that are not zero-emission vehicles. However, it does not bring about a drastic change in the daily modal split. Zero-emission vehicles (collective and private) are the main mode for reaching daily work destinations. E-working is seen as a marginal option, while walking and cycling are the desired mode for reaching shopping and leisure activities. A relevant percentage of vehicles are autonomous. Also, car-sharing has a substantial share in personal mobility. Cities should provide for shorter distances between residential, shopping, and leisure places, requiring areas with a high mix of those activities and connected each other by a dense network of green corridors. Workplaces are mainly located in the city's periphery and far away from residential places. Both residential and working areas would be connected by car infrastructures and efficient collective transport services.*

The next 2050 vision is based on the imaginable process "non-motorized city centres", selected by 20% of participants. The respondent sample that selected this imaginable process has similar socio-economics characteristics to the full sample (Table 3). According to participant responses, the following narrative was constructed for the imaginable process "non-motorized city centres":

This vision is fundamentally based on the full restriction of private vehicles access to city centres. All public space in city centres is recovered for active mobility and socialization – with the exception of public transport road space and platforms. That would increase walking and cycling levels to all daily destinations. E-working is seen as a marginal option. The restriction of private vehicles access to city centres would severely limit both the rollout of autonomous vehicles and the promotion of car-sharing services. There would be a preference for cities that offer a high mix of residential, shopping, leisure, and working places, reduce the distances between those activities. Consequently, working places would be transformed into more mixed-use areas. A dense network of green corridors will connect different places of the case study.

The third imaginable process used was the "e-working dominates". It was selected as most disruptive mainly by young people (studying and working), who travel daily along the case study using collective modes (Table 3). The following 2050 vision has been generated according to the wild card "e-working generalization":

This vision is distinguished by the e-working generalization, with all jobs not requiring physical presence. That would initiate a change in modal split patterns, increasing walking and cycling levels for daily destinations such as shopping and leisure activities. Car ownership rates would decrease in favour of car-sharing solutions. A percentage of vehicles would become autonomous. People would still prefer to live in the city's periphery, but in mixed use neighbourhoods marked by shorter distances between residential, shopping, and leisure places, triggering an increase of active mobility. A dense network of green corridors will connect residential, shopping, and leisure activities. Current workplace destinations would be transformed into mixed use locations, as most of workplaces would be located at individual households or other community (co-working) locations.

Table 3. Main participants´ codes for each 2050 vision

Codes	% of participants coded in each category for each of the visions						
	Desired vision	Visions based on Imaginable Processes (IP)			Visions based on Unimaginable Processes (UP)		
		IP 1	IP 2	IP 3	UP 1	UP 2	UP 3
Transport modes for work trips							
Car	34	34	3	0	15	23	67
Public transport	36	38	13	0	47	51	33
Bus	13	17	6	0	13	7	20
Train/metro	23	21	7	0	34	44	13
Walk	17	17	42	0	18	17	0
Bicycle	13	11	42	0	13	9	0
Teleworking	0	0	0	100	5	0	0
Transport modes for shopping trips							
Car	28	24	3	29	17	19	56
Public transport	19	24	7	16	24	43	26
Bus	11	13	4	-	8	20	21
Train/metro	8	11	3	-	16	23	5
Walk	40	42	54	41	37	29	0
Bicycle	3	0	11	8	4	2	0
On-line	10	7	25	6	18	7	18
Transport modes for leisure trips							
Car	29	32	10	20	19	21	73
Public transport	33	31	10	38	37	52	27
Bus	16	15	6	19	14	11	22
Train/metro	17	16	4	19	23	41	5
Walk	30	31	67	34	31	25	0
Bicycle	5	3	13	8	9	2	0
Other	3	3	0	0	4	0	0
Use of car-sharing services	25	25	-	40	50	100	40
Use of autonomous vehicles	25	25	-	25	10	10	19
Transport energy sources							
Fossil fuels	11	0	-	20	20	0	20
Electric/alternatives	89	100	-	80	80	100	80
Residence location							
City centre (C)	47	44	39	38	31	49	40
Periphery (P)	45	45	48	50	59	37	60
Between C and P	8	11	13	12	10	14	0
Type of neighbourhood							
Very high density and high-rise buildings	11	11	13	17	13	5	13
High density and low-rise buildings	16	17	16	10	7	18	10
Medium density and low-rise buildings	54	56	52	43	47	60	43
Isolated urbanization	13	11	13	26	24	15	23
Other	6	5	6	4	9	2	11

Vision based on IP 1: "Zero-emissions vehicles"
Vision based on IP 2: "Non-motorized city centres"
Vision based on IP 3: "E-working dominates"

Vision based on UP 1: "Overpopulation"
Vision based on UP 2: "Shared motorized mobility dominates"
Vision based on UP 3: "High levels of insecurity in urban areas"

4.3. Visions based on unimaginable processes

The respondents selected "overpopulation" as the most disruptive unimaginable process (52% of the total sample), followed by "shared motorized mobility generalization" (26%), and finally by "high level of insecurity in urban areas" (22%).

The slight majority (52%) of participants that selected "overpopulation" as the most disruptive unimaginable process has similar socio-economics characteristics as the full sample. Almost half of all participants expressed preference to reach work destinations by collective modes (47%), while walking and cycling were preferred for shopping and leisure trips (Table 3). Based on participant responses, the following narrative has been elaborated:

> *This 2050 vision would trigger changes in modal split patterns, with increased use of collective modes for work commuting and increased walking and cycling rates to shopping and leisure locations. Car ownerships rates would decrease in favour of a generalization of car-sharing habits. E-working would be seen as a marginal option. There would be a preference from high-income families to live in the city periphery and in low density places, but with a high land use mix. Current work areas – located in the city's periphery – would be transformed into more multifunctional places. Low-income families would prefer to live in high-density areas in city centres. A dense green network of corridors would connect different places along the case study.*

The next 2050 vision is based on the unimaginable process "shared motorized mobility dominates", selected by 26% of participants as the most disruptive unimaginable process. This group of participants is made up of individuals older than 25 years old and employed, who work in the case study corridor and frequently use public transport modes to reach daily destinations (Table 3). According to the responses, the following narrative has been formulated:

> *It relies on a fundamental travel behaviour change, based on the prohibition of individual car ownership and the generalization of shared motorised mobility. Public modes would be the preferred option for reaching daily destinations – working, shopping, and leisure activities. Walking and cycling would be also a preferred mode, fundamentally for shopping and leisure trips. The use of car would be drastically limited to shared services. E-working would be seen as a marginal option. There would be a preference for living in city centres with shorter distances between residential, shopping, and leisure places. The built environment would provide these activities in mixed use location, connected by a dense network of green corridors. Workplaces – mainly located in the city's periphery – would remain far away from residential areas. Both residential and work areas would be connected by efficient collective transport services.*

The third unimaginable process, "high level of insecurity in urban areas", was selected by a minority of participants (21%). They are mainly women younger than 25 years old that frequently use collective modes for travelling across the case study. Respondents would prefer living in the city periphery in closed communities with private green areas (Table 3). The following 2050 vision has been generated:

> *The visualised transport future is strongly affected by a high level of insecurity in urban areas. Walking and cycling are not advisable. The modal split would be drastically altered, with the private car dominating all daily trips –work, shopping, and leisure.*

There would be also preferences for increasing the level of car sharing, as well as for the promotion of clean and autonomous vehicles with zero emissions. Public green areas would be removed and recovered for car infrastructures. There would be a preference by high-income families for living in the city periphery in private communities. Land uses would be highly segregated in homogenous areas connected by motorized infrastructure. City centres would be mainly transformed into work destinations, with most employees commuting from the city's periphery. Low-income families would also tend to live in those insecure city centres.

4.4. Evaluation of disruptive thinking

The expert evaluation provides new insights into the basic hypothesis underlying this research (Section 2.2) – i.e. that different types of wild cards can be used to stimulate unconventional thinking during participatory visioning processes. This working hypothesis was confirmed when unimaginable processes were used; however, some problems were noted in the 2050 visions based on imaginable processes.

The evaluation shows how the most disruptive 2050 visions – compared to the common 2050 desired vision – were those generated by using the following unimaginable processes: "high level of insecurity in urban areas" and "shared motorised mobility dominates" (Figures 5 and 6). More than 90% of experts find that the 2050 vision "high level of insecurity in urban areas" is disruptive, very disruptive, and highly disruptive. Additionally, almost 70% of experts indicate that the 2050 vision "shared motorised mobility dominates" is disruptive and very disruptive. Different results are found for the third vision generated through the other unimaginable process "overpopulation", where only 43% of experts signal this vision as disruptive and very disruptive. The last is a percentage of experts similar to the obtained one for 2050 desired vision.

Although multiple reasons can explain the previous results, one relevant aspect should be emphasized. The two most disruptive visions ("high level of insecurity in urban areas" and "shared motorised mobility dominates") were obtained from smaller portions of the sample of participants who selected those unimaginable processes during the interview process (Section 4.3). The socio-economic characteristics of these two sub-samples are highly homogenous unlike the population that selected "overpopulation". For example, employed people older than 25 years who travel daily along the corridor in public transport modes were the group that selected "shared motorised mobility dominates" during the interview. In the case of "high level of insecurity in urban areas", it was a majority of women younger than 25 years who travel daily along the corridor in public transport modes. In both cases, these sub-samples had divergent opinions regarding those participants selecting "overpopulation" during interviewed. In other words, smaller population sub-groups seem better equipped to generate divergences and disruptive thinking.

In the experts' opinion, the level of disruption reached by those visions generated on imaginable processes is more similar to the disruption level perceived for the 2050 desired vision (Figures 5 and 6). In all the three cases (non-motorized city centres; zero-emission vehicles; e-working dominates), only a percentage of experts lower than 52% signal these 2050 visions as disruptive, very disruptive, and highly disruptive. Even, the 2050 vision generated by the imaginable process "e-working dominates" is recognised as disruptive by a lower percentage of experts (33%) in comparison with the desired vision (43%). These assessments can indicate higher probability to generate disruptive thinking among participants when highly surprising factors (as unimaginable

processes) are incorporated in the process, as participants are largely used to visualize short-term futures and are strongly affected by linear thinking. It is worth mentioning that the most disruptive level of thinking has been found for the vision generated through the imaginable process "non-motorised city centres", which is selected by a minority of participants during the interview process (20% of participants). That reinforces the findings obtained for the visions generated through unimaginable processes, smaller sample sub-groups can have more divergent opinions on transport and land use futures.

The analysis also brought to the fore that certain components of the 2050 visions are more susceptible to be disruptively visualised by participants. In particular, statements that focused on transport issues reached a level of disruption slightly higher than those focused on land use. That can be a consequence of the generalized perception of transport as a more dynamic sector, where technological developments can have higher impacts – both on short- and long-term futures. On the other hand, land use is seen as more static and permanent over the time, and thus less susceptible to be disruptively visualised.

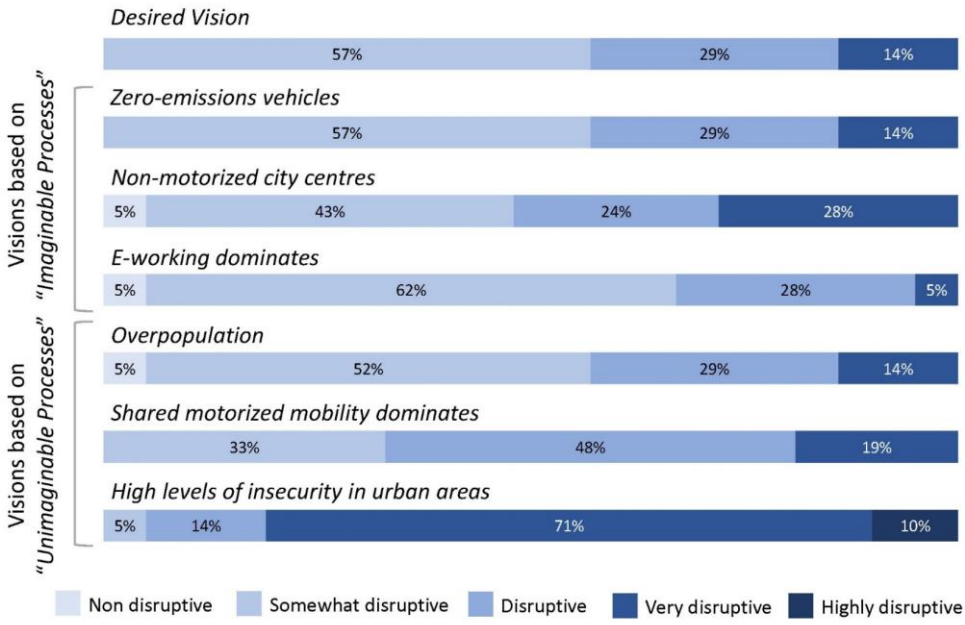

Figure 5. Percentage of experts identifying levels of disruptive thinking

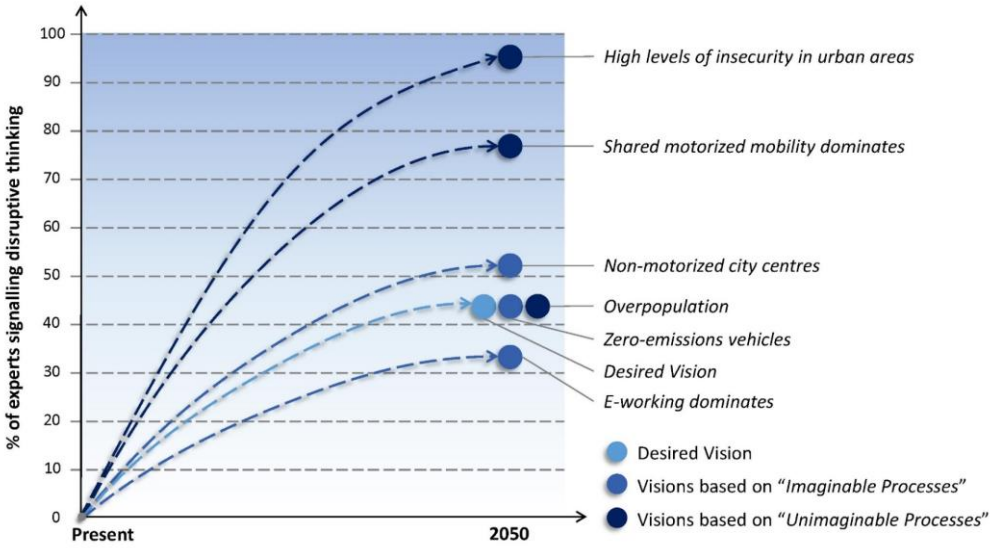

Figure 6. Level of disruption identified by experts for each 2050 visions

5. Conclusions and discussion

The paper sought to answer the following research question: *To what extent can the use of wild cards stimulate a more disruptive thinking in participatory visioning?* A set of seven 2050 visions (one desired common vision and six wild card–based visions) were constructed by using semi-structured interviews. The Henares Corridor in the Metropolitan Area of Madrid (Spain) served as the case study, with an interview sample of 129 participants (between 18 and 32 years old). Their interview responses were analysed and compared on the level of disruptive thinking in the emerging visions for 2050. A group of 21 experts assessed the level of disruption of each vision.

In the reminder, a set of issues are presented, discussing which elements of the visioning process have worked well (or not), and why. The purpose is to comment on what has been learned to distil some "prescriptions" for research and decision-making:

1. *The visionary participants*. They were local people between 18 and 32 years old. This methodological choice was made for two reasons: (i) providing legitimacy by engaging the widest variety of participants rather than a traditional experts-guided process (Mattila and Antikainen, 2011; Shiftan et al., 2003; Wangel, 2011); (ii) engaging a narrow cohort of people with documented capacity to think more frequently outside their comfort zone (Soria-Lara and Banister, 2017a; Tuominen et al., 2014). That is a convenience sample that allows the research team experimenting with a group of participants that can initially have more willingness to visualise futures under wild cards conditions (Bryman, 2016). The limitation is that it would be impossible using the obtained 2050 visions in a real decision-making process, because it is unknown of what population this sample is representative. For example, there is a low percentage of the interviewees living as a couple or having children. That incorporates an evident bias in the obtained 2050 visions, since other people with less individualized lifestyles might sense some of the more severe downsides and problems with commuting to work every day, which would definitely result in alternative future trajectories. Another example comes from recent electoral experiences (e.g. UK referendum to leave EU), which show the importance of older voters in decision-making and the divergences with the younger generation. However, this convenience sample -people between 18 and 32 years old- provides the research team with a more controlled environment to prove causality associated with the working hypothesis (te Brömmelstroet, 2015). Further research steps are needed to distil usable "prescriptions" for thinking disruptively in decision-making, in which the control level of the research environment decreases and the visionary participants are engaged according to the canons of probability sampling. Establishing formal collaborations with regional and local governments can be an excellent way to proceed.

2. *Sample size* is seen as very relevant issue for increasing the chances to generate disruptive thinking. The research design opted for larger samples, engaging one of the highest number of participants in the field of transport scenario building (Melander, 2018). Since disruptive thinking has been related to divergences in the selection of imaginable and unimaginable processes by participants (Section 4.4), larger samples would facilitate the emergence of smaller groups with divergent views able to select the widest range of wild cards. For both imaginable and unimaginable processes, the most disruptive thinking (compared to the desired common vision) was obtained for those visions triggered by wild cards selected by a minority of participants (Section 4.2 and 4.3), such as "non-

motorised city centres", "shared motorised mobility generalization", and "high level of insecurity in urban areas". Moreover, those smaller sample sub-groups have tended in our context to be homogeneous regarding certain socio-economic characteristics. Most of participants selecting "shared motorised mobility generalization" were older than 25 years old, employed, and frequently used public transport modes to travel along the case study. However, the unimaginable process "high level of insecurity in urban areas" was mostly selected by women younger than 25 years old that frequently use public transport modes to travel along the case study. Larger sample size cannot only facilitate higher capacity to generate smaller sub-groups with divergent opinions, but also to provide a minimum number of participants that share socio-economic characteristics and thus create unique population groups in the visioning exercise.

3. *Visioning methods.* The participatory visioning process implemented in this research was based on three crucial methodological choices: (i) the use of semi-structured interviews; (ii) the non-homogenization of responses in one single 2050 vision; (iii) the comparison of a 2050 desired vision *vs* six wild cards visions within one single study, rather than running several exercises separately (with and without wild cards). The pursuit of a larger sample strongly marked the first methodological choice: *using semi-structured interviews*. That choice seemed to be right, as the obtained sample (n=129 participants) facilitated the emergence of divergent and more disruptive future views. The main limitation of semi-structured interviews is the null capacity of participants to interact with each other, missing the opportunity to activate learning processes where participants can modulate their discourses by hearing the rest (Soria-Lara and Banister, 2017b). However, the use of workshops would have drastically limited the capacity to get larger samples. An intermediate via is possible, in which semi-structured interviews are firstly used to recruit larger samples, and workshop are later operationalised to distil future visions. The way in which those semi-structured interviews were coded, processed, and analysed determined the second key methodological choice: *the non-homogenization of responses in one single 2050 vision*. Both the structure and further analysis of semi-structured interviews in different blocks and phases, including multi-options to add several wild cards, facilitated the capture of minority views and their translation into narratives. It was seen how these minority views usually brought by homogenous group of populations resulted in higher level of disruptiveness. The homogenization of responses has been a recurrent procedure in literature to obtain transport future visions (Mason and Alamdari, 2007; Zimmerman et al., 2012), and could be a determinant reason that reduces the probability to obtain non-linear future visions. The interview design, based on distorting the participant´s 2050 desired vision through several phases that added wild cards, conditioned the third key methodological choice: *the comparison of a 2050 desired vision vs six wild cards visions within one single study*. An alternative option is to run several visioning exercises separately, some of which had wild cards and some of which did not (control group). That would facilitate to gain additional and stronger insights into the capacity of wild cards to add non-linear thinking, but other limitations would also appear. For example, different groups of participants would take part in each visioning exercise, limiting the comparability of the obtained outcomes and generating new bias. Moreover, difficulties to obtain larger samples for each visioning exercise would have been also higher, resulting in possible stronger difficulties to reach non-linear thinking.

4. *Wild cards*. The use of wild cards proved useful for generating disruptive thinking between participants when unimaginable processes were used. However, imaginable processes provided 2050 visions with similar level of disruption as the common desired vision. This finding implies that highly surprising factors are needed to generate disruptions and break linear thinking. In this respect, using a wide range of wild cards can be crucial for two main reasons. First, the probability to generate disruption is higher as a larger number of highly surprising factors will be on the table. Second, larger numbers of wild cards can increase the chances to generate divergences between participants. It is key that participants are forced to choose between wild cards rather than to visualize futures for all of them (Von der Gracht and Darkow, 2010). Having to choose between wild cards triggers divergences, as proved during the participatory visioning presented in this research. Moreover, the choice of participants between different types of wild cards have served to incorporate outlier views from participants, represented by those wild cards selected by a minority of participants. Another important discussion is how wild cards are identified. In this paper, wild cards were identified by the research team to break BAU projections from official planning documents in the case study; however, they can also be elaborated by using open participatory processes that also stimulate creative thinking.

5. *Policy-making*. Against the impossibility to consider all alternatives because of people are boundedly rational, this participatory visioning provides decision-making with the option to incorporate unexpected incidents/processes but high impact in planning processes. It can contribute to define a more strategic vision of planning goals that include possible threats and/or accelerators originated by wild cards visions. For example, the COVID-19 crisis during 2020 underlines the importance of incorporating more diverse and non-linear visions into decision-making. This participatory visioning has demonstrated that some of the more disruptive 2050 visions contain things which are now in process due to COVID-19, but which were outside of the BAU visions for planners and decision-makers. A sense check of the obtained visions could contribute to determine the usefulness of wild cards visions, but this sense analysis was not made in the present research. Nevertheless, further steps are still needed to distil useful practice tools by using wild cards (see previous discussion on the visionary participants). This participatory approach that engages the widest range of participants provides legitimacy over planning processes. However, it must be said that each participatory process should be customized for each particular situation, as its success depends on many factors, such as: cost, cultural tradition, time, level of participatory-oriented education, etc. Legal barriers and the low commitment of politicians to those participatory visioning exercises are also seen as obstacles to overcome in real practice.

Finally, this research presents a participatory visioning process aimed at evaluating the capacity of wild cards to stimulate disruptive thinking. The results are encouraging – especially when introducing wild cards. Further research could inform how to deploy wild cards more effectively used during transport visioning processes. In this respect, new challenges are related to the development of efficient methods to generate and identify wild cards as well as the design of effective mechanisms to assess the level of disruption generated through the visioning process.

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