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Scenario archetypes in urban transport planning: Insights from the implementation of LRT systems

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ABSTRACT

The adaptation of transport concepts to changing urban conditions has rendered continuous transformation in the contexts, rationalities and type of decisions involved in urban transport planning. Foresight approaches in future studies offer flexible tools to capture transformations at such different levels. In this work, we explore pathways for the integration of future-scenario methods in transport planning, using the implementation of the Light Rail Transit (LRT) system in Granada (Spain) as a case in point. We applied the concept of "scenario archetype" to review both process-oriented and product-oriented elements in existing planning documents, assisted by a survey to local planning actors about the future of Granada's LRT. As a result, we suggest two main scenario archetypes, robust and flexible, in describing potential relationships between public transport projects and planning processes. Those archetypes entail different planning and communication environments, and therefore, integration pathways for using scenarios in envisioning the future of urban transport.

1. Introduction

The implementation of transport infrastructures in growingly complex cities and regions requires that operational decisions are taken simultaneously with problem framing and strategy-formation processes (Salet et al., 2013). The experience of Light Rail Transit (LRT) systems over the past decades illustrates the rampant conceptual and adaptive nature of new transport solutions. LRT projects have been often proposed under goal-seeking rather than goal-oriented decision processes (De Bruijn and Veeneman, 2009). Such conditions have reduced the influence of conventional assessment methods – i.e. Multi-Criteria Decision Analysis (MCDA), Cost-Benefit Analysis (CBA) – for validating LRT project decisions and managing perspectives in strategic and actor-oriented contexts (Nicolaisen and Olesen, 2017).

Scenario-building methods have showed great potential in combination with conventional methods to tackle complex and multi-dimensional problems: e.g. sustainable and social approaches (Hickman et al., 2012); land use and transport integration (Ariza-Álvarez et al., 2021). Still, in most applications, scenario narratives are used as inputs, pursuing validation functions against fixed goals (Beukers et al., 2014). Scenario narratives developed in academic or policy-level contexts usually miss out the specificities of transport and urban planning-processes. Further research is needed to fit scenario exercises to backgrounds, rationalities and expected outcomes of transport planning processes.

In this paper, we address potential pathways to integrate future-scenario building in transport planning.

In identifying such integration pathways, we use the notion of *scenario archetypes* (Boschetti et al., 2016) as assemblies of scenarios that can be shaped under similar backgrounds and purposes. Our identification of archetypes departs from an extensive review of hypotheses and arguments about the implementation of a new LRT system in urban, regional and transport plans from the metropolitan area of Granada (Navarro-Ligero and Valenzuela-Montes, 2019). We generated tentative storylines (*scenario prototypes*) capturing main argumentative backgrounds and logics of previous planning arguments. We developed archetypes from a further process of re-elaboration of arguments, guided by a survey of local actors. Scenario archetypes were connected to potential opportunities for the integration of transport and urban scenarios in envisioning future expansion plans for the Granada's LRT system.

In section 2, we illustrate the generation of future narratives in different transport fields that have adopted scenario approaches, and further explore those narratives in the inception of the LRT concept. In section 3, we describe the methodology used for the elaboration of

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scenario prototypes and archetypes in the Granada's LRT case. Section 4 is devoted to the description of the generated prototypes and consolidated archetypes. In section 5, we discuss the integration potential of such archetypes in transport planning.

2. Future narratives and scenarios in urban transport

2.1. Emergent future narratives in transport scenario planning

Scenarios are emblematic tools from the heterogeneous field of future studies. Two traditions exist: *forecasting* – "scenarios as science" – and *foresight* – "scenarios as art" (Ramírez and Selin, 2014). Both have been adopted in different fields of transport planning (see Table 1). Contributions from transport scenario simulations (e.g. demand modelling, policy simulation …), can be straightforwardly examined in terms of accuracy, quality of results and policy implications. On the other hand, the contribution of mainstream foresight studies on transport sectors and technologies, as well as visioning exercises in urban planning, are more difficult to unravel, consisting on qualitative *narratives* merging anticipated policy effects with process transformations (e.g. adaptation and organizational learning).

The accumulation of future scenario narratives in global and local epistemic communities may render common models of the future reality: e.g. efficient management, technology-based, multi-sectorial … (Creutzig, 2016). *Scenario archetypes* refer to that shared visions (e.g. optimistic or fatalistic, hierarchical, egalitarian, individualistic) and myths (e.g. techno-optimism, social crisis, inequalities, power conflicts …) about the future, creating referential frames that emerge across multiple scenario exercises and narratives (Boschetti et al., 2016). Accordingly, the exploration of narratives about transport futures goes hand in hand with transformation in urban planning contexts, rationalities and outcomes, parallel to the adoption of different scenario-building elements: backgrounds, methods/techniques and products (Table 1).

Policy integration narratives become prevalent in transport policy simulations that look for creating awareness on the benefits of combining policy options from multiple sectors: e.g. demand management and technological solutions for low-carbon futures (Hickman et al., 2011); transnational projects (TEN-STAC, 2004). Such multi-policy background incorporate "what-if" scenario techniques, based on comparing a projected baseline against different policy assumptions. The generation of informative tools, such as interactive spreadsheet (Hill and Morris, 2012) also adapt outcomes to multi-user and multi-objective decision-support systems (e.g. MCDA). In a similar way, *spatial integration narratives* highlight coordination issues (e.g. infrastructure and land-use conflictual arrangements) in transport and land use scenarios (Vermeiren et al., 2012). They recall participative and collaborative methods, where mediating teams (usually academic) use scenarios to trigger and monitor complex deliberation among stakeholders at different scales (Ariza-Álvarez et al., 2021). Main products combine global scenario narratives with spatially explicit outcomes.

Evolutionary and holistic narratives are mostly found in foresight sectorial studies on transport technologies, mobility and society, in line with backgrounds of research and innovation in international (FUTRE, 2014; GOAL, 2013), national (OPTI, 2009) and local contexts (Vallet et al., 2020). Their approaches incorporate system-thinking, behavioural (Vallet et al., 2020) and social-technical theories of change (Lyons and Davidson, 2016), as well as a repertoire of techniques from global technological forecasting (e.g. Delphi panels). Methods usually take the Shell/GBN approach (see Spaniol and Rowland, 2019): 1) identification of qualitative macro and micro trends; 2) rating the relevance and uncertainty of trends; and 3) relating trends in a scenario matrix or morphological analysis. Sectorial studies generate storylines highlighting plausible future paths, challenges and propose adaptive policy pathways (e.g. real option analysis). *Radical/disruptive change narratives* about social behaviour (transport-demand management) and fast urban growth (transport demand, urban) introduce ambitious target settings (e.g. modal shift; Fiorello et al., 2013) and exploratory processes in land-use and transport integration (Loukopoulos and Scholz, 2004). Visioning techniques build desired scenarios (e.g. sustainable/unsustainable scenarios) or disruptive scenarios (Ariza-Álvarez et al., 2021) in contrast with current undesired trends.

Our interest in connecting previous narratives with specific transport scenario archetypes is justified as an intermediate step to bring foresight approaches, mostly with a global policy-level and academic focus, to practical transport planning environments, assuming that they are already under the influence of consolidated future narratives.

2.2. Exploring future narratives in public transport projects: the case of LRT

The inception and evolution of the LRT concept in the international context illustrates the relevance of archetypical future narratives about system capacity, integration, radical transformations and alternative city models in new transport planning contexts, rationalities and solutions.

Narratives about *transport capacity* have been key in contexts where the decentralization of urban systems have reinforced the advantage of road-based technologies (i.e. car and bus) in order to address new mobility demands; e.g. suburban contexts, city-regions (Vuchic, 2005).

Table 1
Elements of scenario integration related to narratives in different transport planning fields.

Scenario application field	Dominant narratives	Scenario elements adopted		
		Backgrounds	Methods and techniques	Products
Simulation of transport policy scenarios Hill and Morris (2012), TEN-STAC (2004), Hickman et al. (2011), (2010), Hunt et al. (2001)	Policy integration	Assessment of low carbon policies, technologies and goals Scientific/academic awareness, decision support Regional/transnational policies	"What if" policy scenarios and baseline projections Statistically aggregated modelling Interactive expert discussions	Policy informative scenario tools; interactive spreadsheets (Semi)Quantitative MCDA planning-support systems
Sectorial studies on transport technologies, mobility and society Janic (2014), OPTI (2009), GOAL (2013), Lyons and Davidson (2016), Vallet et al. (2020), FUTRE (2014)	Evolutionary, holistic	Co-evolution of social, environmental and spatial aspects Sectorial consultancy, observatories, explorative research Pilot mobility projects	Macro and micro trends Shell/GBN scenario matrix, morphological analysis Theories of change and human behaviour Scenario insights and user-profile scenarios	Structured scenario descriptions Policy pathways/guidance, and research agendas Indicators and Real Option Analysis
Transport and land use integration Fiorello et al. (2013), Loukopoulos & Scholz (2004), Vermeiren et al. (2012), Ariza-Álvarez et al. (2021)	Spatial integration Radical change	Ambitious policy goal settings (modal shifts, behavioural change) Coordination and collaborative planning settings Spatially relevant focus areas	Projected business-as-usual ("negative") *vs.* desired scenarios Collaborative workshops and participatory visioning Wild cards scenarios	Synoptic/spatially explicit development of storylines Assessment models (MCDA) and land-use simulations

In the 1970', North American public-transit planners challenged and rebuilt some aspects of transport rationalities long influenced by road and traffic engineering. They pursued to debunk the myth that public transport systems had to withdraw capacity and robustness to adapt to flexible "door-to-door" access (Vuchic, 2005). In high urban-density contexts, such as the European cities, car and bus systems quickly lose capacity and produce traffic-congestion problems in traditional city-centres. New rail-based solutions needed to conceptualize hybrid or intermedium capacity concepts, in order to fill the gap between the flexibility provided by road-based systems and the robustness of high-capacity transit systems. Hence, "LRT" was coined in North-America as a fuzzy concept encompassing a set of already existing hybrid tramway technologies: e.g. articulated vehicles, higher load capacities, platform segregation, etc. (Thompson, 2000). In countries such as France or Spain, local brands of LRT projects ("metro", "light rail") softened the boundaries between different rail technologies and between road-based or rail-based systems (mixed Right-Of-Way – ROW – implementations). A "modern tramway" concept was also key in improving the image of the electric tramway, replaced by bus systems due to their obsolescence and lack of institutional support (González, 1992).

Spatial, system and policy integration narratives are connected to regional and metropolitan planning contexts in Europe, followed by city-centre renewal plans and mobility and accessibility policies (Hass-Klau and Crampton, 2002). A comprehensive rationality was needed to address multi-sectorial and multi-scale issues of transport (e.g. transport modes, systems, operators, land use integration). A spatially synoptic rationality emerges as transport infrastructure reforms become the backbone of regional and spatial visions, as well as a matter of consensus between actors (De Bruijn and Veeneman, 2009). Where mature transit systems existed (e.g. Belgium, Germany and Netherlands), LRT-based reforms extended centre-suburban connections and made new regional connections, following train-tram interoperability schemes ("Karlsruhe model") (Priemus and Konings, 2001) or replacing previous transport corridors with urban-friendly solutions (e.g. Valencia; Cayuela Prieto, 1990). In French or Spanish urban agglomerations, LRT proposals aimed at re-structuring the previous bus-based transport systems.

Urban transformations and alternative-transport narratives had a later presence in the aforementioned planning reform context, as multiple players emerged around LRT projects (institutions, private partners, mobility collectives, developers, etc.). Competence with BRT solutions for the same niche of demand produced a contestation of capacity and cost-efficiency narratives of LRT, which, in return, generated new arguments about the appealing image of rail-based solutions (De Bruijn and Veeneman, 2009; Richmond, 1998), the link with electric and sustainable systems (Fiorello et al., 2013) or its ability to catalyse urban development and revitalize the city (Ferbrache and Knowles, 2017). Economic recovery and development narratives follow the example of successful development plans, such as Grenoble TAG or the joint-development initiative of the London DLR (González, 1992). The survival of LRT to criticism shows how system-capacity rationalities are transformed to actor-centred approaches (strategic), which diversify arguments supporting (or challenging) LRT solutions, beyond cost-benefit criteria (Nicolaisen and Olesen, 2017). It also made planners rethink transport solutions together with urban models; e.g. North-American Smart Growth movement and the transport-oriented development concept (Jacobson and Forsyth, 2008).

Previous narratives can be identified in the argumentative repertoire of planning documents in the Andalusian region (Spain) and the Granada context (see Section 3.2.). Those will be the departure point for exploring hypotheses about the future of transport and urban development, and identify new future archetypes triggered by LRT interventions.

3. Methodology

3.1. Methodological framework

Our methodological framework aims to generate scenario prototypes and archetypes for transport planning, concerning the integration of scenario-building elements (see Fig. 1).

Scenario prototypes encapsulate the content-based elements of the scenario process, as seminal concepts, ideas and events. Communication elements include the *author* (e.g. the research team), and the initial *backgrounds*, as sets of relevant hypotheses, issues and decisions in scope (e.g. demand, capacity, traffic, urban integration …). Elaboration elements lie on *structures*, or sets of common dimensions guiding scenario construction; and the *development* products: e.g. storylines, figures, graphics, etc.

Scenario archetypes encompass multiple scenario prototypes under more general visions, external to the scenario process. They stress shape-based elements, involved in the representation and transferability of scenario products. *Consolidation* elements extend the development of the scenarios with the evaluation, selection and readjustment of scenarios in tune with the interpretation of actors participating in the decision process, or the general public. *Support/diffusion* elements include a further selection and synthesis of developed products, seeking suitable formats, audiences and communication strategies.

In order to identify potential scenario elements in the Granada's LRT case, we undertook a review of planning arguments for the metropolitan area of Granada, covering claims about capacity, demand, traffic, accessibility and integration in planning documents. The analysis focus on argumentative elements parallel to scenario-building elements (see Fig. 1): *hypotheses* (i.e. claims) held, planning environments (i.e. interrelated decisions, agents and systems) and *products* (i.e. the planning documents and contents) in which they emerged, as well as *mechanisms* and *representations* supporting the hypotheses (Navarro-Ligero, 2020).

The purpose of the exercise was exploratory, not confirmatory, illustrating a set of techniques for scenario building and assessment. We departed from a flexible understanding of scenario methods, following the Informal Logics School (Spaniol and Rowland, 2019).

3.2. Case study: LRT planning environments as sources of arguments and hypotheses

Granada's LRT project (Spain) was amid multiple narratives about the future of the transport systems, the city and its metropolitan expansion. Hence, our interest to explore multiple arguments in planning environments directly related to early decisions stages of the LRT project (1998–2008), as well as other transport and urban planning environments (see Table 2).

Granada's LRT planning environments initiate with the spread of national and regional initiatives during the 1990's. Endorsement of LRT solutions by the Andalusian Transport Department (COPT) required following "Intermodal Transport Plans" (PIT) guidelines for identification of potential "intermedium demand corridors" (COPT/DGT, 1998). Although Granada's urban agglomeration lacked from a dedicated PIT, the regional plan's transport survey (ETAUG, 1998) pointed out the opportunity of implementing a high-capacity transit system along the two main North-South – West and Central – corridors, in which demand rise was overwhelming the bus system. The committee of the regional spatial plan (POTAUG, 1999) approved the LRT solution in 1998, under promises of improving the metropolitan access opportunities. Main strategic decisions were taken with the system implementation survey (SENER/URBACONSULT, 2001): 3-phases implementation, route variants, intermodal regional connections, vehicle types or on-street platform solutions. The Line 1 project surveys (GIASA/AYESA, 2002, 2003) regarded new route and platform adaptations along the West Corridor, with the unforeseen addition of an underground solution for the central section. MCDA assessments showed trade-offs between traffic

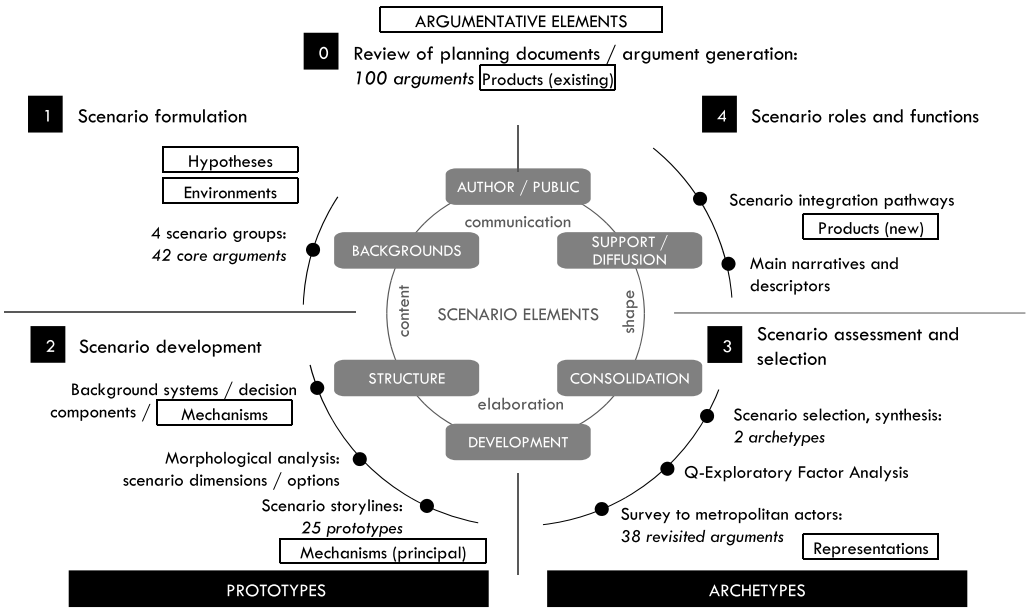

Fig. 1. Elements and main steps in the elaboration of scenario prototypes and archetypes.

Table 2
Arguments in planning documents about LRT related to their core hypotheses and main planning environments (supportive +, counter-argument –, qualifying ?), and distributed over the 4 selected scenario backgrounds (in colours).

LRT hypotheses	MET	MOB	PT	TRA	LRT	URB	ROA	CENT	ACT
H1. Satisfaction of growing mobility needs			+-	+++	+				
H2. LRT as higher capacity mode			+	+	+-	+	-		
H3. Increasing efficiency / effectiveness of PT			-+	-++++	--++++				
H4. Growing metropolitan mobility demand	+	-+		++		+			
H5. Addressing new mobility demands	++	--	-	++	+				
H6. Increasing PT demand	-		?+	?+	?+	?			
H7. Modal shift		++	+++				+		
H8. Congestion reduction in city center	+	+++	+		+	++	+	+++	
H9. Car-traffic demand management	+			++		++	+	+	+
H10. Reduce urban traffic conflicts			+	++	++		-		
H11. Access-supply increase	++		?++++	+	++++				
H12. Improve access-mode management		+++			+		++	+	
H13. Balance and creation of centrality	+	+				+++		++	+
H14. Metropolitan PT quality / integration	++		+++	++	++++	+			
H15. Improved urban integration of transport					++++++	++++	++	++	
H16. Urban revitalization	+		+		+++	+++			
(A) New PT corridors		(B) Urban integration			(C) Metropolitan mobility			(D) City-centre access/mob.	

Environments: MET – metropolitan/spatial planning, MOB – mobility and accessibility management, PT – public transport reforms, TRA – Transport systems planning and policy, LRT – Light Rail Transit projects, URB – Urban development and public space management, ROA – Road infrastructure and traffic planning, CENT – City centre planning, ACT – Land use and activity planning).

integration and cost-efficiency criteria. A later multidisciplinary report (UGR, 2004) added a more comprehensive approach to urban integration, regarding benefits from traffic management, street-section renewal and the attractiveness of LRT image. But mixed technical evidences were ignored in political debates. The Line 1 was executed with a completely undergrounded central section, facing high costs, and dependencies, as well as other decisions, negotiations and opportunities for extension (e.g. opening of a new Mall).

Mobility and transport planning environments generated arguments about the inflexibility of public transport and lack of proper

"agglomeration" systems to address growing and more complex mobility demands (ETAUG, 1998; POTAUG, 1999). The agglomeration municipalities approved the regional plan's own-ROW public transport system, opening the selection of the LRT or bus system to later transport plans. However, only the central municipality developed dedicated mobility plans (Granada/CIEU, 2003, 2012), with arguments that, on the contrary, stood for the rationalization of mobility and accessibility, redefining the functions of the central corridor. A bus system reform after LRT was expected, proving better demand integration and avoiding competence (COPT, 2007). Finally, with the delay of the LRT Line 1, a BRT system was supported as a more flexible and cost-efficient solution for the central corridor (Granada/CIEU, 2012).

Metropolitan and urban planning environments have historically sustained decentralization arguments on a growing regional transport network. But without previous regional plans, pressures over the city centre only increased, and new infrastructures (i.e. North-South by-pass road) produced border tensions in the West (Granada/PGOU, 2001; POTAUG, 1999). The new regional plan articulated its decentralization model in a future radial-concentric road network, with the own-ROW public transport system mostly relegated to existing radial roads. In the same way, LRT-location decisions were mostly reactive to existing development decisions, and the new system was expected to catalyse them (COPT, 2007). Few examples of re-location of new residential developments exist benefiting for improved access to city centre (Albolote/PGOU, 2008). LRT was also part of a public-private strategic intervention for a new health techno-pole in the south (Granada/Campus de la Salud, 2002).

3.3. Generating prototypes based on argumentative analysis

The generation of prototypes consisted on the identification of scenario backgrounds, structures and storylines. It was an expansive task, built on the vision developed by the authors during the argumentative planning analysis and the collection of 100 arguments from planning documents (Navarro-Ligero, 2020).

For the identification of scenario backgrounds, we took those combination of arguments' hypotheses and environments that better splitted arguments in 4 even groups (see Table 2). This number of backgrounds was selected for convenience. For each background, we derived common topics and questions from a sub-set of 42 most representative core arguments (see Section 4.1.).

A scenario structure was developed for each scenario background using the morphological analysis approach (Wiek et al., 2009). It consist of: i) dividing each background's problem space in *dimensions* and potential *options* for each dimension (Table 3); ii) narrowing the multi-dimensional problem space by selecting most compatible combination of options in a compatibility matrix (Fig. 2); and iii) writing scenario storylines conceptualizing each combination. We built scenario prototypes' dimensions by grouping *mechanisms* related to core arguments in common *systems* and *decision components*. Mechanisms included "hard" causal logics, "soft" interpretative-relational logics and social/-discursive framing logics (see Navarro-Ligero and Valenzuela-Montes, 2019). For building scenario matrices, we set compatibility values between mechanisms under a set of exploratory assumptions about future changes (Table 3), connected both to local planning environments and potential LRT-related future narratives (see Sections 2.2. and 3.2.).

Compatibility matrices were processed iteratively to identify most polarizing mechanisms (i.e. principal) within the same decision components, redefining them as *scenario dimensions* and *options* dividing the problem space (see example in Fig. 2; details in Annex A). We reduced the number of scenario possibilities by selecting only those combinations compatible with the principal mechanisms. Finally, we reinterpreted the structure of each frame for writing storylines for the prototypes (see section 4.1). Unused decision components with a high compatibility with the principal mechanisms were added to enrich the storylines.

Table 3
Planning systems, decision components and key argumentative mechanisms, introduced as assumptions in the compatibility matrix. (PT: Public transport; PV: private vehicle).

Systems: decision components	*Key assumptions in argumentative mechanisms and scenario matrices*
(Background A) Definition of new public transport corridors	
Transport corridors: LRT/PT paths and alternatives, PT networks, LRT expansion (technical standards), increment of PT supply, transport modes (public-private)	Flexible vs. robust transport systems Adaptive vs. path-dependent decisions on transport networks PV/PT conflict vs. PT supportive frames PT supply/robustness and traffic reduction causal chain
Population (mobility): Mobility and access	"door-to-door" oriented (flexible) vs. access-capacity integration
Urban system: Centrality, population density	Cost-efficiency density thresholds for new PT nodes vs. coordinated land development decisions
(Background B) LRT urban integration and transformation capacity	
Urban transport: LRT urban integration, transport modes	Implementation dependencies: by LRT platform design or by street space compatibility (segregation, location, prioritization …)
Urban spaces and land use: LRT Spatial compatibility, city economy projection, LRT Effects, development location	Flexible land use management vs. compatibility/asset value LRT-Land use effects: urban development boost vs. urban renewal/ reform-frame effects
Urban image/landscape: traditional vs. new city perspectives	Traditional "tramway" image and mobility policies vs. refurbished and attractive LRT design (i.e. modern stations)
(Background C) Evolution of metropolitan mobility and new transport demands	
Mobility and access management: modal choice, distribution of urban mobility, access management, transport management	Modal dependence vs. free modal choice (e.g. travel-time based …) Demand behaviour and distribution: continuity (e.g. city-centre commuter profiles) vs. new spatial/modal mobility relationships … Demand integration aligned with demand continuity
Spatial structure: infrastructure and road network, strengthening urban planning	Mobility relationships: planned infrastructures (stable) vs free-market (unstable)
(Background D) Access and mobility re-arrangement on city centre	
Mobility and access to city-centre: LRT network and own-ROW, mobility needs of residents and retailers, transport and traffic distribution networks	City-centre actors focus vs. metropolitan re-frame, reinforced by new road hierarchy models LRT-platform segregation model vs. changes in road functions
City-centre urban space: regeneration/ renewal capacity, traditional vs. new city	Alternative spatial frames: city-centre regeneration and traffic management vs. West Border and new metropolitan relationships
Urban and metropolitan space: centrality redistribution	LRT/PT node centrality reinforced by LRT design, rather than traffic management/functional road-capacity approaches

3.4. Consolidation of archetypes: a survey of LRT perspectives

The consolidation of archetypes consisted on the assessment, selection and adjustment of the scenario prototypes. While the former phase was expansive, in the present we wanted to narrow down the number of scenarios, capturing essential ideas and logics underlying real planning environments. We incorporated the perspectives of planning actors (i.e. practitioners, scholars, decision-makers and social agents) through the elaboration of a survey about the image of the LRT in Granada's metropolitan area, regarding its hypothetical expansion.

Firstly, we rewrote original core arguments according to their related prototypes, splitting or combining them when required, in order to build new textual and graphical representations that improved their communication to participants.

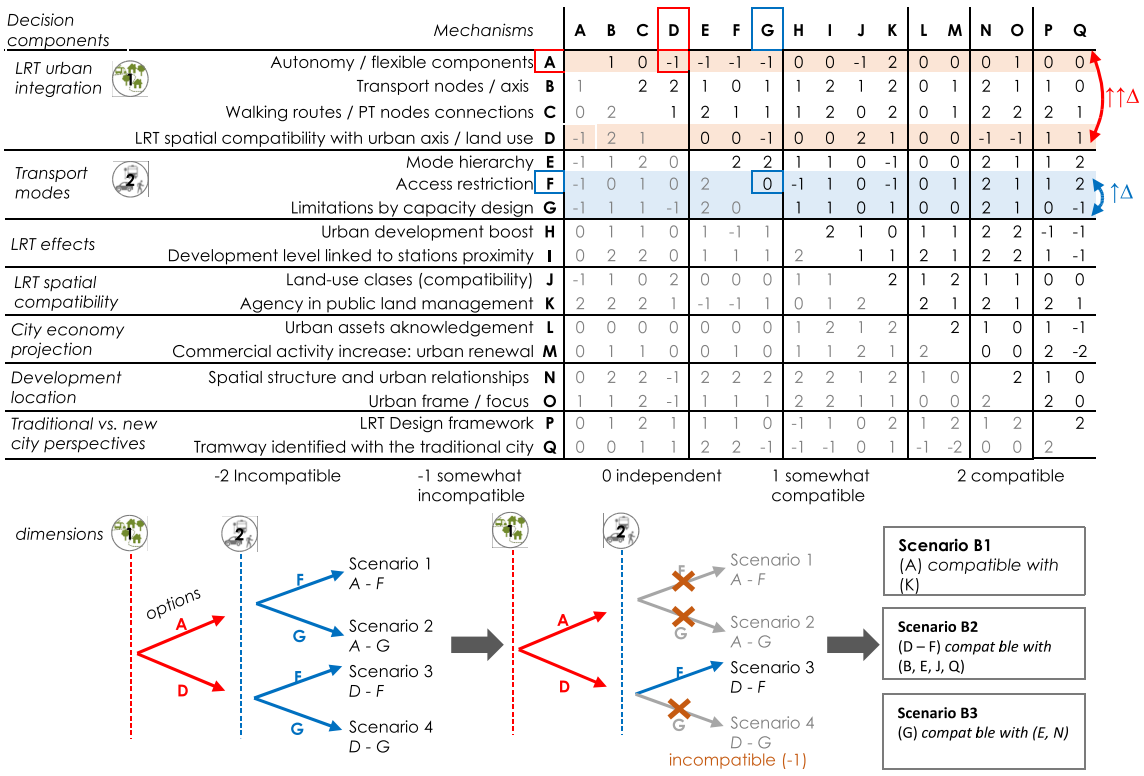

Fig. 2. Example of the use of compatibility matrices for building scenario structures: background B.

Secondly, the resulting 38 arguments were added as form questions, each one asking participants to rate their agreement to the corresponding argument content in a 5-point Likert scale; we suggested them to introduce commentaries at will. We divided the form in four sections, corresponding to the four scenario backgrounds. We added a fifth section in order to determine the profile of the participants and their knowledge and involvement levels in transport planning, urban/regional planning and the Granada's LRT project (see Annex B). Then, we used an online survey platform to share the form with a list of initial contacts, trying to reach a diversity of actors from the aforementioned profiles; we invited them to snowball the survey to other contacts. In parallel, we created a set of referential answers for each scenario prototype.

Thirdly, we performed an Exploratory Factor Analysis (EFA) to the results in order to simplify the structure of answers into 2 to 3 dimensions. Our aim was to identify differences and similarities between the visions of the actors and those contained in the scenario prototypes. Therefore, we used the participants as variables and the arguments as cases (Q-factor approach). For greater control of each step, we used EFA techniques based on Brown (1980, pp. 208–263): centroid technique as extraction method and manual rotation by observing the result clusters and exploring potential relationships (see Annex D). Factors extracted from each group (potential archetypes) linearly combine participants by correlation levels. Only significant correlations ($p < 0.05$; N = number of arguments) were transformed into weights in order to compute an average global score for each argument. Comparisons between average responses and original prototypes suggested guidelines for their modification, synthesis and expansion. Finding common visions across different backgrounds helped in further converging general archetypes (see section 4.2).

Finally, we proposed main archetype narratives, taking back potential planning products and audiences from the reviewed planning environments. We discuss integration pathways considering different mechanisms and functions of scenarios (see section 5).

4. LRT, transport and urban development scenarios

4.1. LRT planning backgrounds and scenario prototypes

After interpreting the scenario structures of each background (i.e. combination of scenario dimensions and options), we generated 25 scenario prototypes as short schematic storylines (see Table 4). Each prototype introduces an alternative hypothetical situation or concept about the future of the LRT and the transport system, combining hypotheses and mechanisms from different core arguments. We offer here a synthesis of the 4 LRT planning backgrounds and their related structures and storylines.

The *background A* involves the role of the LRT system in the design of metropolitan public-transport corridors. Hypotheses about LRT increasing transport capacity, efficiency and effectiveness are put in the context of its spatial and operational design, in articulation with other transport systems and demand centres. Three dimensions were considered: 1) The adaptability of LRT routes; 2) the dependencies assumed in LRT design and management; and 3) the expected function of the LRT corridors in the expansion of the future metropolitan transport system. 5 scenario prototypes emerged:

On one hand, an *access-demands adaptation* (A1) scenario presumes the flexible capacity of LRT components (routes, geometry, station placing …) in order to mould or extend existing bus corridors to new demand centres and connect with regional transport nodes. On the other hand, an *LRT as backbone* (A2) scenario presumes the referential capacity of LRT for restructuring the public transport system, with the LRT corridor fulfilling distribution functions and access demands covered by bus feeders or on-demand transport. The design of a *new independent LRT corridor* (A3) defines an intermediate scenario where adaptation to access demands is granted by new alternative corridors, complementary to others at the same level; this option resolves incompatibilities with previous road-based systems by enhancing the autonomy of the LRT-project decisions.

Segregation of platforms (A4) and *segregation of crossroads and paths*

Table 4
Main dimensions of the scenario prototypes described in this section. (PT: Public Transport, PV: Private Vehicle).

(Scenario background ref.) *Systems*	Decision components	Scenario dimensions (selection order)	Options	Prototypes
(A) *Transport corridors*		(1) Adaptability of LRT routes	a. Adaptable design/flexible components	A1
	LRT/PT paths and alternatives		b. Backbone/referential elements	A2 to A5
		(2) LRT design/management dependency	a. Independent to other modes/traffics	A2, A3
			b. Dependent of conflicts with VP/PT	A4, A5
	PT networks	(3) LRT function in the metropolitan system	a. Structuration of public transport	A2, A4
			b. Integration of mobility and accessibility needs	A1, A3, A5
(B) *Urban transport*		(1) LRT integration mode	a. Flexibility based (parallel to development)	B1
	LRT urban integration		b. Compatibility based (after development)	B2
	Transport modes	(2) Integration priority	a. LRT Access to traditional city centre	B2
			b. LRT capacity and connections	B3
(C) *Mobility and accesibility management*		(1) Modal choice dependency	a. Mobility as a need (modal dependency)	C1, C2
	Modal choice		b. Mobility as a luxury (free modal choice)	C3, C5, C6
	Distribution of urban mobility	(2) Spatial continuity of mobility/ demand	a. Re-structuration and re-scaling mobility	C1, C4, C3
			b. Following actual transport system structure	C2, C5 to C8
	Modal choice	(3) Continuity on modal choice behaviour	a. Continuity on demand profiles	C6
			b. Change on O/D relationships	C3, C4
	Distribution of urban mobility	(4) Basic spatial structure of mobility	a. North-South, centre-periphery axis	C1 to C6
			b. Traditional neighbourhoods/districts	C7, C8
	Access management	(5) Spatial design of PV/PT policies	a. Create new relationships (e.g. park-and-rides)	C3, C6, C8
			b. Create competitive advantages of public transport	C5, C7
		(6) Access management mode	a. Access restriction of VP (less time influence)	C4
			b. Competition for accessible spaces (time-based)	C3
(D) *City-centre urban space*	Traditional vs. new city	(1) Access problem framing/object	a. West Border/Metropolitan access	D1, D2
			b. Centre/Habitability and environmental quality	D3, D4
		(2) Mobility intervention modes	a. Protectionist of the traditional city-centre structure	D1, D3
			b. Transformative (centrality redistribution)	D2, D4

(A5) scenarios are variations of the A2 and A3 scenarios taking into consideration potential conflicts with urban and metropolitan traffics. A4 entails dependencies with the design of the road network and the distribution of the road-platform surface between modes. In A5, LRT follows different paths than other traffics, but conflicts exist with transversal traffic (e.g. radial corridors vs. North-South arterial systems).

The *background B* offers alternative situations for the urban integration of the future LRT system. Scenario prototypes address hypotheses about potential urban impacts in connection with capacity limits and possibilities of LRT systems in urban settings. The coordination environment between master plans, development plans and the LRT project is central. Two dimensions helped in structure 3 prototypes: 1) the LRT integration mode – flexibility/autonomy based or compatibility based; and 2) the element prioritized in integration – access or transport capacity.

Flexible integration (B1) scenario assumes that LRT flexible components, such as availability of public land (e.g. integration in a new development boulevard) or low urban impact technologies (platform integration, noise-proof technologies …) allow project decisions to be taken before or along urban development decisions without producing visual and environmental impacts. In contrast, in *formal integration* (B2) scenario, the reduction of LRT impacts is conditioned by compatibility with consolidated or already planned urban spaces – occupancy impacts, adjacency to vulnerable use classes (GIASA/AYESA, 2003) –. In the case of the historical city centre, the management of the scarcer public space requires public-transport prioritization policies. In *structural integration* (B3) scenario, the integration framework prioritizes the presence and capacity of LRT, displaying its ability for generating new spatial relationships between existing and new developments, as a mean for the relocation of urban activities.

The *background C* looks into more general changes in urban and metropolitan mobility behaviours. It addresses hypotheses about LRT and public transport demand increase, connected to future reforms for attending the potential demand rise. Improvements in traffic and accessibility management are other major hypotheses in mobility plans, in parallel to the metropolitan transformations suggested in new spatial models (POTAUG, 1999). Six dimensions were used, resulting in 8 prototypes. Main dimensions concern modal-choice dependencies (captive demand) of the population (1) and temporal continuity of demand distribution (2) and mobility behaviour (3); supplementary dimensions consider spatial conditions for integrating LRT in demand and access policies (4, 5 and 6).

In *new modal dependence* (C1) and *captive demand* (C2) scenarios, the raise in LRT and public transport demand is produced under modal dependence conditions, tied to profound changes in mobility relationships and scales along new North-South infrastructures in the former (e.g. LRT connections to new work and study centres promoted along ring road access system), or to existing public-transport radial corridors in the later. On the contrary, *modal transition* (C3) scenario presumes more flexible mode choice conditions for the population (e.g. higher proportion of non-work or "luxury" travel), under which LRT must truly become an effective mobility and access alternative to private car. LRT success relies in spatial design, establishing new competition (e.g. travel time difference) and coordination relationships (i.e. interchange) with traditional car-oriented spaces. Alternatively, in *access conditions change* (C4) scenario, LRT success is based on direct accessibility management policies, such as car-access restriction in the city centre.

Free demand (C5) and *steered demand* (C6) scenarios assume continuity of current demand distribution in main transport corridors, like C2, but excluding modal dependence. In C5, modal shift is conditioned by reducing travel time and availability of parking in the current transport networks. In C6, mobility is redirected through higher capacity infrastructures. Integration of LRT in such corridors and interchange policies are here more effective. On parallel, *neighbourhood-contained mobility* (C7) and *corridor-contained mobility* (C8) scenarios depart from similar demand and policy premises than C5 and C6, but with LRT enhancing traditional local mobility structures (walking

distance). Transport infrastructures become secondary, as mere access and distribution elements in C7, or setting urban relationships between neighbourhoods in C8.

Background D covers the reorganization of access and mobility in the city centre after transport reforms. Hypotheses about the role of LRT in improving accessibility and traffic management are connected with urban protection and revitalization strategies reinforcing the city-centre identity in a context of regional decentralization (Granada/CIEU, 2003). Two dimensions were relevant for defining scenarios: 1) the main object in framing access issues – West Border or city-centre area; and 2) the mode of mobility interventions – transformational or protectionist. 4 scenario prototypes were considered.

The *urban frontier* (D1) scenario focuses on the historical West Border problem, applying a protectionist perspective in the contention of traffics out of the city-centre. It implies a deep reorganization of access. Granada's strategy to divert car traffic (Granada/CIEU, 2003) and the prioritization of LRT project in the West corridor align to this scenario. Conversely, *transformation axis* (D2) scenario makes the West Border access problems compatible with a redistribution of centrality along both West and central corridor, reducing congestion in the second.

The *protected zone* (D3) scenario reinforces the need of integral protection areas in the city-centre, balancing internal accessibility for activities (e.g. retailers, jobs) with preservation of the urban quality for residents. Integration and redistribution measures for local traffics are prioritized, with the LRT as a more tangential intervention (e.g. avoiding historic and monumental centres). A *centre re-structuration* (D4) scenario relies more on a careful LRT integration for the revitalization of city centre areas, strengthening connections of the historical city with the metropolitan area.

4.2. Consolidation of LRT scenario archetypes

We use here the survey results (see details in Annex C) to re-interpret and narrow down the number of relevant scenarios for each background. 25 planning actors finally participated in the survey. The lack of stakeholders, policy-makers and regular citizen profiles, despite being contacted, reflected a greater interest from professional and academic sectors. Participants were broadly classified in two fields, practitioners (P) and scholars (S), with different degrees of knowledge and involvement in Granada's LRT project, as well as expertise backgrounds (Table 5). Each rotated Q-EFA factor was associated with a consolidated archetype (A-I, A-II, B-I …) (see bi-plots in Annex D); we summed up as weighted percentages those scores given by participants and the authors – by prototype – with significant correlations with each Q-factor. For interpreting each archetype, we departed from closer prototypes and observe commonalities and differences in the scores given to each argument – polarizing, defined only in one archetype or marginal differences (Table 6).

In background A prototypes, the assumed trade-off between the "backbone" role of LRT and its adaptability did not exist in the vision of the participants. While they mostly agreed about the LRT being referential design element for city-centre access, their opinions were significantly divided about its autonomy, flexibility and adaptability to other urban traffics. Some participants from the practitioners group explicitly pointed out the advantages of bus systems in their comments, as introducing "less rigid features" (P2-type comment).

From the previous, we consolidated two archetypes: *a rigid interaction* (A-I) archetype, linked to perceptions of the LRT as hard-infrastructure (compared to bus), with a somewhat greater capacity. The lesser efficiency and feasibility of LRT in sub-urban low-density settings also aligns with this vision. In general, this archetype matches with the settings of the independent design (A3) and road dependent (A4-A5) prototypes. On the other hand, a *flexible-interaction archetype* (A-II) reflects a more favourable or "ambiguous" (P2-type comment) position to the autonomous design argument. As in prototype A2, LRT retains its backbone character in the future transport system, but with greater ability to commit to mobility and access demands in different contexts (city centre and suburban) without interfering with other traffics (as in prototype A1). This archetype mostly correlates with the perspective of participating scholars.

In background B, the argument about LRT adaptability to urban development decisions divided participants' opinions. Comparisons with the advantages of bus (BRT line) were verbally declared (P1-type comment), in reference to the argument of integration limited by the platform design and capacity requirements. The importance of the LRT as a strategic frame of reference and an activity catalyser was mostly shared among participants. In most cases, the LRT image was quite away from the traditional tramway conception. One of the practitioners declined the "nostalgic" argument, highlighting a modern perception, conditioned by social goals.

We shaped two archetypes: firstly, a *location-based integration* (B-I) archetype mostly consolidates the B3 prototype, seeking the articulation of urban development with a structurally-independent high-capacity LRT. Benefits are delivered through proximity effects. Secondly, an

Table 5
Final participants profile, considering declared areas of expertise and familiarity degrees with Granada's LRT project and other planning processes.

Groups and profile description		N	Declared areas of expertise*						Declared familiarity degree (median)**									
			TRM	MOB	INF	URB	REG	STR	LR0	LR1	MTR	MOB	MPA	REG	URB	DEV	STR	RCH
All		25	.64	.40	.24	.44	.48	.32	2	3	3	4	2	3	2	2	2	3
P: Practitioners		15	.67	.47	.20	.33	.33	.20	1	1	4	4	3	3	2	2	2	2
P1	Transport/urban planners involved in LRT	5	1.00	.40	.20	.60	.60	.00	4	4	4	4	3	3	3	2	2	4
P2	Transport, mobility planners knowing LRT	7	.57	.71	.14	.14	.14	.14	1	1	3	4	3	2	2	2	2	2
P3	Other experts with scarce knowledge of LRT	3	.33	.00	.33	.33	.33	.67	1	1	2	3	1	3	2	2	2	1
S: Scholars		10	.60	.30	.30	.60	.70	.50	3	3.5	2.5	3.5	1.5	3	2	2	2	3.5
S1	Transport field, involved in LRT	4	1.00	.75	.50	.50	.50	.75	3.5	3.5	3.5	3.5	2	2.5	2.5	2	3.5	3.5
S2	Urban/regional planning field, involved in LRT	4	.00	.00	.00	.50	.75	.50	3	4	1	3	1	2.5	2	1.5	2	3.5
S3	Other academics with no involvement in LRT	2	1.00	.00	.50	1.00	1.00	.00	1	1	1	3	0.5	3.5	3	2	1.5	3

*TRM: Transport management; MOB: mobility and traffic; INF: Infrastructure management; URB: urban planning; REG: regional planning; STR: strategic planning (NOTE: Same participants may declare multiple areas of expertise.).
**Familiarity value: No knowledge (0); Somewhat familiarized (1); Well familiarized (2); Actively following (3); Collaboration (4).
**LR0: Preliminary LRT surveys; LR1: Line 1 surveys; MTR: Transport models; MOB: Urban mobility plans; REG: regional plans; URB: urban master plans; DEV: Development plans and projects; STR: Urban thematic strategies; RCH: research.

Table 6
Scenario archetypes, as derived from Q-EFA analysis interpretation (PT: public transport).

Archetypes	Avg. SCORE (1–5) – Main arguments [ref Annex B]	Consolidation patterns/closer prototypes	Participants/Prototypes (aggregated weight%[a])
A-I. Rigid interaction of LRT	5 LRT as a rigid decision element [06]	DEFINING/A4	part = 8: P2(81), P3(8), S1(5), S2(4), S3(4)
	5 Alternative access corridors to city-centre [10]	marginal/A5	
	5 Prioritization of PT/LRT against private car [09]	marginal/A234	
	4 Unfeasibility of LRT in the sub-urban/rural areas [08]	(3) POLARIZING/A45	
	2 Adaptation to traffic flows [04]	defining/A23	
	2 Integrating access, mobility and capacity demands [11]	(2) POLARIZING	
	1 LRT as an adaptable element [01]	(1) POLARIZING/A3	
	1 Independency of LRT decisions [05]	DEFINING/A4	
A-II. Flexible interactions of LRT	5 Efficient performance of LRT corridor [03]	marginal/A23	part = 8 | prot = 1: S1(27), P2(24), S2(18), P1(11), A2 (11), P3 (9)
	4 LRT as an adaptable element [01]	(1) POLARIZING,/A1	
	4 Integrating access, mobility and capacity demands [11]	(2) POLARIZING/A135	
	2 Unfeasibility of LRT in the sub-urban/rural areas [08]	(3) POLARIZING/A123	
	5 LRT as backbone element of public transport [02]	COMMON/A23	
	4 LRT improve urban/metropolitan connections [07]	COMMON/A135	
B-I. Location-based integration	5 LRT compatibility with land use and urban fabric [18]	marginal/B2	part = 8: P2(64/-6[b]), P3(12), P1(13), S2(5)
	4 LRT integration limited by its higher capacity [19]	DEFINING/B3	
	2 Recovery of the tramway legacy in the old city [14]	DEFINING/B3	
	2 Integration of LRT in the urban structure [17]	(1) POLARIZING/B3	
B-II. Urban renewal	5 Pedestrians/PT oriented public space project [16]	DEFINING/B2	part = 8: P1(41), S1(31), S2(17), P3(6), P2(5)
	5 Urban renewal effect of LRT [13]	marginal/B2	
	4 Integration of LRT in the urban structure [17]	(1) POLARIZING/B1	
	4 LRT as catalyser of urban activities [12]	COMMON/B3	
	4 Modernization of urban space [15]	COMMON/B2	
	4 LRT as a spatial frame for urban actions [20]	COMMON/B1	
C-I. New mobility culture	4 Mobility contention on the neighbourhood scale [28]	DEFINING/C78	part = 3 | prot = 7: C8(23), C7(17), C1(-12),P1(9), C2(-9), C3(7), C5(7), S2(6), S3(-6), C6(4)
	2 Dominance of commuting profile –radial– [23]	(2) POLARIZING/C5	
	1 Modal choices limited by captive demand [25]	(1) POLARIZING/C35678	
C-II. Access-needs conditioning	5 Reinforcing urban planning against urban sprawl [31]	marginal/C7	part = 6: P2(46), S2(20), S1(18), P1(16)
	4 Continuity of car/public transport demand trends [22]	DEFINING/C124	
	4 Dominance of commuting profile –radial– [23]	(2) POLARIZING/C2	
	4 More complex spatial mobility patterns [24]	DEFINING/C26	
	4 Modal choices limited by captive demand [25]	(1) POLARIZING/C12	
	4 LRT as a pillar for high-mobility spaces [32]	DEFINING/C26	
	5 LRT time/access competence with private vehicle [29]	COMMON/C57	
	4 Break of trends in modal choice [21]	COMMON/C34	
	4 Articulation of LRT with mobility policies [26]	COMMON/C57	
	4 Diversification and balance of transport modes [27]	COMMON/C67	
D-I. Metropol. traffic management	5 Access managed through large transport axis (D12) [33]	marginal/D12	part = 4 | prot = 1: P2(78), S1(8/-7), D4(-6)
	2 City-centre protection: external traffic pressures [35]	DEFINING	
	1 Urban decentralization through LRT stops [38]	(1) POLARIZING	
D-II. Central stop		(1) POLARIZING/D24	part = 3: P3(41), S2(49), S3(2)

(*continued on next page*)

Table 6 (*continued*)

Archetypes	Avg. SCORE (1–5) – Main arguments [ref Annex B]	Consolidation patterns/closer prototypes	Participants/Prototypes (aggregated weight%[a])
	5 Urban decentralization through LRT stops [38]		
	5 Accessibility managed in integral recovery projects [34]	marginal/D34	
		5 Access restriction in the central ring [37]	
marginal/D1			

[a] only p-value <0.05 included in weighted percentages.
[b] negative symbol means negative correlation with the archetype.

urban renewal integration (B-II) archetype mixes premises of the three original archetypes. The greater penetration of LRT in consolidated urban areas prioritizes the rearrangement of public space. Benefits come from urban renewal effects. Both archetypes' premises are related to the previous rigid and flexible archetypes (A-I and A-II); this is corroborated, especially in the second case, by the perspectives of some practitioners and scholars from urban planning and economics fields.

In background C, the Q-EFA showed a greater contrast between the author's prototypes and the perspective of the survey participants. The structure of the prototypes assumes that dependence in captive mobility profile is incompatible with free modal choice toward public-transport alternatives. But this assumption was challenged by the survey answers, with simultaneous agreement with both conditions. One of the participants (P1-type) stated that even if LRT is able to change people choices and capture car travel, "the private car is still an element of the greater importance in many sectors of the society". The answers and comments also showed the reliance in the effective competition and articulation between modes (e.g. park and ride policies); participants' visions mostly aligned with an urban periphery perspective of metropolitan mobility, complex and needing for more urban planning efforts to avoid dispersion.

Therefore, a first *new mobility culture* (C-I) archetype, aligned with authors' vision, links behavioural change induced by LRT implementation to automobile losing influences in individual and collective mobility decisions (as in C3 and C5 prototypes). Closer to C7 and C8 prototypes, mobility is rationalized in such context, focusing on the neighbourhood scales rather than centre-periphery logics. The participants' visions are mixed in an *access-needs conditioning* (C-II) archetype; as in access restriction (C4) and steered demand (C6) prototypes, new access policies (e.g. city-centre restrictions) use captive demand profiles for increasing LRT demand and modal shift. The archetype is focused on the role of new metropolitan infrastructures for rearranging and planning high-mobility metropolitan spaces. Some correspondence of archetype C-II with rigid/high-capacity perceptions of LRT (A-I/B-I) reinforce this metropolitan scope.

In background D, marginal differences in the survey also weaken the structure of prototypes. For most participants, the argument about accessibility management through integral projects in the city centre was compatible with urban axial transformations along main urban streets and borders. Only the argument about city-centre protection against traffic and accessibility caused more divisions, being considered in some cases complementary aspects (as stated by a P2-type participant). The centrality redistribution argument was also contested. One of the practitioners (P2-type) believed that "the reorganization of land uses and spaces in the urban agglomerations has already happened", with a minor or reactive stance to LRT-project decisions. This comment reaffirmed a shift of the geographical frame to the metropolitan area, in line with prototypes D1 and D2.

A *metropolitan traffic management* (D-I) archetype, mostly aligned with prototype D1, captures the previous metropolitan perspective: LRT supports traffic protection policies along the West Border and the central Gran Via corridor, both creating a "central ring" area with its own spatial identity. The central city retains their activities (functional centrality), distributed along main axis (as in D2, gaining distance with D4).

The *central stop* (D-II) archetype is closer to the D4 prototype, merging it with D3: the LRT help in the decentralization process, complemented by integral renewal interventions in the city centre. The city centre retains symbolic centrality, while losing some functions and spatial dominance. There is some concordance of the later archetype with A-I/B-I perspectives of LRT as a rigid and greater entity system.

The aforementioned correspondences observed across backgrounds give some hints to consolidate two main archetypes, in which we focus the discussion about scenario integration: a *LRT-robust* archetype and a *LRT-flexible* archetype.

The *robust archetype* combines A-I/B-I/C-II archetypes, in line with the vision of one of the P2-type participants (transport manager with a high knowledge of the LRT project). It assumes a lesser flexibility and transformational capacity of the LRT, in terms of integration, coordination with urban development and ability to transform mobility behaviours. The LRT project consolidates already existing high-demand corridors connecting the metropolitan area with the city centre. Access organization modes of the city centre create two variants: the first aligns rigid vision of LRT (A-I) with its greater presence in the city centre and ability to redistribute centrality (D-II), according to a P3-type participant (public expert in strategic and environmental planning); the second aligns B-I/C-II with D-I, gives LRT a secondary role in the reorientation of metropolitan traffics, according to a P2-type participant (mobility planning expert, familiar with the LRT case).

The *flexible archetype* assumes a greater restructuring of urban transport and mobility, with LRT taking part in a whole transformation toward an alternative mobility culture (sustainable, rational, less car-dependent …). LRT retains a referential role, but with a greater ability to influence particular planning decisions beyond the "infrastructure-location" duality – as the robust archetype. This archetype reflects A-II/B-II/C-I archetypes alignment in the vision of a S2-type participant (scholar with a strategic/economic perspective). D-II mostly aligns with the previous arguments, according to the observed position of two scholars (types S1 and S2). An urban regeneration process based on LRT would match a higher degree of transformation in accessibility and mobility policies.

5. Integration of LRT scenario archetypes in transport planning

Capacities of future LRT scenarios can be deployed in two planning production environments: i) the formulation of transport and mobility models, in articulation with conceptual and spatial models for regional and urban planning; and ii) the own LRT implementation programs. The main LRT archetypes, *robust* and *flexible*, define two general narratives about the relationship between both products (see Fig. 3):

The narrative of the *robust LRT archetype* starts from identifying unsuitable features of the current spatial transport model, regarding mismatches with trends in demand distribution and new metropolitan profiles; then, a transport schema is plotted, being the reference of a LRT implementation program based on cost-efficiency and the definition of potential dependencies with other urban and transport systems – e.g. feasibility studies proposed by Granada's regional plan (POTAUG, 1999). The end is to define a new stable transport model, with LRT as a backbone intervention. In parallel, the metropolitan nature of this

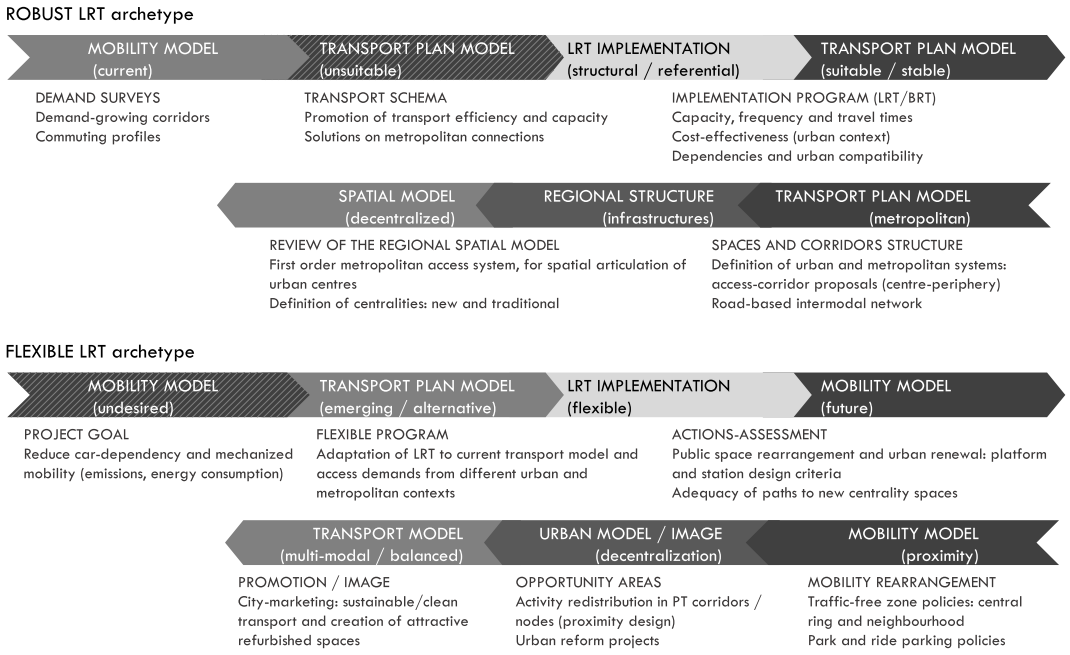

Fig. 3. Integration of main LRT archetypes in transport and spatial models.

transport model will ensure identifiable elements in regional structure (i.e. transport axis and nodes), which will serve as a base for spatial decentralization strategies.

The narrative of the *flexible LRT archetype* departs from stating an undesired car-dependent mobility model. A strategic (i.e. conceptual) transport model gradually emerges, summing up tactical LRT implementation with other flexible programs and policies, adapted to diverse access demands and metropolitan settings. The future mobility model results from the direct application of design and assessment criteria of LRT projects, particular to each space of intervention in the urban context: LRT urban integration, renewal, policy schema, etc. This situation was observed, for example, in continuous adaptations from LRT schema to the Granada's Line 1 project in terms of intermodal connection and platform integration. The creation of a spatial mobility model based on urban quality and proximity leads to the creation of urban opportunity areas, rather than global metropolitan or urban visions; the transport model is here oriented to contribute to the attractiveness of those spaces, developing "green-transport" and "friendly-transport" discourses.

According to internal archetype mechanisms for representing future transport changes, LRT scenario archetypes can be integrated in three ways in transport planning environments:

LRT scenarios introduce *efficient/effective design parameters and transport systems goals* promoting capacity and competitiveness with car and modal balance. The robust archetype emphasize recurring demand profiles and corridors, as those observed in daily-mobility and corridor surveys preceding the first LRT proposals in the Andalusia region (COPT/DGT, 1998). The flexible archetype, in contrast, focus on setting LRT project goals, such as energy consumption standards, or general mobility plan prescriptions, like reducing mechanized mobility rates.

LRT scenarios pose *new relational logics (spatial)* and *organization models* for the transport system reforms and the city transformation. The creation of long term mobility support elements (infrastructural) is especially important in the robust archetype; those elements also ensure future demand centres through articulation of urban developments with infrastructure nodes. Game-changing policy elements reducing the presence of auto-mobile mostly relate with the flexible archetype, as the LRT connects multiple overlapping interventions in the public space and define opportunity areas.

Scenarios create *new frames for integration*, assembling new planning contexts and environments related to the promotion of public transport and accessibility. The metropolitan integration concept through the image of a unifying efficient system is important in the robust archetype. While regional plans (POTAUG, 1999) have previously relied in physical systems (i.e. road) network for defining its spatial model, the flexible archetype use an adaptable language in discursive and policy elements (e.g. defining open own-ROW solutions). The notion of transformation and transition spaces is important for actors to tackle with a new metropolitan-accessibility frame.

6. Discussion and conclusion

In this paper, we addressed different integration pathways for the use of future scenario in transport planning. Our proposal of flexible and robust transport archetypes regards alternative programmatic futures, overcoming the lack of fixed goals in LRT planning environments (De Bruijn and Veeneman, 2009). As other non-thematic and non-normative approaches, like actor-network theory (Nicolaisen and Olesen, 2017) or regime-transition theories (Lyons and Davidson, 2016), archetypes explain how planning practices may be transformed. They are open conceptual assumptions, that could be explored beyond the Granada's context or the LRT case, as they offer a departure point for the development of scenarios involving other concepts (e.g. virtual accessibility, Mobility as a Service) as well as perspectives from multiple actors; e.g. in collaborative planning settings (Ariza-Álvarez et al., 2021).

Some key learnings may be applied to other scenario-building exercises. Firstly, the need for a greater emphasis on flexible scenario structures (i.e. dimensions) that accommodate contradictive perspectives from planning actors: e.g. coexistence of flexible and robust perceptions of LRT, car-dependent and free modal-choice environments. Secondly, prototypes generation made full use of a documental review for capturing practical arguments, while archetypes selected and distilled key messages for potential communication environments. This approach gave greater emphasis to deskwork preparatory and scenario-development stages, as suggested by original perspectives on strategic scenarios (Chermack and Coons, 2015). The encapsulation potential of arguments was useful for feeding planning actors back with their own proposals.

Main limitations of the method and results relate to the restricted scope and the low number of participants and profiles covered. First, transferability and relevance of robust and flexible archetypes should be tested in other planning environments. Second, the low involvement of stakeholders and citizens can be related to the excessive focus on participants familiar or interested in previous planning processes, attracting only the attention of practitioners and scholars. Our method should make use of extended surveys, other sources of information (e.g. press, social media) and tools allowing interactive argumentation exercises, that eventually could reach alternative population groups (e.g. students, citizen collectives, stakeholders …) in order to find new perspectives about the future of urban transport systems.

Author statement

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Declaration of competing interest

None.

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Appendix A. Supplementary data

Supplementary data to this article can be found online at https://doi.org/10.1016/j.tranpol.2022.02.002.

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