IRIS

Integrated and Replicable Solutions for Co-Creation in Sustainable Cities

Project Acronym:	IRIS
Project Full Name:	Integrated and Replicable Solutions for Co-Creation in Sustainable Cities
Grant Agreement:	No 774199
Project Duration:	5 years (starting 1 October 2017)

Deliverable 6.1

Report on baseline, ambition and barriers for Nice Lighthouse

Work Package:	WP6: Nice Lighthouse city demonstration activities
Task:	T6.1: Elaborating baseline, ambition and barriers for Nice Lighthouse interventions
Lead Beneficiary:	UNS
Due Date:	30 September 2018 (M12)
Submission Date:	30 May 2019 (M20)
Deliverable Status:	Final
Deliverable Style:	R
Dissemination Level:	PU
File Name:	D6.1 Report on baseline, ambition and barriers for Nice Lighthouse_v1.2.pdf

This project has received funding from the European Union's Horizon 2020 research and innovation program under grant agreement No 774199

Authors

Surname	First Name	Beneficiary
Attour	Amel	UNS
Barre	Pierre-Jean	UNS
Baudino	Marco	UNS
Chateau	Alain	NCA
Dumetz	Eric	UNS
Foerster	Leticia	UNS
Groll	Sebastien	UNS
Guerroud	Yassine	UNS
Krafft	Jackie	UNS
Keim	Christian	EDF
Laftas	Ibrahim	UNS
Lazaric	Nathalie	UNS
Maleysson	Jean-Charles	NCA
Maillard	Philippe	VEOLIA
Quatraro	Francesco	UNS
Santhia'	Cristina	UNS
Simons	Eric	VULOG

In case you want any additional information or you want to consult with the authors of this document, please send your inquiries to: irissmartcities@gmail.com.

Reviewers

Surname	First Name	Beneficiary	e-mail address
Wahlström	Ulrika	IMCG	ulrika.wahlstrom@imcg.se
Maleysson	Jean-Charles	NCA	jean-charles.maleysson@nicecotedazur.org
Tsarchopoulos	Panagiotis	CERTH	patsar@iti.gr

Version History

Version	Date	Modifications made by
0.1	31/07/2018	Version submitted by Jackie Krafft
0.2	28/09/2018	Final version for review submitted by Jackie Krafft
1.0	30/09/2018	Final version to be released to the EC
1.2	30/05/2019	Final version including RP1 review comments addressed

Disclaimer

Executive Summary

The aim of the report D6.1 is to contribute an in-depth analysis of the baseline, ambition, drivers and barriers for the ecosystem of Nice LH. Based on our academic background and knowledge in the field of the economics of Smart Cities, we provide a characterisation of the baseline, ambition, drivers and barriers as the outcome of an original framework elaborated by UNS, relying upon different advanced academic methodologies. This characterisation enables the definition of strategic orientations for the local ecosystem, together with guidelines aiming at easing the implementation of integrated solutions foreseen in D6.2 “Coordination of NCA integration and demonstration activities”.

The objectives of the deliverable are to better understand how the city will proceed on the way from its current baseline towards the IRIS ambition of developing Smart City solutions in the field of energy, mobility, ICT and citizen engagement. We thus characterise what are the drivers and barriers which Nice LH will find on this path; what strengths and opportunities can be foreseen and used to transform the path into an avenue; what weaknesses and threats can eventually transform existing paths into dead-ends to avoid; what are the key elements in the field of the local ecosystem (in terms of innovation, data, law and regulation, financial, investment, business model, physical infrastructure and citizen engagement) that are likely to have the most positive or negative impact on the next steps of the Smart City.

The scope and context within which this Deliverable was produced, has been of generating results, conclusions and recommendations based on an objective, informed, and comparative setting. In this perspective, this Deliverable is the outcome of recurrent interactions at the local level, with different types of partners (city authorities, large companies, small and medium enterprises, support organisations, research and education actors). We also relied on the contribution of a large set of actors outside of Nice, i.e., in Gothenburg and Utrecht ecosystems. We did so in view of comparing the situation in Nice LH with other IRIS LH cities, not in a competitive way but rather in a collaborative one. As such, D6.1 is nested in a perspective where IRIS collaboration exists not despite of Smart Cities global competition, but rather because of that, as ecosystems cannot be considered in isolation or disconnected one from the other; as well IRIS cooperation could make all partners better equipped in the global competition becoming smarter and performing higher. In this context, we acknowledge the collaboration with different IRIS partners in the different LH cities, especially the ones involved in D567.1 and D567.2, who gave us time and detailed information to carry out our study, and helped us in refining our conclusions through repeated interactions on the basis of questionnaires and interviews.

Our work has been conducted over the time period ranging from October 01, 2017 until September 30, 2018. A first part of the period (from October 2017 to April 2018) was dedicated to the collection of data in Nice LH in view of designing a portrait of the local ecosystem from which we have been able to characterise the baseline, the ambition, as well as drivers and barriers of Nice LH in relation to the other IRIS LH cities. We performed a SWOT (Strengths - Weaknesses - Opportunities – Threats) analysis relying on the TIS (Technological Innovation System) methodology which characterises a set of seven different functions framing within the city ecosystem: Entrepreneurial Experimentation and Production (F1); Knowledge Development (F2); Knowledge Exchange (F3); Guidance of Search (F4); Market Formation (F5); Resource Mobilisation (F6); Resistance to Change (F7). From this, we performed an analysis both at the ecosystem level, and at the Transition Track level. Specifically, for both levels, it is possible to identify

which are the functions, compared to the other LH cities, for which Nice LH presents strengths and opportunities (together constituting a driver), as well as weaknesses and threats (together constituting a barrier). To complement the baseline, we also performed a social acceptance study based on a questionnaire focused on households and their habits and inclination to change their energy, mobility and ICT behaviours. The second part of the period (from May 2018 to September 2018) has been devoted to the exploitation of data via different economic methods and tools (spider graphs based on an original UNS methodology, NVivo descriptive statistics for qualitative data such as interviews, simulation and costs-benefits analysis, advanced econometric methods for the social acceptance section) and the production of results in line with our current protocols of research and related previous expertise.

From our analysis, interesting results emerge for Nice LH, and we want here to provide within this executive summary a brief, non-exhaustive overview. At the ecosystem level, it emerges how Nice LH possesses, as a major strength and as well as a valuable opportunity, its Entrepreneurial Experimentation and Production (F1) and Knowledge Development (F2) within the Smart City environment, together with a robust vision for the Formation of Market opportunities (F5). On the other hand, it appears that Resource Mobilisation (F6) and Resistance to Change (F7) constitute two fields in which progress has to be achieved. At the Transition Track level, our findings exhibit distinctive patterns. On the one hand, for TT1, TT2 and TT3, actions related to Entrepreneurial Experimentation and Production (F1), Market Formation (F5) and Resistance to Change (F7) could be consolidated. On the other hand, for TT4 and TT5, Entrepreneurial Experimentation and Production (F1), and Knowledge Development (F2), appear as Primary Functions, and actions in these fields should be prioritised. The results emerging from the social acceptance study corroborate the ones of the SWOT analysis, providing a more in-depth analysis for the level of engagement of citizens in the domains of energy, mobility and ICT.

Grounded on these conclusions and in the light of all the findings and results emerging from our empirical analysis (with all the usual caveats related to the conduct of such analysis), for each IS, we provide highlights that appear to be useful for the development of the IRIS action plan, as well as providing concrete and useful recommendations in the direction of target audiences. Broadly speaking, the main target group for this report is represented by the IRIS partners, especially the city administration and the related governmental institutions, but also all the actors composing the ecosystem, such as: the general public, private companies (large and small), education, research, and supporting organisations. As a final step, for each target audiences, D6.1 sets conclusions not only at the sole ecosystem level, but also at the Transition Track level for Nice LH city, with systematic comparison of the local situation with the other LH cities, and identifies fields in which Nice could disseminate/receive expertise from Utrecht and Gothenburg, and eventually beyond.

Based on these different contributions, D6.1 is intended to have an impact on various deliverables, especially D6.2 “Coordination of NCA integration and demonstration activities”. As well, by collecting data on Utrecht and Gothenburg, while providing a deeper analysis of Nice in relation to other LH cities as control group, D6.1 can provide insights for D5.1 “Baseline, ambition & barriers for Utrecht lighthouse interventions” and for D5.2 “Planning of Utrecht integration and demonstration activities”, and also for D7.1 “Baseline, ambition & barriers for Gothenburg lighthouse interventions” and D7.2 “Planning of

Utrecht integration and demonstration activities". An impact can also be expected on D2.1 "Lessons learnt through cooperation with other Lighthouse projects", D3.2 "Sustainable business model dashboard tool", D3.4 "SCUIBI-programme 3.0 hanbook for implementation in IRIS cities and beyond", D8.1 "A road map for replication activities", and D10.9 "Communication and dissemination tools and materials".

Table of Contents

List of Figures

List of Tables

List of Abbreviations and Acronyms

Abbreviation	Definition
BEPOS	Positive Energy Building
CIP	City Innovation Platform
CSTB	Centre Scientifique et Technique du Batiment
CUSA	Citizen Utilities Savings Through Awareness
D6.1	Deliverable 6.1
d.f.	Degrees of Freedom
DoA	Description of the Action
DHW	Domestic Hot Water
DSO	Distribution System Operator
EDF	Electricité de France
EU	European Union
EV	Electric Vehicle
FC	Follower Cities
FI	Future Internet
FIT	Feed in Tariffs
FP7	7th Framework Program
GDPR	General Data Protection Regulation
GPS	Global Positioning System
ICT	Information and Communication Technologies
IESE	Instituto de Estudios Superiores de la Empresa
IESE-CIMI	IESE-Cities In Motion Index
IIA	Independence of Irrelevant Alternatives
IMREDD	Institut Méditerranéen du Risque, de l'Environnement et du Développement Durable
IoT	Internet of Things
IS	Integrated Solutions – IRIS Solutions
KPIs	Key Performance Indicators
kWp	Kilowatt peak
LEM	Local Energy Management
LFP	Lithium Iron Phosphate
LH	Lighthouse
LHCSM	Lighthouse City Site Manager
LMO	Lithium ion Manganese Oxide battery

LR	Likelihood-ratio test
N.	Number of
NCA	Metropole Nice Côte d'Azur
NMC	Nickel Manganese Cobalt
PCA	Principal Component Analysis
P/D/R	Pilot, Development and Replication phases
PV	Photovoltaic
R^2	Coefficient of Determination
RT2020	Réglementation Thermique 2020 (France)
SBM	Sustainable Business Model
SDI	Sustainable Development Indicators
SME	Small and Medium Enterprises
SNS	Social Network Services
SWOT	Strength, Weakness, Opportunities, Threats
TIS	Technological Innovation System
TT	Transition Track
TRL	Technology Readiness Level
TSO	Transmission System Operator
UNS	University of Nice Sophia Antipolis
V2G	Vehicle to Grid
WP	Work Package

1. Introduction

This report (D6.1) characterises the baseline, ambition, drivers and barriers for the ecosystem of Nice LH. Based on our academic competences in the fields of the economics of innovation, energy consumption, and sustainable issues, as well as transport and mobility in Smart Cities, we generated the baseline, ambition, drivers and barriers as the outcome of an original UNS framework which is able to derive both strategic orientations, as well as highligths, for the development of an action plan. We take this double positioning as an asset for the IRIS project, as demonstration activities in Smart Cities are necessarily embedded within strategic and policy goals that benefit from being better articulated and aligned.

1.1 Scope, objectives and expected impact

Since the beginning of the new century, the world population has been growing rapidly, with towns and cities accommodating half of this population and using 70% of available energy resources. The urban population is expected to rise to 70% by 2050 (UNCTAD, 2017), and this creates a tremendous pressure on every aspect of the urban living. Cities need to provide solutions to significantly increase their overall energy and resource efficiency through actions addressing the building stock, energy systems, mobility, and air quality.

Such a pressure towards efficient cities has triggered several Smart City initiatives in Europe and outside of Europe. These initiatives are introducing two major changes at the city level:

- While traditional city management involves mere urban planning, Smart City management entails the establishment of a strategic coordination plan among different stakeholders (who interact in different subsystems such as transportation, health, education, environment, etc.) within a single smart macrosystem that integrates the full usage of Information and Communication Technologies (ICT) with the city's resources and local ecosystem characteristics, in this way leading to a sustainable path of socio-economic development.
- There is an emerging global competition among cities where talents, growth and investments, quality of city life and the attractiveness of cities as environments for learning, innovation, doing business and job creation, now became key parameters for success. Cities are now included in rankings that shape their attractivity both in terms of business actors and investors, and every local ecosystem has to take aligned and proactive actions in order to increase its own visibility in these rankings based on a solid acknowledgement of existing assets and handicaps.

In the context of the IRIS project, it becomes crucial to understand how Nice, together with the other LH cities, will proceed on the way from the current baseline towards the IRIS ambition of developing Smart City solutions in the fields of energy, mobility, ICT and citizen engagement. The issue is to understand how IRIS cities are implementing this essential transition from mere urban planning towards Smart City management and related strategic coordination. In the context of a strong competition between cities to reach the best level in Smart Cities rankings, the IRIS project represents a unique opportunity for cities to take advantage of their collaboration in the project to assess good points and less

good ones, making progress together whenever a partner city performs better and is ready to share its expertise.

From the kick off of the project, the recurrent identification of a need for a joint approach led D567.1/D567.2 lead editors to stand for a dedicated Working session “Session 1B: Lighthouse Cities site exchange” that was held on this occasion of the Consortium Plenary Board in Goteborg (M6) – 27-29th of March 2018. Conclusions of this Working session were to set-up a “cooperation structure/LH Task Force” between LH” that aims at facilitating benchmark. It has been decided that this “cooperation structure/LH Task Force” will learn by doing, and therefore will adopt a joint approach focusing at first stage for both D567.1 and D567.2, and aiming at lasting during the whole project lifecycle. Final conclusions of the workshop were that despite the need for a joint approach, LHs keep having their own specificity: local context, geographical features, and national financial & legal regulations. As a consequence, when appropriate, some chapters will integrate a focus part dedicated to each LH.

D6.1 has been developed within this scope and context, and our contribution was dedicated to develop the baseline, ambition, drivers and barriers of Nice LH. To achieve this objective, we elaborated an approach based on a SWOT and social acceptance study, in line with modern developments in the economics of Smart Cities at the academic level, that reveal the baseline, ambition, drivers and barriers as an outcome of observation and assessment of the local ecosystem. This choice in the approach has been motivated by the willingness to provide an objective description of the ecosystem, avoiding segmented or partial representation. We also generated an informed description of it, and one of the critical efforts of UNS has been dedicated to collecting data, using inputs from all types of actors (city authorities, large companies, SMEs, support organisations, research and education actors). Finally, we aimed at elaborating a comparative setting, and for this we relied on the contribution of a large set of actors outside of Nice, i.e., in the Gothenburg and Utrecht ecosystems.

At the city level, we believe that the value of our analysis is strong, as the identification of baseline, ambition, drivers and barriers helps to better coordinate efforts at the local level, aligning incentives of actors that are private/public, large/small, incumbent/newcomers, together with characterising the propensity of consumers and end users to become smarter citizens. Again, the analysis produced here involves a comparison between Nice and other LH cities, but by no means a competition among them. The IRIS project is based on city collaboration (LHs and Follower Cities (FCs)) in view of exchanging experience, developing solutions at the local level, and consolidating them for replication at a larger scale. The conclusions of our analysis are fully embedded in this logic: by defining room for improvement in Nice that could equally be applied to all cities in the IRIS consortium, the intended outcome is to generate recommendations that may help all IRIS cities to be better off. In particular, thanks to the IRIS cooperation framework, the recommendations in D6.1 could make all partners better equipped in the global competition, becoming smarter and performing higher.

We further appraise recommendations and highlights for a smooth development of the IRIS project and contribute to define guidelines for Nice LH, that aim at easing the implementation of the IS foreseen in D6.2 “Coordination of NCA integration and demonstration activities”. In addition, we further elaborate

recommendations for the whole Nice Ecosystem, with highlights to each target audiences that have an impact on a longer term.

1.2 Contributions of partners

The work combines quantitative and qualitative analysis, with strong contributions from all IRIS partners and other actors in Nice, as well as collaboration from partners and actors in Gothenburg and Utrecht.

The work benefits from the participation of all the IRIS partners involved in WP6 (especially in D6.1 and D6.2, in coordination with the LHCSM, WP6-lead and TT-leads), since they all accepted to dedicate time and effort to gather data for our study, through the ecosystem questionnaire, the social acceptance questionnaire and face-to-face interviews. Beyond the IRIS partners, we could also rely on actors from Nice that helped us to frame a more global picture of the forces and weaknesses of the local ecosystem.

We could also count on the inputs from the IRIS partners in WP5 Utrecht and WP7 Gothenburg (especially in D57.1 and D57.2) for the definition of opportunities and threats when considering Nice with respect to other LH Smart Cities, in the form of data collected from the ecosystem questionnaire.

The list of contributors to our study can be provided here (in alphabetical order): AVEM, Azzura Lights, FUEL CELL SYSTEM, Akademiskahus AB, ALPHEEIS, ASKOLL, BA06-GOELECTRIX, BOEX, CAH, Capenergies, CCI, CEA, CHALMERS UNIVERSITY, CITY OF GOTEBORG, CITY OF NICE, CITY OF UTRECHT, CLEANENERGY PLANET, Club Smart grid cote d'azur, CSTB, EDF, EIFFAGE, ENECO, ENEDIS, ERIDANIS, ETSI, FARMGRID, FAUCON, GOELECTRIX, GRIDPOCKET, HELIOCLIM, HKU, HSB, IMCG, IMPERIHOME, INCUBATEUR PACA EST, IOTHINK SOLUTIONS, Johanneberg Science Park, KMO, MARIANKA, METRY, MILANAMOS, ORANGE, OVEZIA, POLYMAGE, Polytech, Riksbyggen, RTE, SCITY COOP, SENSEOR, SKAVENJI, SMARTSERVICE CONNECT, STEDIN, SUSTAINOMY, Trivector Traffic, TYRENS, UNS, UTRECHT UNIVERSITY, UTRECHTINC, VEOLIA, VULOG, WAYNOTE, WEVER, WIT.

We are particularly grateful to Christian Keim (EDF), Eric Simons (VULOG), Philippe Mailliard (VEOLIA) and Jean-Charles Maleysson (NCA) for their direct inputs to D6.1.

1.3 Relation to other activities

D6.1 is intended to exercise an impact on various deliverables, especially on D6.2 “Coordination of NCA integration and demonstration activities”. By collecting data on Utrecht and Gothenburg, while providing a deeper analysis of Nice in relation to other LH cities as control group, D6.1 can provide insights for D5.1 “Baseline, ambition & barriers for Utrecht lighthouse interventions” and D5.2 “Planning of Utrecht integration and demonstration activities”, as well as D7.1 “Baseline, ambition & barriers for Gothenburg lighthouse interventions” and D7.2 “Planning of Utrecht integration and demonstration activities”. An impact can also be expected on D2.1 “Lessons learnt through cooperation with other Lighthouse projects”, D3.2 “Sustainable business model dashboard tool”, D3.4 “SCUIBI-programme 3.0 hanbook for

implementation in IRIS cities and beyond", D8.1 "A road map for replication activities", and D10.9 "Communication and dissemination tools and materials".

1.4 Structure of the Deliverable

The rest of the Deliverable is organised as follows.

Chapter 2 presents the methodology on which the work in D6.1 is based. Specifically, it explains how we generated the baseline, ambition, drivers and barriers. One of the key methods used here, the SWOT, is considered as an *ex ante* evaluation exercise taking into account both the challenges inside the local ecosystem, but also the way in which other ecosystems in close or more distant neighbourhoods are performing. We have implemented and improved this method, in combination with the social acceptance study, using a focus group (Nice), and a control group (other LH cities, like Gothenburg and Utrecht). It has used both original surveys and interviews of experts that UNS designed and conducted for the IRIS project.

Chapter 3 characterises the Baseline, ambitions, drivers and barriers of Nice Lighthouse at the city level. It reports the findings and results emerging from the SWOT and social acceptance analyses, relying on the methodological frameworks which are first presented and then improved in view of the IRIS context. In particular, Chapter 3 explains in detail the approach, the description of work, and the results of the study we have conducted for the IRIS project, following two major steps: the first one, involving the Nice LH SWOT, is based on all the data we collected from policy institutions, research and education bodies, companies (including start-ups, SMEs and large companies), as well as supporting organisations; the second step, concerning the Nice LH study on social acceptance, focuses on a category of actors – i.e., consumers of energy and mobility services – that has been incorporated only indirectly in the Nice LH SWOT. As such, the social acceptance study serves as a complement to the SWOT. With this double entry, i.e., new technologies and the way in which consumers are adopting services offered by these technologies, we aim to provide an exhaustive picture of Nice LH with respect to other comparable Smart Cities.

Chapter 4 characterises the Baseline, ambitions, drivers and barriers of Nice Lighthouse demonstrators, based on the findings and results emerging from Chapter 3. It elaborates a series of recommendations on how to move to relevant objective-setting for the planned IRIS intervention/demonstration, defining recommendations to respective target audiences, and opening perspectives for the best articulation of the next phases of the IRIS project. This is achieved by emphasising for each Integrated Solutions in Transition Tracks where Nice LH city is involved at a notable level, functions in the SWOT and results in the social acceptance study that represent forces and opportunities or weaknesses and threats with the aim of prioritising actions. After having identified the *ex-ante* situation of Nice LH city before the enactment of the IRIS project (the baseline), attention is drawn to the ways of improvement for Nice LH city to reduce the gap in the scores with reference to the other LH cities (the ambition); this is performed through a careful examination of the drivers that Nice LH could take advantage of, and barriers that shall be overcome.

Chapter 5 describes the potential outputs for the other work packages, relying upon the results of the analysis performed in D6.1.

Chapter 6 concludes, and finally, Chapter 7 provides a series of recommendations based on all the main findings emerging from our empirical analysis.

At the end of the document, a series of Annex will report all complementary information used in this work. Especially, in Annex 1, 2 and 5, we report the full text of the ecosystem questionnaire, the guide of interview and the social acceptance questionnaire we used to collect the data, and express where the KPIs were integrated in our study. Annex 10 provides a detailed overview of the literature on Smart Cities, the indicators defining a Smart City, and the Smart City rankings. Understanding which factors contribute to define a city as “smart”, enables to better comprehend the methodological framework and the description of results, as well as the definition of strengths and weaknesses of a city in the SWOT analysis.

2. Methodology

2.1 Rationale

There are many ways to provide a baseline analysis, as well as a characterisation of the ambitions, barriers and drivers to achieve a given objective. Among these many possible ways, the SWOT analysis (Strengths - Weaknesses - Opportunities - Threats) is recognised by the European Commission as a strategy analysis tool[1]. It is an open, flexible tool that can be applied to the study of the strengths and weaknesses of an organisation, a geographical area, or a sector, with the study of the opportunities and threats to their environment. The aim of the analysis is to take into account internal and external factors, maximising the potential of strengths and opportunities, while minimising the impact of weaknesses and threats.

In the IRIS context, the SWOT is intended to define the current situation in the local ecosystem of Nice LH city, to explore the different possible paths towards the objectives of demonstration and replication of integrated solutions (IS) in the fields of energy and mobility, to contribute anticipating how these paths may materialise as large avenues overtime to encourage (or alternatively as dead-ends to avoid), and ultimately to shape the likely scenarios of evolution. This SWOT is thus elaborated in view of an *ex ante* evaluation, in order to determine, or check, strategic approaches in Nice LH city, but also to provide guidelines for the development of demonstration activities.

This whole exercise is never easy, as paths are not known in advance, and every ecosystem can be considered as a set of complex systems, since each actor/group of actors has expectations, objectives, beliefs and interactions that are specific, potentially involving at the collective level (at the level of a city, in particular) phenomena of imbalance, disruptive dynamics, path dependencies, and self-organisation; all phenomena that are at the heart of modern developments in the social sciences and sciences & techniques. The challenge of the exercise is to avoid these adversities and guide the ecosystem on a smooth evolution.

This chapter describes the main methodologies used in our work. We will first describe the SWOT and TIS methodologies. Subsequently, we will explain the methods we used to elaborate the SWOT analysis. The choice of the SWOT was made in order to pose a diagnosis on the baseline, ambition, drivers and barriers in Nice LH with the other IRIS LH cities (Gothenburg and Utrecht) considered as a control group. In a similar fashion, we will then explain, in a dedicated section of this chapter, the methodology and methods utilised in the social acceptance study. The latter was carried out to provide additional and complementary information for the Nice LH SWOT, by investigating not only the generation of smart technologies, but also the way in which they might be adopted by citizens.

2.2 Integrated SWOT and TIS approach: standard method

2.2.1 SWOT

The SWOT analysis is a standard tool where the different strengths, weaknesses, opportunities and threats are represented in a table (see Tab. 1), in which four different quadrants are delineated, one for each attribute of the SWOT. In the common use of this tool, strengths and weaknesses (SW) are related to internal elements, while opportunities and threats (OT) refer to external elements. In the context of the IRIS project, the content of the analysis lies in the assessment of the forces and weaknesses of some functions or elements that one may observe inside the local ecosystem of Nice LH, whereas opportunities and threats direct the attention on functions or elements of Nice LH in comparison with other Smart Cities.

Tab. 1: Definition of Strengths, Weaknesses, Opportunities and Threats.

SWOT ANALYSIS	
STRENGTHS (S) Functions (elements) where Nice LH ecosystem has an outstanding performance	**WEAKNESSES (W)** Functions (elements) where Nice LH ecosystem has a poor performance
OPPORTUNITIES (O) Functions (elements) of the Nice LH Ecosystem that give it an advantage over others	**THREATS (T)** Functions (elements) of the Nice LH Ecosystem that give it a disadvantage over others

Although widely used in academia and business, the standard SWOT analysis has some limitations, the major one being that it is not grounded on a solid analytical framework. Implications might be that the real value of discovering forces, weaknesses, opportunities and threats is misused, and that the results are simply there to validate strategic choices that are already in place or echo the vision of some actors in the ecosystem but not of a large number of them.

2.2.2 TIS

In view of developing the IRIS SWOT with solid analytical grounds, we are using the TIS methodology (standing for Technological Innovation System), which has been developed in a Manual for Analysts at the University of Utrecht (Hekkert et al., 2011); in addition, the TIS is also largely familiar to the University of Gothenburg and the University of Nice (Hekkert et al. 2007; Bergek et al., 2008; Krafft, 2004). The TIS methodology is able to characterise a set of seven different functions, integrating and connecting them into a consistent body of analysis. Specifically, the TIS methodology is dedicated to analyse and evaluate the development of a particular technological field in terms of the structures and processes that support or hamper it. Concerning the structure of the innovation system, a major task is identifying the actors and rules that make up the system. Moving on to how the system is functioning, it requires more attention on 7 functions[2]: Entrepreneurial Experimentation and Production, Knowledge Development, Knowledge Exchange, Guidance of Search, Market Formation, Resource Mobilisation, and Resistance to Change.

The first function (F1), Entrepreneurial Experimentation and Production, is dedicated to identifying the initiatives at the local level and the appropriate quantitative and qualitive efforts in respect to the objectives of Nice LH. Basically, this function identifies the way in which the local ecosystem innovates and how the major actors are involved in this innovation process.

The second function (F2), Knowledge Development, is focused on whether knowledge development is sufficient for the development of the innovation process, and if the type of knowledge created fits with the targeted objectives.

The third function (F3), Knowledge Exchange, analyses whether links between science and industry, or users and industry, are effective, and if knowledge exchanges are sufficient across geographical borders.

The fourth function (F4), Guidance of Search, controls if there is a clear vision on how the industry or the market should develop, if the strategy is grounded on a clear policy goal, and if the expectations of the different actors are sufficiently aligned.

The fifth function (F5), Market Formation, evaluates the current and expected size of the market, and if the different actors diverge or converge in future market appraisal.

The sixth function (F6), Resource Mobilisation, focuses on how resources can be included in the project of the ecosystem, and especially if key resources are available within the ecosystem or outside of it.

The seventh function (F7), Resistance to Change, identifies if there are limits in the development of the project, as this may involve a change of habits in consumption, development and production.

Each of the system functions can be scored on a 5-point Likert scale. If one of the seven functions gets 1, this means that the ecosystem performs very badly in this function; contrariwise, if the function ranks 5, this is an indicator that the ecosystem is very strong in that domain. A spider graph can be represented for the ecosystem under study (Fig. 1).

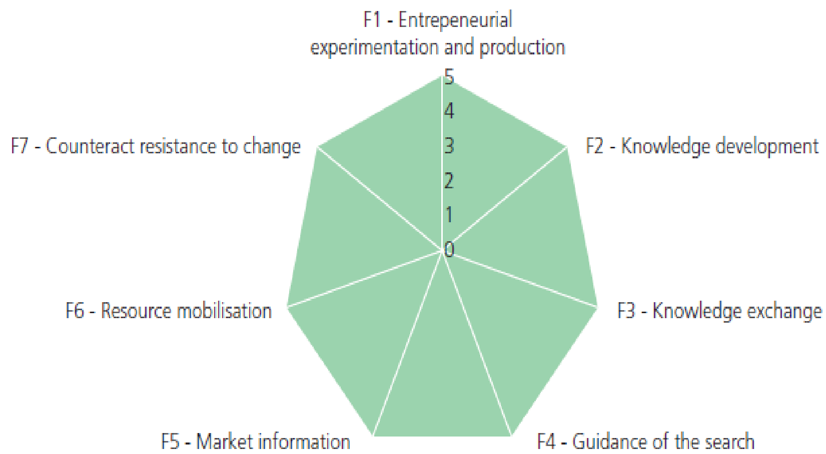

Fig. 1: Overview of functions fulfilment in a spider graph (source: Hekkert et al., 2011).

Depending of the stage of development of the technology at the level of the local ecosystem, some functions will be more important than others. For instance, in the pre-development phase, Knowledge Development (F2) will be more central than other functions and might also be impacted by the way in which knowledge is exchanged at the local level, the way in which there is a clear convergent vision among actors, and the way in which actors successfully mobilise critical resources. In the development phase, Knowledge Development (F2) is still of primary importance, as well as how it can turn into Entrepreneurial Activities (F1) at the local level. In the take-off phase, Entrepreneurial Activities (F1) and Resistance to Change (F7) will be of higher importance. In the acceleration phase, Market Formation (F5) drives most of the concerns (Fig. 2).

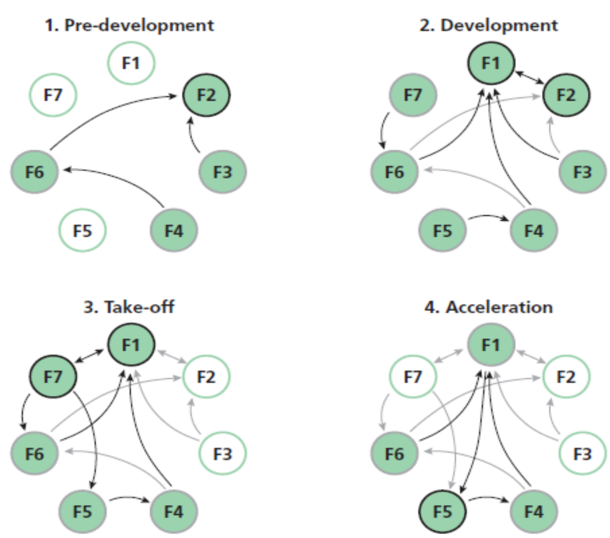

Fig. 2: Functional patterns per phase (source: Hekkert et al., 2011).

Summing up, the TIS methodology allows us to develop the SWOT analysis, since we are able to stress the functions on which the local ecosystem is strong or weak, the functions on which some efforts could be brought to turn an opportunity into a force, and the functions that perform badly and represent a barrier for the development of the ecosystem. Moreover, it is also possible to mitigate the absolute results of the SWOT with respect to the stage of development of the Transition Tracks of the ecosystem, by distinguishing primary functions that exert a direct influence in specific development stages and background functions that are in support across stages. In detail, the five Transition Tracks are: Renewable and energy positive districts (TT1), Flexible energy management and storage (TT2), Intelligent mobility solutions (TT3), Digital transformation and services (TT4), and Citizen Engagement and Co-creation (TT5)[3]. It is important to remark that within these five tracks, the IRIS project aims at providing a set of integrated solutions built on top of both mature and innovative technologies.

2.3 Social acceptance: standard method

The analysis of social acceptance relies on an empirical methodology whose source of information is drawn by a questionnaire focused on households and their habits and inclination to change in energy, mobility and ICT behaviours (namely, the broad fields encompassing the different Transition Tracks). Specifically, in order to study the factors influencing the disposition of the citizens of Nice to become 'smart', and to increase our understanding of their willingness to adopt smart services, an empirical survey was designed and conducted; the questionnaire has been built from an important literature review in the fields of innovation adoption[4], transportation and energy habits, which will be reported below. Data were gathered in April 2018 following a quota sampling method. Specifically, interviews were conducted on a sample of 500 individuals living in Nice and 501 individuals living in another city in France. The latter city was taken as a benchmark with respect to Nice, since it represents a French city sharing similar populational characteristics compared to Nice, such as demographic, socio-economic as well similar Smart Cities initiatives. The group of citizens living in the control city is treated and labelled as the 'control group' in the following sections. Nice citizens and citizens of the control group city were interviewed by phone during a period of three weeks. The survey is composed of six parts that will be described below[5].

The aim of the first part of the questionnaire was to build a profile of the citizens who participated in the survey. Specifically: their socio-demographic characteristics (gender, age, level of education and profession), place of residence, type of residence (villa, apartment, other), their status (tenant, landlord), and household size and characteristics. To sum up:

- Localisation (question RS1)
- Gender (question RS2)
- Age class (question RS3bis)
- Number of members composing the household (question RS4)
- Number of children below the age of 16 living in the household (question RS5)
- House type (question RS6)

- Occupational housing status (question RS7)
- Profession (question RS9)
- Level of Education (question RS10)

In the second part of the questionnaire, the goal was to find out more about citizens' mobility behaviours. Questions have been built from a literature review on ecological transport mode adoption (Pasaoglu et al., 2014; Plötz et al., 2014). Citizens were asked if they are in possession/not in possession of a private transport mode (classical car, electric car, hybrid car, two-wheeled vehicle, bicycle, etc.), the frequency of use for alternatives modes of transport rather than car (always, frequently, occasionally, never), the distance in kilometres between their house and their work/study place (less than 5km, between 5 and 10 km, 10 and 15 km, more than 20 km), and the transport mode they chose for their daily home-work/home-study journeys (own car, bus, tramway, bicycle, etc.), for shopping and for leisure activities. In synthesis:

- Disposition of a personal mode of transport (question RS8)
- Frequency of utilisation of alternative modes of transport besides the car (question Q1)
- Distance home - work/home - study place (question Q2)
- Mean of transport used to go to work/study (question Q3)
- Mean of transport used for shopping (question Q3bis)
- Mean of transport used for leisure (question Q3ter)

The third part focuses on citizens' energy habits. Questions have been built based on the theoretical framework developed in Kendel et al. (2017). A general profile of Nice citizens and their control group could be drawn thanks to questions asking survey participants about the type of heating they have in their house (collective, gas individual, electric individual, other), the energy provider (EDF, Direct Energie, Engie, other), and if insulation activities or the setting up of devices utilising renewable energies have been carried out in their houses (yes or no). Then, survey participants were also asked about their daily energy habits. More precisely, they were asked if they always, often, rarely or never (i) lower the heating system when a room is unoccupied or (ii) when their house is unoccupied for a long period, (iii) if they turn off the light in rooms where there is no one, (iv) if they check the energy consumption of new devices before buying them. In synthesis:

- Type of heating system (question Q4)
- Energy provider (question Q5)
- Set up of energy devices relying on renewable resources (question Q6)
- Carrying out of insulation activities (question Q7)
- Energy habits (question Q8)

The third part also presents a section dealing with a cross analysis between energy and mobility habits; specifically, it refers to the usage of the electric car service. The latter is a city service which was firstly implemented in Nice in 2011 as a pilot scheme, and then extended to the rest of France. Overall, the electric car service can be seen as a smart alternative mode of transport. The questions covering this issue are the following:

- Degree of utilisation of the electric car service (question Q11)
- Propensity to use the electric car service (question Q11bis)

The fourth part of the questionnaire tries to know more about citizens' environmental awareness. Specifically, what citizens attribute as a cause for climate change; environmental consequences related to mobility and energy habits, and whether citizens had recently changed their journey and/or energy habits (for environmental reasons) following a family advise; in synthesis:

- Reasons for climate change (question Q13)[6]
- Thinking about environmental reasons in relation to mobility and energy habits (question Q14)
- Frequency of family advices related to changing mobility and energy habits (question Q15)

The fifth part of the questionnaire focuses on citizens' adoption and use of information and communication technologies. Questions have been built based on an important review of the ICT adoption literature. The first two questions are adapted from Cecere et al. (2015): if survey participants are (yes or no) owners of a laptop or a smartphone allowing them to use the internet. If yes, if they use (yes or no) the following social network services (SNS): Facebook, Twitter, LinkedIn, Snapchat, WhatsApp, others. Then, survey participants had to indicate if (i) they use these types of services: at least once a week, at least once a month, at least once a trimester or never; (ii) and if they are very, rather, not, or not at all concerned about the possibility that their personal data could be stored, the accessibility of their personal data by unauthorised third parties, the possible usages of their personal data by the app server, the possibility of their personal data being sold. Then, based on a previous survey carried out in Instant Mobility for Passengers and Goods (Grant Agreement FP7-2011-ICT-FI), a EU 7th Framework Program (FP7) project funded under the Programme "ICT-Future of the internet-Use case scenarios and early trials" and conducted from 2011 to 2012, questions have been built to measure survey participants willingness to use smart services that are geolocation-based on the one hand, and conditioned to individuals' location disclosure on the other hand (Attour, 2017). More precisely, they were asked if they are (yes or no) willing to use smart geolocation-based services if the system stored, reuses, gives access or sells their location to third parties. In the IRIS context, these last two questions were applied to smart energy services in addition to smart mobility, with the aim of being able to compare the willingness of Nice citizens to adopt both smart mobility and smart energy services. In our study, survey participants were asked if they used or frequently[7] used a mobile application allowing them to follow their energy consumption at home, and how they value their level of concern regarding the storage, reuse, accessibility or commercialisation of their energy consumption information. The answer to this question is based on a Likert scale, from strongly concerned to not at all concerned. If survey participants did not use such a mobile application,

they were asked if they would be willing to use such device in the future knowing that the system might: store, reuse, give access or sell their consumption data. To summarise:

- Possession of a smartphone or laptop enabling internet access (question Q16)
- Utilisation of social apps (question Q16bis)
- Reasons of concern in using smart apps (question Q17)
- Usage of the geolocation service (question Q18)
- Reasons of concern in using the geolocation service (question Q19)
- Usage of a smart app tracking energy consumptions (question Q20)
- Reasons not to use a smart app tracking energy consumptions (question Q20bis)
- Reasons of concern in using a smart app tracking energy consumptions (question Q20ter)

Finally, the sixth and last part of the questionnaire regroups questions to better understand survey participant willingness to change their transport and energy habits. Four key questions were built. The first one investigates their motivations to change their transport habits in relation to: (i) reducing the carbon footprint, (ii) improving the quality of life of the city, (iii) considering economic reasons, (iv) considering health reasons, (v) considering other reasons other than the ones proposed here. Then, survey participants were asked the time frame within which they expect to modify their transport habits: very soon, rather soon, not so soon, not soon. These last two questions had been then re-asked considering the case of willingness and motivations to change energy habits. Always with reference to mobility habits, individuals were further asked whether they would be keen to change their energy provider. In synthesis:

- Reasons to change mobility habits (question Q9)
- Timing in changing mobility habits (question Q9bis)
- Reasons to change energy habits (question Q10)
- Timing in changing energy habits (question Q10bis)
- Willingness to change energy provider (question Q12)

2.4 Integrated SWOT and TIS approach: method improvements

2.4.1 *Description of work – the five steps of analysis*

The work on SWOT and TIS combines quantitative and qualitative analysis. Specifically, relying on an extensive literature (see, e.g., Jeyaraj et al., 2012; Bell and Rochford, 2016; Aich and Ghosh, 2016; Khoshbakht et al., 2017; Hekkert et al., 2011; Hekkert et al. 2007; Bergek et al., 2008; Krafft, 2004), we elaborated a questionnaire composed of 58 questions (questionnaire attached in Annex 1), structured

into 7 sections corresponding to the 7 functions of the TIS analysis. For each question, the possible answers are “Very low, Low, Average, Strong, Very strong” corresponding to a 5-point Likert scale “1, 2, 3, 4, 5”. This gives us a quantitative appraisal of the global forces and weaknesses of the local ecosystem under focus. In view of determining the opportunities and threats, we needed to elaborate a control group of respondents external to the local ecosystem. We also elaborated a guide of interview (attached in Annex 2) to collect qualitative information from face-to-face interviews with some of the major actors in the ecosystem, in order to help us refining the results of the SWOT. The guide of interview was based on the exploitation of 44 questionnaires in Nice LH and 32 in the other LH cities (19 in Gothenburg and 13 in Utrecht). Our sample in Nice, but also in Gothenburg and Utrecht, is composed of a well-balanced representation of the actors involved in public decision-making, including hard and soft regulations (legislation, standards and IPR, together with ethics, norms and behaviours), research and education, supply with large incumbent firms as well as start-ups, company support and innovation network organisations.

The first step in the analysis is to elaborate the sample and delimit the structure of the ecosystem (focus and control group), i.e., identifying who is active in it. As shown in Fig. 3, this includes: i) actors (research and education, supply, demand), ii) support organisations (finance, innovation and company support, network organisations); iii) institutions (government bodies, hard and soft institutions). A well-balanced sample of respondents of these three categories ensures the robustness of results.

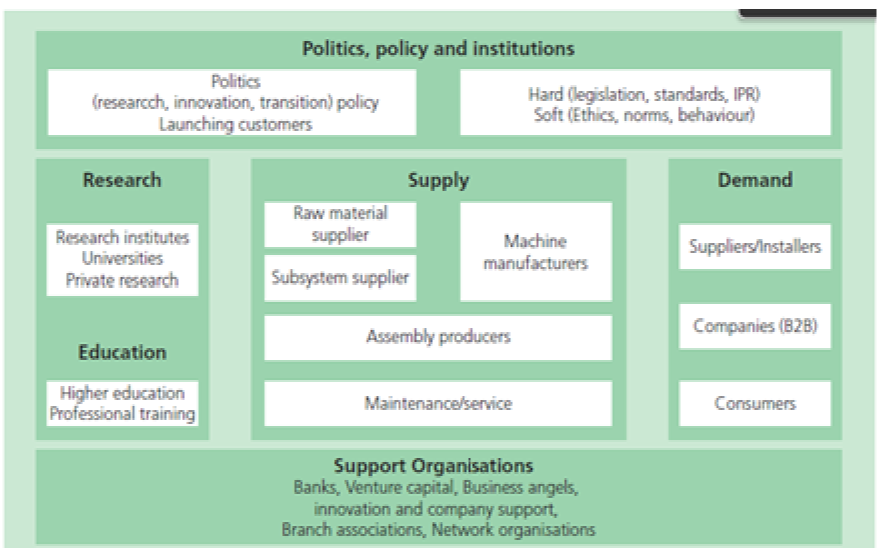

Fig. 3: Structure of the innovation system (source: Hekkert et al., 2011).

This represented structure has strong connections with the functions described in paragraph 2.2.2:

- Supply actors – basically large and small companies – are the key developers of Entrepreneurial Experimentation and Production (F1), as they contribute to the development of radical or more incremental innovation.
- Supply actors, but also research and education, can be considered as key sources of Knowledge Development (F2)
- Support organisations are the essential promoters of Knowledge Exchange (F3)

- Local policy actors, like city authorities, are one of the best representatives of Guidance of Search (F4)
- Supply actors are again a key in Market Formation (F5)
- Supply actors, support organisations, research and education, as well as policy actors, are essential in the development of Resource Mobilisation (F6)
- All actors are important with reference to Resistance to Change (F7), as this relates to a change of habits in consumption, development and production.

The second step is to determine the phase of development, since to every stage corresponds a different structure; in addition, certain functions will be more relevant than others. The reference here is an S-shape diffusion curve. The usual decomposition represented below regroups 4 phases: predevelopment (is there a working prototype?), development (is there a commercial application?), take-off (is there a fast market growth?), and acceleration (is there market saturation?). In the IRIS context, we adapted to 3 stages: pilot (P), demonstration (D), and replication (R) (Fig. 4).

The third step is to make sure that all the different functions will be understood and filled in appropriately. The best way to provide a good assessment is to involve a sufficient number of experts in the evaluation, and ask them very specific diagnostic questions, whether the amount of activities is sufficient, and whether they form a barrier for the innovation system to further develop and move towards the following phase of development.

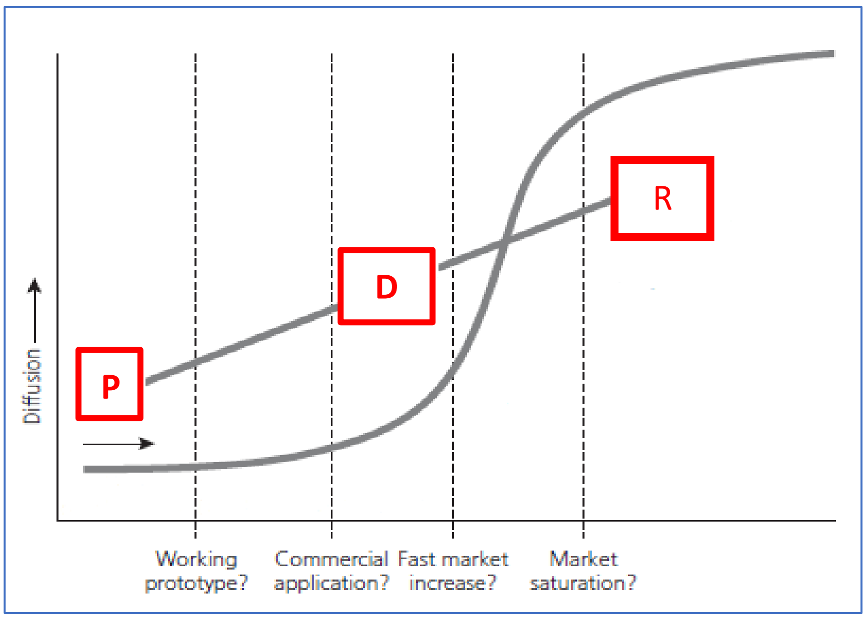

Fig. 4: Phases of development (adapted from: Hekkert et al., 2011).

The fourth step and the fifth step is dedicated to the main forces and weaknesses internal to the system, as well as to the opportunities and threats external to the system, and to provide guidelines for appropriate policy or strategy making.

Summing up, Fig. 5 provides an overview of the different key steps in the analysis.

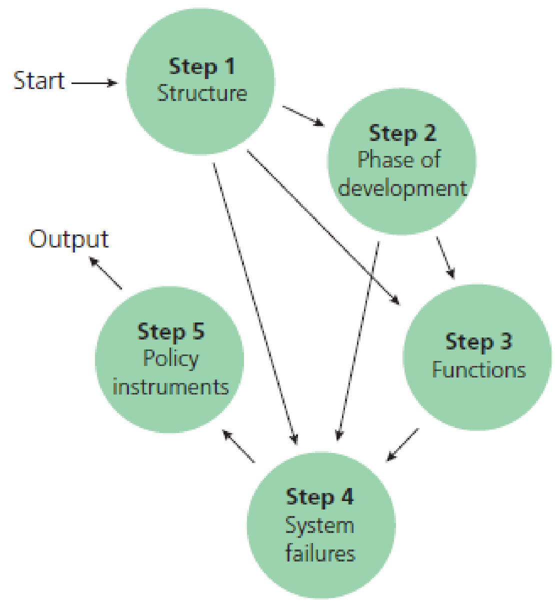

Fig. 5: Schematic representation of the 5 steps in analysing a Technological Innovation System for policy analysis (source: Hekkert et al., 2011).

To go through these different steps, we primarily exploit data from the questionnaire, as well as qualitative information from interviews; the combination of qualitative and quantitative information is intended to give us a fine and exhaustive appraisal of the ecosystem on which to build the SWOT.

2.4.2 Description of work questionnaire and interviews

To elaborate the SWOT, we developed and conducted a protocol based on two pillars:

- Quantitative: an ecosystem survey where we collected anonymised data in Nice (using Utrecht and Gothenburg as a reference or 'control group') from which we built spider graphs for investigating strengths, weaknesses, opportunities and threats, and derived results with a double entry: ecosystem and Transition Tracks.
- Qualitative: a series of face-to-face interviews with key actors in Nice, in order to get more details on strengths, weaknesses, opportunities and threats in view of refining the survey analysis, and to develop scenarios on how to overcome weaknesses, or turn threats into opportunities.

The initial quantitative analysis is based on the exploitation of 44 questionnaires in Nice LH and 32 in the other LH cities, i.e., the control group (19 in Gothenburg and 13 in Utrecht). The qualitative interviews in Nice LH served to provide a comparative assessment of the forces and weaknesses, also double checking the inconsistencies revealed in the quantitative study (if any). The sample of 20 interviews we conducted is obviously by no means representative for the entire ecosystem, but we did again take care of a well-balanced representation for the different categories of actors, and we managed to interview top representatives for each actor.

Ecosystem survey

With reference to the questionnaire, the latter has been elaborated in view of collecting data from key actors in the ecosystem on the forces and weaknesses in Nice LH to operate the SWOT (see Tab. 2). Our sample is composed of a well-balanced representation of actors involved in public decision-making, including hard and soft institutions, research and education, supply with large incumbent firms as well as start-ups, company support and innovation network organisations. While public institutions are able to express the views of citizens, we believe that this could only capture an indirect vision of it; therefore, we decided to dedicate a special section to this specific issue to get an overview of the direct demand through the social acceptance study.

Tab. 2: Structure of actors questioned in Nice.

Structure of the Nice ecosystem questioned		
Politics, policy and institutions: 4		
Research and education: 5	**Supply: 30**	**Demand** Public institutions may provide a representation of indirect demand. A focus on social acceptance will capture direct demand.
Support organisations: 5		

The same exercise was replicated with a sample of actors in the control group (see Tab. 3). The latter is smaller compared to Nice LH, but in the former sample, the number of the different types of actors resulted to be rather equivalent (with the share of supply actors being less important compared to Nice LH). We can explain the difference in sample size by the fact that Nice had the opportunity and resources to contact a large spectrum of actors, while for the control group we approached essentially the IRIS partners that had less resources to dedicate to that task.

We circulated the questionnaire and used different ways to approach top representatives for different types of actors. To contact the actors (Tab. 3), we firstly approached them by email and then we followed them up by phone. In both cases, each participant was assured that all answers would have been kept confidential.

Tab. 3: Structure of actors questioned in the control group.

Structure of control group questioned		
Politics, policy and institutions: 10		
Research and education: 7	**Supply: 10**	**Demand** Public institutions may provide a representation of indirect demand.
Support organisations: 5		

Our ecosystem questionnaire included a Transition Track entry to identify the stage of development of technologies (see Fig. 6 below). It turns out that Tracks 1, 2, and 3 can be characterised by a stage of development which is relatively advanced, i.e., development/replication; while Tracks 4 and 5 are more at an early stage pre-pilot/pilot. This is consistent with the fact that the project is not considering any substantial development of new technologies, except from those related to the CIP platform and citizen engagement services.

Transitions Tracks	Integrated Solutions	Lighthouse Cities									Follower Cities			
		Utrecht			Nice Cote d' Azur			Gothenburg			Vaasa	Alex	Tenerife	Focsani
#1 Smart renewables and closed-loop energy positive districts	IS-1.1: Positive Energy Buildings	-	-	R	-	D	R	P	D	R	R	R	R	-
	IS-1.2: Near zero energy retrofit district	P	D	R	P	D	R	P	D	R	R	R	R	R
	IS-1.3: Symbiotic waste heat networks	-	-	R	P	D	R	P	-	R	R	R	-	-
#2 Smart Energy Management and Storage for Energy Grid Flexibility	IS-2.1: Flexible electricity grid networks	-	D	R	P	D	R	-	D	R	R	-	-	-
	IS-2.2: Smart multi-sourced low temperature district hea with innovative storage solutions	P	-	R	P	D	R	P	D	R	R	R	-	R
	IS-2.3: Utilizing 2nd life batteries for smart large scale sto schemes	-	D	R	P	D	R	-	D	R	-	-	R	-
#3 Smart e-Mobility Sector	IS-3.1: Smart Solar V2G EVs charging	P	D	R	P	D	R	P	-	R	R	R	R	R
	IS-3.2: Innovative Mobility Services for the Citizens	P	D	R	P	D	R	P	D	R	R	R	R	R
#4 City Innovation Platform (CIP)	IS-4.1: Services for Urban Monitoring	P	D	R	P	D	R	P	-	R	R	R	R	R
	IS-4.2: Services for City Management and Planning	P	D	R	-	-	-	P	D	R	R	-	-	R
	IS4.3: Services for Mobility	P	D	R	-	D	R	-	-	-	R	-	R	R
	IS-4.4: Services for Grid Flexibility	P	D	R	-	-	-	-	D	R	R	R	-	-
#5 Citizen engagement and Co-creation	IS-5.1: Co-creating the energy transition in your even environment	P	D	R	P	D	R	P	D	R	R	R	R	R
	IS-5.2: Participatory city modelling	P	D	R	P	D	R	P	D	R	R	-	-	-
	IS-5.3: Living labs	-	D	R	-	-	-	P	D	R	R	-	-	-
	IS-5.4: Apps and interfaces for energy efficient behaviour	P	D	R	P	D	R	-	D	R	R	R	R	R

Fig. 6: IRIS Integrated Solutions Matrix.

Fig. 6 expresses that while all TTs are equally important, TT4 and TT5 represent domains in which further efforts are implemented relative to other Transition Tracks in order to get a robust evidence that the solutions can operate at a large scale. From this, we could interpret TT1, TT2 and TT3 as being in a phase of "Demonstration/Replication", meaning that they benefit of both a technological and a market maturity, whereas TT4 and TT5 are more likely to be classified as in the "Pre-pilot/Pilot" phase involving that a

prototype is produced and that there is some sound evidence that the new technology and potential uses can work.

Ecosystem interview

We performed a qualitative analysis of the fully transcript interviews. Using the software NVivo which is designed to organise and analyse transcripts, we were able to find insightful content from qualitative data such as interviews. From this, we could isolate questions in the interview and ecosystem questionnaire that led without ambiguity the respondent or the interviewee to be able to express a positive (or negative) impact of the question on the function. We called them 'critical questions' and decided to use them in the calculation of the scores, even if the whole set of questions was indeed considered to feed the interpretation. This step has been crucial to match the responses of the ecosystem questionnaire with the narrative collected during the interviews, leading to a SWOT strongly based on quantitative and qualitative data.

Our semi-structured interview guide consists of two parts (see in Annex 2). First, we asked about the general characteristics of the firm or organisation and the role of the interviewee in that organisation. The second set of questions referred to a business idea (i.e., promising project which engages and structures the future business model) that actors could foresee in the context of the Smart City. Interviews were conducted face-to-face or via telephone or Skype, and lasted on average one hour (between 40 minutes and 2 hours). These were recorded and transcribed through verbatim.

Tab. 4: Structure of actors interviewed in Nice.

Structure of the Nice ecosystem interviewed		
Politics, policy and institutions: 3		
Research and education: 3	Supply: 11	Demand Public institutions may provide a representation of indirect demand. A focus on social acceptance will capture direct demand.
Support organisations: 3		

2.5 Social acceptance: method improvements

The analysis of social acceptance was carried out utilising econometric and statistical methods designed to deal with qualitative data deriving from surveys. Specifically, the aim of the analysis of social acceptance is to analyse survey participants' responses to the questionnaire, studying their habits and their inclination to adopt smart practices (i.e., positive willingness to change, with special regard to environmentally responsible behaviours) with reference to the domains related to:

- Mobility

- Energy
- ICT
- Environment

In particular, the main objective for each domain consists of analysing: first, which is the influence exercised by certain key variables (*in primis*, socio-demographic characteristics) on the habits of individuals related to each domain. Secondly, which is the impact exercised by the same socio-demographic variables on individuals' inclination to change, quantifying, in both cases, these effects. Thirdly, whether there exists a significant difference in terms of habits and inclination to change among individuals living in Nice and individuals living in the control city. To this aim, we exploited a cross-sectional dataset built upon the answers we received from the questionnaire; due to the fact that the latter involve qualitative responses, virtually all the variables of the dataset we have generated are ordinal or categorical (with the exception age, constituting a discrete variable). For the analysis, with reference to the empirical strategy we decided to adopt, the latter can be summarised into three main steps, which will be replicated in a virtually identical fashion for each domain when analysing both the habits and the inclination towards change by citizens[8]. These steps rely, each one, on a different statistical method, and can be briefly summarised as follows; in the first step, we implemented a series of tests to assess the degree of association between the variables of interest (namely, socio-demographic variables and variables associated to each domain). In the second step, we performed principal component analysis (PCA)[9], in order to reduce the dimensionality of the data. In the third step, we carried out econometric analysis in order to quantify the effects of certain key variables on habits and inclination to change; this was mainly performed using multinomial logit models, which represent econometric methods well suited to treat qualitative survey data[10]. Providing more statistical details on these methods without references to practical examples deriving from the data, may result to be rather cumbersome to an audience not familiar with statistics. In the light of this, the description of such methods will be expanded when describing the findings emerging from the social acceptance study in Chapter 4. In addition, for the ease of exposition, the complete (tehnical) explanation for each method is reported in the technical Annexes 7, 8 and 9 (with reference to the sole mobility habits[11]).

3. Baseline, ambition, drivers and barriers of Nice Lighthouse at the city level

In this chapter, we provide the “baseline” as the results of our SWOT and social acceptance study, i.e., as a description of the current situation of the ecosystem of Nice and the different Transition Tracks before the IRIS project starts and any intervention has been made. The “ambition” also comes out from these results, as it designs a benchmark when other IRIS LH cities that compose the control or reference group are scoring better; a benchmark that the IRIS project should encourage to achieve through the close collaboration among partners. We also generate, from our results, a detailed account of the drivers and barriers on the way from the baseline to the ambition.

3.1 SWOT: baseline, ambition, drivers and barriers at the Ecosystem level

Based on the methodology described in Chapter 2, we were able to generate a spider graph for the ecosystem level, with Nice in blue and the control group in yellow. The baseline is thus given by the blue line, and the ambition materialises when the yellow line expands the blue line.

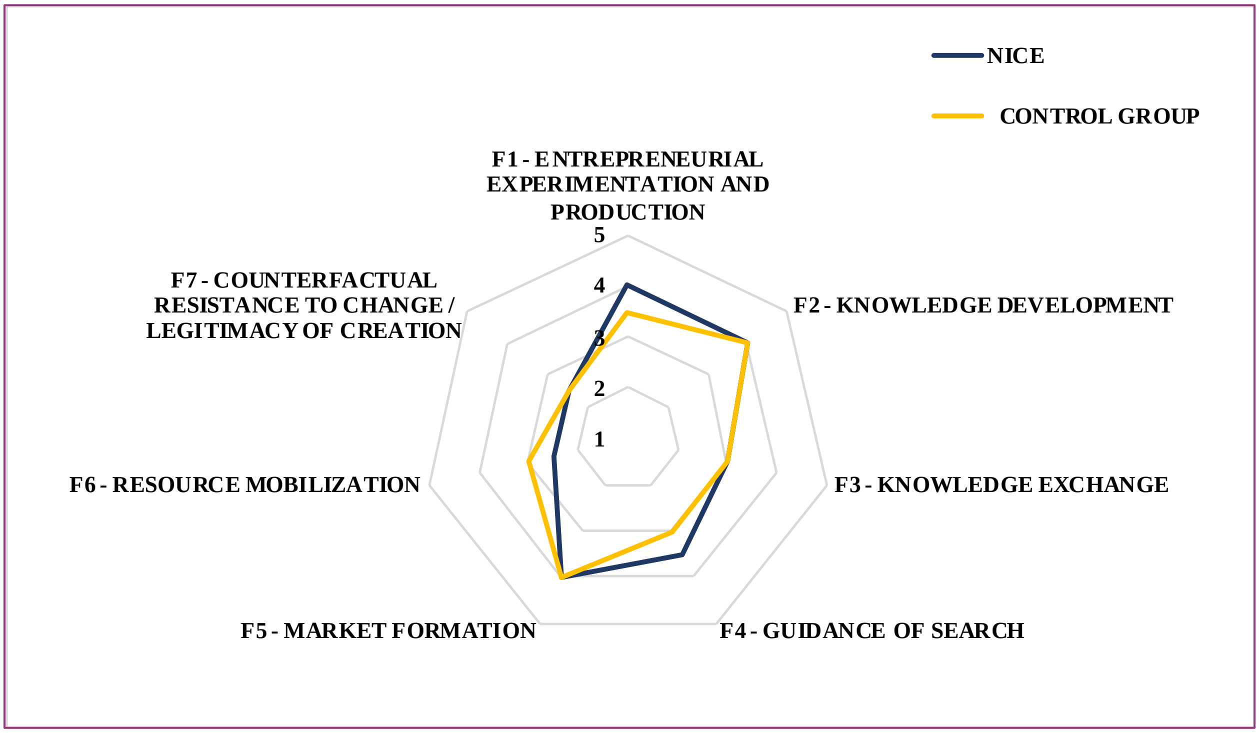

Fig. 7: Spider graph ecosystem Nice and the other LHs as a control group.

Trying firstly to assess the strenghts and weaknesses of Nice LH, we choose to consider significant thresholds for each function values: a strength will be detected whenever a score is above or equal to 3.5, while a weakness will be characterised by a score below or equal to 2.5. A difference of 1 point in the score sets the limit between a strength and a weakness.

Strengths and Weaknesses

Functions F1, F2, F4, F5, have a high score and correspond to a strength for Nice. Alternatively, Nice also has weaknesses relative to F6 and F7. We can interpret this as Nice being a showcase of Entrepreneurial Experimentation (F1) and Knowledge Creation (F2) in the domain of Smart Cities, together with Nice as having a robust vision of the Development of Market Opportunities (F5). Nice also benefits of a strong alignment and coordination among actors and Guidance of Search (F4) from public actors in charge of the development of the Smart City. On the other hand, Nice also exhibits weaknesses, as some tensions may occur in the Mobilisation of human and financial Resources (F6) whenever the expected entrepreneurial demonstration, market formation and knowledge stimulation are high. We can also report some Resistance to Change (F7) at the organisational level, as Smart City issues involve a transversal approach which may not appear in current vertical/silos structures of local actors. Resistance to Change can also echo a limited ability or motivation of consumers, and end users to adopt new solutions in energy, mobility and ICT.

Opportunities and Threats

Looking now at the opportunities and threats of Nice LH, the city is performing slightly better in Functions F1 and F4 compared to the other LH cities composing the control group. This confirms that entrepreneurial dynamism, together with strong guidance by political decision-makers, is a key for success. Nice definitely has an advantage in that field that needs to be consolidated in view of performing higher. However, we can also confirm that Resource Mobilisation (F6) is a field in which progress has to be achieved, as Nice appears behind the control group. This function is of crucial importance, especially whenever the city wants to maintain a high level of Entrepreneurial Experimentation and Market Formation based on sound Knowledge Development.

Tab. 5 summarises the findings, with Drivers underlined as the combination between Strengths and Opportunities, while Barriers appearing as the combination between Weaknesses and Threats.

Tab. 5: SWOT ecosystem.

SWOT Nice Ecosystem	
STRENGTHS (S)	**WEAKNESSES (W)**
F1 - Entrepreneurial Experimentation and Production **F2 - Knowledge Development** **F4 - Guidance of Search** **F5 - Market Formation**	**F6 - Resource Mobilisation** **F7 - Counterfactual Resistance to Change/Legitimacy of Creation**
OPPORTUNITIES (O)	**THREATS (T)**
F1 - Entrepreneurial Experimentation and Production **F4 - Guidance of Search**	**F6 - Resource Mobilisation**

DRIVERS

BARRIERS

3.2 SWOT: baseline, ambition, drivers and barriers at the Transition Track level

The same methodology was used for each Transition Track, and it was able to exhibit the following five spider graphs, providing for each one the respective score of Nice and of the control group. The baseline is again given by the blue line, and the ambition materialises when the yellow line expands the blue line. This TT level complements the global picture of the ecosystem level: it is as if we could zoom on the components of the ecosystem level by getting at the technological profiles of evolution. We could decompose for each TT the situation of Nice compared to the other Smart Cities (Gothenburg + Utrecht).

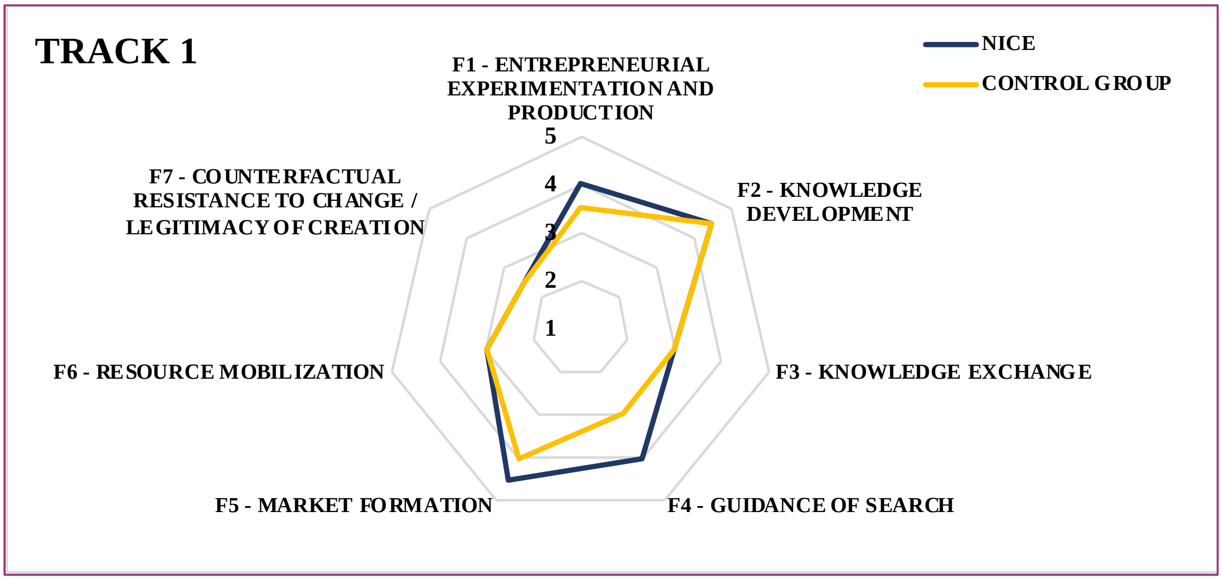

Fig.8: Spider graph TT1 Nice and the other LHs as a control group.

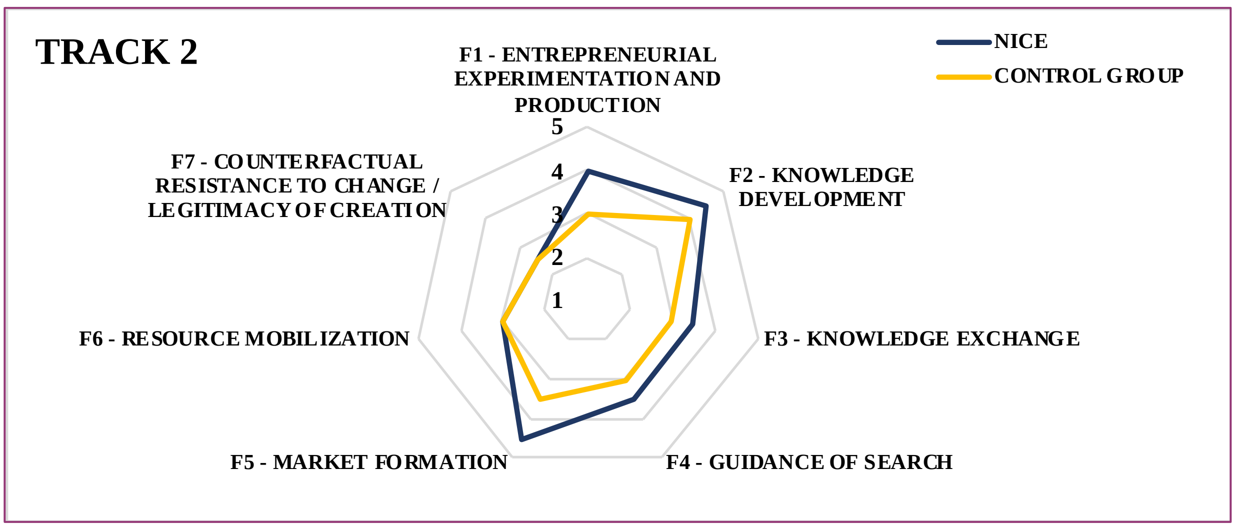

Fig.9: Spider graph TT2 Nice and the other LHs as a control group.

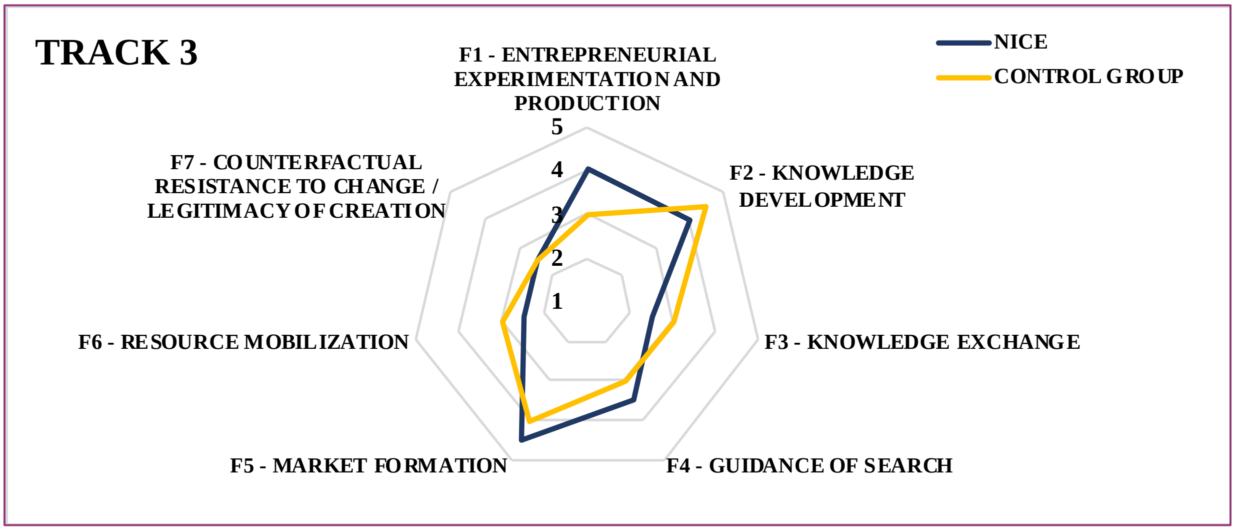

Fig.10: Spider graph TT3 Nice and the other LHs as a control group.

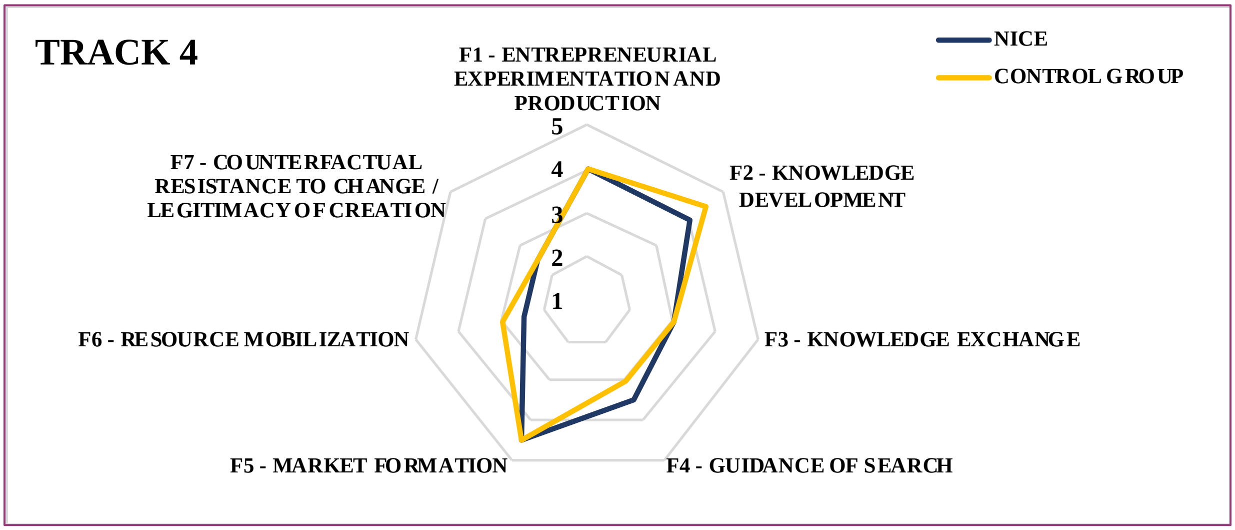

Fig.11: Spider graph TT4 Nice and the other LHs as a control group.

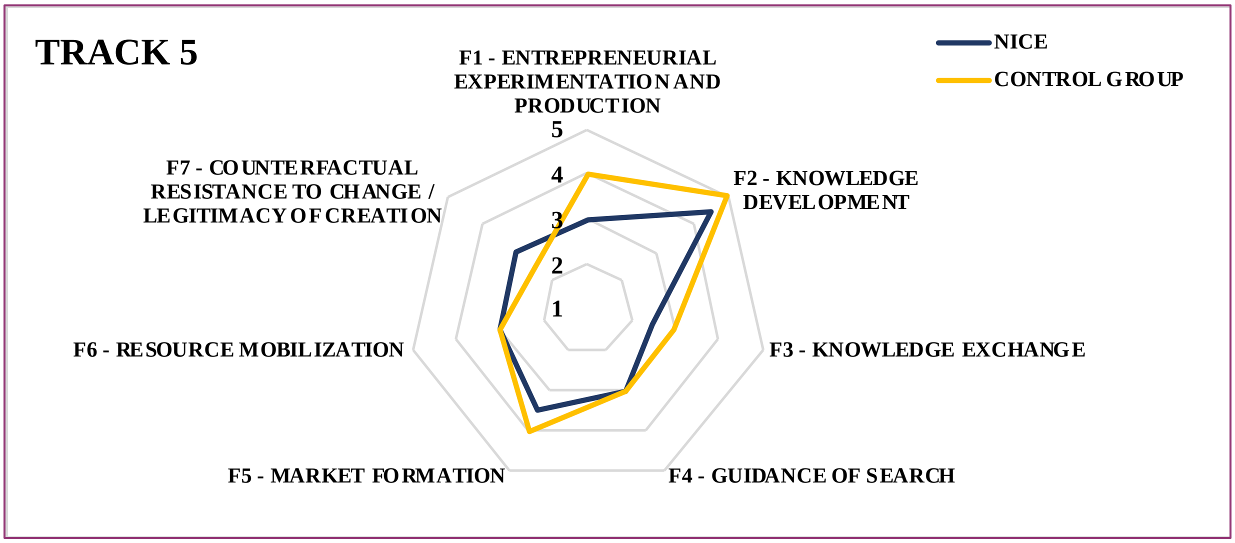

Fig.12: Spider graph TT5 Nice and the other LHs as a control group.

For these results at the level of Transition Tracks, we have to consider their global results first, and second, we can contextualise with respect to their stages of development.

Strengths and weaknesses

At the level of Nice LH observed apart from the other Smart Cities, we find out that Transition Tracks converge in exhibiting a clear strength in Entrepreneurial Experimentation (F1), Knowledge Creation (F2), Guidance of Search (F4) and Market Formation (F5), as these functions obtain 4 to 5 times across the different Transition Tracks a score above or equal to 3.5. The function Knowledge Exchange (F3) obtains such a score as well, but only once, suggesting heterogeneity in considering this as a strength across the Transition Tracks for all the actors. On the weaknesses side, a significant number of Transition Tracks tend to include Resistance to Change (F7) as a barrier, as this function gets less than 2.5 in score at least 4 times. Finally, at least for two Transition Tracks, Knowledge Exchange (F3) and Resource Mobilisation (F6) also score less than 2.5, meaning that these functions are weaknesses not for all but for some Transition Tracks.

Opportunities and threats

Considering now Nice LH in comparison with the other LH Smart Cities, Entrepreneurial Experimentation (F1), Guidance of Search (F4), and Market Formation (F5) are opportunities in that Nice LH is better placed than the other LH Smart Cities, with a score of 3.5 or above fulfilled at least 3 to 4 times across Transition Tracks. Knowledge Creation (F2) and Knowledge Exchange (F3) are also an opportunity but with a larger disparity across Transition Tracks, as these functions obtain once for each a higher score than the other Smart Cities. In the global assessment of threats, Knowledge Development (F2), Knowledge Exchange (F3) and Resource Mobilisation (F6) appear as more often cited (twice or three times each) as a comparative advantage of the other Smart Cities compared to Nice, while Entrepreneurial Experimentation and Production (F1) and Market Formation (F5) are also cited at least once.

The results are reported in Tab. 6, with again the drivers are underlined as the combination between strengths and opportunities, while barriers appearing as the combination between weaknesses and threats.

Tab. 6: SWOT Transition Tracks[12].

STRENGTHS (S)	WEAKNESSES (W)
TT 1 – F1, F2, F4, F5	TT 1 – F7
TT 2 – F1, F2, F3, F4, F5	TT 2 – F7
TT 3 – F1, F2, F4, F5	TT 3 – F3, F6, F7
TT 4 – F1, F2, F4, F5	TT 4 – F6, F7
TT 5 – F2, F5	TT 5 – F3
OPPORTUNITIES (O)	**THREATS (T)**
TT 1 – F1, F4, F5	TT 1 –
TT 2 – F1, F2, F3, F4, F5	TT 2 –
TT 3 – F1, F4, F5	TT 3 – F2, F3, F6
TT 4 – F4	TT 4 – F2, F6
TT 5 –	TT 5 – F1, F2, F3, F5

DRIVERS **BARRIERS**

Mitigating the results with the Transition Tracks stages of development

As suggested earlier, TT1, TT2 and TT3 are advanced in terms of technology and market solutions and should be considered as in a phase of "demonstration/replication"; while TT4 and TT5 are in a process of showing more evidence of their technological and commercial robustness and should be classified as "pre-pilot/pilot".

This has direct implications on results and interpretation. In our framework, the system should ideally perform with the following characteristics; for TT1, TT2 and TT3, primary functions which should reach a high score in F1, F5 and F7 in view of being able to be classified within forces and opportunities, with support functions being represented by F2, F3, F4, and F6. Alternatively, TT4 and TT5 should either be strong, or be able to bring a set of opportunities in the primary functions F1 and F2, with background functions being F3, F4, F5, F6, and F7.

Tab. 7: Primary and background functions across stages of development.

Stages / Functions	Pre-Pilot/Pilot (TT4, TT5)	Demonstration/Replication (TT 1, TT2, TT3)
Primary Functions	F1, F2	F1, F5, F7
Background Functions	F3, F4, F5, F6, F7	F2, F3, F4, F6

For “demonstration/replication”, observations do not significantly depart from the literature scenario. TT1, TT2 and TT3 are all characterised by F1 and F5 with high scores: Entrepreneurial Experimentation and Market Formation are definitely a strength in Nice, and also an opportunity, as Nice is outperforming the other Smart Cities in these functions. We can also report high scores on many support functions in these Transition Tracks (F2 and F4 for TT1 and TT3, and F2, F3, F4 and F6 for TT2). The global results at the ecosystem level regarding the weakness in F6 Resource Mobilisation does not seem to affect significantly at the level of TT1 and TT2, while it is still present for TT3, which is also poorly performing in F3 Knowledge Exchange. When we turn to weaknesses and threats, it becomes clearer that there is a difference between TT1 and TT2, with no threats, and weaknesses only in F7 Resistance to Change, and TT3 (which again has to do better in F7 Resistance to Change and compared to the other Smart Cities) has to take care of F2 knowledge creation, F3 Knowledge Exchange and F6 Resource Mobilisation.

For “pre-pilot/pilot” TTs, TT4 has significant strengths in the primary functions Entrepreneurial Experimentation (F1) and Knowledge Development (F2), and benefits of an advantage over the other Smart Cities to be highly supported by Guidance of Search (F4). But in the meantime, threats and weaknesses are still paving the way, especially in Knowledge Development (F2), which is indeed a primary function in which the other Smart Cities score better.

The two tables below summarise the findings, with drivers (as already specified above) underlined as the combination between strengths and opportunities, while barriers appearing as the combination between weaknesses and threats.

Tab.8: SWOT Transition Tracks in phase of Demonstration/Replication: TT1, TT2, TT3.

TTs in phase of Demonstration/Replication: TT1, TT2, TT3	
STRENGTHS (S)	**WEAKNESSES (W)**
TT 1	**TT 1**
Primary functions: F1, F5 **Background functions: F2, F4**	**Primary functions: F7** **Background functions: None**
TT 2	**TT 2**
Primary functions: F1, F5 **Background functions: F2, F3, F4**	**Primary functions: F7** **Background functions: None**
TT 3	**TT 3**
Primary functions: F1, F5 **Background functions: F2, F4**	**Primary functions: F7** **Background functions: F3, F6**
OPPORTUNITIES (O)	**THREATS (T)**
TT 1	**TT 1**
Primary functions: F1, F5 **Background functions: F4**	**Primary functions: None** **Primary functions: None**
TT 2	**TT 2**
Primary functions: F1, F5 **Background functions: F2, F3, F4**	**Primary functions: None** **Primary functions: None**
TT 3	**TT 3**
Primary functions: F1, F5 **Background functions: F4**	**Primary functions: None** **Background functions: F2, F3, F6**

DRIVERS **BARRIERS**

Tab.9: SWOT Transition Tracks in phase of Pre-Pilot/Pilot: TT4, TT5.

TTs in phase of Pre-Pilot/Pilot: TT4, TT5	
STRENGTHS (S)	**WEAKNESSES (W)**
TT 4	**TT 4**
Primary functions: F1, F2 **Background functions: F4, F5**	**Primary functions: None** **Secondary functions: F6, F7**
TT 5	**TT 5**
Primary functions: F2, F5 **Background functions: None**	**Primary functions: None** **Background functions: F3**
OPPORTUNITIES (O)	**THREATS (T)**
TT 4	**TT 4**
Primary functions: None **Background functions: F4**	**Primary functions: F2** **Background functions: F6**
TT 5	**TT 5**
Primary functions: None **Background functions: None**	**Primary functions: F1, F2** **Background functions: F3, F5**

DRIVERS **BARRIERS**

3.3 Social acceptance study: baseline, ambition, drivers and barriers in Nice LH

We provide here a detailed statistical analysis inherent the responses that the individuals interviewed provided to the questionnaire. This section is organised into two subsections; the first subsection provides, through descriptive statistics, an introductory summary of the socio-demographic characteristics of respondents. The second subsection continues the analysis by examining, through econometric analysis, the habits and inclination to change of individuals with reference to the domains of mobility, energy, ICT and environment.

3.3.1 Socio-demographic profile of individuals interviewed

Descriptive statistics for the sample inherent demographic variables on gender and age are provided in Tab. 10. Among the people interviewed, the number of females is slightly inferior to the number of males for both the two cities, with this difference resulting to be somewhat more pronounced for the control city. With reference to the mean age of the individuals interviewed, it is possible to observe a difference of 6 years between the mean ages of Nice and the control city (resulting to be 49 and 43 years

respectively). Moreover, the same value of the standard deviation for both the two cities suggests that the latter experience a very similar trend for what concerns the dispersion of age values from their corresponding mean.

Tab. 10: Gender and Age (by city).

	N. respondents	Nice (500)	Control city (501)
Gender	Male	253	257
	Female	247	244
Age	Mean	49	43
	Max	95	93
	Min	18	18

For the ease of exposition, additional descriptive statistics inherent age class, household composition, profession and education are reported in Annex 6.

3.3.2 Habits and inclination to change

In this section, the habits and inclination to change of the individuals interviewed inherent the four domains (mobility, energy, ICT and environment) will be analysed, utilising the statistical methods introduced in Chapter 2.

Mobility habits

The variables utilised for studying mobility habits refer to the answers related to questions Q1-Q3. The main objective here is to study the factors influencing the degree of utilisation of the different modes of transport besides the personal car, as well as to analyse the propensity of individuals to use alternative modes of transport (e.g., bus, tramway, bike, electric car service, etc.).

We begin the analysis by a pairwise assessment of the degree of association among the variables of interest related to socio-demographic characteristics and mobility; these variables can be both categorical (*Localisation* (RS1), *Gender* (RS2), *Profession* (RS9), *Mean of transport used to go to work/study* (Q3) and for *Leisure* (Q3ter)) and ordinal (*Age class* (RS3bis), Education (RS10), *Number of members composing the household* (RS4), *Frequency of utilization of the different modes of transport besides the car* (Q1_1 - Q1_5) and *Distance Home - work/study place* (Q2)); therefore, three cases of pairwise association emerge (categorical-ordinal, categorical-categorical, ordinal-ordinal). In computing the correlation indexes, it is a good practice to utilise different test statistics depending on the nature of the variables in question. From the correlation matrix among variables of interest (Tab. 28), it is possible to observe the presence of significant and positive correlations among the socio-demographic variables (RS1 - RS5; RS9 and RS10), with the exception of the pairwise correlations between *Number of members composing the household* and *Age class*, and *Number of members composing the household* and *Profession*, which appear to be negative (although remaining strongly significant). Among socio-demographic variables, the one associated to *Gender* appears to hold the lowest level of association towards the other variables. Then, a significant (although not particularly strong) relationship emerges, on average, among most of the socio-demographic variables and variables on alternative modes of transport (with the exception of the variable

related to electric car service)[13]. Furthermore, a few positive associations emerge between the degree of usage of certain alternative modes of transport (besides car) and the mode of transport utilised for going to work and for leisure (mainly, bus and tramway). These values might provide a positive preliminary insight for a subsequent and more refined analysis on the cause-effect relationship among the same variables.

To proxy mobility habits, we consider the answers related to Q3 and Q3ter. Q3 lists, for each individual, the modes of transport utilised to go to work (/place of study), whereas Q3ter refers to the modes of transport used in the spare time. Both questions allow individuals to select more than one alternative (over a total of 13 alternative modes of transport). Despite the significant number of alternatives, it is reasonable to assume that much of the variability in the data is explained by a few modes of transport (which are presumably the ones used the most by individuals). To this aim, Q1 provides information about the degree of utilisation of the most common modes of transport within the city besides the personal car; i.e., bus, tramway, train and electric car service. In order to reduce the number of modes of transport in Q3 and Q3ter, we perform principal component analysis (PCA) for ordinal variables in Q1, to detect which modes of transport capture most of the information within the data. After having performed principal component analysis, it is possible to infer how bus and tramway represent the two items which help explaining the highest degree of variability within the data on alternative modes of transport (besides the other cluster encompassing all the remaining modes of transport)[14]. This result further mirrors the outcomes emerging from Tabs. 11 and 12 regarding the measures of association between the variables of interest.

We now proceed in the analysis, trying to detect the impact of socio-demographic variables on mobility habits. To this aim, we utilise the multinomial logistic model developed by Dubin and McFadden (1984), which enables to deal with discrete choices deriving from a set of different alternatives, as it happens in our case. Specifically, the aim is to quantify the effect of the socio-demographic characteristics on the different modes of transport used to go to the work/study place and used for leisure (Q3 and Q3ter, respectively)[15]. Tabs. 11 and 12 report the margins for the estimates related to Q3 and Q3ter respectively (robust standard errors were utilised in the estimation to relax the assumption of homoscedasticity).

Tab.11: Multinomial logit model marginal effect estimations (%) [likelihood for the mode of transport chosen to go to work (/study) place (Q3)].

Variables	Car	Bus	Tramway	Other
Localisation				
Nice	5.20	4.74 **	-10.15 **	0.21
Control city	ref.	ref.	ref.	ref.
Gender				
Male	2.62	-7.15 **	-6.13 **	10.67 **
Female	ref.	ref.	ref.	ref.
Age category[16]				
Working	2.56	-6.29 **	-13.94 ***	17.68 ***
Student	ref.	ref.	ref.	ref.
N. members per household	2.78 **	2.03 **	-2.62 **	-2.19 **

Note: levels of significance: ∗ p < 0.10, ∗∗p < 0.05, and ∗∗∗ p < 0.01. (Robust) standard errors not reported.

Tab.12: Multinomial logit model marginal effect estimations (%) [likelihood for the mode of transport chosen for leisure (Q3ter)].

Variables	Car	Bus	Tramway	Other
Localisation				
Nice	15.83 **	2.09	-14.18 ***	-3.74
Control city	ref.	ref.	ref.	ref.
Gender				
Male	6.02 *	-4.64 **	-7.02 **	5.65 *
Female	ref.	ref.	ref.	ref.
Age category				
Working	16.26 **	-5.71 **	-12.87 **	2.32
Retired	25.81 **	-3.93 *	-14.74 **	-7.15
Student	ref.	ref.	ref.	ref.
N. members per household	7.41 ***	-1.02	-1.50	-4.89 **

Note: levels of significance: ∗ p < 0.10, ∗∗p < 0.05, and ∗∗∗ p < 0.01. (Robust) standard errors not reported.

From Tabs. 11 and 12, mixed interesting results emerge. First of all, it appears that the number of members per household has a significant effect on the choice of transport to go to work (/study place) in Q3. Always with reference to Q3, gender and age category seem not to affect the choice of using the car. Conversely, with reference to Q3ter, a significant relationship emerges between the choice to use the personal car for leisure and all the socio-demographic variables. For instance, looking at Tab. 12, being in Nice increases the likelihood to choose the car for leisure of around 16 percentage points more with respect to the control city; in addition, being a male increases the chance of selecting the car by 6.02% and being a retired individual makes it more likely to select the car of around 26% more than being a student. It also appears that one unit increase in the number of individuals composing the household corresponds to an increase of 7.41% in probability in selecting the car. Similar significant results apply to the cases of bus and tramway selection, even though the corresponding coefficients hold negative sign, thus denoting the probability of selecting those items of transport for leisure less likely with reference to our set of socio-demographic variables.

Inclination to change mobility habits

The variables utilised for studying individuals' attitude to change mobility habits refer to the answers related to questions Q9 and Q9bis. Specifically, Q9 (categorical variable) includes a set of possible reasons for which an individual would change his/her mobility habits (carbon footprint reduction, city life

improvement, economic reasons, health reasons, other), while Q9bis (ordinal variable) reports the timing according to which such a change would occur (very soon, rather soon, not so soon, not soon). We firstly assess the correlation coefficients between these two variables and the set of variables belonging to mobility habits (Tab. 13). The emerging results denote for Q9 a positive and significant correlation with respect to localisation (0.11**) and profession (0.14***), and for Q9bis a weak but significant negative association with age category (-0.05*) and a negative and significant association with education (-0.07 **). Q9 and Q9bis are also significantly and negatively correlated between each other (-0.06**). In consideration of the data availability, a principal component analysis does not appear necessary here. Tab. 13 reports the econometric results for the impact of socio-demographic characteristics on inclination to change mobility habits for the individuals (Q9). The usual multinomial logit model is utilised for this estimation.

Tab.13: Multinomial logit model marginal effect estimations (%) [likelihood for the reason of change in mobility habits (Q9)].

Variables	City life improvement[17]	Economic reasons	Health reasons	Other reasons
Localisation				
Nice	-10.13 **	2.61	4.33	3.19 *
Control city	ref.	ref.	ref.	ref.
Gender				
Male	-4.04	4.14	-1.79	1.69 *
Female	ref.	ref.	ref.	ref.
Age category				
Working	7.69 *	-12.96 **	2.72	2.56
Retired	10.41 *	-22.47 ***	12.06*	4.66
Student	ref.	ref.	ref.	ref.
N. members per household	-1.32	1.19	1.73	-1.63 **

Note: levels of significance: ∗ p < 0.10, ∗∗p < 0.05, and ∗∗∗ p < 0.01. (Robust) standard errors not reported.

An interesting result emerging from Tab. 13, is that for retired and working individuals (compared to students), economic reasons do not seem to constitute the main cause of change in their mobility habits; rather, the latter seem to be driven by reasons linked to the improvement of the overall quality of the city life and, to a minor extent, to health reasons (and this is especially true for retired individuals). In addition,

city life improvement represents a reason for change in mobility habits more likely to be present in the control city than in Nice (where the reason for change appears to be motivated more by other factors).

Next, we investigate the timing (Q9bis) for which changes in mobility habits should be implemented by citizens in relation to the reasons of change reported in Tab. 13. Results are reported in Tab. 14[18].

Tab.14: Ordered multinomial logit model marginal effect estimations (%) [timing in changing mobility habits (Q9bis)].

Variables	Very soon	Rather soon	Not so soon	Not soon
Localisation				
Nice	38.5	40.5	8.5	12.4
Control city	39.0	40.4	8.4	12.2
Gender				
Male	40.0	40.1	8.1	11.8
Female	37.5	40.8	8.7	12.9
Age category				
Working	40.5	40.0	8.0	11.5
Retired	33.0	41.9	9.9	15.2
Student	39.8	40.2	8.2	11.8

Note: (Robust) standard errors not reported.

Tab. 14 reports, for each variable, the percentages of individuals subdivided according to the timing in changing their mobility habits. For instance, the 38.5% of individuals in Nice are keen to change their mobility habits very soon. From Tab. 14, it is possible to observe how, first of all, for both Nice and the control city the inclination to change mobility habits appears to rely to a considerably fast timing (indeed, the inclination to change for both cities lies for approximately the 80% in the categories very soon and rather soon). Of course, from what emerges in the complementary Tab. 13, the inclination to change mobility habits in the two cities appears to be driven by different causes. Then, a remarkably similar result in terms of timing emerges when considering both gender and age category. Nonetheless, from Tab. 13, contrarily to the estimates inherent the other variables, the estimates for gender do not appear to be remarkably significant; therefore, the latter may not hold enough explanatory power. With reference to age category, it seems that individuals belonging to the working category are the ones who remain keener to change their mobility habits in a very fast timing compared to the other age classes. If this gap appears minimal when compared to students, the same gap consists of almost 8 percentage points when compared to retired individuals (respectively 40.5% against 33%). Among retired individuals, around the 15% of them seems not to change their mobility habits any time soon.

Energy habits

The variables utilised for studying energy habits refer to the answers related to questions Q4-Q8. The main objective here is to analyse individuals' behaviour with reference to: *Type of heating system* (Q4), *Energy provider* (Q5), *Set up of energy devices relying on renewable resources* (Q6), *Carrying out of insulation activities* (Q7) and *Energy habits* (Q8_1 - Q8_6). When examining the level of association between socio-demographic variables and variables on energy, significant correlations emerge with reference to the latter and variables related to localisation and age category. Education and profession appear to show as well significant levels of association but in relation to a smaller number of variables. Finally, gender and number of members per household seem to be poorly associated with variables on energy (with the exception of Q4). The implementation of econometric analysis deriving from Q4-Q7 may result to be a rather cumbersome process, due to the fact that, compared to the questions related to the other domains, Q4-Q7 may entail severe issues of endogeneity[19]. This is particularly true when considering Q4, Q5 and Q7. Indeed, when considering the likelihood of installing a predetermined type of heating system, choosing a certain energy provider, and/or carrying out home insulation activities, it can be the case that these likelihoods may be affected by unobserved variables (embedded into the error term of the regression equation) capturing some sort of collective consensus among co-owners living in the same building (e.g., total number of co-owners living within the same building, presence of a building administrator, etc.). In fact, this is especially true when considering individuals living in condominiums (i.e., apartments); the latter category represents around the 70% of individuals interviewed in the case of the control city and around the 90% when considering Nice. Besides house type, many covariates related to socio-demographic characteristics (which have been utilised in previous regression analysis), such as profession, education and gender could also be potentially correlated to these unobserved variables that proxy collective consensus in terms of energy decisions. In the light of all this, and due to the difficulty in finding proper instruments able to alleviate the potential presence of endogeneity, econometric analysis for Q4-Q7[20] will not be performed. Instead, we utilise descriptive statistics, relying on the results emerging from the correlation matrix among the variables of interest. Results are reported in Figs. 13-16.

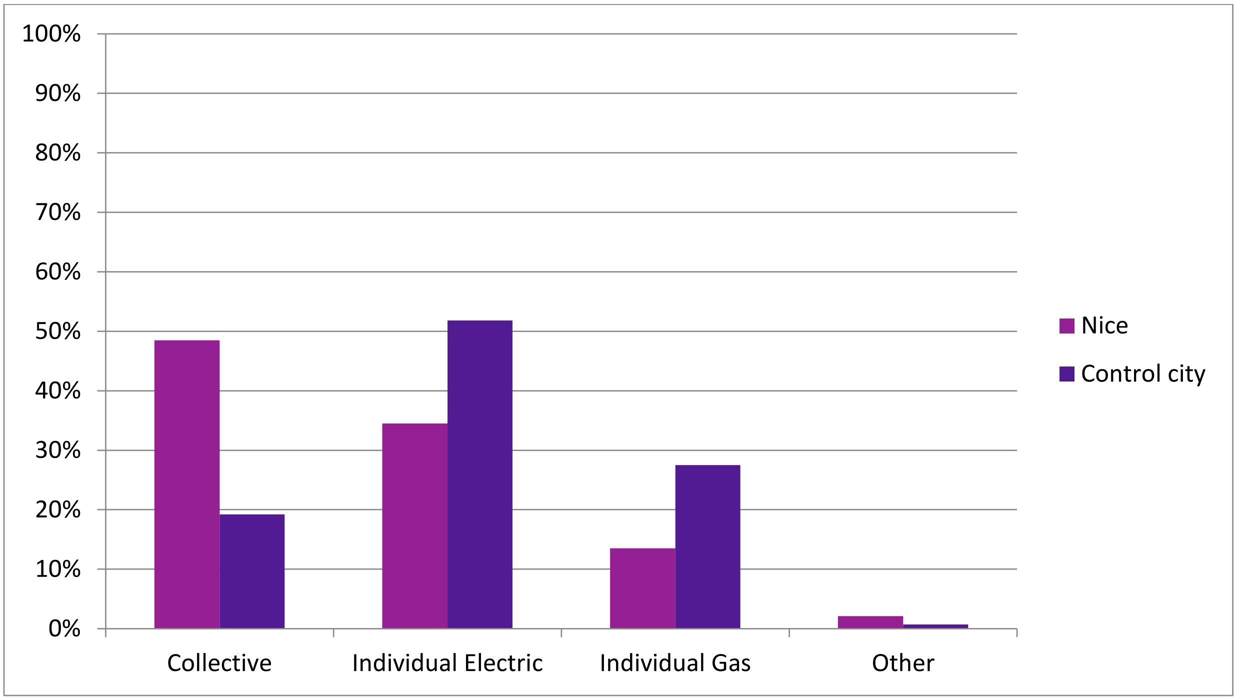

Fig.13: Heating system (by localisation).

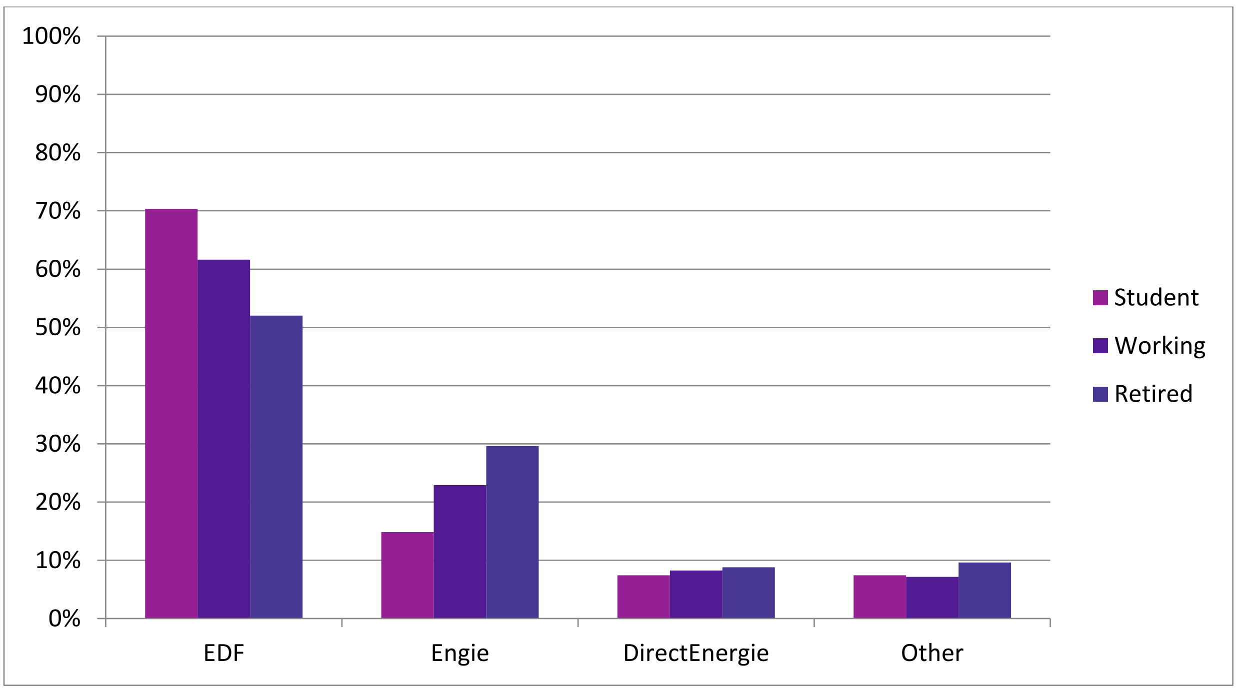

Fig.14: Energy provider (by age category, Nice).

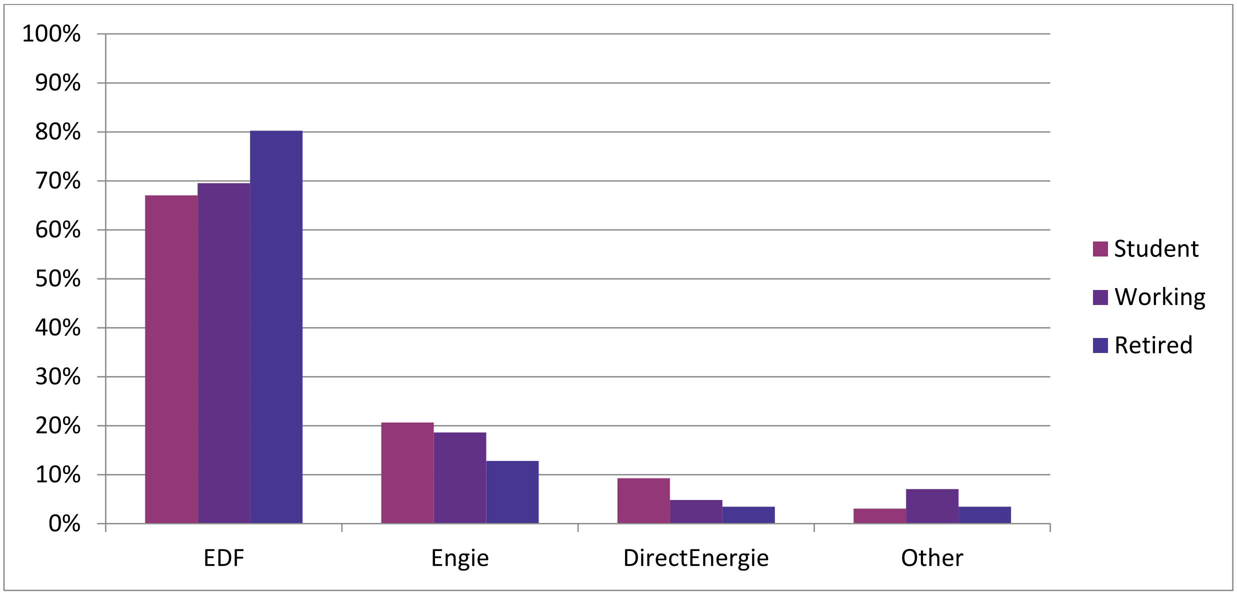

Fig.15: Energy provider (by age category, control city).

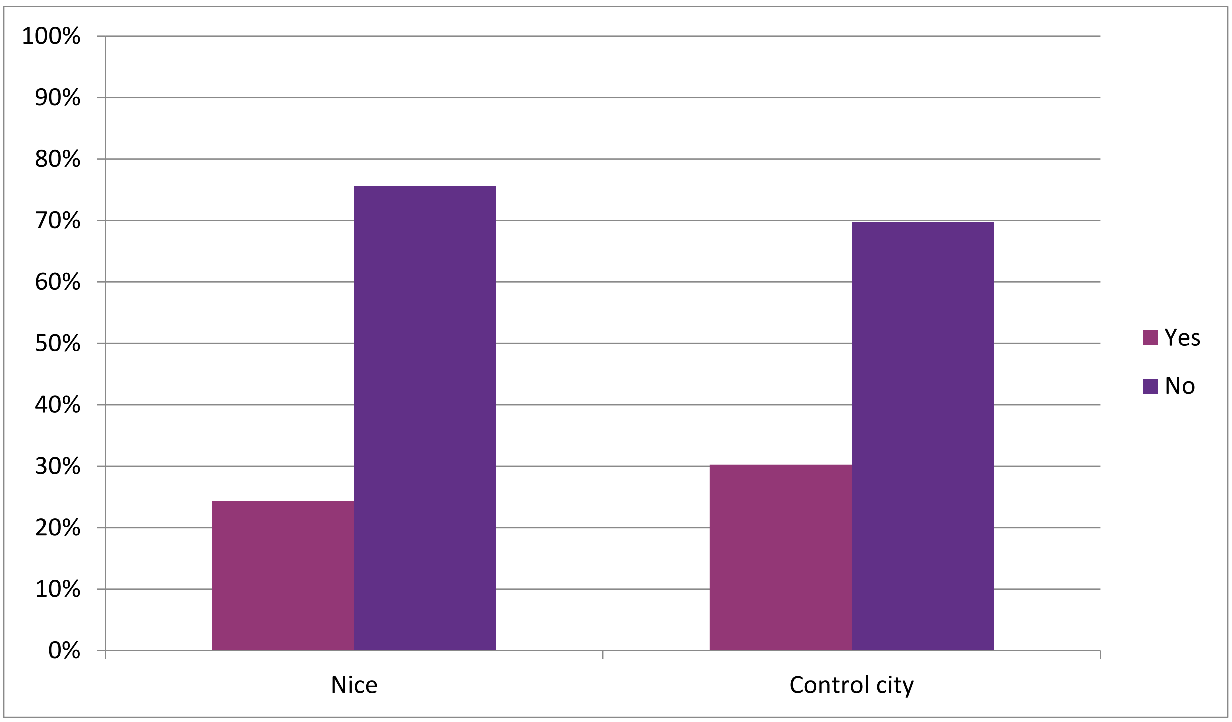

Fig.16: Insulation activities carried out by individuals (by localisation).

From the figures above, interesting results emerge. With reference to Fig. 13, it is possible to notice how in Nice, the percentage of usage of the two types of heating system (collective (gas + electric) against individual) by citizens is rather the same. Conversely, in the control city there is a clear predominance towards the usage of individual heating systems. With regard to Figs. 14 and 15, it is possible to observe how EDF holds a major market share in both the two cities, greatly exceeding the market share of the second biggest competitor (Engie). Curiously, whereas in Nice the most numerous category choosing EDF is represented by students followed by work and retired individuals, in the control city, the trend is

reversed. Finally, with reference to Fig. 16, it appears that in both cities, the percentage of individuals who have carried out insulation activities during the past five years represent a minority (representing, approximately, the 25% in Nice and 30% in the control city).

We then proceed in the analysis by examining the answers related to Q8. The latter indicates, for each energy habit, the relative frequency which individuals can choose (always, often, rarely, never). After performing PCA, it seems that the first two habits (inherent the lowering of the heating system when a room is not utilised or when the individual is absent for a long period) load on a common factor (presumably captured by the degree of saving in the usage of the heating system). For both these two habits, individuals seem to perform always or often (with percentages being rather equal within the two cities); nevertheless, the vast majority of individuals (around 77% in the control city and 66% in Nice) seems to always lower the heating system following a long absence. With reference to the other energy habits listed in Q8, the latter load on another common factor, which could be described as some sort of habit in rationalising the usage of electric devices. From individuals' responses it emerges than around the 62% of citizens in both cities always utilise low-consumption light bulbs; this sum up to more than 80% in both cities when also considering individuals doing this often. Percentages remain remarkably similar when considering the habit related to turning off the light in rooms with no people. These percentages clearly denote a rather high sensitivity for energy-efficient lighting. In addition, it seems that more than half of the individuals (in both cities) get always (or often) informed about the energetic consumption of a newly-acquired electronic device. Finally, when considering the unplugging of unused devices, it appears on the contrary that no dominant frequency pattern emerges; nonetheless, this last habit remains less important with respect to the others.

Inclination to change energy habits

The variables utilised for studying individuals' attitude to change energy habits refer to the answers related to questions Q10 and Q10bis. The latter are identical to Q9 and Q9bis, respectively. Indeed, Q10 (categorical variable) includes a set of possible reasons for which an individual would change his/her energy habits (carbon footprint reduction, city life improvement, economic reasons, health reasons, other), while Q10bis (ordinal variable) reports the timing according to which such a change would occur (very soon, rather soon, not so soon, not soon). We firstly assess the correlation coefficients between these two variables and the set of variables belonging to energy habits. The emerging results denote for Q10 a positive and significant correlation with respect to localisation (0.16 ***), profession (0.13 ***), and type of heating system (0.10 **) and for Q10bis a weak but significant negative association with age category (-0.05*) and a negative and significant association with localisation (-0.08 ***). Q9 and Q9bis are also significantly and negatively correlated between each other (-0.31 ***). Subsequently, Tab. 15 reports the econometric results for the impact of socio-demographic characteristics on inclination to change energy habits for the individuals (Q10). The usual multinomial logit model is utilised for the estimation.

Tab.15: Multinomial logit model marginal effect estimations (%) [likelihood for the reason of change in energy habits (Q10)].

Variables	City life improvement	Economic reasons	Health reasons	Carbon footprint reduction
Localisation				
Nice	3.69	- 8.98 **	7.11 **	- 1.82
Control city	ref.	ref.	ref.	ref.
Age category				
Working	- 0.55	2.07	1.23	- 2.76
Retired	- 0.90	- 6.83	5.94	1.79
Student	ref.	ref.	ref.	ref.
Insulation activities				
Yes	3.28	- 0.20	- 6.94 **	3.86
No	ref.	ref.	ref.	ref.

Note: levels of significance: ∗ p < 0.10, ∗∗p < 0.05, and ∗∗∗ p < 0.01. (Robust) standard errors not reported.

From the estimates reported in Tab. 15, it appears that localisation constitutes the main factor explaining the choices of individuals in terms of changing energy habits. Particularly, individuals in Nice are more likely to change their energy habits due to health reason rather than economic reasons. In addition, individuals who carried out insulation activities seem to be less likely to change energy habits because of health reasons.

Next, we investigate the timing (Q10bis) for which changes in energy habits should be implemented by citizens in relation to the reasons of change reported in Tab. 15. Results are reported in Tab. 16.

Tab.16: Ordered multinomial logit model marginal effect estimations (%) [timing in changing energy habits (Q10bis)].

Variables	Very soon	Rather soon	Not so soon	Not soon
Localisation				
Nice	51.9	39.6	3.2	5.3
Control city	44.7	49.6	3.2	2.5
Age category				
Working	51.4	43.1	2.6	2.9
Retired	43.9	43.9	4.5	8.3
Student	42.8	52.7	3.5	0.9
Insulation activities				
Yes	45.3	44.4	5.9	4.4
No	49.4	44.6	2.1	3.9

Note: (Robust) standard errors not reported.

Looking at Tab. 16, when considering localisation, it is possible to notice how the vast majority of individuals in both the two cities are keen to change their energy behaviour very soon or rather soon; the same trend applies with reference to individuals who performed insulation activities. Overall, it thus seems that individuals are generally keen to change their energy habits in a remarkably fast timing.

Cross analysis between mobility and energy habits

To complete this subsection, we lastly perform a cross analysis between mobility and energy habits. In order to do so, we analyse responses from Q11, dealing with the frequency of utilisation of the electric car service (I use the service, I do not use the service, I do not know the service). The latter constitutes indeed the perfect example where the domains of mobility and energy intersect, when studying individuals' habits. In fact, the usage of the electric car service has already been analysed in the previous section on mobility (when studying the alternative modes of transport besides personal car), but the variable associated to the usage of the electric car service appeared to be non-significant. Nonetheless, Q11 constitutes an important complement for the analysis on the electric car service, since it also provides information on the fact that an individual does know or does not know about the service. We hence perform a more detailed analysis, drawing upon the responses to Q11. When deriving the correlation coefficients for Q11 and socio-demographic variables, a significant degree of association emerges with respect to age category and localisation. Considering this, and to highlight this relationship better, we provide descriptive statistics in Figs. 17 and 18.

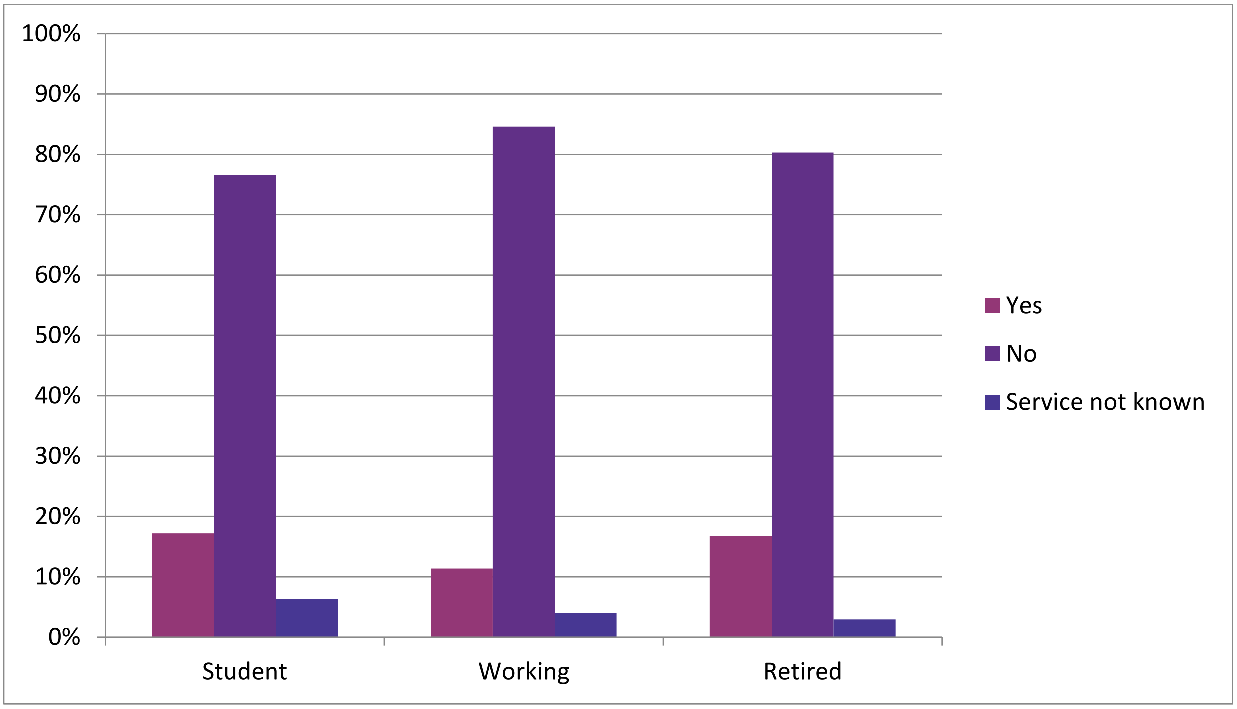

Fig.17: Utilisation of the electric car service (by age category, Nice).

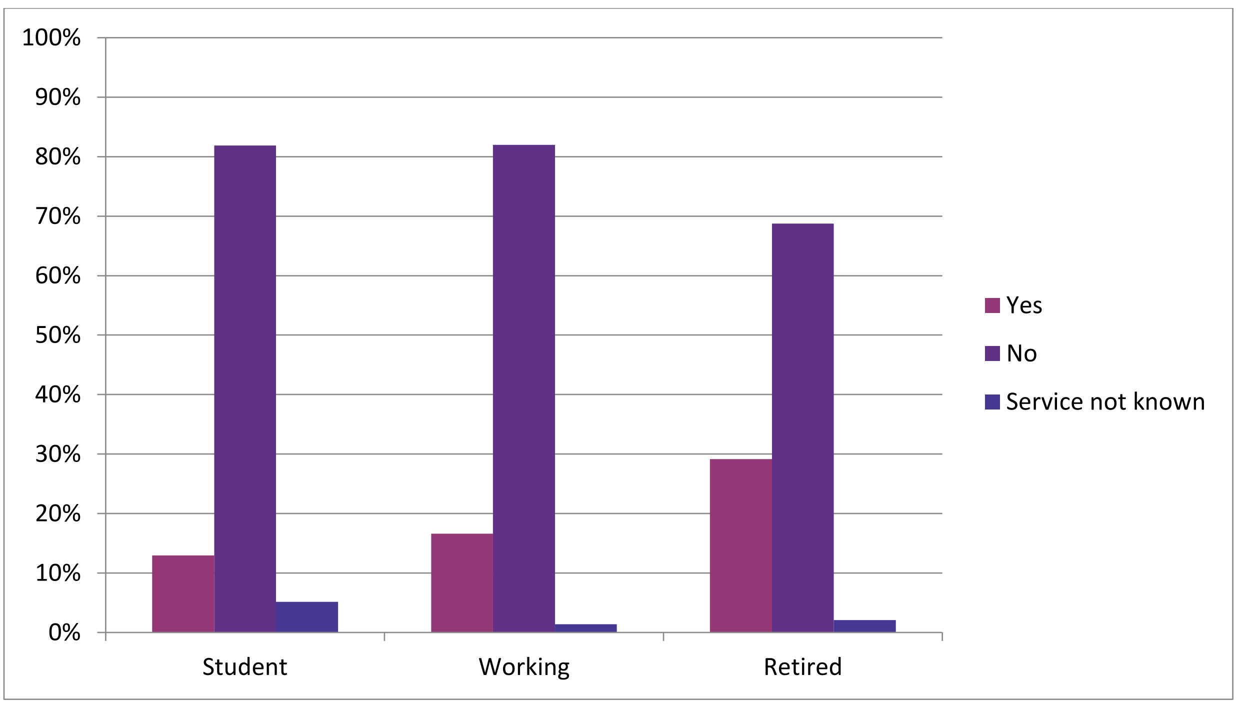

Fig.18: Utilisation of the electric car service (by age category, control city).

From Figs. 17 and 18, it is possible to observe how the number of individuals (in each age category and for each city) who does not utilise the electric car service (although being conscious of its existence) greatly exceeds the number of individuals who do not utilise the service or do not know about it. When comparing the age categories, however, something interesting appears. Indeed, retired individuals represent the age category using the most the electric car service in the control city, whereas in Nice the

same age category basically equals the one of students. In particular, for the case of the control city, it appears that approximately one third of all retired individuals use the electric car service; these results are interesting, because they entail that the usage of the electric car service does not decrease with age, as one might easily assume.

ICT habits

In general terms, with reference to ICT, the distinction between habits and inclination to change (habits) does not appear particularly neat, especially when considering the inclination to change as a positive attitude of individuals in adopting smart practices; as a matter of fact, the adoption of smart practices results to be clear, for instance, for what concerns positive changes in mobility habits (e.g., changing mobility habits in order to improve the quality of city life) or energy habits (e.g., changing energy habits in order to reduce Co2 emissions), but it does not result to be clear enough with reference to the usage of ICT. Indeed, the degree of utilisation of ICT already constitutes a measure for smart behaviour *per se* (smart practices are indeed generally associated by definition to the adoption of ICT). Nonetheless, changes of individuals' behaviour (as well as habits) related to ICT in order to adopt smart practices, can be more easily evaluated when considering a cross analysis between ICT and the domains associated with energy and mobility. For instance, when asking individuals for their predisposition to change energy habits following the introduction of a smart app providing daily amounts of energy consumed. In this subsection, ICT habits are analysed; subsequently, the following subsection deals with an analysis of individuals' habits deriving from a cross analysis between ICT and the two domains of mobility and energy. The variables which will be investigated refer to the answers related to questions Q16-Q20 in the questionnaire.

We start first of all by disentangling the impact exercised by each socio-demographic variable on the probability of owning a smart device which allows connecting to the internet (Q16)[21]. The latter variable appears to be significantly associated to the age category (-0.23 ***), education (-0.17 ***) and gender (0.10 **). We then utilise a logit model[22] in order to quantify the impact of socio-demographic variables on the probability of using a smart internet device. Results are reported in Tab. 17.

Tab.17: Logit model marginal effect estimations (%) [likelihood for the usage of a smart internet device (Q16)].

	dy/dy	Std. Err.
Localisation		
Nice	0.59	0.006
Control city	ref.	ref.
Gender		
Male	1.22 *	0.007
Female	ref.	ref.
Age category		
Working	-2.82	0.017
Retired	-5.42 **	0.018
Student	ref.	ref.
N. members per household	0.56	0.004
Education		
Primaire	-12.13 **	0.054
College	-4.68 *	0.026
Bac +2	2.17 *	0.012
Bac +3	2.59 **	0.011
Bac +5	1.56	0.012
Bac	ref.	ref.

Note: levels of significance: $*p < 0.10$, $**p < 0.05$, and $***p < 0.01$. (Robust) standard errors used.

From Tab. 17, it is possible to observe how being a man seems to increase the likelihood of using smart internet devices of around 1.20% point with respect to being a female. On the other hand, concerning age category, retired individuals appear significantly less keen to use smart internet devices compared to students. Finally, an interesting pattern emerges when considering education; indeed, it seems that the higher the education level, the higher is the probability of using smart internet devices.

Among the various and most common internet applications (e.g., Twitter, Whatsapp, Facebook, etc.), from our sample, the most utilised one results to be Facebook. Whereas it is intuitive to think that the usage of these apps tends to decrease with age (as it is indeed the case in our sample), a distinction between gender and localisation seems less intuitive. Fig. 19 reports the percentages of individuals utilising Facebook, clustered by gender and localisation.

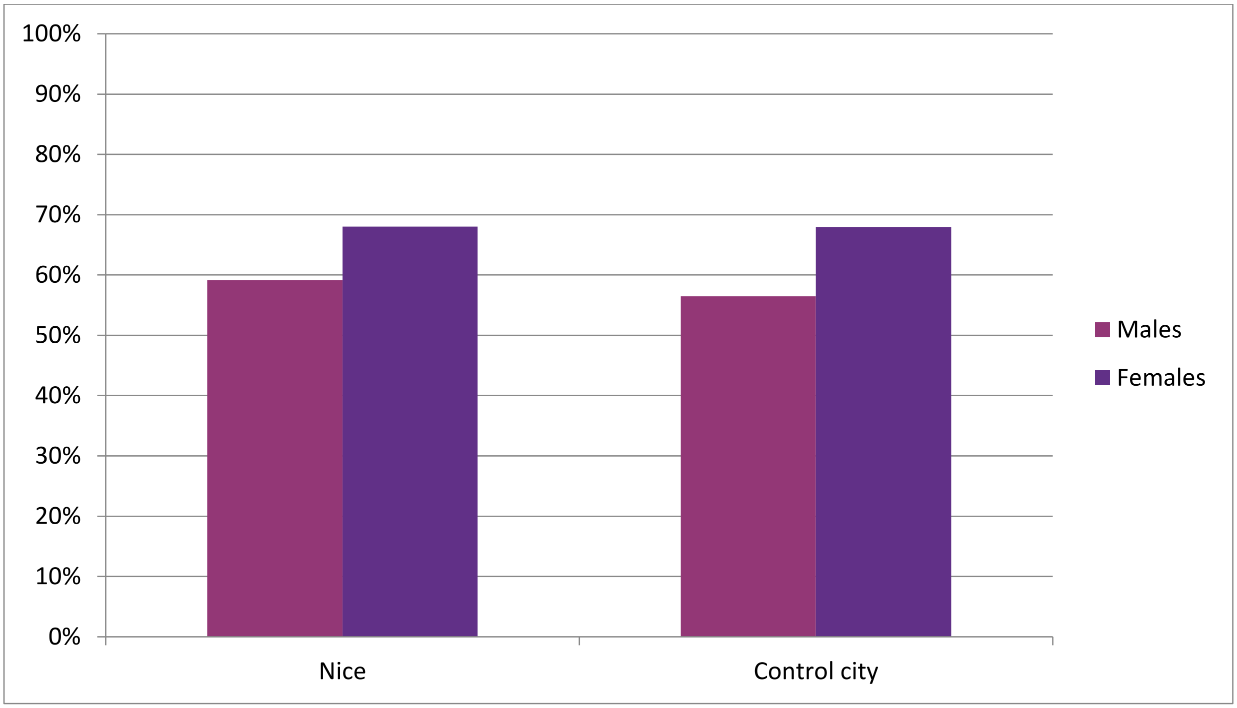

Fig.19: Utilisation of Facebook (by gender and localisation).

From Fig. 19, it is possible to notice how in Nice, around 60% of males use Facebook, with this percentage being lower in the control city. Conversely, the percentage of females in Nice using Facebook almost reaches 70% and approximately the same trend applies for the control city. From these results, it appears that localisation does not seem to exercise a relevant role in differentiating the usage of this app. Conversely, a curious difference emerges when considering gender; indeed, females appear to utilise Facebook more than males (and this happens in both Nice and in the control city, the latter showing a slightly more pronounced gap with respect to Nice).

The probability of utilising smart apps by individuals can be reasonably affected by some exogenous factors. Q17 reports some of the most common causes which can negatively affect the usage of apps by people, and precisely: the way personal data are stored, the accessibility of personal data by unauthorised third parties, the possible usages of personal data by the app server, the possibility of personal data being sold), with a related degree of concern (very concerned, rather concerned, not concerned, not at all concerned). From the statistics inherent Q17, it appears how, for each of these four causes, the majority of individuals (approximately the 60% or more, for each cause) seem to be very or rather concerned in a remarkably similar manner for both the two cities. After performing principal component analysis, it seems that all these four causes of concern can be associated to one unique factor explaining the worries

of the individuals interviewed. Reasonably, this factor relates to the fear of having personal data stolen and disseminated without authorisation.

Inclination to change: cross analysis between ICT and mobility habits

We begin the cross analysis between ICT and mobility by studying the characteristics inherent the adoption of a geolocation application on personal mobile phone by individuals. The latter is a positioning system tracking the geographical location of an object, and it is usually utilised when using a mode of transport to reach a specific location; the best example is represented by the GPS. Q18 provides the frequency of usage of the geolocation service by individuals (at least once per week, at least once per month, at least once per trimester, never). The aim is to study the effect of socio-demographic features of individuals on their frequency of usage of the geolocation service. By firstly assessing the degree of association between the frequency of utilisation of the geolocation service, socio-demographic variables and variables inherent the different modes of transport utilised for leisure (Q3ter), interesting results emerge. Indeed, the variable capturing the frequency of utilisation of the geolocation service appears significantly correlated with most of the socio-demographic variables (age category (-0.15 ***), gender (0.13 ***), localisation (-0.08 ***), profession (-0.10 ***)), whereas the same association with reference to the modes of transport appears less clear (only a significant correlation appears with reference to tramway (0.05 *). Subsequently, Tab. 18 quantifies these effects through an ordered multinomial logistic regression.

Tab.18: Ordered multinomial logit model marginal effect estimations (%) [timing in changing mobility habits concerning the usage of the geolocation service (Q18)].

Variables	At least once per week	At least once per month	At least once per trimester	Never
Localisation				
Nice	58.1	15.8	6.7	19.4
Control city	61.4	14.2	8.4	16.0
Gender				
Male	63.6	13.1	9.5	13.8
Female	55.3	17.1	5.6	22.1
Profession				
Student	67.2	10.9	11.6	10.3
Intermediary	57.3	16.9	10.3	20.2
Intellectual	66.2	11.9	9.0	11.6
Tradesman	64.7	13.0	12.1	13.2

Note: (Robust) standard errors not reported.

From Tab. 18, it is possible to observe how more than half of the individuals, both in Nice and in the control city, use the geolocation service at least once per week. The same proportion holds when considering gender and profession; among the types of professions which present significant coefficients, it is possible to observe intermediaries, tradesman, students and intellectuals. The first two categories involve a type of job which is likely associated with travelling and therefore the usage of geolocation services appears reasonable. Conversely, for the last two categories, the logic beneath the usage of the geolocation service might appear less intuitive. Finally, there seems to be no effect on the mode of transport selected by individuals (when travelling for leisure) on the utilisation of the geolocation service.

Q19 reports some of the most common causes which can negatively affect the usage of the geolocation service, in a very similar fashion compared to Q17 (which deals with the usage of smart apps). From the answers related to Q19, also in this case, it emerges that the risk of having personal information stolen and disseminated without authorisation constitutes, for individuals belonging to each city, the main exogenous factors hindering the usage of geolocation services.

Inclination to change: cross analysis between ICT and energy habits

We continue in the cross analysis examining the linkages between ICT and energy. To this aim, we study the characteristics inherent the adoption by individuals of a smart app allowing the monitoring of the domestic energy consumption. Such app is freely downloadable on any smartphone. Q20 provides the frequency of usage for this app by individuals (at least once per week, at least once per month, at least once per trimester, less than once per trimester, never). Like in the case of mobility, the aim here is to study the effect of socio-demographic features of individuals on their frequency of usage of such app. We firstly assess the degree of association between the frequency of utilisation of the geolocation service, socio-demographic variables and variables inherent the energy domain. It appears that significant degrees of association emerge with reference to age category (-0.15 ***) and occupational status (-0.07 **). Nonetheless, the number of individuals who provided a response to Q20 is remarkably reduced (only 242 observations over 1,001) and this might likely affect the reliability of the estimates for the asymptotic standard errors; therefore, ultimately, the significance of correlation indexes should be interpreted with caution. Tab. 19 subsequently quantifies these effects through an ordered multinomial logistic regression.

Tab.19: Ordered multinomial logit model marginal effect estimations (%) [timing in changing energy habits concerning the usage of a smart app for tracking energy consumptions (Q20)].

Variables	At least once per week	At least once per month	At least once per trimester	Never
Age category				
Working	14.0	36.9	23.0	26.0
Retired	11.4	37.4	16.4	34.8
Student	16.5	31.0	37.2	15.3
Occupational housing status				
Tenant	14.2	36.0	24.9	24.9
Landlord	14.1	36.1	24.5	25.3
House type				
Villa	14.2	36.0	25.2	24.6
Apartment	14.1	36.1	24.6	25.2

Note: only significant estimates are reported. (Robust) standard errors not reported.

From Tab. 19 it is possible to observe how, in relation to each variable, the percentage related to the frequency in the usage of the smart app to track energy consumption corresponds to around the 36% for the voice "at least once per month" (with the exception of the category "student"). All the other voices

for the frequency in the usage of such an app, for each variable, have lower shares. It is also interesting to notice how both tenants and landlords uphold a very similar behaviour in the frequency of utilisation of the app, and the same happens when distinguishing between individuals living in villas and individuals living in apartments. With reference to the age category, there appears to be less uniformity among classes, with the percentage of students not using the app, for instance, resulting to be remarkably lower than the corresponding percentages for working and retired individuals (15.3% against 26% and 34.8% respectively).

Similarly to Q17, Q20ter reports some of the most common causes which can negatively affect the usage of the smart app to track energy consumption (which are similar to the ones provided in Q17; specifically: the way personal data are stored, the accessibility of personal data by unauthorised third parties, the possible usages of personal data by the energy provider, the possibility of personal data being sold). Conversely to Q17, however, with reference to personal information deriving from the usage of this smart energy app, the majority of individuals (both in Nice and in the control city) does not seem to be particularly concerned for the possibility that their personal information could be accessed by unauthorised third parties, or that the energy provider may utilise such data. Moreover, the way personal data are stored does not seem to concern individuals neither. Par contrary, the only cause which seems to exercise particular concern among individuals (more in Nice than in the control city) is represented by the possibility that personal information could be intentionally sold by the energy provider to third parties.

Environmental habits

The last domain to be analysed is related to the environment, and specifically it refers to the level of environmental sensitivity by individuals, which is measured by environmentally-friendly habits and inclination to change. As in the case of ICT, also the environmental sensitivity must be analysed in conjunction with the domains of energy and mobility, since the habits related to these two domains deeply affect the level of environmental sustainability of the city (in Smart Cities, citizens adopt environmentally sustainable solutions). A cross analysis between the habits related to the domains of environment, mobility and energy will hence be performed in this subsection. Before proceeding with this, it is useful to shed some light on the main causes which individuals think are responsible for climate change, the latter constituting one of the main indicators for environmental degradation. Q13 provides a list of possible causes (Q13_1 - Q13_5): massive usage of personal car, massive energy consumption, industrial pollution, irresponsible behaviours undertaken by individuals, exogenous factors unrelated to human activities. An agreement scale is further associated to these causes (from strongly agree to strongly disagree). After having performed PCA in order to detect the presence of a common factor behind all these causes, it is possible to obtain a first factor loading on the first four causes and a second factor encompassing the last cause. This result can reasonably subdivide the cause of global warming into two main factors: the first one is related to human activities, whereas the second one to exogenous natural processes out of human control. For what concerns the responses related to the first four causes (related to human activities), the vast majority of respondents (approximately the 80% for each cause) strongly agrees or agrees on the fact that the latter represent crucial determinants for climate change. This pattern appears to be rather homogenous for both the two cities. Conversely, with regards to the fifth cause (not related to human activities), the majority of respondents, for each city, does not agree or strongly

disagree, that the natural cycle represents the cause of climate change. In this case, however, a different trend seems to emerge between the two cities. Indeed, while in Nice the percentages of people who disagree or strongly disagree, represent together the 63% of the total respondents, in the control city the same percentages approximately result to be just the 51% of the total respondents, thus denoting a different weight attributed to natural factors for climate change depending on location.

We now continue our investigation by performing a cross analysis between environment and the domains of mobility and energy; specifically, we assess the relationship between mobility and energy habits of citizens in relation to their level of environmental awareness. In order to do so, we consider Q14, which provides a range of agreement scale for individuals to think about environmental consequences when using the personal car or utilising electrical devices (strongly agree, agree, disagree, strongly disagree). To quantify the impact exercised by socio-demographic characteristics of citizens in this regard, we perform an ordered multinomial logistic regression. Results are reported in Tabs. 20 and 21.

Tab.20: Ordered multinomial logit model marginal effect estimations (%) [Thinking about environmental consequences each time you use your mode of transport (Q14_1)].

Variables	Strongly agree	Agree	Disagree	Strongly disagree
Localisation				
Nice	20.2	29.5	26.0	24.3
Control city	25.6	31.7	23.6	19.1
Age category				
Working	23.1	30.7	24.7	21.4
Retired	27.1	31.9	22.9	18.0
Student	17.5	27.7	26.9	27.8
Mean of transport used for leisure				
Car	17.9	28.4	27.0	26.6
N. members per household				
(1)	20.7	29.6	25.7	24.1
(3)	24.4	31.1	24.1	20.4
(5)	28.5	32.1	22.3	17.1

Note: (Robust) standard errors not reported.

Tab.21: Ordered multinomial logit model marginal effect estimations (%) [Thinking about environmental consequences each time you use electrical devices (Q14_2)].

Variables	Strongly agree	Agree	Disagree	Strongly disagree
Localisation				
Nice	15.3	29.8	30.2	24.8
Control city	19.4	32.9	28.0	19.8
Age category				
Working	17.6	31.6	28.9	21.8
Retired	19.0	32.5	28.2	20.3
Student	14.3	28.8	30.6	26.4

Note: only significant estimates are reported. (Robust) standard errors not reported.

From Tab. 21, it appears that for virtually all variables there exists a uniform pattern in the distribution of individuals among the various ranking categories. Indeed, the percentage of individuals who strongly agree and agree rather equals the percentage of individuals who disagree and strongly disagree. When considering individuals who strongly agree or agree, it is possible to notice a more pronounced gap between the two alternatives (with a predominance for the option agree for all variables) with respect to the same gap between individuals who disagree and who strongly disagree. It also appears that the more numerous a household becomes, the more the same household is likely to think about environmental consequences when using a mode of transport.

Results emerging from Tab. 21 are similar the ones of Tab. 20; specifically, the share of individuals who strongly agree and agree rather equals the percentage of individuals who disagree and strongly disagree. Nonetheless, in this case, rather pronounced gaps emerge when comparing both individuals who agree and strongly agree (e.g., a gap of around 15 percentage points is present with reference to people living in Nice), and individuals who disagree and strongly disagree (even though in this case the same gaps result to be slightly less reduced in absolute magnitude). In both the two cases, the highest percentage lies in the category agree/disagree rather than strongly agree/disagree.

Inclination to change environmental habits

We continue the cross analysis between the domains of environment, mobility and energy, by evaluating the relationship between the inclination of individuals to change their mobility and energy habits towards more environmentally-friendly practices. Q15_1 and Q15_2 provide a frequency option (very often, often, rarely, never) related to the solicitations received by individuals from family members in order to adopt smarter practices inherent mobility and energy (respectively). To quantify the impact exercised by socio-

demographic characteristics of citizens in this regard, we perform an ordered multinomial logistic regression. Results are reported in Tabs. 22 and 23.

Tab. 22: Ordered multinomial logit model marginal effect estimations (%) [Solicitations received to adopt smarter mobility solutions (Q15_1)].

Variables	Never	Rarely	Often	Very often
Localisation				
Nice	62.5	21.7	11.7	4.2
Control city	55.9	24.2	14.4	5.5
Profession				
Retired	71.6	17.4	08.2	2.8
Intellectual	56.6	24.2	14.0	5.2

Note: only significant estimates are reported. (Robust) standard errors not reported.

Tab. 23: Ordered multinomial logit model marginal effect estimations (%) [Solicitations received to adopt smarter energy solutions (Q15_2)].

Variables	Never	Rarely	Often	Very often
Localisation				
Nice	56.0	24.9	14.7	4.4
Control city	48.4	27.4	18.4	5.8
N. members per household				
(1)	55.1	25.2	15.2	4.5
(3)	50.4	26.8	17.4	5.4
(5)	45.7	28.0	19.8	6.5

Note: only significant estimates are reported. (Robust) standard errors not reported.

From Tab. 22, it appears that the vast majority of individuals rarely (or never) receive solicitations towards smart changes in their mobility habits from their family. This trend is particularly remarked with reference to retired individuals. When looking at Tab. 23, results do not seem to diverge remarkably from the ones of Tab. 22, even though the percentage of individuals rarely (or never) receiving solicitations towards smart changes in their energy habits is slightly higher compared to Tab. 22. It is interesting to notice, however, that when considering the number of members composing the household, the frequency of

solicitations towards adopting smart habits increase with the number of members composing the household.

3.4 Guidelines for the Nice Ecosystem

Based on the results we obtained, we can derive guidelines for the Nice Ecosystem, as well as highlights for each target audiences.

Function 1: Entrepreneurial Experimentation and Production (Strength)

According to our study, Nice LH ecosystem is perceived by local actors as having a real entrepreneurial and productive dynamics. In our questionnaire, respondents highlighted the fact that in Nice, there is a real motivation on the part of both old incumbent members as well as newcomers to stimulate the development of new technologies, new products and services on Smart City aspects. We also note that for almost all the actors, this development is intensified by three correlated elements: the presence of a large number of actors; the presence of new players (both start-ups grown up in the ecosystem or large groups setting up a branch locally are seen as beneficial); a diversity of actors (from different sectoral domains).

The strength of the entrepreneurial and productive dynamics in Nice is also based on the fact that the actors see, in the development of the Smart City in Nice, real technological and commercial opportunities. Thus, many affirm that the territory offers the actors the possibility of participating in major national and European projects such as the IRIS H2020 project, or in the recent past other EU FP7 projects like INTERFACE, CITYOPT, GRID4EU, or FLEXGRID at the regional level. In addition, the majority of stakeholders claims that the degree of innovation of the Nice ecosystem is high and therefore considers the city of Nice as a great field of innovation and Entrepreneurial Experimentation. This evidence highlights a real quality of the city of Nice. Indeed, during our interviews, the actors recognise the work of each other, and, during our interviews, many actors from distinct sectors and companies different in size were very positive about the level of innovation of the different actors. It can thus be seen that one of the reasons for the attractiveness of innovation actors (companies, researchers, entrepreneurs) in Nice is linked or related to the degree of innovation of the actors already present locally. During the interviews, the actors put a lot of emphasis on the specificity of the local business ecosystem, mentioning the fact that it includes a diversity of competent and innovative actors. Thus, we can notice that we have a real snowball effect at the level of innovation on the Nice ecosystem.

Regarding innovation itself, the players say that their activities in the field of Smart City in the territory have great chances of leading to breakthrough on a technological and market level. This shows once again that Nice is really a place of privileged innovation where the technologies, products and services of tomorrow are born and tested.

In the meantime, all is not perfect, and there is still room for improvement so that the entrepreneurial and productive dynamics in Nice becomes even stronger. Indeed, at the level of start-ups but also large companies, the feeling is that there is support, investment and real help at the level of innovation and

experimentation from local public actors. However, it is also expressed that it loses intensity in the later phases, especially from demonstration to replication. As a result, according to some actors, there is a lack of support for long-term continuity and the total success of technological and entrepreneurial projects.

In sum, concerning the foundations of this entrepreneurial and productive dynamism, in addition to the reasons mentioned previously, during the interviews, on many occasions actors have supported the fact that the innovation is supported by various communities present on the territory (Métropole Nice Côte D'Azur, but also Sophia-Antipolis Agglomeration Community, Principality of Monaco employment area, etc.), together with support organisations, associations and corporate clubs (the Smart Grid Club in particular).

Another piece of information that came out of the interviewees was that the Metropole Nice Côte d'Azur (NCA) has been able to create a dynamic environment, this will bring us to the discussion on Function 4: Guidance of Search, which will be detailed later on.

Recommendation: Consolidate Entrepreneurial Experimentation and Production (F1)

Highlights:

(1) In line with expectations, companies (large and small) are central in Entrepreneurial Experimentation and Production.
(2) Our results also show that city authorities have also to be included in the Entrepreneurial Experimentation and Production. City authorities are setting objectives for the territory and the citizens (through local public procurement and public innovation procurement), and the fulfilment of these objectives are dependent on the coordination of actors and management of action.

Function 2: Knowledge Development (Strength)

As previously stressed, one of the most peculiar and successful ability of Nice has been to become a showcase of Entrepreneurial Experimentation and this has led to an intensive Knowledge Development. The level and the quality of Knowledge Development is in fact resulted a strength for Nice, obtaining a score of 4 as can be seen in the TIS Spider Graph (Fig. 7).

It is a common perception among the members of the ecosystem that pilot projects developed in Nice are an occasion for local actors to test their solutions. They are as well encouraged to realise advanced and pioneer innovation projects. Indeed, this is plausible thanks to the capacity of local companies to create scientific and technical knowledge and translate them into business opportunities. What emerges from our analysis is a strong and characteristic propensity to innovate, supported by the proximity and the knowledge spillover present in the Nice ecosystem.

It is interesting to notice that innovation is generally the result of the collaboration among actors belonging to the ecosystem, as F3 reveals, in particular these are often the result of the relationship created between big national or international firms and local start-ups or SMEs.

The availability and the level of scientific and technical knowledge within the ecosystem are considered elevated, and they are continuously exploited to achieve further results. Nevertheless, as just pointed out, reaching a high technical profile is not sufficient if products are not practically implemented or commercialised. There are many evidence of companies who have shown a successful performance in launching a new business; inevitably their survival depends also on many external factors that can make it difficult, but overall, we can state that the local ecosystem is favourable to support innovation process which arise from communication and cross fertilisation between actors and sectors.

An essential aspect to stimulate scientific Knowledge Development is considered the data sharing between actors that is actually in place in some cases, but that could be enhanced and better coordinated. Among the interviewees, a public actor has given a remarkable point of view regarding the effects that Knowledge Development has on regulation. He has pointed out the importance of pilot projects tested in Nice as an occasion to reflect on the future legislations concerning all domains covered by the Smart City, and understand how the current legislation, at local as well as national level, should be updated. In other words, these experiences, which permit to develop, connect and test together different and innovative solutions, are also used to prefigurate the future laws regulating the field under experiment.

Recommendation: Consolidate Knowledge Development (F2)

Highlights:

(1) In line with expectations, our results confirm that companies (large and small) together with research and education actors are central in entrepreneurial experimentation and production.
(2) Our results also show that regulation amendments at a local or national level are often seen as necessary.

Function 3: Knowledge Exchange

As can be noted looking at Nice ecosystem's SWOT, Knowledge Exchange (F3) does not appear in the table. The score of 3 is the average outcome of aspects investigated in the questionnaire; the qualitative interviews, despite providing interesting positive elements, confirm the absence of a net prevalence of these over the more negative ones. The domain under examination is crucial as well as complex. In fact, the exchange of expertise is critical in developing new knowledge and many examples have been reported regarding the Nice ecosystem itself, however difficulties arise because of the large number of actors and the differences which exist among them leading to higher coordination costs.

From a global overview of the ecosystem we can affirm that a good working dynamic among actors involved in the conception and construction of the Smart City at local level exists. This emerges especially from the inputs from private companies, reinforcing the idea that the virtuous collaboration among actors has been determinant in the success of pilot projects conducted in Nice and in achieving targets set by the Metropolis itself. In addition to that, this dynamic facilitates the cooperation in coordinating complex Smart City projects.

One of the first concrete outcome of the shared goals and ambitions for the Smart City has been the creation of new associations or clubs with the aim to share and increase knowledge, usually on a specific thematic. The Club Smart Grids, which include all major actors and welcome local start-ups working in the energy sector and solutions for the Smart City, is the best example of the added value of this kind of association. This created environment is ideal for already established actors as well as newcomers to meet informally and forge new relationships which give rise to additional beneficial interactions.

Regarding the limits that prevent such exchanges we can refer to the existence of an advert behaviour towards sharing data and relative lack of trust towards other actors. The lack of legal tools to protect such parties has been one of the main disincentive faced by certain companies to be encouraged to invest in a middle or long-term R&D collaboration.

Looking deeper at different possibilities of transferring knowledge, one of the most well-established one seems to be the relation between big companies and start-ups. Usually it materialises in contracts of collaboration for specific projects; it often happens that start-ups are highly specialised, and they can offer advices or solutions in their particular fields. Generally, as said before, Knowledge Exchange among private actors are the most frequent and occur easily thanks to the participation to city level or regional projects and informal relationships.

Recently, the relation between the academic world and the public sector has matured, enabling the latter to exploit solutions experimented in the University field of research or to strengthen a project thanks to methodologies conducted by academics. Despite this, as some actors have mentioned, the relations between the academic world and the industrial world in many fields remain very weak in France and in particular at the local level when compared to what is happening in other regions of the world. Likewise, companies of different size belonging to private sector conduct some initiative in collaboration with Universities or other research centres.

A link which appears quite weak is the one between all "innovators" and the final users, meaning that these actors reach the consumers with their product or service, but they are not able to build a reciprocal relation to obtain feedbacks, capture consumers' needs and potential suggestions. This is an important weakness to overcome since the involvement of citizens is a fundamental part of the Smart City concept.

Cross border exchanges at national and international level are also considerable sources for developing knowledge. There are big enterprises working in different parts of the country which maintain strong links among the different units, as well as enterprises which have built collaboration abroad. In both cases the advantage is the contact with skilled professionals, the exchange of expertise and the participation at geographical widespread projects. Another influential role is played by the internal exchanges at the organisation itself. We have found evidence, in both big private companies and public institutions, of hierarchical structures mainly working "in silos" which hamper the circulation of information and create barriers to transversal work, which is always a desirable Smart City characteristic.

Recommendation: Consolidate Knowledge Exchange (F3)

Highlights:

(1) Our results show that though Knowledge Exchange between science and industry is advanced, user-industry relationships need to be further developed.
(2) Knowledge Exchange is better achieved through transversal communication architectures in businesses and public organisations.

Function 4: Guidance of Search (Strength with nuance)

According to our methodology, Guidance of Search appears as a strength for the Nice ecosystem. However, in our interviews, a large number of actors gave evidence that leads us to mitigate this result.

First of all, as we saw in functions 1 and 3, the ecosystem players respect each other enormously, value the skills of local businesses and rely on trust between its members. Many actors told us about the importance of their counterparts and the relations between them in the territory by saying that the Nice ecosystem was based on trust and exchange between its members. As previously stated, the best example of this in the field of Smart City is the Smart Grid Club 06. Many actors told us about the importance of this Club on the territory insofar as the latter is a place of privileged exchange between all the actors closely related to energy and its problems. The link being found is that the Smart Grid Club was created by an initiative of the Chamber of Commerce and Industry of Nice Côte d'Azur, and therefore, indirectly, is the work of the Nice Côte d'Azur Metropolis. It encourages and is at the origins of many projects around this theme. Labelled City Ambassador of Innovation in Europe to the Web Summit 2017, Territory of Innovation and Great Ambition in 2018, the Metropolis of Nice does not hide its ambitions and affirms to want to become "the Green Capital of the Mediterranean". This is very positive because it allows the actors present in the ecosystem, the actors wanting to engage in the ecosystem and innovative start-ups, to know what are the aspirations of the city of Nice, and therefore to be able to project into the future. Added to this, is the fact that respondents are generally in agreement that local public players have a vision of the technological and economic prospects of the Smart City of Nice. In addition, during the interviews, actors underlined the fact that Nice has ambitious plans to develop the Smart City which motivates them to develop their own business and projects in this field.

The actors of the ecosystem also say that the development of the Smart City is predictable in its technological dimension to a large extent, but they point out the fact, whether for public and private actors, that today the main questions and research are focused at the level of business model creation to support its new products and services.

Putting into perspective the previous assertions, we can see that public and private actors say they can predict, at least at the technological level, the development of the Smart City. The question that can be asked from now on is: Are these predictions between the different actors aligned in terms of potential prospects in the face of uncertainties (technological, political, consumer adoption, etc.)? Knowing that for an alignment to exist, there must first be some coordination between them. The answer to that question was rather mixed. Indeed, the actors affirm that this one is rather average. However, at the same time,

they declare that a lack of alignment and coordination of stakeholders in the Smart City ecosystem of Nice in terms of potential prospects in the face of uncertainties rather acts as a brake on the development of Smart City.

This is all the true since some of the players consider themselves to be related to the choices and strategic positioning of other companies in the ecosystem. Thus, they advocate the existence of a certain interdependence between the actors of the ecosystem in certain sectors of activities. When we go further in the analysis, we can dismiss the fact that this is a question of the size of the company, the answers to this question are scattered among the different groups of companies. So, we can presume that there is space for improvement around this axis. The public authorities acknowledge their implication to ensure this coordination, indeed during the interviews many actors have expressed their feelings about Nice Côte d'Azur Metropolis and mentioned to us that the latter had real power to influence the strategic choices of companies in the Nice ecosystem.

Despite all these positive points, it is necessary, even more than for the other forces noted, to qualify this observation. During the interviews, many elements lead us to think that at the level of the direction and guidance, there are many ways to improve. The actors of the ecosystem are aware that it is the public authorities to be the coordinator of the strategy of the territory and to carry the ambition of the city. As a result, many of the following points are made in direction to local public authorities.

Firstly, some stakeholders consider that the local ecosystem and the areas related to the Smart City and the energy transition lack from a direction on the part of public actors. They feel that the ambitions of the territory are good but remain general and especially political oriented. They therefore highlight the fact that there is a lack of translation of the strategic objectives into operational objectives. According to one interviewee, institutional actors have understood the Smart City issue and the energy transition but do not know how to achieve the objectives that have been set at the political level. This has the consequence, according to another actor, that certain companies (large companies, SMEs or start-Ups) do not have, even today, a clear perspective on what will be their specific activity in the field of Smart City. To all this is added the fact that because of the lack of translation of strategic ambitions into operational objectives, some actors feel that public actors are interested in the Smart City and the energy transition only for political reasons and reputational and therefore have a lack of global vision for their territory.

We can assume the existence of a contrast at the level of Guidance of Search, and that many players aware of the challenges of the Smart City are expecting more in that field.

Recommendation: Consolidate Guidance of Search (F4)

Highlights:

(1) In line with expectations, our results confirm that city authorities provide a useful alignment in the coordination of actors.
(2) In the meantime, our results show that policy guidance could target more ambitious or better qualified objectives.

Function 5: Market Formation (Strength)

The function Market Formation, which looks at current and expected size of the market related to the Smart City, has appeared as a strength in Nice, indicating that actors have already seized the opportunities offered by the process of transforming Nice in a Smart City and have high aspirations to continue business development.

Most of private actors interviewed agree that innovation linked to the Smart City is able to create new kinds of businesses, markets and expand existing ones. The energy sector seems to be particularly promising in this sense thanks to the numerous new and flexible methods to produce, store and sell energy. It is however important to highlight that almost every type of technical or technological innovation introduced in citizen's life require an adequate educational formation and there are companies which have translated this into their mission. More broadly, technological innovation linked to Smart Cities is able to create new business or offer new opportunities to existing business. This also to draw attention to the interdependence of different sectors related to the Smart Cities: innovation in a particular field may bring changes and further opportunities in other sectors too.

Moreover, one of the missions for which public actors are actively engaged is exactly the creation of new markets for local companies. In fact, regarding actual market dimensions, both big companies working on the territory and some small ones born locally, have the perception that it has not a critical size yet, however the perspective of reaching a maturity stage is strong. Even the categories of clients at which companies address, are going to increase in the future years, there are several examples of firms that have started their business with a limited target of clients and that have later expanded. To name one: the adoption of electric vehicles has been pushed by different public actors and certain categories of companies to conduct their business in an innovative and "greener" way, later it has been employed for car-sharing services and it has reached single individuals.

Evidence collected shows that there are positive economic expectations of the impact of innovations related to the Nice Smart City in the short-term, and that it becomes even stronger when speaking of the long-term, indicating the fact that a Smart City has a great potential to transform the market of its whole ecosystem, but it requires some time to reach a significant portion of people and market share.

Recommendation: Consolidate Market Formation (F5)

Highlights:

(1) In line with expectations, our results confirm that companies (large and small) perceive high opportunities in market development.
(2) However, there are many uncertainties (financial, regulatory, demand) that prevent having a clear view of how market opportunities will develop.

Function 6: Resource Mobilisation (Weaknesses and Threats)

As seen in our report the function F6, Resource Mobilisation, has scored 2.5 on the 5-point scale, placing this function as a weakness for Nice, furthermore this function has a singular particularity, it has also underperformed the control group, reason why it was also placed as a threat. Even though this function is not one of the primary functions it has nevertheless a pivot role in all stages of development, reason why attention to this result is recommended.

In order to better understand this result, a deeper analysis of the interviews took place with the aim to identify critical points that could be interfering with the function at the ecosystem level.

Interestingly enough, during the interviews it was noticed that there is a lack of homogeneity amongst the actors, meaning that key points have emerged, but they are not necessarily the same or they do not necessarily have the same impact for each actor. This further analysis suggests that not only this function is sensitive, but it might also require a complex action plan in order to be able to convert its weakness into a strength.

Among those remarks six have emerged more frequently. An interesting fact is that most of the negative remarks were coming from large private companies. Small and medium sized companies (start-ups included) and public actors seem to have a more optimistic view on how resources are mobilised in the local ecosystem.

Most of the large companies' remarks are linked to the idea of either a scarcity of financial or human resources. According to some of them most of the financial resources for Smart Cities projects in Nice come from European funds rather than at the territory level and even though this fact was highlighted as a positive input for F1 it also drives a sense of insecurity. The fear is that if European funds, related to Smart Cities, seize to exist it will impact the development of the Nice Smart City plan.

Some large company participants mentioned that, with reference to human resources, another problem they seem to have in common is that competences demanded for new domains of Smart City activities can be hard to find locally, hence, the need to search at corporate level. However, when they reach out to their parent company demanding the resources to be allocated locally they often face resistance and sometimes their request is denied. One of the reasons they seem to face this type of barrier is because companies are not encouraged to invest resources in the local ecosystem if they do not have relevant business opportunities, if that is true there might be a point of attention related on how the business model of such projects are being elaborated or presented.

Another point that seems to be a common denominator is the difficulty in recruiting people locally; indeed, the high technical skills and competences needed are not necessarily found locally not formed by local academic actors in the level that is riquired.

That being said, there were also evidence of positive outcomes related to this function, especially coming from the local SMEs. For instance, they feel that consumers are actively involved in some projects and

experimentations, this is of utmost importance for their business, especially in the early stages. They also seem to perceive that projects launched here in partnership with other local actors are beneficial and facilitate access to EU financial resources. It also comes up that the local ecosystem is constituted by exceptional resources and competences that facilitate the development of innovative enterprises, which is a good indicator since it helps validate F1 (Entrepreneurial Experimentation and Production) as a force as it was shown by the results.

Recommendation: Consolidate resource mobilisation (F6)

Highlights:

(1) Compared to smaller companies or public actors, large companies appear more concerned with financial and human resources mobilisation.
(2) Large companies consider that while financial resources accrue in the initial stages of development, the development of a business model robust in the medium-long run is more difficult to frame.
(3) Large companies tend to face more human resources constraints, as higher skilled and more specific profiles are required.

Function 7: Counterfactual Resistance to Change/legitimacy of creation (Weakness)

It is understood that projects related to Smart Cities will evoke some changes in the *status quo* in order to develop and implement new solutions. This change affects all stakeholders, from private companies to the public sector as well as the citizens, hence the importance of this function.

From all the functions, during the interviews, this was the one that received the most negative inputs. These remarks came from a well-balanced pool of actors, meaning from the private (large and small companies) and public sector, which is a clear indication that resistance to change represents a weakness to all actors in the ecosystem.

Differently from the previous function (F6) in this case it was found a more homogenous discourse among actors, one of the remarks that seem to appear more frequently is their concern related to a lack of sensitisation, formation and information in order to achieve positive changes. This remark appeared during interviews from actors from all sectors. However, it seems to impact start-ups and SMEs the most, all in all this is not surprising given the fact that usually those type of companies often are the ones to have the most innovative projects or services that would evidently demand more from their environment in what concerns a change of habits and/or consumption.

Another point that came across multiple times is a perception that there is a resistance to change in order to avoid risks and overcome traditional principals as well as a tendency to stay within one's comfort zone. This insight is interesting as it might be mitigated if the previous one mentioned is reinforced, if people are better informed they might be more open to adopt new habits and solutions.

On the regulatory side, two types of remarks were identified. First that the perception of regulations as a negative thing can be a psychological blockage that might slow down certain level of progress and secondly that some regulatory impositions or administrative rules limit or slow down changes and the development of the Smart City. It is true that regulations might impose barriers, especially when it comes to a fast-paced innovative environment where changes happen much quicker than the time needed to change certain regulations.

Interviewees from the private sector also seem to agree that they face some resistance from the public sphere when they reach out to them in search of certain types of support in order to have their project implemented. As mentioned before, on the literature review, projects related to Smart Cities often engage and depend on the collaboration of public and private. As pointed out for one of the interviewees, it is pointless to create an innovative mobility solution, for example electric bikes, if there are not enough safe cycling routes for users to go from point A to point B.

A last observation is that in our results this function F7 appears as a weakness as it received a score equal or below 2.5. It is not as a threat since it did not score lower than the control group, however the latter also showed a weak result meaning even though F7 is not a threat it is a common weakness shared by Nice LH city as well as the control group.

Even though this function F7 was very harshly rated, not all comments were negative, actors pointed out that they feel supported by the local ecosystem, that they find in Nice an openness to change and the existence of local actors that create tools to guide citizens towards a positive change of habits and to inform them, as well as a will from the local government to influence changes in behaviour towards the creation of a Smart City.

Recommendation: Consolidate actions removing Resistance to Change (F7)

Highlights:

(1) In line with our expectations, all target audiences face resistance to change, related to habits in consumption, development and production.
(2) Regulatory issues are largely seen as limiting demonstation activities.
(3) More public-private partnerships are expected to overcome resistance to change.

4. Baseline, ambitions, drivers and barriers of Nice Lighthouse demonstrators

The main objective of Chapter 4 is to help generating recommendations on how to move to relevant objective-setting for the planned IRIS intervention/demonstration activities based on the results of our SWOT and social acceptance study. We contribute emphasizing for each Integrated Solution in Transition Tracks where Nice is involved at a significant level, functions in the SWOT and results in the social acceptance study that represent forces and opportunities or weaknesses and threats with the aim of prioritizing actions. Having identified the “Baseline”, i.e., the state of the ecosystem before the IRIS project starts, as the result of our SWOT and social acceptance UNS study, the “Ambition” could be further interpreted as reaching at least the score/result of the other cities when these cities score better. From the baseline to the ambition, we have identified “Drivers” that Nice LH could take advantage of, and “Barriers” that are needed to overcome. Based on that, we appraise recommendations and highlights for a smooth development of the IRIS project and contribute to define guidelines for Nice LH that aim at easing the implementation of the IS foreseen in D6.2 “Coordination of NCA integration and demonstration activities”.

Integrated Solutions (IS) related to the CIP platform and citizen engagement services appear as the most innovative and challenging, as their deployment is simultaneous. This involves a distinction between TT1, TT2 and TT3, on the one hand, and TT4 and TT5, on the other hand. This is consistent with our SWOT and social acceptance results. Accordingly, in this chapter we elaborate:

- For TT1, TT2 and TT3, actions related to Entrepreneurial Experimentation and Production (F1), Market Formation (F5) and Resistance to Change (F7) could be consolidated, as the outcome of our SWOT analysis makes them appear as primary functions. Other functions like Knowledge Development (F2), Knowledge Exchange (F3), Guidance of Search (F4) and Resource Mobilization (F6) appear in our SWOT as background functions, and thus involve less pressing actions. For each IS, we provide some highlights that appear useful for the development of the IRIS action plan.

- For TT4 and TT5, Entrepreneurial Experimentation and Production (F1), and Knowledge Development (F2) appear as primary functions, and actions in these fields should be prioritized. Actions related to Knowledge Exchange (F3), Guidance of Search (F4), Market Formation (F5), Resource Mobilization (F6) and Resistance to Change (F7) appear as playing a less priority role. We provide for each corresponding IS a list of highlights.

4.1 Transition Track 1 - Smart renewables and closed-loop energy positive districts

4.1.1 IS-1.1 - Positive energy buildings

Overview of demonstrators

The DoA plans the construction of two positive energy buildings in Nice Meridia: Palazzo Meridia and the Institut Méditerranéen du Risque, de l'Environnement et du Développement Durable (IMREDD) building. Both represent a challenge for Nice, with high rise wooden structure for one of them, and a large glazed area for the other, and for both large surfaces of PV panels on the roof top, as well as different flexibility options, such as local large capacity batteries, to implement and test in view of increasing the ratio of PV electricity self-consumption.

Baseline and ambitions of demonstrators

At the core of this IS is the development of a collective self-consumption at building scale, which has been already experimented in few projects in Europe, but is considered as a new concept for commercial and residential customers in France. As a baseline, the city of Nice is developing the urban area of Nice Meridia district, with CSTB as a coordinator of the IS-1 and, more peculiarly, leader of the IS-1.1 demonstration activities. CSTB will collaborate with several partners: UNS-IMREDD (owner of the IMREDD building) and NEXITY (owner of the Palazzo Meridia building) as end-users, EDF (the French electricity producer) providing energy and balancing the grid, and ENEDIS (the French DSO) distributing and managing consumers' energy data and in charge of the compliance with the legal framework related to self consumption. The ambition of IS-1.1 is to test at the level of Nice Meridia the two positive energy buildings under construction, which are dedicated to host distinct types of activity (Palazzo Meridia is an office building, while IMREDD is an educational building), based on near-surface geothermy (IDEX operator). As of today, thermal and electric energy systems are independent.

Barriers and drivers of demonstrators

According to the SWOT analysis and the social acceptance study, it is possible to prioritize actions, especially related to the fields of primary functions like Entrepreneurial Experimentation and Production (F1), Market Formation (F5) and Resistance to Change (F7). Nice, as an ecosystem, is well positioned to develop relevant actions with many high scores in these three functions compared to the other IRIS cities. Entrepreneurial Experimentation and Production is for IS1.1 within the hands of CSTB who operates in collaboration with IMREDD, NEXITY, EDF and ENEDIS, and these partners are all sharing a high level of expertise in the fields of Market Formation and Resistance to Change (legal framework, energy habits).

Recommendation 1 : Consolidate Entrepreneurial Experimentation and Production (F1)

The positive energy buildings are intended to be a locus for experimentation and demonstration in Nice Meridia, a district where there is coexistence of business, education and residential use. It is a booming area with 350,000 m2 property programme ambitions, and the expected creation of new jobs. With key actors in the energy sector present as partners in the IRIS project (CSTB coordinator of IS1.1; EDF, on the intelligent energy management at the building and the district levels; and ENEDIS on the management of the electricity distribution network and the monitoring of consumption), the challenge lies in testing the advanced solutions envisaged on the management of energy at the building level, focusing on collective self-consumption market at building scale. Key issues in the field of experimentation and production include high-efficiency photovoltaic power generation (greater than 21.5%) associated with lithium Ion large capacity battery storage at building level. The solutions are expected to be supervised by a programmable intelligence layer (Energy Management System) according to the following anticipated scenarios: maximization of self-consumption, load shedding and peak shaving as well as flexibility management and system services support.

To consolidate the experimentation and production in the field of positive energy buildings, the collaboration with Gothenburg is particularly valuable on innovative elements like energy efficient envelopes, local electricity production from solar PV, and electric power storage with Li-Ion batteries. The feedback from other related projects like Stroomversnelling, FED, m2M Grid and CELSIUS Smart Cities should be high in that matter.

Highlights:

(1) Experimentation and production of positive energy building within mixed-activities districts and buildings.
(2) Focus on scenarios on self-consumption and resale of energy on the grid.
(3) Disentangle key operation issues with lithium battery storage.

Recommendation 2 : Consolidate Market Formation (F5)

While Gothenburg is particularly advanced in market formation and business models with high experience in surplus energy trading between legal entities in a district, current French regulation does not allow such transactions. Only recently the "collective self consumption" has been recognized as legal since 2017 and regulated since 2018. Within this exception scheme, there is only one single legal/moral entity, bounding all participants under one single contract. Moreover, differently from other countries (Sweden, Germany, Denmark, etc.), the French law does not allow any new local multi utilities to be created. All distribution level infrastructure is operated by ENEDIS as the national Distribution System Operator (DSO), or the few listed "régies locales", but no new ones are allowed.

Transactions in energy reselling from renewable energy sources as PV and Wind occur today in France, but they are essentially based on regulated Feed in Tariffs (FIT). Major actors in the Nice ecosystem do

not consider this as a market, but rather as a source of market distortion in the energy wholesale market, as in the current context there is a deregulated market, on the one hand, while, on the other hand, renewables yet are regulated. The mechanisms that once favoured the development of decentralized PV installation are now gradually disappearing, due to the fact that the cost of PV has sharply decreased. This involves that there is "no more need" for a FIT, as the technology is becoming "competitive" with other ones.

Recently, new energy related governmental policies tend to support the creation of Positive Energy Building (such as autonomous buildings in Nice Meridia - Palazzo Meridia and IMREDD - qualified BEPOS), and market opportunities might be revigorated by the future thermal regulation (RT2020). Thanks to the French "Energy Transition Law", the development of small scale self-consumption endeavours (<100 kWp) are endorsed by government subsidies to sustain both investment and operation costs; while calls for tenders are imposed for bigger installations (>100 kWp), with regulation for the FIT and no other subsidy. Indirectly, such regulation fosters the capital investment in the emerging "self consumption" PV sector by reducing long-term uncertainty and providing a stable business model, in a context where a return on investment is achieved in about 15 years.

In view of capturing these emerging market opportunities, self-consumption scenarios are to be explored with a key trade-off between storage capacity and profitability, as shown in the preliminary simulations elaborated so far in the context of the IMREDD's building. Profitability is a matter of medium to long-term period, and the investment involves thus a careful estimation of the risks associated with the implementation of the IRIS plan, like the one provided in Fig. 20 below.

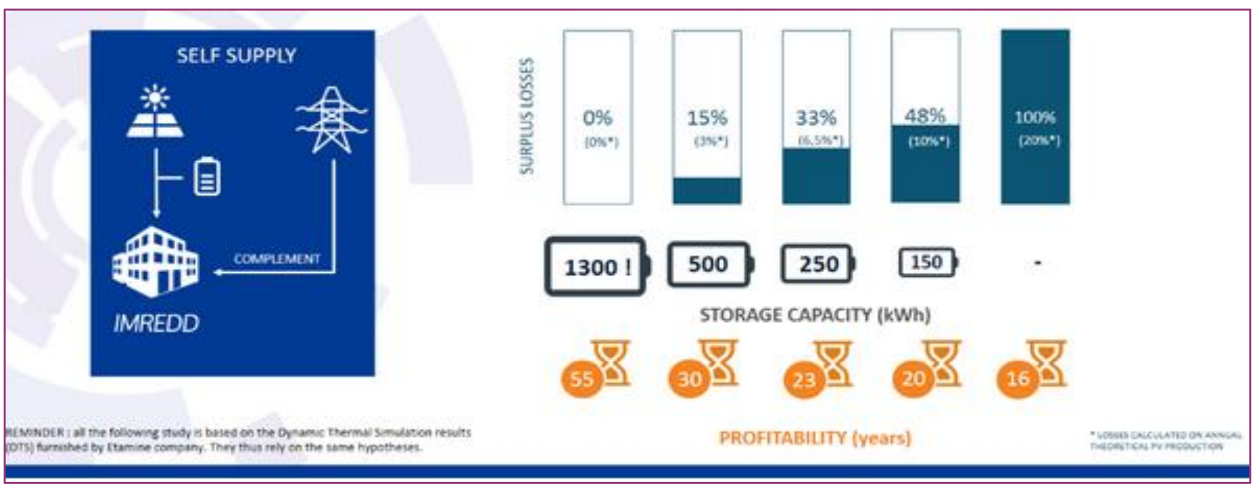

Fig. 20: First results of a simulation for a self-consumption scenario at IMREDD.

A final dimension has to be considered in F5. The development of a system of electricity generation and storage could increase the value of a building, especially for buildings intended for real estate operations such as the Palazzo Nexity.

<u>Highlights</u>:

(1) Explore self-consumption scenarios in relation to risks and costs (storage capacity versus profitability).
(2) Explore energy bill savings from storage as to reduce grid connection fees and ensure not to pass during peak hours.
(3) Explore returns on investment in mixed-use buildings and districts.

Recommendation 3: Consolidate actions in removing Resistance to Change (F7)

The SWOT analysis considered different types of barriers to change, i.e., related to technological, financial, regulation, and consumer behaviours.

Regarding consumer behaviour, energy positive building operation is much more connected to building design, construction materials, and to its energy infrastructure (local energy production and storage resources and EMS energy management system) than to the end consumer behavior. In that context, end consumers might have a more predominant role in energy efficient building, rather than in energy positive building; in the latter case, behavioural change is known to be about 10% on average.

Focusing on financial issues, energy positive building comes along with increasing capital expenditures for a long-term reduction of operational costs, which at some point balance out each other. Longer term returns on investments are thus expected to be the outcome, with a potential disincentive for the actors involved (*in primis*, building owners and property developers).

Highlights:

(1) End user habits and inclination to change have to be taken into account *in primis* by building owners and property developers.
(2) Positive energy building is a longer term return on investments than traditional building, potentially leading to a disincentive for impatient capital.

4.1.2 IS-1.2: Near zero energy retrofit district

Overview of demonstrators

The DoA plans the optimization of the heating load curve, with demonstrators taking place in a densely populated social housing area with low incomes and multicultural households in the district of Les Moulins. It is also planned to develop a demonstrator, i.e. the REPERE service, conceived as a commissioning process from the design of the operation. The solutions are to be tested on two high-rise buildings built in 1974 and located in Les Moulins.

Baseline and ambition of demonstrators

The baseline is that in the district Les Moulins, mid-rise and high-buildings built in the 1960s have been part in 2010 of a refurbishment program, but Tower 31, Tower 32, Tower 41, and Tower 42 remain a degraded enclave. As a reference in terms of energy savings, the comparison will be performed on the basis of the consumption of the buildings after their thermal retroffiting which was terminated in May 2018 (rolling out of an external thermal insulation composite system). The ambition is the optimization of the heating load curve in view of improving the efficiency of heat distribution into these multi-storey buildings. The step from the baseline to the ambition is the deployment of smart appliances to control and to monitor hot water distribution at building, floor and apartment levels for a more accurate follow-up of the temperature inside the dwellings. The expected outome is the possibility to better adapt the use of thermal energy according to the needs of the residents in terms of heating and cooling of dwellings. As for the REPERE service, the baseline is given with two buildings (towers 13 and 14) that have been recently refurbished with a large panel of energy-efficient measures. The ambition is that the REPERE service should increase awareness of end users and valorise such type of renewable energy solution in cities and districts. CSTB, CAH (social housing company) and Cofely (operator of the district heating network, in replacement of former Veolia company) are joint partners for the demonstrator.

Barriers and drivers of demonstrators

According to the SWOT analysis and social acceptance study, the actions to be developed in priority concern the Entrepreneurial Experimentation and Production (F1), Market Formation (F5) and Resistance to Change (F7). In terms of F1, the project is in the hands of CSTB, CAH and COFELY which all have high expertise in the field, only consolidation of existing forces will be needed from the baseline to the ambition in the rationalization of energy use in this district. F5 may represent some challenges as CAH is developping a three-step scenario. Step 1 is leading to the modification of heating distribution and individual load curve monitoring for each of the two distribution circuits (circuit North and circuit South) with the objective to reach a 5% of energy savings. Step 2 is the implementation of a medium grain regulation of energy distribution at floor level with a potential additional gain of energy of 10%. Step 3 is the implementation of fine grain energy supply regulation for each dwelling and generating up to 20% of energy savings. F7 will also need to be consolidated in various ways, like energy habits and inclination to change towards smarter energy behaviors. This would give a clear pricing signal to such type of solutions for the territory and hopefully foster more similar projects. According to the SWOT analysis and social acceptance study, still F1, F5 and F7 appear as prioritary in view of progressing from the baseline to the ambition.

Recommendation 1: Consolidate entrepreneurial experimentation and production (F1)

The urban renewal plan is dedicated to optimise the global thermal energy production versus the cumulative need of each end users. The main challenge is not to develop highly innovative elements, but rather to implement technologies that provide the means to rationalize the energy production to match

the need of each individual and not to align on the average need of all residents. It thus combines traditional solutions (external thermal insulation, replacement of windows) with more novel solutions (like smart regulators, connected sensors, adaptive edge monitoring and control) deployed at a large scale, as the whole plan involves about 100 apartments for each tower, and replicable at the district level.

Highlights:

(1) Enforce solutions for the optimisation of the heating load curve and energy savings.
(2) Develop monitoring solutions involving the residents paying the energy bills.

Recommendation 2: Consolidate market formation (F5)

In this specific context, the social landlord (as owner) has a key role in managing the cost of the heat network and in balancing the costs of operation with the costs charged to the tenants. Energy saving habits are key elements in alleviating these costs.

Highlights:

(1) Both building owners and tenants are engaged in the consolidation of market opportunities.
(2) There are cumulative effects in energy savings habits to take into consideration and to develop.

Recommendation 3: Consolidate actions in removing Resistance to Change (F7)

The split of incentives between tenants and building owners is based on regulatory issues. In the social housing area, city regulation should tend to favour the consolidation of these opportunities at least at an experimental level. The social acceptance study shows that key motivations for removing resistance to change are economic (pay a lower bill), especially for younger categories of the population, but also related to health and better living, especially with reference to the older categories of the population.

Highlights:

(1) Regulation should tend to consolidate opportunities in removing resistance to change.
(2) Younger categories of the population are more inclined to energy savings for economic reasons, while the motivation for older categories of the populations resides into health and better living reasons.

4.1.3 IS-1.3: Symbiotic waste heat networks

Overview of the demonstrators

The demonstrator is located in the Grand Arenas development district. The context is the extraction of the residual calories contained in the effluent water of a waste water treatment plant, distributing it through a low temperature network to the end users of a new eco district, and generating heating and cooling by using decentralized heat pumps. EDF is actually implementing a dashboard solution for the future network, which will be based and connected to the district energy system. The dashboard should give full visibility to the projects stakes and assets, and represents some type of advertisement and sensitisation tool for other potential customers.

Baseline and ambitions of demonstrators

The baseline is developing novel technologies related to the reuse of residual thermal energy from waste water for heating and cooling systems and makes the new related services accessible for the business district of Grand Arenas composed of a diversity of building profiles. One of the key ambitions is to make these circular economy solutions usable for a large audience of citizens at work in their office.

Barriers and drivers

The drivers are the extant strengths of the ecosystem in terms of Entrepreneurial Experimentation and Production (F1), Market Formation (F5) and Resistance to Change (F7), while the barriers may be that these forces still need to be consolidated in the diffusion at a large scale of these circular economy solutions towards different types of end users. In that perspective, the dashboard tool is an efficient way to include more end users in the process.

Recommendation 1: Consolidate Entrepreneurial Experimentation and Production (F1)

The main challenge is here to implement novel technologies that provide smart reuse of waste heat, and through a dashboard, increase public awareness on renewable district scale energy solutions.

<u>Highlights</u>:

(1) Experiment low temperature district heating cooling network.
(2) Experiment dashboard solution.

Recommendation 2: Consolidate Market Formation (F5)

In the Nice context, commercialisation is not straightforward as new pricing contracts for the energy have to be developed, and end users are not attached to the proposed contract as they can choose to produce heating/cooling for themselves. The other challenge is that "air to water heat pumps" are considered as to be approved by the city administration, but once approved this generates a forerunner case for the other real estate undertakings, in line with local environmental code ("Charte environnementale"). This requires strict conditions on the energy pricing to be competitive.

Highlights:

(1) Develop new pricing contracts, in a context where switching opportunities exist for customers.
(2) Pricing strategies are fierce and impact the business strategies.

Recommendation 3: Consolidate removing Resistance to Change (F7)

All systems promoting a circular economy have pros and cons, but these systems tend to penetrate more and more into mentalities and attitudes of people leaving in smart cities, especially when these systems prove to have large, efficient outcomes.

Highlights:

(1) Promote symbiotic solutions as circular economy experiences.
(2) Involve citizens in realizing these solutions, which are to be replicated at a larger scale.

4.2 Transition Track 2 – Smart energy management and storage for grid flexibility

4.2.1 IS-2.1: Flexible electricity grid networks

Overview of demonstrators

The main challenge here is to overcome a paradigm shift in the new context of decentralized energy production and the availability of two-way energy flows. The role of the Local Energy Management (LEM), a new concept related to this change in paradigm, is to understand and manage the interdependence and interactions between different prosumers at a district scale and the national energy market. The district where the solutions will be tested is Nice Meridia, with a subsequent replication on Grand Arenas district.

EDF is leading this IS and is holding the role of the energy aggregator managing the LEM, in order to offer various energy flexibility services and to optimize the operation of certain assets (production, storage and

consumption). EDF takes the charge of developing the different energy management systems (EMS) of the district energy framework to test the LEM operation.

Baseline and ambitions of demonstrators

The baseline is composed of different explored case studies of LEMs, leaning on the IRIS partners' infrastructures and assets. The ambition is reaching an upper level coordination of works done in TT1 by optimizing the operation towards the energy market, and works done in TT3 by identifying potential additional revenue streams from the use of electrical vehicle and associated EV charging infrastructure to provide flexibility from a smart centralized charging management. With the LEM, the DSO might reduce grid congestion (medium and low voltage), the TSO and national energy market could bid on different flexibility services for day or intraday supply-demand balance.

Barriers and drivers of demonstrators

According to the SWOT analysis and social acceptance study, the success of the solution will lie on the fonctions Entrepreneurial Experimentation and production (F1), Market Formation (F5), and Resistance to Change (F7). In the context of the solution, F1 is dependent on a large number of partners, and the coordination of their respective efforts. In the meantime, F5 and F7 also play a role as each of the partners has to develop its own business model, faced with specific legal and regulation constraints, and characterised with different end users not only at the level of a building but at the level of a district.

Recommendation 1: Consolidate Entrepreneurial Experimentation and Production (F1)

The solution is concerned with energy management issues at the level not of a single building, but rather of the smart district to which it belongs. All the actors involved in this Transition Track are testing new solutions in view of developing optimal scenarios with a qualitative improvement. A higher degree of complexity is required, as the experimentations for developing a smart city district are much more difficult to implement compared to single positive energy buildings.

Highlights:

(1) The extension of entrepreneurial experimentations from one building to one district might have disruptive implications and unexpected outcomes.
(2) The involvement of key actors in the field is essential to consolidate opportunities, as more technological and contractual complexity is expected to occur.

Recommendation 2: Consolidate Market Formation (F5)

Adding the potential creation of a neighbourhood-wide energy market involves major changes to the actual energy market design. Within the smart district area of Nice Eco Valley, the diversity of energy consuming profiles can potentially optimise the supply-demand balance of the local distribution network and provide system services. However, the actual market design is still at the Transmission System Operator (TSO) level and not at the Distribution System Operator (DSO) level. The experimentation could lead to identify possible optimisation opportunities for the local grid, through the optimisation of a network of energy management systems. In this manner, a local energy management system could leverage enough grid flexibility for the energy market by managing a range of local energy conversions and storage facilities. In the scenario of a very high penetration of decentralised intermittent renewable energy systems and a high rate of electric vehicle adoption, a local energy management system might provide a very efficient mean to ensure the safe operation of the local grid.

Highlights:

(1) Develop and test the Local Energy Management with the aim of optimising energy consumption, energy bill reduction or even new revenue streams.
(2) Optimise energy storage and distribution in a smart district.

Recommendation 3: Consolidate actions in moving Resistance to Change (F7)

Concerning energy management on the network at the neighbourhood scale, cutting off production of domestic hot water or individual (or even collective) heating in full winter during peak consumption is not straightforward to implement, as the capital investments are still high for the needed automation systems and ICT infrastructure, compared to the achievable time of usage and resulting valorisation. However, these adjustments may be highly beneficial at the collective level and with transitory and non-significant perceived negative impacts at the individual level. Our results show that residents in Nice already have energy efficiency sensitivity and claim they are inclined to change their behaviours in a short time span. The number of members composing the households also increases the frequency of solicitation to change energy habits.

In Nice demonstration activities, however, the target is the business market, not the consumer market. It might happen that internal temperature could be regulated, but for tertiary buildings. The engagement is that the temperature level through should not be noticeable, to avoid interference with the end user and operator of the building, and fines might apply in case of degradation of the performance indicator. All flexibility and optimisation should be “invisible” to the client. However, dysfunctions might eventually happen, and there is a problem of acceptance of that particular event.

Highlights:

(1) Experiment temperature adjustments in tertiary buildings, controlling for the cost/energy saving balance.
(2) Control for dysfunctions and acceptance.

4.2.2 IS-2.2: Smart multi-sourced low temperature district heating with innovative storage solutions

Overview of demonstrators

The challenge is to capture excess heat produced in one building, store this energy and reuse it in other buildings within a smart district. There is here again a shift in paradigm that can be better qualified using Smart Energy Management Scheme, able again to operate in the new context of decentralized energy production and the availability of a two-way energy flow. The way we understand it is very similar to the issues in IS-2.1, and the recommendations or highlights will be very close to the points raised earlier.

Baseline and ambitions of demonstrators

NCA launched in 2017 a 25-years tender for district heating and cooling network (DHC) of Nice Méridia for a total amount of 24, 4 Millions € (18,8M for initial investment, 5,6M€ for major maintenance work).This bid was won by IDEX, with official contract signed with NCA on the 14th of August, 2018. The ambition is to develop a Smart DHC optimization algorithm, aggregating DHC connected building consumptions and production forecast by optimally matching production with the actual and forecasted energy needs.

Barriers and drivers of demonstrators

As a result of the SWOT analysis and social acceptance study, Entrepreneurial Experimentation and production (F1), Market formation (F5) and Resistance to Change (F7) need to be consolidated in the optimisation of equipments (network, pumps, components of network) in view of optimising the distribution of energy according to the needs, and in particular minimising the production of heat, cold, and electricity in general by an efficient balancing and yhe availability of temporary energy storage assets.

Recommendation 1: Consolidate Entrepreneurial Experimentation and Production (F1)

Highlights:

(1) The development of an efficient Smart Energy Management Scheme is a challenge.

Recommendation 2: Consolidate Market Formation (F5)

Highlights:

(1) Monitor energy storage and distribution in a smart district.

Recommendation 3: Consolidate actions in removing Resistance to Change (F7)

Highlights:

(1) More solicitations towards households with a large number of members should pay up in removing resistance to change.
(2) Involve citizens in realizing these circular economy solutions which are operational at a large scale.

4.2.3 IS-2.3: Utilising 2nd life batteries for smart large scale storage scheme

Overview of the demonstrators

As a circular economy promising initiative, the use of such second life batteries from electrical vehicles (EV) as a flexibility component of a micro grid is challenging and appealing. However, both technical, market and legitimacy dimensions have to be investigated. These 2nd life batteries will be deployed in Nice Meridia area, more peculiarly in the IMREDD building. This building being equipped with PV panels for a peak production of 175KWc, the 2nd life battery will be used and compare to the new battery-based storage device in terms of their respective relevance to dynamically balance energy within a local micro-grid.

Baseline and ambitions of the demonstrators

In terms of baseline, Nice is considering the deployment of a battery system with a capacity of about 50 kWh, based on e-vehicle batteries, so Li-Ion technology. The ambition is potentially integrating these in a larger 100-150 kWh battery system based on a new large capacity battery appliance based also on Li-Ion technology, the latter beign designed for smart building application. Both technical and functional specifications are still under assessment, also taking into consideration the whole system might be about 5m x 2,5 m large and 3m high.

Barriers and drivers of the demonstrators

According to the SWOT analysis and social acceptance study, efforts should be dedicated to consolidate Entrepreneurial experimentation and production (F1), Market Formation (F5) and Resistance to Change (F7) in the various facets of selection, implementation and operationalization of the solutions.

Recommendation 1: Consolidate Entrepreneurial Experimentation and Production (F1)

One promising option lies in reusing car batteries in buildings. However, the possibility of extending the life of batteries from electric vehicles is still under study by major players in the sector (battery manufacturers, car manufacturers) whose views are not convergent on their second life use after having been "mobile used". There is also a debate on the technologies being used: mainly lithium, but there is also a great diversity of couples of oxidation-reduction (reactions between the electrodes and the electrolyte), with some more adapted than others to stationary energy storage from renewable sources, though eventually less safe: LMO, LFP, NMC, etc.

Highlights:

(1) Make sure there is a common understanding/definition of what is a second life battery.
(2) Explore a large spectrum of sector (car sector may be one) and technology opportunities (Lithium may be one).
(3) Disentangle whenever mobile use of the battery might be a limit in its second life fixed use.

Recommendation 2: Consolidate Market Formation (F5)

There is a challenge in the implementation of such business, namely the (current) inexistence of a market for second-life batteries. Despite a potential identified in various reports and scientific publications, the question of profitability remains a sensitive point.

Highlights:

(1) Second life battery market is still underdeveloped and products at the prototype stage.
(2) Profitability (including maintenance costs) is still to be proven.

Recommendation 3: Consolidate actions in removing Resistance to Change (F7)

Stationary storage tests in second life should be good opportunities to start development, but this is to be explored, eventually with Renault and Nissan.

Highlights:

(1) Explore stationary storage tests.

4.3 Transition Track 3 – Smart e-mobility

4.3.1 IS-3.1: Smart Solar V2G EV charging

Overview of the demonstrators

This Track and IS-3.1 in particular represent a critical link between energy and mobility solutions, as electric vehicles could provide all-in-one cheap and easy e-mobility, better city life, and potentially lower and stable energy bills (vehicle to grid scenario). There are many innovative elements in Smart e-Mobility, at a technological level, business level and legitimacy as well.

Baseline and ambitions

Different modes of car sharing have already been experimented in Nice with the former Autobleu service. The ambition is to move towards free floating which is the most advanced operating system of car sharing, taking into account the multiple possibilities of having a car fleet and a charging infrastructure operated by a single operator, with charging infrastructure being centralised or decentralised; or the car fleet and the charging infrastructure operated by at least two operators. The development of the use of electrical vehicles, both personal and shared, combined with the free floating requires to adopt an optimal management of the EV charging infrastructure and the integration of the notion of "smart charging". Additionally the smart charging solution must be integrated in the larger smart grid management at building, district or city level as a component of the electrical grid flexibility.

Barriers and drivers

As shown from the SWOT analysis and social acceptance study, Nice has distinctive strengths in Entrepreneurial Experimentation and Production (F1), Market Formation (F5) and Resistance to Change (F7), due to past experience accumulated with the initiative Autobleu. In the meantime, new challenges on the way of free floating tend to suggest that all these three functions need to be consolidated.

Recommendation 1: Consolidate Entrepreneurial Experimentation and Production (F1)

A lot of initiatives are based on a combination of previous actions operated in Nice, with a focus on EV public charging.

Highlights:

(1) Use of EV public charging stations.

Recommendation 2: Consolidate Market Formation (F5)

The development of public/private charging station networks through the possibility of accessing to closed buildings by outsiders and leased fleet managers is a strength that will give new inputs to the electric vehicle rental market, and potentially also on the sale of this type of vehicles. It also requires the creation of a smart charging system, which will be able to recognize the user and set a tariff for recharging to compensate the owner and/or the terminal operator.

Highlights:

(1) Develop proximity, easy access.
(2) Develop tariffs associated with the type and timing of use.

Recommendation 3: Consolidate actions in removing Resistance to Change (F7)

Previous results have documented in the ecosystem a relative delay in the use of electric vehicles, whether the reluctance is grounded on robust evidence or not. A catching up process may occur soon in the very promising context of development of free-floating and the desired future access to the charging stations of private and public buildings.

Highlights:

(1) Expand smart mobility focusing on e-cars.
(2) Explore the interoperability from one smart mobility to the other, like cycle-tramway, or cycle-train.
(3) Incentivize citizens to adopt smart mobility in their home-office commute, probably based on a rewarding model.

4.3.2 IS-3.2: Innovative mobility services for the citizens

Overview of demonstrators

E-car sharing systems aim at strengthening the urban mobility system, with cheaper costs for households, and potentially smart energy storage in V2G car batteries.

Baseline and ambitions of demonstrators

While the extant system allows citizens to use a shared car service from one charging infrastructure to the other, the ambition is to go beyond this baseline provided by the former system Autobleu and move towards free floating. Free floating provides a qualitative improvement to the citizen as it allows the user to drop the car out of a charging point. All the partners in Nice ecosystem focus on a scenario where EV car that might be in the sharing system or privately onwed by the end users, could be accessible to charging points located in private car park. Moreover, the mutualisation of public and private charging points is instrumental to optimize the use of the EV charging infrastructures and the deployment of new charging points. The deployment of air quality sensors to detect pollution peak is a mean to inform citizen of air pollution alerts and favor other transportation means than their personal gas-powered vehicles such as electric cars, with shared cars in free floating being a relevant answer.

Barriers and drivers of demonstrators

The SWOT analysis and social acceptance study show that Entrepreneurial Experimentation and production (F1), Market Formation (F5) and Resistance to Change (F7) need to be consolidated to ensure a smooth transition from the baseline to the ambition.

Recommendation 1: Consolidate Entrepreneurial Experimentation and Production (F1)

Existing solutions implemented by VULOG in collaboration with other partners in Nice could provide the necessary information and context to explore a promising public/private mix charging points deployment.

<u>Highlights</u>:

(1) Deploying a Proof of Concept consisting in checking the whole user experience of a driver willing to charge his EV car in private properties could be a first step, potentially offering replicable conclusions to any similar deployment in European cities.
(2) Identification of the changes required by this deployment, in terms of adapted location, technical and contractual design.
(3) Reuse of existing investments and infrastructures (charging station, car sharing platform).

Recommendation 2: Consolidate Market Formation (F5)

Our own social acceptance results tend to show that mobility habits are in majority related to the use of traditional cars, especially for the category of population “working males” that are using this type of mobility massively. While other categories of the population (females, students) are using smarter mobility devices, like the tramway, the EV use still remains confidential. On the other hand, many categories of the population claim that they have a propensity to change their mobility habits for

economic reasons, but more predominantly for health reasons and quality of life. As a reminder, the 38% of our sample is keen to change mobility habits, including the working categories of the population.

Highlights:

(1) Increase the share of EV as a mobility service in the city.
(2) Develop interoperable subscriptions with other e-mobility services.
(3) Focus on categories of the population (students, women) having a strong inclination to change mobility habits in the near future.

Recommendation 3: Consolidate actions in removing Resistance to Change (F7)

EV is often seen as a mobility service adapted to the city, while a large share of the population does not work in the city, but in surrounding areas (Sophia Antipolis and Monaco). Autonomy capacity, or the possibility of fast charging, is thus a dimension to be better controlled for larger scale diffusion of this transport among the population. Access to fast lanes or easy park are also areas to investigate.

Highlights:

(1) Autonomy of the battery, fast charging.

4.4 Transition Track 4 – City innovation platform

4.4.1 IS-4.1: Services for urban monitoring and IS-4.3 Services for mobility

Overview of demonstrators

The aim is given the expertise of Nice in data collection through sensors and data management at the level of the city, to go beyond the extant solutions and make of the city innovation platform the backbone of the smart city in the fields of energy, mobility and citizen engagement. It is also to investigate the opportunities led by the City Innovation Platform for mobility, in general either personal cars and shared vehicles (bikes, cars), public transports (bus, tramways), or walking.

Baseline and ambitions of demonstrators

The ambition here is to develop a City Innovation Platform for multi-stakeholder collaboration and services. The development of an open ICT system and open application programme stakeholders is a key step, involving advances in experimentation and production, as well as additional knowledge and

competences upscaling. The ambition means developing infrastructures and systems for the collection, transformation, distribution and protection of data at the level of the city. Compared to the baseline, this involves advanced efforts in the deployment of smart sensors and related networks, the development of the IoT management and big data processing capabilities, as well as city data sharing (i.e., to whom and for which purpose).

Barriers and drivers of demonstrators

The outcome of the SWOT analysis and social acceptance study is to highlight that consolidated efforts are needed in Entrepreneurial Experimentation and Production (F1) and Knowledge Development (F2), as this TT4 is more in a phase of pre-pilot/pilot compared to TT1-3.

Recommendation 1: Consolidate Entrepreneurial Experimentation and Production (F1)

The major issue is anticipating what business solutions could work for the collection, protection, use and share of data at the level of the city. Data collected should be sufficiently rich (big data), but in the meantime able to be used in an efficient (QoS) and connected model (IoT), taking also into account the large diversity of potential users (data sharing), as well as legal issues (including privacy, GDPR, etc.). Our results show that the city data sharing model developed by NCA, extended with a public private partnership, is a promising and sustainable solution.

As for mobility issues, the main efforts here are dedicated to enforce the development of mobile applications for shared e-bikes, in view of a better monitoring and use. Our results show that Nice citizens are frequent users of such applications and that this plays a positive role in their inclination to change towards smart mobility choices, especially towards public transports or mobility services developed by the city.

Highlights:

(1) Data sharing and legal issues are of primary importance.
(1) City model, with public private partnership, is a promising, sustainable solution.
(2) Development of apps is valuable to citizens which prove to be highly connected all across the different categories of the population.
(3) Mobility apps are expected a positive impact on their inclination to change towards smarter mobility behaviours.

Recommendation 2: Consolidate Knowledge Development (F2)

The generation of a unified sensor network is also required, generating information from mobile and fixed objects altogether, involving experimentations in the IoT field as well. On mobility issues, the pool of

shared bikes is already high and the GPS system in place allows the whole city coverage. Further efforts should be dedicated on the information provided by the app, and whether this information fits with the expectations of citizens and generates a better use of smart mobility solutions, not only of e-bikes, but also of other modes of transports in the city. Of primary importance is the combination of different modes of transports, and the ability of apps to account for that.

Highlights:

(1) Monitoring sensors is a key step.
(2) Integrate them into a unified network is a second step.
(3) Further advancements and competences in new fields of big data and IoT are expected.
(4) Including the combination of transports in the apps might be valuable.

4.5 Transition Track 5 – Citizen engagement and co-creation

4.5.1 IS-5.1: Co-creating the energy transition in your everyday environment

Overview of the demonstrators

The challenge is to better qualify the ways in which citizens could be better informed and involved in smart initiatives, at best committed or co-creators. This is a novel way to approach issues, less technology-centric and more focused on the way in which different categories of the population might appropriate technologies and adopt services, which in the end result to be critical, as the success of business solutions resides in large part on this. In the development of the project, we are aware that while there are different types of actions to develop in this field, all are not as efficient everywhere, and adjustments have to be expected from one location to the other.

Baseline and ambitions of demonstrators

The baseline is given by Nice having accumulated information on 300 families participating to the CITYOPT project to monitor the conditions under which consumers could modify their behaviours. In the Nice Grid project, 40 houses with solar panels have been equipped with smart meters and remote control of equipment. The aim of CITYOPT is to develop citizens into prosumers, i.e., citizens producing energy for their own consumption. The ambition of smart management of peak pollution is to change behaviour of travellers and car drivers through the use of collective/green mobility solutions or alternative paths for cars in order to reduce air pollution. In that demonstrator, Service Bleu is a useful app aiming at reporting

to the municipality all incidents occurring in everyday city life (degradation and disfunctions of urban infrastructures).

Barriers and drivers of demonstrators

As the outline of the SWOT analysis and social acceptance study, the demonstrator within this TT5 is deemed to be at a pilot/pre-piot stage, leading to the need to consolidate Entrepreneurial Experimentation and Production (F1) as well as Knowledge Development (F2).

Recommendation 1: Consolidate Entrepreneurial Experimentation and Production (F1)

The experience already implemented in Nice allows a large collection of data, with the CITYOPT project, Nice Grid project. Our own study conveys convergent views, with data on 500 households in Nice.

Highlights:

(1) Regulation should tend to consolidate opportunities in the development of prosumers, with better incentives for the households, especially whenever they are tenants.
(2) Change agents are more frequent than expected: younger categories of the population are more inclined to energy savings for economic reasons, while the motivation for older categories of the populations resides into health and better living reasons.
(3) Benchmark of existing citizen engagement/change behaviour experiments to improve air quality proved that the solution based on rewards which will be tried is unique.

Recommendation 2: Consolidate Knowledge Development (F2)

The lessons to be drawn is that a further involvement of citizens is a necessary step for the success of the technological solutions, and it may not be the more innovative solution that will be adopted in the end.

Highlights:

(1) The best technology is not necessarily the one which will be adopted.
(2) Knowledge development should integrate the gap between the best technology and the one actually adopted.
(3) Benchmark of existing citizen engagement/change behaviour experiments to improve air quality proved that the engagement is better when the citizens are participating to air quality measurements.
(4) Make Service Bleu more visible to the citizens and increase its use.

4.5.2 IS-5.2: Participatory city modelling

Overview of the demonstrators

This demonstator is based on the idea that the development of shared decision-making, via online applications, can contribute to render the citizen more sensitive to the development of his own city. The idea is to reduce the distance between the citizens and the city administration through participatory actions.

Baseline and ambitions of demonstrators

On the baseline, we can document that CityOpt, a European project that went on between 2014 and 2017, provided the general objective of developing new solutions for an optimal energy management in cities that engage users, create new partnerships connecting city leaders and stakeholders and create new business models. This experience as a baseline has delivered a set of applications and related guidelines that support efficient planning, detailed design and operation of energy systems in urban districts. Experimentation which associated NCA, EDF and CSTB, has been conducted in the NCA metropolitan area for testing an operational demand-response tool amongst 150 households. The ambition is to make use of this experience for a scaled up demonstrator in the city of Nice.

Barriers and drivers of demonstrators

The SWOT analysis and social acceptance study show that Entrepreneurial Experimentation and Production (F1) together with Knowledge Development (F2) need both to be consolidated going from CityOpt to the city participatory modelling, starting with the development of apps to be tested.

Recommendation 1: Consolidate Entrepreneurial Experimentation and Production (F1)

Civitech is intended to act in this way, facilitating interactions between citizens and the city.

Highlights:

(1) Civitech must prove their capacity getting valuable inputs from the citizens.
(2) The City shall consider implementing further improvements in view of establishing a quantifiable positive impact with the citizens, not only a bottom-up communication.

Recommendation 2: Consolidate Knowledge Development (F2)

The involvement of citizens providing key inputs to the city in a bottom-up way is a necessary step for the success of technological solutions developed by companies such as Civocracy; nonetheless, further knowledge development should be placed on what the city can do with these inputs in an interacting manner, and how to provide feedbacks to the different categories of the population using this system.

Highlights:

(1) Develop an open system of communication, with interactions from the citizen to the city and from the city to the citizen.
(2) Reactiveness is a key in this process of knowledge development.

4.5.3 IS-5.3: Apps and interfaces for energy efficient behaviour

Overview of demonstrators

The intention is to develop apps and interfaces for stimulating energy efficient behaviours, and increasing energy saving through increasing awareness of citizens. The idea is that these apps favour learning processes and smart behaviors via regular use and consciousness.

Baseline and ambitions of demonstrators

The baseline is given by the consideration that the development of apps progressively enables citizens to act as prosumers. The ambition is to develop a new tool Personal Energy Threshold designed in view of providing real-time data on energy production and consumption, but also informing on the possible fit between current needs and available supply. Two tools developed by Engie “I am learning energy” et “Vertuoz habitat and community” will be demonstrated with the support of a local district association and of the social housinh operator CAH.

Barriers and drivers of demonstrators

The SWOT analysis and social acceptance study lead to the result that the development of apps and interfaces for energy efficient behaviour tend to be dependent on the consolidation of Entrepreneurial Experimentation and Production (F1) and Knowledge development (F2).

Recommendation 1: Consolidate Entrepreneurial Experimentation and Production (F1)

The CITYOPT experiment has shown that a very large part of the population is ICT sensitive, and claims they have adequate skills to be able to use friendly online applications. They are also inclined to change

their energy habits if this produces tangible results in terms of economic or quality of life, depending on the categories of the population. The former CUSA citizen engagement pre-pilot application shows that a 200 euros savings on cold and hot water consumptions could be reached with the appropriate metering/showing/coaching solution.

Highlights:

(1) Nice citizens have a high sensitivity to online applications, and this is a highly positive point for their inclination to become smarter citizens, especially in the field of energy.
(2) The categories of the population, however, differ in the motivations of their willingness to change their energy habits.

Recommendation 2: Consolidate Knowledge Development (F2)

In this field, privacy rests as a key point to be taken into account for further efforts to develop these apps. Our results show that while a large of the population in Nice is not particularly worried disclosing personal information on social networks, data might be geolocalised, stored, used, and eventually shared in market transactions, and this might represent a limit. Our results show that residents are confident in their energy provider, and that the only limit to their privacy is on their data to be sold to third parties.

Highlights:

(1) Residents are confident in their energy provider.
(2) Residents will not disclose personal data if a risk of market transactions arises on it.

5. Output to other work packages

We believe there are many WPs and Deliverables that might benefit from D6.1. We will now explain how D6.1 provides output to other work packages, tasks and deliverables within the IRIS project.

5.1 WP2 – EU wide cooperation ongoing projects, initiatives and communities

Our contribution in D6.1 shows that learning from outside and focusing on a different Smart City experience might appear as a way to remove current barriers, like the ones affecting the functions related to Knowledge Exchange (F3) and Resistance to Change (F7). Although our results show that most of the concerns would be blown away within the collaboration of the IRIS project, the expertise beyond IRIS could also be an asset. In that context, D6.1 could be a source for WP2 “EU wide cooperation with ongoing projects, initiatives and communities”, and especially for D2.1 “Lessons learnt though cooperation with other Lighthouse projects”.

5.2 WP3 – Development of bankable business models and exploitation activities

D6.1 can also be viewed as an input in WP3 “Development of bankable business models and exploitation activities”, especially in D3.2 “Sustainable Business Model Dash-board tool” (due M24 by UNS) which is investigating the basic pillars of the IRIS Sustainable Business Model (SBM) by providing a dashboard for local ecosystems. With D6.1, we contribute to D3.2 by providing the anonymised data collected (cross-country or cross-city approach) to focus on specific functions of the ecosystem questionnaire, like innovation, Technology Readiness Level (TRL), and regulation; all elements that are expected to be as crucial in the development of new business models for LHs and FCs.

Another point is that D6.1 deals considerably with Entrepreneurial Experimentation and Production (F1) as well as Market Formation (F5), which are important components in understanding the business models. As such, it provides inputs for D3.4 “SCUIBI-program 3.0 handbook for implementation in IRIS cities & beyond”.

5.3 WP5/WP6/WP7 – Utrecht/Nice/Gothenburg demonstration activities

As undelined in Chapter 5 above, D6.1 is able to elaborate recommendations for the whole Nice Ecosystem, also with highlights for each Transition Tracks and related target audiences. By focusing on the baseline, ambition & barriers for Nice lighthouse interventions, D6.1 offers a frame that is beneficial for D6.2 “Planning of Nice integration and demonstration activities”, with recommendations and highlights from D6.1 elaborated with the aim of easing the implementation of the IS foreseen in D6.2. By collecting data on Utrecht and Gothenburg, while providing deeper analysis of Nice in relation with other

LH cities as control group, D6.1 can provide insights for D5.1 “Baseline, ambition & barriers for Utrecht lighthouse interventions” and D5.2 “Planning of Utrecht integration and demonstration activities”, as well as D7.1 “Baseline, ambition & barriers for Gothenburg lighthouse interventions” and D7.2 “Planning of Utrecht integration and demonstration activities”.

5.4 WP8 – Replication by lighthouse regions, follower cities, European market uptake

D6.1 is primarily targeted to LH cities, but FCs can also be included as a target audience, since they could typically observe what others have already experienced, with major obstacles together with strong opportunities on the path to a Smart City depicted in D6.1. D8.1 “A Roadmap for replication of activities” could get both insights and a benchmark from D6.1.

5.5 WP10 – Communication and dissemination

Results in D6.1 have been already presented at many academic and non-academic events, including Innovative City 27-28 June, Palais des Congrès Acropolis, Nice. From D6.1, we expect to produce academic papers to be presented in National and International conferences, and later on, published in top scientific journals in the field. All publications will be uploaded at Emdesk and will be reported in D10.9 “Communication and dissemination tools and materials”.

6. Conclusions

D6.1 has provided the baseline and ambition for Nice LH, together with a detailed examine of the forces, opportunities, strenghts, weaknesses and threaths of the Nice LH local ecosystem. This has been performed through an empirical analysis relying upon the collection of qualitative and quantitative information deriving from ecosystem questionnaires and face-to-face interviews that we carried out with the relevant subjects of interest (mainly public actors, private organisations and citizens). For the empirical analysis, we utilised the SWOT method, which in detecting the strengths and weaknesses of the Nice LH ecosystem with respect to the other LH cities, allowed us to better understand how to coordinate the efforts at the local level, aligning the incentives of different types of actors who are interacting in a strategic framework (*in primis*, private companies, public sector, and citizens). The SWOT relies upon the TIS methodology, which explicitly defines a set of seven different functions within the Smart City environment to which different target audiences are addressed.

The SWOT is not intended to be an instrument to instigate competition among LH cities, but rather it should be seen as a tool to boost reciprocal cooperation, in view of exchanging innovative developing solutions at the local level and consolidating them for a subsequent replication at a larger scale. The final aim is to make all partners better equipped in the global competition context, to help LH cities becoming smarter and performing higher. A complementary analysis to the SWOT has been subsequently carried out in the social acceptance study, which has enabled us to understand in more depth the attitude of the citizens of Nice to become smarter through their level of engagement in smart activities in the domains of energy, mobility and ICT. In the next sections, the main findings emerging from these analyses are reported in details.

This section reports the main conclusions we obtain from this Deliverable.

6.1 The ecosystem as Smart City

We performed a SWOT analysis of the Nice LH ecosystem. The idea that guided this report has been to disentangle the good points and the less good points characterising the local ecosystem in view of providing a comprehensive list of barriers (weaknesses and threats) and drivers (strengths and opportunities). Our results are drawn from an ecosystem survey from which we collected raw data (based on 44 responses in Nice, 19 in Gothenburg and 13 in Utrecht) on the seven key functions structuring the Nice LH SWOT. We also performed a set of 20 face-to-face interviews where we could test and refine our preliminary findings on the strengths, weaknesses, opportunities and threats of the local ecosystem.

The general conclusion is that Nice, and the other Smart Cities Gothenburg and Utrecht as control group, are not over or under performing on the same functions, leading to the conclusion that the LH cities have different models of development in which some dimensions are leading the evolution while others may lag behind. The baseline picture we drew on Nice LH is that many functions are successfully dealt inside the local ecosystem. In the meantime, none of the 7 functions is fully fulfilled; indeed, the maximum score

being 4, indicates that there is scope for improvement. For most of the time, when scores appear weaker, the ambition could be achieved trhough close collaboration with the other LH IRIS cities. In few cases, and for some functions, Nice should take into consideration the experience of other Smart Cities projects in Europe and beyond.

Then, with reference to the drivers in the Nice LH ecosystem, the latter are numerous and can be listed as follows:

- Driver 1: the local ecosystem innovates in line with Smart City objectives (smarter energy and mobility solutions, City innovation platform, and citizen engagement) and major actors (large incumbent companies and small innovative firms, but also public actors, research and education and supporting organisations) are involved in this innovation process.
- Driver 2: the project is not considering substantial development of new technologies, except from those related to the CIP platform and citizen engagement services; knowledge development is sufficient for the development of the Smart City innovation process. The type of knowledge created fits with the targeted objectives.
- Driver 3: there is a clear vision on how the industry or the market should develop; the Smart City strategy is grounded on a strong policy goal, and the expectations of the different actors are sufficiently aligned with the objectives.
- Driver 4: Smart City market opportunities are expected to be high, and the different actors converge in this appraisal.

In addition, Nice gets on Driver 1 a competitive advantage to be shared and strengthened within the IRIS collaboration, especially in the direction of the other LH cities.

Barriers in Nice are few, yet their identification is crucial as the underestimation of their importance might create additional costs and delays to the action plan. They concern both:

- Barrier 1: how resources (human, physical, financial) can be included in the Smart City project of the ecosystem, and especially whether key resources are available within the ecosystem or outside of it.
- Barrier 2: whether the development of a Smart City project involves a change of habits in consumption, development and production, which can be accommodated.

6.2 The Transition Tracks in the Smart City

Leaving the ecosystem level and zooming in on its components, i.e., the Transition Tracks, there are again many positive elements to consider, generated from the SWOT analysis. The drivers are the following:

- Driver 1: TT1 (Smart renewables and closed loop energy positive districts), TT2 (Smart energy management and storage for energy networks flexibility), TT3 (Smart e-mobility), and TT4 (City innovation platform) develop high ambitions in terms of demonstrations and these actions are undertaken by major actors in place in Nice LH.

- Driver 2: TT1 (Smart renewables and closed loop energy positive districts), TT2 (Smart energy management and storage for energy networks flewibility), TT3 (Smart e-mobility), and TT5 (Citizen engagement) represent for the different actors involved significant market opportunities to mature and capture.
- Driver 3: TT4 (City innovation platform) and TT5 (Citizen engagement) require more substantial development of technologies, and the challenges on knowledge development are more important compared to other Transition Tracks.

At Transition Track level, Nice LH exhibits a competitive advantage in Drivers 1 and 2, and through the IRIS collaboration, Nice LH could disseminate its expertise in entrepreneurial experimentation and market formation to the other LH cities, especially with reference to the TT1 (Smart renewables and closed loop energy positive districts), TT2 (Smart energy management and storage for energy networks flewibility), and TT3 (Smart e-mobility). Another field of expertise operates at the level of TT4 (City innovation platform), which is characterised by a great involvement of public actors in the guidance of search that is revealed to be quite a successful model, in line with local public procurement and local public innovation procurement requirements.

At the level of the Transition Tracks, we can list the following barriers:

- Barrier 1: the same limit observed at the level of the ecosystem, which is related to both resource mobilisation and resistance to change, is also valid at the level of each Transition Tracks.
- Barrier 2: TT4 (City innovation platform) and TT5 (Citizen engagement) could remove many of the barriers by the collaboration with the other LH cities on entrepreneurial experimentation and production as well as on knowledge development.

6.3 Social acceptance in the Smart City

This social acceptance study was performed as a complement to the SWOT. Indeed, the SWOT was directed to supply actors (large and small companies), education and research (research centers and universities), support organisations (innovation networks, clubs, etc.), policy actors (city authorities), while missing the opportunity to focus on citizens, consumers and end users, as a distinct category of actors in the ecosystem.

The study on SA thus relied upon a survey carried out on a sample of 1,001 individuals in the city of Nice and in the control city, where individuals living in the control city have been treated as the control group. Specifically, the main objective of the survey has been that one of studying participants' habits and their inclination to adopt smart practices with reference to the domains related to mobility, energy, ICT and environment. To this aim, variables related to socio-demographic characteristics of citizens and variables related to each of the four domains have been utilised. From the analysis, some noteworthy results emerge.

With reference to mobility habits, individuals living in Nice are more likely to utilise the bus over the tramway to go to work (with respect to the control city). In addition, in both cities, males and working individuals are less likely to use the bus or the tramway to go to work (with respect to females and students, respectively). Finally, it seems that the bigger the household, the higher are the chances of utilising the car or the bus to go to work instead of the tramway or other modes of transport. When considering the mode of transport used for leisure, individuals living in Nice are more likely to use the car over the tramway compared to the control city. In addition, males and working individuals (together with retired citizens) always remain less likely to utilise the bus or the tramway compared to females and students, but more likely to use the car. Finally, household size remains positively correlated with the usage of the car, and negatively with other modes of transport (besides bus and tramway). When considering the reasons of individuals to change mobility behaviour, it seems that city life improvement is less likely to be selected in Nice with respect to the control city. Then, compared to students, working and retired individuals are more likely to select city life improvement as a reason to change mobility behaviour rather than economic reasons. Overall, these results suggest for Nice a predominance of the utilisation of the car and the bus over the tramway with respect to the control city; this trend is strengthened by the fact that city life improvement does not constitute, on average, a reason for changing mobility habits in Nice, as it happens instead in the control city. As a matter of fact, the usage of the car as preferred mode of transport is considered, in general, as an obstacle for the improvement of the city environmental conditions; under this perspective, based on the evidence of the analysed sample, the control city results to be more “environmentally friendly” than Nice in terms of mobility habits, also in the light of the more widespread usage of alternative modes of transport besides personal car and a higher sensitivity of its citizens for environmental consequences related to mobility habits.

With reference to energy habits, the two cities present rather similar characteristics. First of all, individuals who have performed insulations activities and/or who have set up energy devices relying on renewable resources (e.g., solar panels) remain indeed a minority in both Nice and in the control city. Secondly, we have that, on the other hand, individuals’ habits in relation to the usage of electric devices and heating system seem to be remarkably more environmentally-friendly (with a rather similar trend in both cities); indeed, the majority of individuals in both Nice and in the control city are frequently involved in responsible energy behaviours such as: turning off the lights and heating system when it is not necessary (thus avoiding energy wastes), using energy-efficient lighting, and getting informed on the energetic consumption of newly-acquired electronic devices. When comparing the two cities with reference to the reasons of change in energy behaviour, it appears that health reasons are predominant over economic ones in Nice over the control city. Regarding the reasons related to city life improvement, unclear results emerge for both cities.

With reference to ICT, the usage of devices enabling internet access (or “smart ICT devices”, e.g., smart phones, laptops, etc.), although decreasing with age, results to be widespread in the vast majority of individuals in both cities, thus denoting a “smart” ICT character of citizens in both Nice and in the control city. From the analysis it also appears that higher levels of education are associated to a higher probability of using smart ICT devices. A cross analysis between ICT and energy habits and ICT and mobility habits has been additionally performed. With reference to ICT and mobility, it emerges that more than half of the

individuals in both cities utilise, at least once per week, geolocation services on their smartphone. Per contrary, when considering ICT and energy, only a tiny minority of individuals (in both cities) utilise ICT devices enabling the tracking of household energy consumptions. One cause beneath this trend could be represented by the fear of individuals for the possibility that personal information could be intentionally sold by the energy provider to third parties. Thus, the protection of sensitive information seems to represent a remarkably important aspect among the causes influencing the usage of ICT energy devices.

With reference to environmental sensitivity, the latter is intrinsically related to the domains of mobility and energy, and this involves necessarily the implementation of a cross analysis. With reference to environmental-mobility habits, less than half of the individuals in Nice think about environmental consequences each time they use a mode of transport. Conversely, more than half of the individuals in the control city do. This trend perfectly mirrors the lower level of environmental sensitivity in Nice compared to the control city (previously discussed) when considering mobility habits. However, from the analysis, it also appears that the larger is the household size, the more the members of the household are likely to think about environmental consequences when using a mode of transport. With reference to environmental-mobility habits, similar results emerge with reference to localisation. Nonetheless, from the analysis, city life improvement did not seem to represent a significant cause explaining the inclination to change energy habits by individuals, thus the effective linkage between the domains of energy and environmental sensitivity does not appear properly clear. This may suggest that, although citizens may be prone to think about environmental consequences when using electric devices, the real drivers influencing the usage of the same electric devices may rely on other types of causes (possibly health or economic reasons).

7. Recommendations

We believe that the IRIS project represents a unique opportunity for cities to collaborate and exchange their experience in view of developing the action plan in a smooth way, in order to become better places to accommodate the fast pace urban growth and to make city life better and more sustainable for its citizens. Eventually, this process could also reflect a better Smart City ranking position, which is nevertheless a current form of showcasing the city and its projects.

Despite the usual caveats that may appear in our study concerning the SWOT and social acceptance, we are framing the following recommendations for appropriate target audiences.

7.1 Perform well altogether: private actors-public actors

The major lesson of our ecosystem SWOT is that Nice, but also the other IRIS LH Smart Cities, share good result on how: i) to develop Smart City knowledge, through the progress of new and existing technology (F2) and ii) to anticipate the Market Opportunities (F5). These constitute without any doubt key components for performing as a successful Smart City. The target audience, here, is especially represented by the dense network of companies (large or small), which are active in the ecosystem in all fields, like smart renewables, near zero energy buildings, energy management and storage flexibility, ICT, and platforms. Technologies implemented are based on sound technological knowledge, and on competences provided by public and private research centres, as well as equipment providers, where quality and experience seems available not necessarily at the local level of the ecosystem, but at least at the national level. Market size is perceived as still moderate, but is expected to grow significantly in the next coming years, with significant market opportunities to be captured by both incumbent companies and newcomers. The actors all describe a large potential for market solutions dedicated to all kinds of consumers, in an inclusive way. City authorities, which are usually not central in the development of technology and market formation, tend here to play a role in the coordination of actions and alignment of actors, as well as in the generation of scenarios for the development of the ecosystem, which is deemed to increase in the future (public procurement and public innovation procurement at the local level), also in the context of the growing importance of the city innovation platform expecting to better connect the whole ecosystem.

7.2 Do better: research-industry and users-industry

Alternatively, there are functions that need further improvements like: i) Knowledge Exchange (F3) which had an average score, and ii) Resistance to Change (F7), which had a low score for Nice but also for the other IRIS LH Smart Cities. While for sure Knowledge Exchange exists in the IRIS Smart Cities, our results show that, at least in Nice, knowledge fuels primarily among networks of actors that are limited to a recurrent set of members that know each other well and for a long time. From the results we gathered, we cannot not infer much for the other LH cities, as our data is limited to the ecosystem questionnaire. We can however recommend that the same step taken in Nice can be taken by the others. Overall,

Knowledge Exchange could be better off if the ecosystems remain more open to actors belonging to academia, as many successful Smart Cities have recognised universities and research centers as a key source of inventions leading to novel market applications. Solutions to make ecosystems more open could be explored, since Nice, Gothenburg and Utrecht are able to benefit from the experience of non-IRIS cities in the wide EU cooperation with other ongoing projects in WP2 “EU wide cooperation with ongoing projects, initiatives and communities”. Other solutions could also be investigated in a non-EU context. Apart from the relations with academia, Knowledge Exchange could also be improved in relation to end users and consumers, as new solutions ultimately depend on how they are adopted by the final demand. Target audiences by this recommendation are companies that develop technologies, but also research and education as technological sourcing providers and user communities as technology adopters.

Resistance to Change (F7) is somewhat inevitable whenever a Smart City project develops. Technological challenge may be more complex than expected at the time the project is launched. For instance, when moving from an initial setting of positive energy building towards a smart district context, there are new uncertainties and risks to take into consideration. As another illustration for resistance to change, shortage in financial sources might also be observed in ambitious projects. Finally, regulation and legislation issues may arise at the level of contract structures, like service agreement between public and private parties, or at the level of data and privacy, like GDPR, involving further costs and potential disincentive for actors engaged in a Smart City project. Last but not least, actors engaged in Smart Cities projects should also be aware of the potential resistance to change that they might face by cizitens themselves. Indeed, when developing new solutions, services, or technologies, is of outmost importance to consider and incentivize the degree of involvement of users and citizens, for example through the development of programs aimed at educating users in parallel to the development of a certain service and/or product; this might accelerate their acceptance and usage of those same services and/or products. Target audiences, here, include all the actors in the ecosystem.

7.3 Learn from each other: ecosystems of Nice/Gothenburg/Utrecht… and beyond

Finally, there are important functions in which Nice should learn from Gothenburg and Utrecht, as well as other functions in which Nice could disseminate to the other IRIS Smart Cities. Recommendations are provided in the Tabs. 24 and 25 below; first to strengthen drivers, and second to remove barriers. Target audiences are also listed in each of the two tables.

Tab. 24: Collaboration within IRIS to strengthen drivers.

Within IRIS		
From Nice LH ecosystem to the other LH cities	Entrepreneurial Experimentation Guidance of Search	Companies City authorities
From the other LH cities to Nice	Resource Mobilisation	Companies, support organisations, research and education, city authorities
From Nice LH ecosystem TT1, TT2, TT3 to the other LH cities	Entrepreneurial Experimentation Market Formation	companies

From the other LH cities to TT4 and TT5 in Nice LH	Entrepreneurial Experimentation Knowledge Development	Companies Research and education

Tab. 25: Collaboration within IRIS and beyond to remove barriers.

Within IRIS and beyond		
Nice LH and the other IRIS cities	Resource Mobilisation Resistance to Change	Companies, support organisations, research and education, city authorities
TT1, TT2, TT3, TT4 and TT5 in Nice LH and the other IRIS cities	Resistance to Change	Companies, support organisations, research and education, city authorities
TT4 in Nice LH and the other LH IRIS cities	Resource Mobilisation	Companies, support organisations, research and education, city authorities
TT5 in Nice LH and the other LH IRIS cities	Knowledge Exchange	Support organisations

Nice could learn from Gothenburg and Utrecht in Resource Mobilisation (F6), as the other Smart Cities appear to be better organised and structured to attract financial resources, as well as human resources. Recruiting talents and funds from outside, and developing them from the inside, are activities that Gothenburg and Utrecht appear prone to develop in a successful way, and this should be diffused to the city of Nice. In the meantime, the highest is the level of entrepreneurial experimentation (as a reminder, Nice scores high in Entrepreneurial Experimentation and Production (F1)) the more difficult resource mobilisation might be achieved.

Nice appears better off in functions like: i) Entrepreneurial Experimentation and Production (F1) and ii) Guidance of Search (F4). Nice could then bring to the other LH Smart Cities its expertise in: developing breakthrough projects (both in terms of technologies and market opportunities), developing incentives to be part of such projects (for a large number of diverse players), and redeploying past experience gained on previous projects (to get the ability to cope with current and future risks). This goes hand in hand with a high guidance of search, a strong involvement of public actors with a pivotal role in the alignment and coordination of actors.

7.4 Incorporate social acceptance

With reference to social acceptance, our recommendations have two main limitations. The first refers to the sample size. Indeed, 500 individuals represent a rather reduced number, and this may not provide a faithful depiction of reality for the entire population of Nice. The second limitation deals with the fact that the results of this empirical analysis are city-specific, and therefore a comparison with other IRIS cities may result rather cumbersome.

Nonetheless, even in the light of these limitations, we could provide some seminal suggestions. With reference to mobility, students and female individuals might be used as a driver for an increasing

awareness of city life improvement among the population, especially for what concerns the usage of alternative modes of transport. Then, in a similar fashion, individuals who have adopted environmentally friendly solutions could be used as a driver to increase the awareness in adopting sustainable energetic behaviours among the other citizens.

A last remark, from the contribution of this work, is that it becomes transparent that the collective agreement on the way forward to build a Smart City is through collaboration, co-participation and co-creation amongst all stakeholders, namely companies, education and research, city authorities, and support organisations. It is by building a community-driven approach that needs to go beyond vows to concrete actions to engage citizens in this new path. Our results show many positive advancements for Nice and the other LHs cities in the IRIS project; nonetheless, it is of outmost importance that attention should equally be paid (and perhaps even more importantly) to the weaker findings emerging from both the SWOT and social acceptance investigations. The evolution of a Smart City needs to develop at all levels in a harmonic way, one step at a time with all stakeholders going towards the same direction. All players are equally essential and important in this evolution process. Technology and policies can only go as far as citizens are willing to accept changes, but in order to change citizens' mindsets, there needs to be an equal change in governments' and companies' mindsets as well. It is not an easy task, but nevertheless, the tools necessary to such aim are available; they only need to be appropriately applied. In that perspective, we are confident that D6.1 contributes to provide such tools in view of future developments along these lines of thought, and for an optimal development of the IRIS action plan.

7.5 Highligths for the development of the IRIS action plan

The work elaborated within this Deliverable enables the definition of strategic orientations for the local ecosystem, together with guidelines aiming at easing the implementation of integrated solutions foreseen in D6.2 "Coordination of NCA integration and demonstration activities". Tab. 26 reports below the main recommendations for each IS, together with the corresponding function.

Tab.26: Recommendations for each Integrated Solution.

Integrated solution	Recommendations
IS-1.1: Positive energy buildings	- Experimentation and production of positive energy building within mixed-use districts and buildings (F1) - Focus on scenarios on self-consumption and resale of energy on the grid (F1) - Disentangle key issues with lithium battery storage (F1) - Explore self-consumption scenarios in relation to risks and costs (storage capacity versus profitability) (F5) - Explore energy bill savings from storage as to reduce grid connection fees and ensure not to pass during peak hours (F5) - Explore returns on investments in mixed-use buildings and districts (F5)

	- End user habits and inclination of change have to be taken into account *in primis* by building owner and property developer (F7) - Positive energy building is a longer term return on investments than traditional building, potentially leading to a disincentive for impatient capital (F7)
IS-1.2: Near zero energy retrofit district	- Enforce solutions for the optimization of the heating load curve and energy savings (F1) - Develop monitoring solutions involving the residents paying the energy bills (F1) - Both buildings owners and tenants are engaged in the consolidation of market opportunities (F5) - There are cumulative effects in energy savings habits to take into consideration and develop (F5) - Regulation should tend to consolidate opportunities in removing resistance to change (F7) - Younger categories of the population are more inclined to energy savings for economic reasons, while the motivation for older categories of the populations resides into health and better living reasons (F7)
IS-1.3: Symbiotic waste heat networks	- Experiment low temperature district heating cooling network (F1) - Experiment dashboard solution (F1) - Develop new pricing contracts, in a context where switching opportunities exist for customers (F5) - Pricing strategies are fierce and impact the business strategies (F5) - Promote symbiotic solutions as circular economy experiences (F7) - Involve citizens in realizing these solutions, which are to be replicated at a larger scale (F7)
IS-2.1: Flexible electricity grid networks	- The extension of entrepreneurial experimentations from one building to one district might have disruptive implications and unexpected outcomes (F1) - The involvement of key actors in the field is essential to consolidate opportunities as more technological and contractual complexity is expected to occur (F1)

	- Develop and test the Local Energy Management with the aim of optimising energy consumption, energy bill reduction or even new revenue streams (F5) - Optimise energy storage and distribution in a smart district (F5) - Experiment temperature adjustments in tertiary buildings, controlling for the cost/energy saving balance (F7) - Control for dysfunctions and acceptance (F7)
IS-2.2: Smart multi-sourced low temperature district heating with innovative storage solutions	- The development of an efficient Smart Energy Management Scheme is in a challenge (F1) - Monitor energy storage and distribution in a smart district (F5) - More solicitations towards households with a large number of members should pay up in removing resistance to change (F7) - Involve citizens in realizing these circular economy solutions are operational at a large scale (F7)
IS-2.3: Utilising 2nd life batteries for smart large-scale storage scheme	- Make sure there is a common understanding/definition of what is a second life battery (F1) - Explore a large spectrum of sector (car sector may be one) and technology opportunities (Lithium may be one) (F1) - Disentangle whenever mobile use of the battery might be a limit in its second life fixed use (F1) - Second life battery market is still underdeveloped and products at the prototype stage (F5) - Profitability (including maintenance costs) is still to be proven (F5) - Explore stationary storage tests (F7)
IS-3.1: Smart Solar V2G EV charging	- Use of EV public charging stations (F1) - Develop proximity, easy access (F5) - Develop tariffs associated with the type and timing of use (F5) - Expand smart mobility focusing on e-cars (F7) - Explore the interoperability from one smart mobility to the other, like cycle-tramway, or cycle-train (F7) - Incentivize citizens to adopt smart mobility in their home-office commute, probably based on a rewarding model (F7)

IS-3.2: Innovative mobility services for the citizens	- Deploy a Proof of Concept consisting in checking the whole user experience of a driver willing to charge his EV car in private properties could be a first step, potentially offering replicable conclusions to any similar deployment in European cities (F1) - Identification of the changes required by this deployment, in terms of adapted location, technical and contractual design (F1) - Reuse of existing investments and infrastructures (charging station, car sharing platform) (F1) - Increase the share of EV as a mobility service in the city (F5) - Develop interoperable subscriptions with other e-mobility services (F5) - Focus on categories of populations (students, women) having a strong inclination to change mobility habits in near future (F5) - Autonomy of the battery, fast charging (F7)
IS-4.1: Services for urban monitoring and IS-4.3: Services for mobility	- Data sharing and legal issues are of primary importance (F1) - City model, with public private partnership, is a promising, sustainable solution (F1) - Development of apps is valuable to citizens which prove to be highly connected all across the different categories of the population (F1) - Mobility apps are expected a positive impact on their inclination to change towards smarter mobility behaviours (F1) - Monitoring sensors is a key step (F2) - Integrate them into a unified network is a second step (F2) - Further advancements and competences in new fields of big data and IoT are expected (F2) - Including the combination of transports in the apps might be valuable (F2)
IS-5.1: Co-creating the energy transition in your everyday environment	- Regulation should tend to consolidate opportunities in the development of prosumers, with better incentives for the households, especially whenever they are tenants (F1) - Change agents are more frequent than expected: younger categories of the population are more inclined to energy savings for economic reasons, while the motivation for older categories of the populations resides into health and better living reasons (F1)

	- Benchmark of existing citizen engagement/change behaviour experiments to improve air quality proved that the solution based on rewards which will be tried is unique (F1) - The best technology is not necessarily the one which will be adopted (F2) - Knowledge development should integrate the gap between the best technology and the one actually adopted (F2) - Benchmark of existing citizen engagement/change behaviour experiments to improve air quality proved that the engagement is better when the citizens are participating to air quality measurements (F2) Make Service Bleu more visible to the citizens and increase its use (F2)
IS-5.2: Participatory city modelling	- Civitech must prove their capacity getting valuable inputs from the citizens (F1) - The City shall consider implementing further improvements in view of establishing a quantifiable positive impact with the citizens, not only a bottom-up communication (F1) - Develop an open system of communication, with interactions from the citizen to the city and from the city to the citizen (F2) - Reactiveness is key in this process of knowledge development (F2)
IS-5.3: Apps and interfaces for energy efficient behaviour	- Nice citizens have a high sensitivity to online applications, and this is a highly positive point for their inclination to become smarter citizens, especially in the field of energy (F1) - Categories of the populations however differ in the motivations of their willingness to change their energy habits (F1) - Residents are confident in their energy provider (F2) - Residents will not disclose personal data if a risk of market transactions arises on it (F2)

8. References

[1] UNCTAD (2017). "Handbook of Statistics 2017". Available at: http://unctad.org/en/PublicationChapters/tdstat42_FS11_en.pdf/.

[2] Albino, V., Berardi, U., and Dangelico, R. (2015). “Smart Cities: Definitions, Dimensions, Performance, and Initiatives”. *Journal of Urban Technology*, vol. 22, pp. 3-21.

[3] Ashan, H. and Haque, M. (2017). “Threshold Effects of Human Capital: Schooling and Economic Growth”. *Economics letters*, vol. 156, pp. 48-52.

[4] Attour, A. (2017) "Individuals’ Privacy Concerns over Smart Mobility Solutions", Communication to the special session “The French Research Association for Digital Economy” of the 66th Annual Congress of the French Economic Association (AFSE), Nice, France, 19-21 June 2017.

[5] Barns, S. (2018). “Smart Cities and Urban Data Platforms: Designing Interfaces for Smart Governance”. *City, Culture and Society*, vol. 12, pp. 5-12.

[6] Ben Letaifa, S. (2014). “The Uneasy Transition from Supply Chains to Ecosystems: The Value Creation and Value Capture Dilemma”. *Management Decision*, vol. 52(2), pp. 278-295.

[7] Berardi, U. (2013a). “Clarifying the New Interpretations of the Concept of Sustainable Building”. *Sustainable Cities and Society*, vol. 8, pp. 72-78.

[8] Berardi, U. (2013b). “Sustainability Assessments of Urban Communities through Rating Systems”. *Environment, Development and Sustainability*, vol. 15(8), pp. 1573-1591.

[9] Bergek, A., Jacobsson, S., Carlsson, B., Lindmark, S., and Rickne, A. (2008). “Analyzing the Functional Dynamics of Technological Innovation Systems: A scheme of Analysis”. *Research policy*, vol. 37(3), pp. 407-429.

[10] Canton, J. (2011). “The Extreme Future of Megacities”. *Significance*, vol. 8, pp. 53-56.

[11] Caragliu, A., Del Bo, C., and Nijkamp P. (2011). “Smart Cities in Europe”. *Journal of Urban Technology*, vol. 18, pp. 65-82.

[12] Cecere, G. et al. (2015). “Perceived Internet Privacy Concerns on Social Networks in Europe”. *Technological Forecasting and Social Change*, vol. 96, pp. 277-287.

[13] CISCO (2017). Cities and Communities. Available at: https://www.cisco.com/c/en/us/solutions/industries/smart-connected-communities.html.

[14] Cities in Motion Index 2014. Consulted on April 2018 at https://www.iese.edu/en/multimedia/ST-0333-E_tcm41-159595.pdf.

[15] Cities in Motion Index 2015. Consulted on April 2018 at: https://www.iese.edu/research/pdfs/ST-0366-E.pdf.

[16] Cities in Motion Index 2016. Consulted on April 2018 at: https://www.iese.edu/research/pdfs/ST-0396-E.pdf.

[17] Cities in Motion Index 2017. Consulted on April 2018 at: https://www.iese.edu/research/pdfs/ST-0442-E.pdf.

[18] Cities in Motion Methodology and Modeling Index 2014. Consulted on April 2018 at: https://www.iese.edu/research/pdfs/ST-0335-E.pdf.

[19] Colldahl, C. et al. (2013). “Smart Cities: Strategic Sustainable Development for an Urban World”. Technical report, Blekinge Institute of Technology.

[20]Docherty, I. et al. (2018). “The Governance of Smart Mobility”. *Transportation Research Part A: Policy and Practice* (forthcoming).

[21] Dubin, J.A. and McFadden, D. L. (1984). “An Econometric Analysis of Residential Electric Appliance Holdings and Consumption”. *Econometrica*, vol.52(2), pp. 345-362.

[22]European Commission (2015). “Smart Cities and Communities”. Available at: http://ec.europa.eu/eip/smartcities/.

[23]Field, A. P. (2013). “Discovering Statistics Using IBM SPSS Statistics”. Sage Publications.

[24]Giffinger, R., Fertner, C., Kramar, H., Kalasek, R., Pichler-Milanovic, N., & Meijers, E. (2007). “Smart Cities - Ranking of European Medium-Sized Cities”. Vienna University of Technology, mimeo.

[25]Hall, P. (2000). “Creative Cities and Economic Development”. *Urban Studies*, vol. 37(4), pp. 633-649.

[26]Harrison, C. et al. (2010). “Foundations for Smarter Cities”. *Journal of Research and Development*, vol. 54(4), pp. 350-365.

[27]Hekkert, M., Negro, S., Heimeriks, G., and Harmsen, R. (2011). “Technological Innovation System Analysis: A manual for Analysts”. Technical report, University of Utrecht.

[28]Hekkert, M., Suurs, R., Negro, S., Kuhlmann, S., Smits, R. (2007). “Functions of Innovation Systems: A New Approach for Analysing Technological Change”. *Technological Forecasting and Social Change*, vol. 74, pp. 413-432.

[29]Hollands, R. (2008). “Will the Real Smart City Please Stand Up?”. *City*, vol. 12(3), pp. 303-320.

[30]IBM, 2009. A Vision of Smarter Cities. Available at: https://www-03.ibm.com/press/attachments/IBV_Smarter_Cities_-_Final.pdf.

[31]Kendel, A., Lazaric, N. (2017). “What Do People ‘Learn by Looking’ at Direct Feedback on Their Energy Consumption? Results of a Field Study in Southern France”. *Energy Policy*, vol. 108, pp. 593-605.

[32]Burns, A., Burns, R. (2008). “Basic Marketing Research” (Second ed.). *New Jersey: Pearson Education*.

[33]Jeyaraj, K. L. et al. (2012). “Application of SWOT and Principal Component Analysis in a Textile Company - A Case Study”. *International Journal of Engineering Research and Development*, vol. 1(9), pp.46-54.

[34]Bell, G. G. and Rochford L. (2016). “Rediscovering SWOT’s Integrative Nature: A New Understanding of an Dld Framework”. *The International Journal of Management Education*, vol. 14, pp. 310-326.

[35]Aich A. and Ghosh S. K. (2016). “Application of SWOT Analysis for the Selection of Technology for Processing and Disposal of MSW”. *Procedia Environmental Sciences*, vol. 35, pp. 209-228.

[36]Krafft, J., (2004). “Entry, Exit and Knowledge: Evidence from a Cluster in the Info-Communications”. *Research Policy*, vol. 33(10), pp. 1687-1706.

[37]Lazaroiu, G. C., and Roscia, M. (2012). “Definition Methodology for the Smart Cities Model”. *Energy*, vol. 47, pp. 326-332.

[38]Lombardi, P. et al. (2012). “Modelling the Smart City performance”. *Innovation: The European Journal of Social Science Research*, vol. 25(2), pp 137-149.

[39]Long, J. S., and Freese J. (2014). “Regression Models for Categorical Dependent Variables Using Stata”, 3rd ed., Stata Press.

[40]Mayer, A. L. (2008). “Strengths and Weaknesses of Common Sustainability Indices for Multidimensional Systems”. *Environment International*, vol. 34(2), pp. 277-291.

[41]Mori, K., Christodoulou, A. (2012). “Review of Sustainability Indices and Indicators: Towards a New City Sustainability Index (CSI)”. *Environmental Impact Assessment Review*, vol. 32, pp. 94-106. doi:10.1016/j.eiar.2011.06.001.

[42]Mosannenzadeh, F. and Vettorato, D. (2014). “Defining Smart City. A Conceptual Framework Based on Keyword Analysis”. *Tema. Journal of Land Use, Mobility and Environment*.doi:10.6092/1970-9870/2523.

[43]Musterd, S., and Ostendorf, W. (2004). “Creative Cultural Knowledge Cities: Perspectives and Planning Strategies”. *Built Environment*, vol. 30(3), 188-193.

[44]ORACLE (2018). Oracle’s Primavera Smart City solution. Available at: http://www.oracle.com/us/products/applications/primavera/smart-city-solution-brief-2875315.pdf.

[45]Partridge, H.L. (2004). “Developing a Human Perspective to the Digital Divide in the “Smart City””. Australian Library and Information Association Biennial Conference, 21-24 September, Queensland, Australia.

[46]Pasaoglu, G., Fiorello, D., Martino, A., Zani, L., Zubaryeva, A., Thiel, C. (2014). “Travel Patterns and the Potential Use of Electric Cars - Results from a Direct Survey in Six European Countries”. *Technological Forecasting and Social Change*, vol. 87, pp. 51-59.

[47]Payil, S. and Kokate, K. (2017). “Identifying Factors Governing Attitude of Rural Women Towards Self-Help Groups Using Principal Component Analysis”. *Journal of Rural Studies*, vol. 55, pp. 157-167.

[48]Perera, C. et al. (2014). “Sensing as a Service Model for Smart Cities Supported by Internet of Things”. *Transactions on Emerging Telecommunications Technologies*, vol. 25, pp. 81-93.

[49]Plötz, P., Schneider U., Globisch J., Dütschke E. (2014). “Who Will Buy Electric Vehicles? Identifying Early Adopters in Germany”. *Transportation Research Part A*, vol. 67, pp. 96-109.

[50]Reiner, C., Meyer, S., Sardavar, S. (2017). “Urban Attraction Policies for International Academic Talent: Munich and Vienna in Comparison”. *Cities*, vol. 61, pp. 27-35.

[51]Reinoso, H. and Turego, M. (2016). “Examining the Factor Structure of MUIS-C Scale among Baby Boomers with Hepatitis C”. Applied Nursing Research, vol.32, pp. 111-116.

[52]Rios, P. (2008). “Creating “the Smart City””. Technical report, available at: http://archive.udmercy.edu: 8080/bitstream/handle/10429/393/2008_rios_smart.pdf?sequence=1.

[53]Rodriguez-Pose, A. and Ketterer, T. (2012). “Do local amenities affect the appeal of regions in Europe for migrants?”. Journal of Regional Science, vol. 52, pp. 535-561.

[54]Schaffers, H. Komninos, N., Pallot, M., Trousse, B., Nilsson, M., Oliveira, A. (2011). “Smart Cities and the Future Internet: Towards Cooperation Frameworks for Open Innovation”. *The Future Internet Assembly*, vol. 6656, pp. 431-446.

[55]Schönert, M. (2003). “Städteranking und Imagebildung: Die 20 größten Städte in Nachrichten- und Wirtschaftsmagazinen”. BAW vol. 2(03), pp.1-8

[56]Tanguay, G. A., Rajaonson, J., Lefebvre, J., and Lanoie, P. (2010). “Measuring the Sustainability of Cities: An Analysis of the Use of Local Indicators”. *Ecological Indicators*, vol. 10(2), pp. 407–418.

[57]Teixeira, A. and Queiros, A. (2016). “Economic Growth, Human Capital and Structural Change: A Dynamic Panel Data Analysis”. *Research Policy*, vol. 45, pp. 1636-1648.

[58]Thompson, M. (2018). "Social Capital, Innovation and Economic Growth". *Journal of Behavioral and Experimental Economics*, vol. 73, pp. 46-52.

[59]Toppeta, D. (2010). "The Smart City Vision: How Innovation and ICT can Build Smart, "Liveable", Sustainable Cities". Think! Report, The Innovation Knowledge Foundation, 005, Milan.

[60]Williams, R., (2006). "Generalized Ordered Logit/Partial Proportional Odds Models for Ordinal Dependent Variables". *Stata Journal*, vol. 6, pp. 58-82.

9. Annexes

Annex 1: Ecosystem questionnaire

Note: KPIs measuring technical performance are documented through the description of the main field of activity and stage of development, as well as in F1, F2, and F3); KPIs measuring economic performance are documented in F1 and F5); KPIs measuring social performance are inherent in F1 and F7; KPIs measuring legal performance are captured in F7.

Name of the company/organisation:

Company/organisation age:

Company/organisation size:

Name of the Contact:

Function of the Contact:

Contact details:

Main field of activity:

Secondary field of:

Stage of development (pilot, development in the local ecosystem, development outside the local ecosystem):

Date of involvement in Smart City activities:

Size of the team dedicated to Smart City activities:

F1 - Entrepreneurial Experimentation and Production

1. In your opinion, the number of key players in the Smart City ecosystem is:

☐ Very low ☐ Low ☐ Average ☐ strong ☐ Very strong

2. According to you, the diversity of these key players is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

3. Choices and positioning of these actors in the Smart City have an effect on your own activity which is:

 Very low Low Medium Strong Very strong

4. The effect of your own activity on the choices and positioning of other actors is:

 Very low Low Medium Strong Very strong

5. According to you, the degree of innovation of the actors in the Smart City is:

 Very low Low Medium Strong Very strong

6. Within the Smart City ecosystem, the share of your activities involving technological breakthroughs could be qualified as:

 Very low Low Medium Strong Very strong

7. The share of your activity involving market creation/disruption in the Smart City could be qualified as:

 Very low Low Medium Strong Very strong

8. According to you, the opportunities offered by the development of the Smart City for your own company/organisation are:

 Very low Low Medium Fort Very strong

9. According to you, the interest and efforts of the actors in the Smart City dedicated to impulse development and large-scale production of technologies/products/services are:

 Very low Low Medium Strong Very strong

10. According to you, the efforts and contribution of the actors already installed in the Smart City are:

□ Very low □ Low □ Medium □ Strong □ Very strong

11. According to you, the efforts and contribution of new actors are:

□ Very low □ Low □ Medium □ Strong □ Very strong

12. In view of moving to a next phase of development of the Smart City, the presence of new players plays a role that you would value as:

□ Very low □ Low □ Medium □ Strong □ Very strong

13. The presence of new players could generate barriers to the development of the Smart City, in an extent that you would value as:

□ Very low □ Low □ Medium □ Strong □ Very strong

14. According to you, within the Smart City ecosystem, the following uncertainties seem very low, low, medium, strong or very strong:

Type of uncertainties	Intensity
Technology	□ Very low □ Low □ Medium □ Strong □ Very strong
Human resources available	□ Very low □ Low □ Medium □ Strong □ Very strong
Financial resources available	□ Very low □ Low □ Medium □ Strong □ Very strong
Physical infrastructure	□ Very low □ Low □ Medium □ Strong □ Very strong
Industrial partners	□ Very low □ Low □ Medium □ Strong □ Very strong
Consumer behaviours	□ Very low □ Low □ Medium □ Strong □ Very strong
Local policy institutions and guidance	□ Very low □ Low □ Medium □ Strong □ Very strong

15. Your own experience with these risks could be qualified as:

 Very low Low Medium Strong Very strong

16. Did you gain this experience through participation in other Smart City projects, and if so would you value is as:

 Very low Low Medium Strong Very strong

17. Your ability to cope with these risks can be qualified as:

 Very low Low Medium Strong Very strong

F2 - Knowledge Development

18. According to you, scientific and technical knowledge required for the development of the Smart City are:

 Very low Low Medium Strong Very strong

19. Would you say that local access to scientific and technical knowledge related to the development of innovation in technologies/products/services in the Smart City is:

 Very low Low Medium Strong Very strong

20. In your opinion, the availability at the local level of market knowledge in the Smart City ecosystem is:

 Very low Low Medium Strong Very strong

21. The quality of the technical knowledge available within the Smart City seems to you as:

 Very low Low Medium Strong Very strong

22. Do you think the quality of market knowledge within the Smart City is:

 Very low Low Medium Strong Very strong

23. Existing knowledge (related to technical, market issues) is a plus for new knowledge to be developed within the Smart City, would you range this as:

□ Very low □ Low □ Medium □ Strong □ Very strong

F3 - Knowledge Exchange

24. According to you, Knowledge Exchange between academic actors and industrial actors in the Smart City is:

□ Very low □ Low □ Medium □ Strong □ Very strong

25. According to you, Knowledge Exchange between end users and industrial players is:

□ Very low □ Low □ Medium □ Strong □ Very strong

26. According to you, Knowledge Exchange with actors external to the ecosystem is:

□ Very low □ Low □ Medium □ Strong □ Very strong

27. Do you think the lack of Knowledge Exchange within the ecosystem of Smart City could be considered as:

□ Very low □ Low □ Medium □ Strong □ Very strong

28. In your opinion, this lack of Knowledge Exchange could create barriers you value as:

□ Very low □ Low □ Medium □ Strong □ Very strong

F4 - Guidance of Search

29. The development of the Smart City ecosystem in the near future can be anticipated and planed with a degree of precision you value as:

□ Very low □ Low □ Medium □ Strong □ Very strong

30. In your opinion, technological development is a dimension that can be anticipated and planed with a degree of precision that is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

31. According to you, the economic dimension is rather predictable in a range that is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

32. Do you think the vision of local public actors and institutions on technological development challenges in the Smart City is in sum:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

33. Do you think the vision of local public actors and institutions on economic issues involved by the Smart City more likely is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

34. In your opinion, the alignment/coordination of actors in the Smart City ecosystem regarding potential uncertainties (technological, political, consumer adoption, etc.) is

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

35. According to you, the lack of alignment/coordination of the actors could hinder the development of the Smart City in a range that is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

F5 - Market Formation

36. In your opinion, the size of the current market is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

37. In your opinion, the expected market size is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

38. Concerning your own activities in the Smart City, would you consider market opportunities as exploratory and long-term oriented, in a range you value as:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

39. Your activities related to the Smart City involve market opportunities that are exploitation and short-term oriented, in a range that is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

40. In your opinion, the size of the market is a barrier to future development, in an extent which is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

41. According to you, the Smart City could generate economic benefits in the short-term that are:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

42. According to you, the Smart City could generate economic benefits in the long-term that are:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

43. Your activities are oriented towards a particular group of users, in an extent which is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

44. In your opinion, market opportunities are socially inclusive in an extent which is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

F6 - Resource Mobilisation

45. According to you, the presence of mobilisable/accessible human resources within the Smart City ecosystem is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

46. According to you, the availability of financial resources existing within the ecosystem of the Smart City is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

47. According to you, the level of development of the physical infrastructures of the Smart City is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

48. You would value the constraints of the ecosystem of the Smart City as

For human resources:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

For financial resources:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

For physical infrastructures:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

F7 – Counterfactual Resistance to Change/legitimacy of creation

49. In your opinion, the time needed to develop and mature the ecosystem of the Smart City is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

50. You would value technological Resistance to Change as:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

51. According to you, support/subsidies at the local level the Smart City activities are:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

52. Do you think barriers related to regulation and legislation are:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

53. According to you, within the Smart City, these barriers are related to:

Legislation, standards, and industrial/intellectual property, in an extent which is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

Related to ethics, standards, behaviours:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

54. In your opinion, barriers are related to:

Contract structures (public-private), in an extent which is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

Data and privacy, in an extent which is:

☐ Very low ☐ Low ☐ Medium ☐ Strong ☐ Very strong

Liability and security, in an extent which is:

□ Very low □ Low □ Medium □ Strong □ Very strong

Electronic communication networks, in an extent which is:

□ Very low □ Low □ Medium □ Strong □ Very strong

55. The involvement and citizen participation is a factor of development of your activities, in an extent which is:

□ Very low □ Low □ Medium □ Strong □ Very strong

56. Compared to other projects of Smart City at the national/international level, would you say that the Smart City regroups favourable conditions of development, in a range that is:

□ Very low □ Low □ Medium □ Strong □ Very strong

57. Would you consider the development of the Smart City as beneficial for other municipalities in the neighbourhood, in an extent which you value as:

□ Very low □ Low □ Medium □ Strong □ Very strong

58. The project of Smart City generates/will generate a positive impact on the image of the city, in a range that is:

□ Very low □ Low □ Medium □ Strong □ Very strong

Annex 2: Guide of interview

Note: KPIs measuring technical performance are documented through the description of the general information, as well as in the description of the future project; KPIs measuring economic performance are documented in customer value proposition and profit formula/revenue model; KPIs measuring environmental performance are captured in the description of the origin and development of the future project.

1. Introduction

2. General information: the company in the Smart City

3. Future project (focus on the most promising project) for the company in the Smart City

4. Origin of the future project

5. Customer value proposition

6. Key resources

9. Profit formula/revenue model

10. Development of the future project

11. End of the interview

Annex 3: Description of the seven functions (TIS)

Abbreviation	Number of function	Noun	Definition
F1	Function 1	**Entrepreneurial Experimentation and Production**	Is dedicated to identifying the initiatives at the local level and the appropriate quantitative and qualitive efforts in respect with the objectives of Nice LH. Basically, this function identifies the way in which the local ecosystem innovates and how the major actors are involved in this innovation process.
F2	Function 2	**Knowledge Development**	Is focused on whether Knowledge Development is sufficient for the development of the innovation process, and if the type of knowledge created fits with the targeted objectives.
F3	Function 3	**Knowledge Exchange**	Is focused on whether Knowledge Development is sufficient for the development of the innovation process, and if the type of knowledge created fits with the targeted objectives.
F4	Function 4	**Guidance of Search**	Controls if there is a clear vision on how the industry or the market should develop, if the strategy is grounded on a clear policy goal, and if the expectations of the different actors are sufficiently aligned.
F5	Function 5	**Market Formation**	Evaluates the current and expected size of the market, and if the different actors diverge or converge in future market appraisal.
F6	Function 6	**Resource Mobilisation**	Focuses on how resources can be included in the project of the ecosystem, and especially if key resources are available within the ecosystem or outside of it.
F7	Function 7	**Resistance to Change**	Identifies if there are limits in the development of the project, as it involves a change of habits in consumption, development and production.

Annex 4: Description of the five Transition Tracks

Abbreviation	Number of function	Noun	Definition
TT1	Transition Track 1	**Smart renewables and closed-loop energy positive districts**	Integrating: (a) a high share of locally produced and consumed renewable energy at district scale, (b) energy savings at building level reducing the citizens' energy bill and (c) energy savings at district level. Demonstrated solutions integrate: high renewables penetration like district scale PV and biomass for district heating, near zero energy housing retrofit, energy efficient low temperature district heating, and smart public lighting that is energy efficient, powered by renewables and connected to the district energy system.
TT2	Transition Track 2	**Smart Energy Management and Storage for Grid Flexibility**	Integrating smart energy management and renewable energy storage for: (a) maximum profits of renewable power/heat/gas, (b) maximum self-consumption reducing grid stress and curtailment, and (c) unlocking the financial value of grid flexibility. Demonstrated technical solutions include: smart ICT to interconnect energy management systems at home, building and district level, and to integrate maximal renewables production (track 2), V2G storage in e-cars operated in car sharing systems (Track 3) with additional stationary energy storage.
TT3	Transition Track 3	**Smart e-Mobility Sector**	Integrating electric vehicles and e-car sharing systems in the urban mobility system offering: (a) local zero-emission mobility, (b) lower household mobility costs, and (c) smart energy storage in V2G car batteries. Demonstrated solutions include: extensive deployment of (V2G) e-cars, exploitation of (V2G) e-cars in local car sharing systems, and district-wide smart (V2G) charging stations powered mainly by renewables.
TT4	Transition Track 4	**City Innovation Platform (CIP)**	Cutting edge information technology and data framework enabling: (a) the above-

			mentioned solutions, maximising cost-effectiveness of the integrated infrastructure. Next, the City Innovation Platform with open standards-based application program interfaces (APIs) provides meaningful data and information services for households, municipality and other stakeholders, allowing for a Data Market with new business models. A common architecture, harmonised data models and a sustainable data governance plan ensure the interoperability and replicability of the solutions, transferring them from city to city. The City Data Market and the service marketplace manage access to all data and services, with appropriate licenses and flexible pricing models in and across cities, and allowing real time KPI monitoring and benchmarking of smart energy and mobility performances.
TT5	Transition Track 5	**Citizen engagement and Co-Creation**	Design and demonstration of feedback mechanisms and inclusive services for citizens to achieve that they are intrinsically motivated to: (a) save energy, (b) shift their energy consumption to periods with redundant renewables, (c) use electric vehicles and (d) change the vehicle ownership culture towards a use or common mobility assets culture. Demonstrated solutions include: game-theory based engagement methods and instruments ranging from co-creating infotainment apps, local school campaigns, offering training on the job to students living in the district by partaking in the demo activities, competitive energy games using the home energy management system, energy ambassadors creating local energy communities, to crowd-funding creating a sense of being part of the solution.

Annex 5: Social acceptance questionnaire

Note: KPIs measuring environmental performanceare captured through Q9 and Q10; KPIs measuring social performance are inherent Q11 and Q12; KPIs measuring performance of ICT are documented through Q16 to Q20ter.

Socio-demographic profile

RS1 - You live in:

1. Nice
2. Bordeaux

RS2 - You are:

1. Male
2. Female

RS3bis - What is your age?

RS4 - How many people live in your household (including yourself)?

RS5 - How many children live in your household?

RS6 - Which is your house type?

1. Apartment
2. Villa
3. Other

RS7 - Are you the tenant or the owner of your house?

1. Owner
2. Tenant
3. Other

RS8 - Do you have (more than one response is possible):

1. Personal car (classic)
2. Personal car (electric)
3. Personal car (hybrid)
4. Two-wheeled vehicle (motorbike, scooter, etc.)
5. Bike (classic)
6. Bike (electric)

7. Other modes of transport

RS9 - You are:

1. Student
2. Retired
3. Workman
4. Employee
5. Intermediary
6. Intellectual
7. Tradesman
8. Farmer
9. Unemployed

RS10 - Your highest education level is:

1. Elementary school
2. Middle school
3. High school
4. Bac + 2
5. Bac + 3
6. Bac +5

Urban mobility and preferred mode of transport

Q1 - Among the modes of public transport of the city of Nice/city of Bordeaux, you use (more than one response is possible):

1. Vélo bleu or V3 (Vcube)
2. Bus
3. Train (TER)
4. Train (Grande ligne)
5. Tramway
6. Electric car service (Auto-bleue/bluecar)

Q2 - How far is your place of residence from your place of work/place of study?

1. Less than 5km
2. 5 – 10 km
3. 10 – 15km
4. 20km and more

Q3 - For your commute home - work place/home - study place, which mode of transports do you mainly use?

1. Personal car
2. Two-wheeled vehicle (motorbike, scooter, etc.)
3. Bike (classic)
4. Bike (electric)
5. Other modes of transport
6. Vélo bleu or V3
7. Bus
8. Train (TER or Grande ligne)
9. Tramway
10. Electric car service (Auto-bleue/bluecar)
11. Carpooling
12. Walking
13. Other

Q3bis – To go shopping, you mainly use:

1. Personal car
2. Two-wheeled vehicle (motorbike, scooter, etc.)
3. Bike (classic)
4. Bike (electric)
5. Other modes of transport
6. Vélo bleu or V3
7. Bus
8. Train (TER or Grande ligne)
9. Tramway
10. Electric car service (Auto-bleue/bluecar)
11. Carpooling
12. Walking
13. Other

Q3ter – In your spare time (leisure), do you mainly use:

1. Personal car
2. Two-wheeled vehicle (motorbike, scooter, etc.)
3. Bike (classic)
4. Bike (electric)
5. Other modes of transport
6. Vélo bleu or V3
7. Bus
8. Train (TER or Grande ligne)
9. Tramway
10. Electric car service (Auto-bleue/bluecar)
11. Carpooling

12. Walking
13. Other

Heating equipment and energy habits

Q4 – Which heating system do you utilise in your house?

1. Collective
2. Individual (electric)
3. Individual (gas)
4. Other
5. Unknown

Q5 – Which is your energy provider?

1. EDF
2. Direct Energie
3. Engie
4. Autre
5. Unknown

Q6. Have you installed in your house devices using renewable energies (solar panels for hot water, wood stove, geothermal ...)?

1. Yes
2. No

Q7 - Has your home been insulated in the last 5 years (either by you, your trustee, or your landlord)?

1. Yes
2. No

Q8 - Do you take the following actions (Very Often, Often, Rarely, Never)?

1. I lower/turn the heating off when a room is unoccupied
2. I lower/turn the heating off when I leave my house for a long time
3. I use low-energy light bulbs
4. I unplug my devices
5. I turn off the light in rooms where there is no one
6. When I buy new electrical equipment, I inquire about its energy consumption

Inclination to become smart citizens

Q9 - Which of the following reasons motivate you to change your mobility habits in the near future?

1. Reduce the carbon footprint
2. City life improvement
3. Economic reasons (reduce expenditures on transportation)
4. Health reasons
5. Pour aucune de ces raisons

Q9bis - In the near future, would you be “Very”, “Rather”, “Not so much” or “Not at all” keen to change your mobility habits?

1. Very soon
2. Rather soon
3. Not so soon
4. Not soon
5. I do not know

Q10 - Which of the following reasons motivate you to change your energy habits in the near future?

1. Reduce the carbon footprint
2. City life improvement
3. Economic reasons (reduce expenditures on energy)
4. Health reasons
5. Pour aucune de ces raisons

Q10bis - In the near future, would you be “Very”, “Rather”, “Not so much” or “Not at all” keen to change your energy habits?

1. Very soon
2. Rather soon
3. Not so soon
4. Not soon
5. I do not know

Q11 - Do you use the city's Auto Bleue service?

1. Yes
2. No, even though I know the service
3. I do not know the service

Q11bis. Are you going to use this service (Q11)?

1. For sure
2. Probably yes
3. Probably no
4. For sure no
5. I do not know

Q12 - Would you be willing to change your energy provider to switch to green electricity (wind, hydro, photovoltaic energy, etc.)?

1. Yes, provided I save money

2. Yes, provided it does not cost me more
3. Yes, even if it costs me more
4. I have already switched to green electricity
5. I do not know

Environmental sensitivity

Q13 - In general, do you think that climate change is due to (strongly agree, agree, disagree, strongly disagree, do not know):

1. Massive use of personal cars
2. Massive consumption of energy (electricity, gas, etc.)
3. Industrial production methods that are too polluting
4. Consumer behaviour
5. A natural cycle of the environment (natural causes not related to human activity, for example)

Q14 - In general, do you think about environmental consequences each time you (strongly agree, agree, disagree, strongly disagree, do not know):

1. Choose/use your mode of transportation for your trips
2. Use electrical equipment

Q15 How often does your family encourages you to (Very often, Often, Rarely, Never):

1. Modify your main mode of transport for reasons of sustainable development?
2. Modify your energy practices ?
3. Change the energy supplier ?
4. Take into account the environmental effects of the products you buy?

Protection of personal information & Smart Citizens

Q16 - Do you personally own a computer or smartphone that allows you to go on the Internet?

1. Yes
2. No

Q16bis – Do you use the following apps? (Yes, No)?

1. Facebook
2. Twitter
3. LinkedIn
4. Snapchat
5. Whatsapp
6. Other

Q17 - Generally, when you use social networks on the internet, are you "Very worried", "Somewhat worried", "Not very worried" or "Not worried at all" about:

1. The way personal information is stored
2. Accessibility (who can access) to this personal information
3. How your personal information can be used by the social network
4. The possibility that this personal information may be sold or disclosed to third parties

Q18 - How often do you use internet or mobile services based on geolocation?

1. At least once per week
2. At least once per month
3. At least once per trimester
4. Never

Q19 - This (Q18) requires that you communicate, at the time of usage of the service, your geographical location. Are you hence willing to use it ?

1. Yes
2. No

Q20 - How often do you use mobile or internet applications to track and better understand your energy consumption at home?

1. At least once per week
2. At least once per month
3. At least once per trimester
4. Less often

Q20bis - For which reasons, do you not use this application more often (Q20)?

1. It is not useful
2. I do not think about using it
3. Other (explain)

Q20ter - When using this app, are you "Very worried," "Somewhat worried," "Not worried" or "Not worried at all" about:

1. The way personal information is stored
2. Accessibility (who can access) to this personal information
3. How your personal information can be used by the energy provider
4. The possibility that this personal information may be sold or disclosed to third parties

Annex 6: Additional descriptive statistics on socio-demographic features

When decomposing the sample into age classes (Fig. 21), for the city of Nice it appears that the older is an age class, the more numerous is the number of people belonging to that class with respect to younger classes. Conversely, for the control city, the youngest age class holds the highest number of individuals with respect to the other age classes.

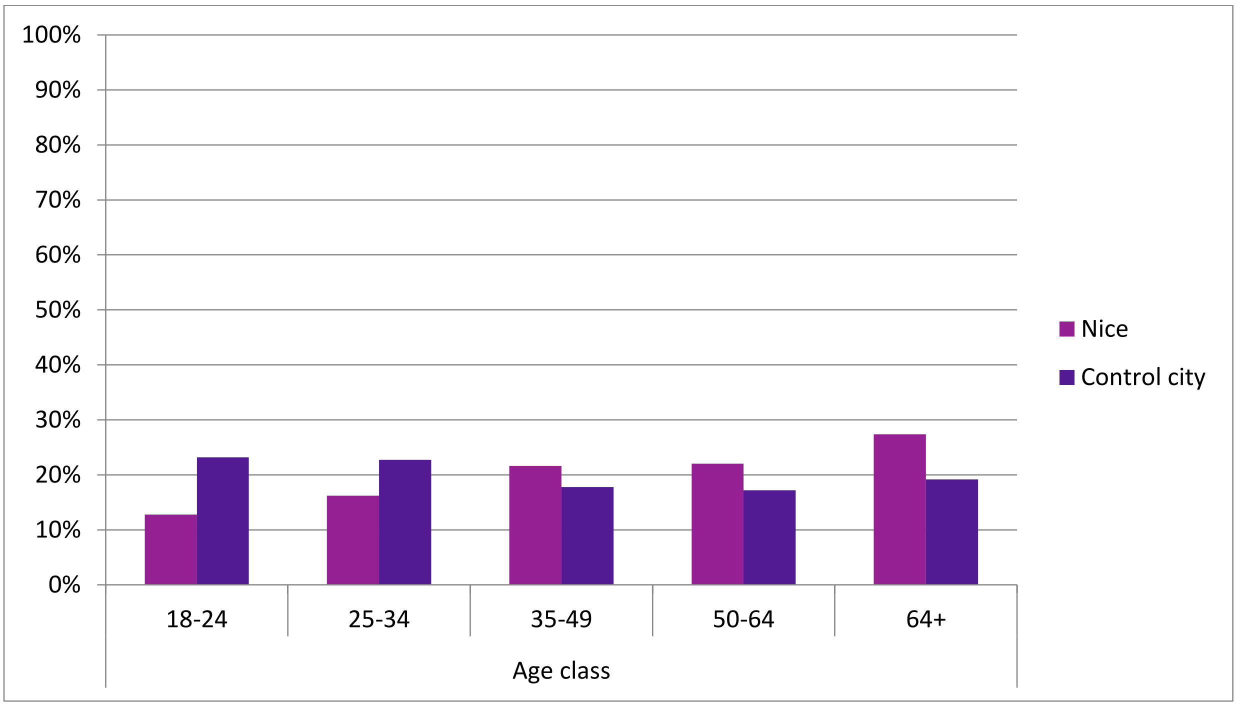

Fig.21: Age class (by city).

With reference to the number of individuals composing the household (Fig. 22), for the city of Nice, around the 65% of the people interviewed are single or live with just one other person. Households made of 3 or 4 individuals follow (both at around 14%). Households constituted by 5 or more individuals represent a minority. A similar trend holds when considering the control city.

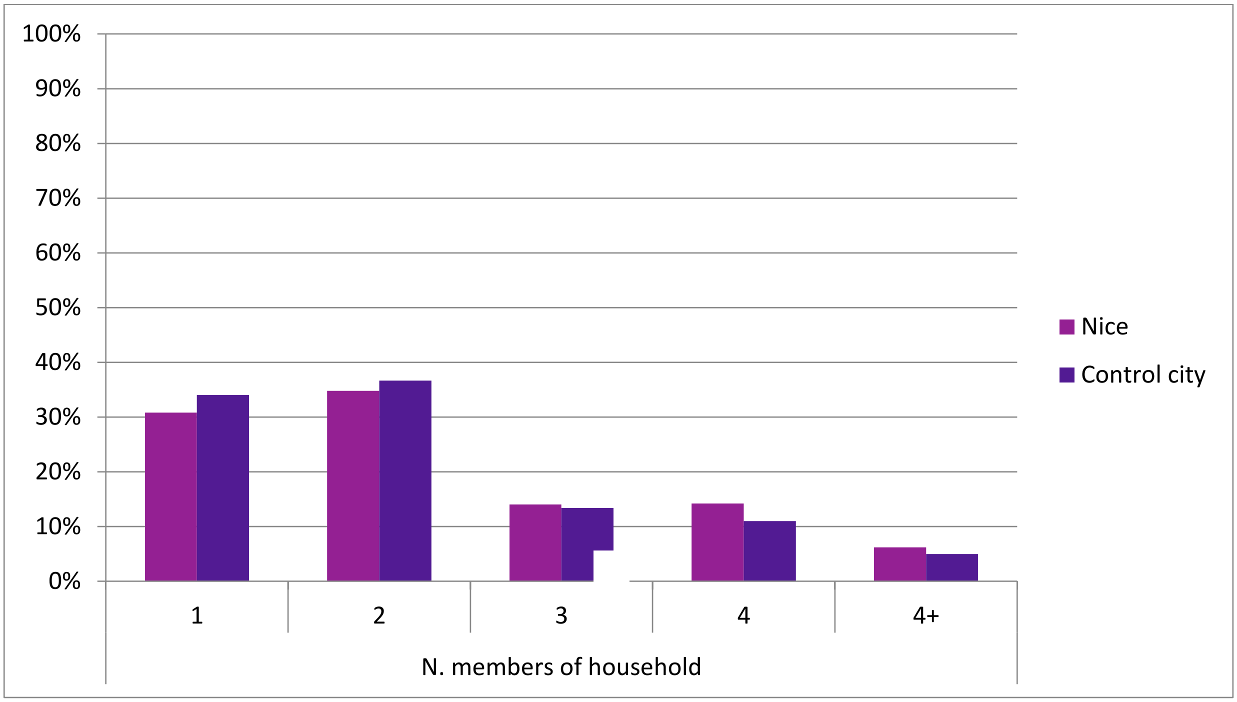

Fig.22: N. members of households (by city).

Related to the number of individuals composing the household is the number of children (under the age of 16) living in each household. Since it is reasonable to assume that individuals below the age of 25 are less likely to have children, it is a better strategy to exclude this particular category of individuals (who, also, must live alone) when analysing the number of children living in each household. Following this strategy, the percentage of households without children accounts approximately to 60% for Nice and 70% for the control city. When also considering in this counting the households having 1 or 2 children, the total percentages rise to 95% for Nice and 97% for the control city (Fig. 23). Thus, for both cities, only a tiny minority of respondents has 3 or more children.

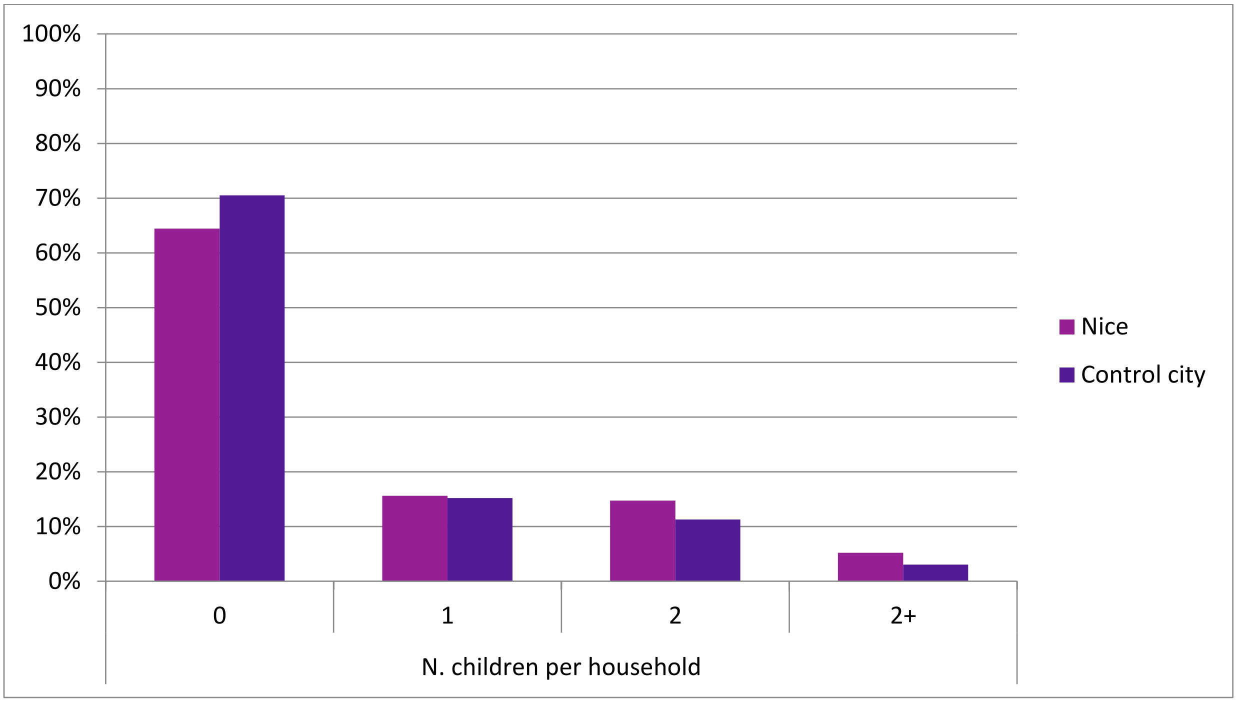

Fig.23: N. children per household (by city).

For what concerns the profession of the people interviewed (Fig. 24) it is straightforward to notice that around the 30% of the individuals of the sample living in Nice are retired. Always for Nice, the two most recurrent job types among active individuals are represented by employees and intermediaries. Conversely, in the control city, the percentage of retired people, although remaining high in absolute value, is significantly lower with respect to Nice. Moreover, the percentage of students appears rather higher than in Nice. Among active people, the percentage of individuals working as intermediaries remains closer to the same percentage inherent the city of Nice.

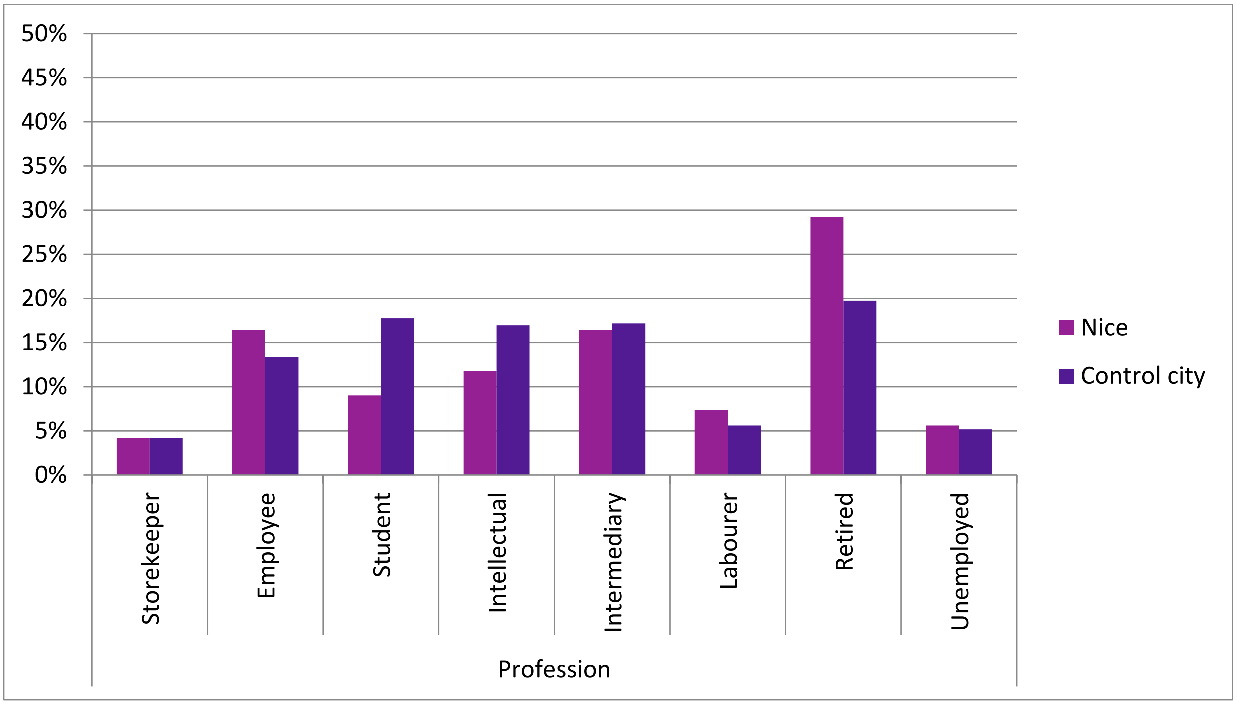

Fig.24: Profession (by city).

With reference to education, the denominations utilised here correspond to the ones of the French Educational System (Fig. 25). Specifically, “Primaire” corresponds to elementary school, “College” to middle school, “Bac” (abbreviation for “Baccalauréat”) to high school, “Bac+2” to 2 additional years of education after high school (namely university), “Bac+3” to 3 additional years of education after high school, and “Bac+5” to 5 or more additional years of education after high school. Looking at Fig. 25 it is possible to observe how the percentage of individuals holding the sole middle school diploma (“College”) in Nice is significantly higher than in the control city (although both the two percentages remain lower than 20% over the total). As for individuals holding the sole high school diploma (“Bac”), the same gap between the percentages of the two cities results to be much more reduced. Moreover, it is interesting to notice how individuals with just the high school diploma represent the majority in Nice, whereas in the control city half of all the individuals interviewed has at least 2 years of university education.

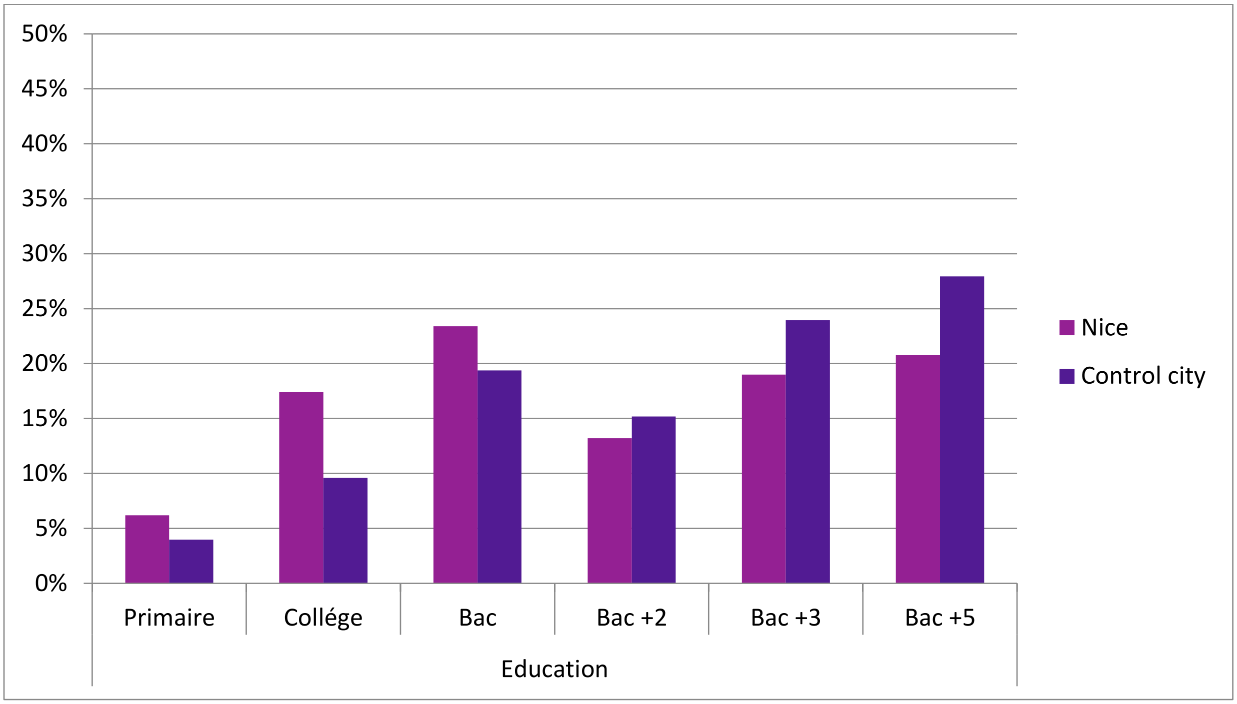

Fig.25: Educational level (by city).

Annex 7: Correlation coefficients among socio-demographic variables and variables on mobility

To assess the pairwise relationship between categorical variables related to socio-demographic features and mobility, we implement a series of non-parametric chi squared tests. The latter are tests which are suited to study the relationship between nominal variables, and the non-parametric nature allows to relax the assumption of a predetermined distribution in the data (mainly, a normal distribution). The strength of association for categorical variables is then provided by the Cramer's V measure of association[23], which ranges from 0 (weak association) to 1 (strong association). To assess the pairwise level of association between categorical and ordinal variables, and between two ordinal variables, we utilise the Kendall's τ coefficient[24]. The latter ranges from -1 (strong, negative ordinal association), to +1 (strong, positive ordinal association), with 0 denoting weak ordinal association. The Kendall's τ coefficient makes corrections for ties, and it is derived from a non-parametric test (the Tau test). The level of significance for the Kendall's τ coefficients is simply derived by the z-score of a standard normal distribution, which is computed by dividing the same coefficients for their correspondent asymptotic standard error[25]. Tab. 27 reports the correlation matrix for the variables of interest.

Tab. 27: Correlation matrix among socio-demographic variables and variables on mobility[26].

	RS10	RS4	RS3bis	RS2	RS1	RS9	Bike	Bus	Train	Tramway	Electric car service	Q2	Q3	Q3ter
Education	1													
N. members per household	-0.02	1												
Age class	0.17 ***	-0.11 ***	1											
Gender	0.05 *	0.01	-0.03	1										
Localisation	0.03	0.05 *	0.15 ***	0.00	1									
Profession	0.11 ***	-0.11 ***	0.41 ***	0.30 ***	0.18 ***	1								
Bike	-0.01	0.04	0.01	- 0.07 **	0.04	0.01	1							
Bus	-0-01	0.01	-0.02	- 0.07 **	0.03	- 0.07 ***	0.04	1						
Train	0.02	0.03	0.08 **	- 0.05 *	0.01	0.05 **	0.06*	0.06 **	1					
Tramway	0.03	-0.02	- 0.12 ***	- 0.03	- 0.04	- 0.07 ***	- 0.01	0.04	0.04	1				
Electric car service	-0-03	0.01	- 0.00	- 0.03	0.04	0.02	0.09 ***	- 0.02	0.01	- 0.05	1			
Dist. Work/study place	-0.01	0.03	- 0.02	0.04	0.01	0.04	-0.01	0.02	0.04	0.03	0.00	1		
Modes of transport for work	-0.02	-0.02	0.03	-0.10 ***	0.10 **	0.04	- 0.03	0.17 ***	- 0.01	- 0.08 **	-0.04	0.21 ***	1	
Modes of transport for leisure	0.07	0.01	0.11 ***	- 0.03	0.17 ***	0.04	0.00	0.07 **	- 0.04	-0.06 *	0.01	0.00	0.32 ***	1

Note: Cramer's V statistics reported. Levels of significance from chi squared test: $\ast\, p < 0.10$, $\ast\ast p < 0.05$, and $\ast\ast\ast\, p < 0.01$. The variables bike, bus, train, tramway and electric car service refer to Q1_1 - Q1_5 respectively.

Annex 8: Principal component analysis (PCA)

This Annex section provides the detailed statistics and results of principal component analysis, (PCA), carried out on the different sets of ordinal variables related to mobility. Principal component analysis is a data reduction method used to re-express multivariate data with fewer dimensions, and it represents a well-suited methodology when dealing with ordinal data. In particular, the aim of this technique is to reduce the number of variables of interest, re-expressing them as a linear combination of a reduced number of common factors, which capture the maximum degree of information from the original variables. The PCA methodology draws upon the standard procedure carried out in the literature on principal component analysis for ordinal data (see, e.g., Field, 2013; Reinoso and Turego, 2016; Payil and Kokate, 2017). The detailed description and results of the PCA methodology will now be reported for the data on mobility. The variables of interest derive from Q1 and refer to the degree of utilisation (everyday, at least one time per week, at least one time per month, not very often, never) of: bus, tramway, train, bike, and electric car service. Before proceeding with PCA, we must be sure, first of all, that the variables of interest are indeed suitable for such a type of analysis. Accordingly, a Bartlett test of sphericity[27] is performed to see whether there exist sufficient intercorrelations among the variables in order to conduct PCA; from the test results (Tab. 28), the associated null hypothesis of no intercorrelation among variables is strongly rejected ($p<0.001$). In addition, the Kaiser-Meyer-Olkin (KMO) measure is computed to assess the proportion of variance among variables which might constitute common variance[28]. The value of the KMO test suggests that the variables of interest are suited for running a principal component analysis (although the KMO values results to be slightly higher than 0.5).

Tab.28: Bartlett test of sphericity and KMO measure of sampling adequacy.

Bartlett test of sphericity		KMO measure of sampling adequacy	Determinant of the correlation matrix
Chi-square	p-value		
159.181	0.000	0.507	0.853

We hence proceed in running a PCA, orthogonally transforming the set of variables of interest into a set of linearly uncorrelated factors (i.e., the principal components). To such aim, an eigen decomposition of the covariance matrix of the variables of interest, M, is performed[29], thus obtaining unit-length linear combinations (i.e., factors) of the variables with the greatest variance (the higher is the variance associated to a component, the higher is its explanatory power in explaining the variability within the data). In this context, the first principal component (/factor) holds maximal overall variance. The second principal component holds maximal variance among all unit length linear combinations which are uncorrelated to the first principal component, and so on. All the principal factors combined contain the same information as the original variables, but the important information is partitioned over the factors in a way that the first factor captures the highest variability within the original data, thus reducing the information of the former set of variables into a lower dimension. Tab. 29 provides the eigenvalues of the covariance matrix M for our variables of interest, along with the corresponding variance.

Tab.29: Eigen decomposition of the covariance matrix M.

Factor	Eigenvalue	% of Variance	Cumulative %
Factor 1	1.38045	0.2761	0.2761
Factor 2	1.12786	0.2256	0.5017
Factor 3	0.95881	0.1918	0.6934
Factor 4	0.89435	0.1789	0.8723
Factor 5	0.63852	0.1277	1.0000

Looking at Tab 29, it is possible to notice how Factor 1 and Factor 2 explain, respectively, the 27.61% and 22.56% of the overall variability within the data, and the cumulative variance derived from the sum of the two variances accounts to 50.17% of the total variability.

Subsequently, following the Kaiser's rule, we retain those factors whose eigenvalue is equal or higher than unity[30]. As an additional visual check, and to facilitate the examine of eigenvalues, a scree plot (Fig. 26) is provided to graphically represent all the potential breaks in the plot between the principal components (explaining most of the variation within the data) and the remaining components (explaining less variation).

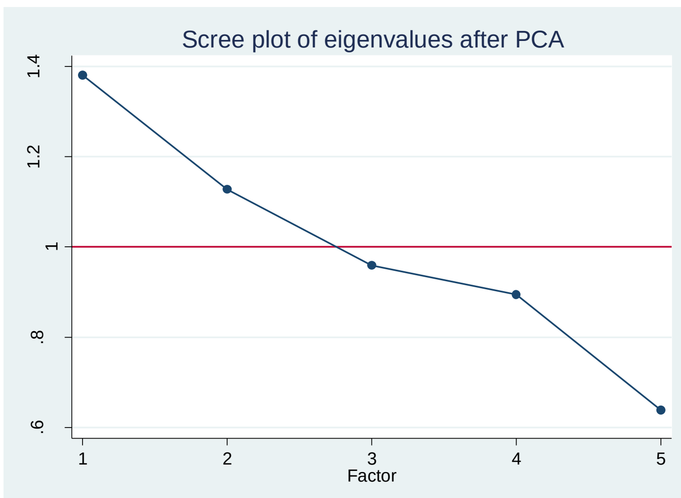

Fig.26: Scree plot of eigenvalues.

In this case, only the first two factors possess an eigenvalue higher than unity. Therefore, only the first two factors will be retained, whereas the others will be discarded. As it is common in the literature (see, e.g., Reinoso and Turego, 2016) in order to improve the interpretability of results, we further perform an oblique rotation of the factor loading matrix, which allows for correlations among the rotated factors, providing the highest possible correlation on fewest possible factors. After rotating the factor loading matrix, it is possible to derive the precise loads of the two factors associated to the variables of interest[31]. The summary of results is reported in Tab. 30.

Tab.30: Rotated factor loadings.

Variable	Factor 1	Factor 2	Uniqueness
Tramway	0.8054	-0.1106	0.3440
Bus	0.8006	0.0993	0.3448
Bike	0.0652	0.7162	0.4802
Electric car service	-0.2293	0.6060	0.5877
Train	0.1818	0.4767	0.7350

As already stated, the aim of the principal component analysis which was performed in this section is to reduce the data (here related to the mean of transport utilised by the people interviewed besides personal car), trying to derive information on some latent components associated to our variables of interest. Looking at Tab. 30, it is eventually possible to observe a pattern of association between factor loadings and variables of interest; particularly, the items tramway and bus both load on Factor 1, whereas the items bike, electric car service and train load on Factor 2[32]. From these results, it hence appears that the set of items comprehensive of bus and tramway captures a latent characteristic specific of these two modes of transport (presumably, some preference of citizens related to efficiency, comfort, etc., when having to select an alternative mode of transport), which differentiates them from the other modes of transport. These two items will hence be isolated from the other items in questions Q3 and Q3ter.

Annex 9: Multinomial logistic regression

A multinomial logistic model is a statistical model which generalises the standard logit model into a multiclass setting (i.e., when the dependent variable is not binary anymore, but rather is represented by a set of three or more possible categorical, unordered and independent outcomes). In other words, it is a model testing the probability of choice of a set of different alternatives over a set of covariates (which can be either continuous or discrete). In addition, all the covariates are alternative-invariant, that is, they do not vary over the alternative chosen, but solely over the individual[33].

In general terms, suppose that the individual *i* can choose the alternative *j* belonging to a set of *k* different alternatives (*j = 1,2,…,k*). Assuming 1 as a base outcome for the different alternatives, the probability that individual *i* chooses alternative *j* is:

$$p_{ij} = P(A_i = i|X_i) = \frac{exp(X_i\beta_j)}{\sum_{m=1}^{k} exp(X_i\beta_m)} \; (= \Omega(X\beta)) \qquad (1)$$

Where A_{i} is the alternative chosen by individual *i*, X_i is the row vector of observed values of the independent variables ($X_i = \{x_1, x_2, \dots, x_n\}$) for the individual i, and β_m is the coefficient vector for outcome *m*. In rough terms, the interpretation of the coefficient related to alternative *j*, can be summarised as follows: in comparison to the base alternative, an increase in the independent variable makes the selection of alternative *j* more or less likely. Due to its non-linear nature, the model is estimated through maximum-likelihood. Also due to the fact that the multinomial logit model is non-linear, the coefficients cannot be interpreted directly as the effect of the covariate on the outcome variable. In fact, the marginal effect of the covariate *z* is obtained by differentiating expression (1), to obtain:

$$\frac{\partial P(A_i = i|X_i)}{\partial x_z} = \Omega(X\beta)[1 - \Omega(X\beta)]\beta_z \qquad (2)$$

In our specific case, we want to quantify the probability of choosing the mode of transport to go to the work (/study) place (Q3), and for leisure (Q3ter), depending on individual socio-demographic characteristics (which are used as covariates); i.e., *Localisation* (RS1), *Gender* (RS2) and *Number of members per household* (RS4). In order to avoid consuming an excessive number of degrees of freedom, the variable *Profession* (RS9), is not included as a control in our regression equation; in addition, for the same reason, the variable *Age class* (RS3bis) is manipulated in order to reduce it into a dummy variable ("age category") indicating if an individual belongs to a working age category ("working age"), retired age category ("retired age"), or student age category ("student age")[34], the latter being used as a benchmark. We estimate two separate multinomial logistic equations; the first one associates to the dependent variable the range of alternatives (modes of transport) related to Q3, whereas the second, to Q3ter:

$$p_{ij} = P\left(A_i \in Q_{working/study} = i|X_i\right) = \Omega(X\beta) \qquad (3)$$

$$p_{ij} = P(A_i \in Q_{leisure} = i|X_i) = \Omega(X\beta) \quad (4)$$

where $Q_{working/study}$ is the set of alternatives inherent Q3 and $Q_{leisure}$ the set of alternatives inherent Q3ter, and $\Omega(.)$ represents the logistic function. In our specific case, the alternatives included in the two sets are exactly the same (13 in total).

Since Q3 deals with the mean of transport utilised to go to the work (/study) place, when estimating equation A3.1, the observations inherent individuals who are retired or unemployed are not considered. After the results emerging from PCA, it seems appropriate to reduce the number of alternatives so that only the items related to car, tramway and bus are considered as separate categories, whereas all the remaining modes of transport are pooled together into a single category ("*other*"). Eventually, the number of alternatives in both $Q_{working/study}$ and $Q_{leisure}$ reduces to the same number, *k=4*. Specifically, the set of alternatives for the outcome variable that an individual can choose is: $Q = \{car, bus, tramway, other\}$. On the other hand, the set of covariates utilised in both equations is comprehensive of the *n=4* elements: $X = \{localisation, gender, age\ category, n. members\ per\ household$[35]$\}$. These four elements are mainly dummy variables: *localisation = {the control city, Nice}*, *gender = {female, male}*, where the first element of each set represents the reference category. With reference to *Age category*, we have that for Q3, *age category = {student age, working age}*, whereas for Q3ter, *age category = {student age, working age, retired age}*. Finally, the variable *Number of members per household*, is an ordinal variable with possible range [1,∞).

We now proceed in carrying out a series of tests in order to evaluate the goodness of fit of our model specification. Firstly, we perform a likelihood-ratio (LR) test to check whether all the coefficients associated to the covariates are simultaneously equal to zero. Results are reported in Tab. 31.

Tab.31: LR test for independent variables.

Choice set	Variable	Chi-squared statistic	d.f.
$Q_{working/study}$	City (Nice)	15.198 **	3
	Gender (Male)	18.026 ***	3
	Age category (Work)	32.832 ***	3
	N. members household	13.581 **	3
	Profession	(all categories not significant)	3
	Education	(all categories not significant)	3
$Q_{leisure}$	City (Nice)	44.982 ***	3
	Gender (Male)	18.673 ***	3
	Age category (Work)	30.768 ***	3
	Age category (Retired)	30.985 ***	3
	N. members household	29.714 ***	3
	Profession	(all categories not significant)	3
	Education	(all categories not significant)	3

Note: levels of significance from chi squared test: ∗ p < 0.10, ∗∗p < 0.05, and ∗∗∗ p < 0.01.

The null hypothesis for which the coefficient associated to the corresponding variable is 0 is strongly rejected for all variables with the exception of *Profession* and *Education* (both in Q3 and Q3ter). The former variables will be subsequently retained in the vector of controls used in the econometric estimation. These first results provide preliminary evidence that the remaining covariates of interest may exercise a significant impact on the decision of individuals to select a particular mode of transport.

In addition, a LR test to check for potential nested models inherent the socio-demographic variables is implemented. Particularly, the objective is to consider whether the variables related to *Age category* and *Number of members per household*, add statistically significant improvement to the model comprehensive of the sole *Localisation* and *Gender* variables. In other words, this test provides evidence on whether the model Model2: $y = f(localisation, gender, n.members\ per\ household, age\ category)$ can be rewritten as Model1: $y = f(localisation, gender)$, thus restricting to zero the additional parameter of Model2.

Tab.32: LR test for nested models (Assumption: Model1 nested in Model2).

Choice set	LR test	
	Chi-squared statistic	d.f.
$Q_{working/study}$	47.90 ***	6
$Q_{leisure}$	59.52 ***	9

Note: levels of significance from chi squared test: ∗ p < 0.10, ∗∗p < 0.05, and ∗∗∗ p < 0.01.

The test statistics resulting from Tab. 32 provide significant evidence that the variables related to *Age category* and *Number of members per household* provide a statistically significant improvement in model fitting, therefore they should be retained in the set of covariates. To better refine our estimation, we subsequently performed a likelihood-ratio test and a Wald test, to check whether the alternatives related to the choices of bus and tramway in the outcome variable can be combined together. Results are reported in Tab. 33.

Tab.33: LR test for combining alternatives (bus and tramway).

Choice set	LR test		Wald test	
	Chi-squared statistic	d.f.	Chi-squared statistic	d.f.
$Q_{working/study}$	29.308 ***	4	27.549 ***	4
$Q_{leisure}$	20.400 **	5	19.943 **	5

Note: levels of significance from chi squared test: ∗ p < 0.10, ∗∗p < 0.05, and ∗∗∗ p < 0.01.

From the test statistics of Tab. 33, the null hypothesis according to which the coefficient associated to the pair of alternatives bus and tramway is 0 (i.e., the two alternatives can be combined) is reject in both cases, with a higher level of significance in Q3 with respect to Q3ter. In addition, we further perform a series of Hausman tests to check for the hypothesis of independence of irrelevant alternatives (IIA)[36]. Results are reported in Tab. 34.

Tab.34: Hausman tests for IIA assumption.

Alternative	Chi-squared statistic	d.f.
Other	0.640	10
Car	12.351	10
Bus	-0.618	10
Tramway	-0.019	10

Note: levels of significance from chi squared test: ∗ p < 0.10, ∗∗p < 0.05, and ∗∗∗ p < 0.01.

The null hypothesis for which odds are independent of other alternatives is not rejected for the mode of transport related to the items other and car. Despite the fact that the value of the chi-squared statistic is negative (i.e., the asymptotic properties for the estimated model are not fully met), this condition assures us that the IIA assumption has not been violated also with reference to the items of bus and tramway.

To improve the goodness of fit of the model, a robustness check is additionally performed for the multinomial logit margins computed for each of the four alternatives (car, bus, tramway and other), with reference to the two model specifications (relative estimates reported in the main text in Tabs. 13 and 14). This procedure is carried out by adding additional covariates which may exercise an impact on the choice of mode of transport utilised by individuals. Results are reported in Tabs. 35-38.

Tab.35: Robustness check for Qwork/study and Qleisure (marginal effects for the item: car).

	$Q_{work/study}$				$Q_{leisure}$			
Variables	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Nice	5.20	5.19	5.36	5.93	15.83 ***	15.82 ***	15.93 ***	16.14 ***
Male	2.62	2.48	1.05	1.07	6.02 *	6.20 *	6.33 *	5.55
Work	2.56	1.89	0.40	-0.01	16.26 **	17.09 ***	17.99 ***	17.35 **
Retired	N/A	N/A	N/A	N/A	25.81 ***	27.35 ***	31.37 ***	32.31 ***
N. members household	2.78 **	2.76 **	2.80 **	2.65 *	7.41 ***	7.45 ***	7.40 ***	7.43 ***
i.Education	NO	YES	YES	YES	NO	YES	YES	YES
i.Work distance	NO	NO	YES	YES	NO	NO	YES	YES
i.Geo loc. service	NO	NO	NO	YES	NO	NO	NO	YES
N. observations	698	698	698	698	1,001	1,001	1,001	1,001
Wald chi-squared	88.28	93.63	101.98	107.82	139.94	140.64	141.24	140.85
Count R-squared	0.438	0.437	0.428	0.434	0.496	0.489	0.488	0.473

Note: levels of significance: ∗ p < 0.10, ∗∗p < 0.05, and ∗∗∗ p < 0.01. (Robust) standard errors not reported. (1) refers to the original regression specification, whereas (2)-(4) refer to the model specification comprehensive of a series of additional covariates.

Tab.36: Robustness check for Qwork/study and Qleisure (marginal effects for the item: bus).

	$Q_{work/study}$				$Q_{leisure}$			
Variables	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Nice	4.74 **	4.68 **	4.66 **	4.50 *	2.09	2.08	2.05	2.43
Male	-7.15 **	-7.00 **	-6.98 **	-6.89 **	-4.64 **	-4.71 **	-4.74 **	-4.52 **
Work	-6.29 **	-5.64 **	-5.63 **	-5.95 **	-5.71 **	-6.01 **	-6.27 **	-5.96 **
Retired	N/A	N/A	N/A	N/A	-3.93 *	-4.51 *	-5.61 *	-6.20 **
N. members household	2.03 **	2.07 **	2.07 **	2.11 **	-1.02	-1.02	-1.01	-0.77
i.Education	NO	YES	YES	YES	NO	YES	YES	YES
i.Work distance	NO	NO	YES	YES	NO	NO	YES	YES
i.Geo loc. service	NO	NO	NO	YES	NO	NO	NO	YES
N. observations	698	698	698	698	1,001	1,001	1,001	1,001
Wald chi-squared	88.28	93.63	101.98	107.82	139.94	140.64	141.24	140.85
Count R-squared	0.438	0.437	0.428	0.434	0.496	0.489	0.488	0.473

Note: levels of significance: ∗ $p < 0.10$, ∗∗$p < 0.05$, and ∗∗∗ $p < 0.01$. (Robust) standard errors not reported. (1) refers to the original regression specification, whereas (2)-(4) refer to the model specification comprehensive of a series of additional covariates.

Tab.37: Robustness check for Qwork/study and Qleisure (marginal effects for the item: tramway).

	$Q_{work/study}$				$Q_{leisure}$			
Variables	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Nice	-10.15 **	-10.14 **	-10.20 ***	-10.10 ***	-14.18 ***	-14.15 ***	-14.20 ***	-13.50 ***
Male	-6.13 **	-6.42 **	-5.26 *	-5.63 *	-7.02 **	-7.18 **	-7.25 **	-8.05 **
Work	-13.94 ***	-14.73 ***	-13.47 ***	-13.71 ***	-12.87 ***	-13.50 ***	-13.99 ***	-14.24 ***
Retired	N/A	N/A	N/A	N/A	-14.74 ***	-15.96 ***	-18.06 ***	-17.27 ***
N. members household	-2.62 **	-2.67 **	-2.70 **	-2.39 **	-1.50	-1.53	-1.51	-1.56
i.Education	NO	YES	YES	YES	NO	YES	YES	YES
i.Work distance	NO	NO	YES	YES	NO	NO	YES	YES
i.Geo loc. service	NO	NO	NO	YES	NO	NO	NO	YES
N. observations	698	698	698	698	1,001	1,001	1,001	1,001
Wald chi-squared	88.28	93.63	101.98	107.82	139.94	140.64	141.24	140.85
Count R-squared	0.438	0.437	0.428	0.434	0.496	0.489	0.488	0.473

Note: levels of significance: ∗ p < 0.10, ∗∗p < 0.05, and ∗∗∗ p < 0.01. (Robust) standard errors not reported. (1) refers to the original regression specification, whereas (2)-(4) refer to the model specification comprehensive of a series of additional covariates.

Tab.38: Robustness check for Qwork/study and Qleisure (marginal effects for the item: other).

	$Q_{work/study}$				$Q_{leisure}$			
Variables	(1)	(2)	(3)	(4)	(1)	(2)	(3)	(4)
Nice	0.21	0.27	0.18	-0.29	-3.74	-3.75	-3.79	-5.07
Male	10.67 **	10.94 **	11.18 **	11.44 **	5.65 *	5.69 *	5.66 *	7.02 *
Work	17.68 ***	18.48 **	18.70 ***	19.66 ***	2.32	2.43	2.27	2.85
Retired	N/A	N/A	N/A	N/A	-7.15	-6.88	-7.70	-8.84
N. members household	-2.19	-2.15	-2.17	-2.37	-4.89 **	-4.90 **	-4.88 **	-5.09 **
i.Education	NO	YES	YES	YES	NO	YES	YES	YES
i.Work distance	NO	NO	YES	YES	NO	NO	YES	YES
i.Geo loc. service	NO	NO	NO	YES	NO	NO	NO	YES
N. observations	698	698	698	698	1,001	1,001	1,001	1,001
Wald chi-squared	88.28	93.63	101.98	107.82	139.94	140.64	141.24	140.85
Count R-squared	0.438	0.437	0.428	0.434	0.496	0.489	0.488	0.473

Note: levels of significance: ∗ p < 0.10, ∗∗p < 0.05, and ∗∗∗ p < 0.01. (Robust) standard errors not reported. (1) refers to the original regression specification, whereas (2)-(4) refer to the model specification comprehensive of a series of additional covariates.

From Tabs. 35-38, it is possible to notice how the estimates for the socio-demographic variables of interest remain rather stable with reference to each of the alternatives. In addition, the coefficient of determination provided by the count R^2 provides further evidence that our model is reasonably well fitted.

Annex 10: Smart Cities: a state of the art

Literature review

As represented in Fig. 27[37], the number of contributions (books) on Smart Cities has been flat for most of the time, except for two important peaks; one during the industrial revolution, and the second one now, after the ICT revolution, indicating a recent public interest for the matter and numerous sources of information.

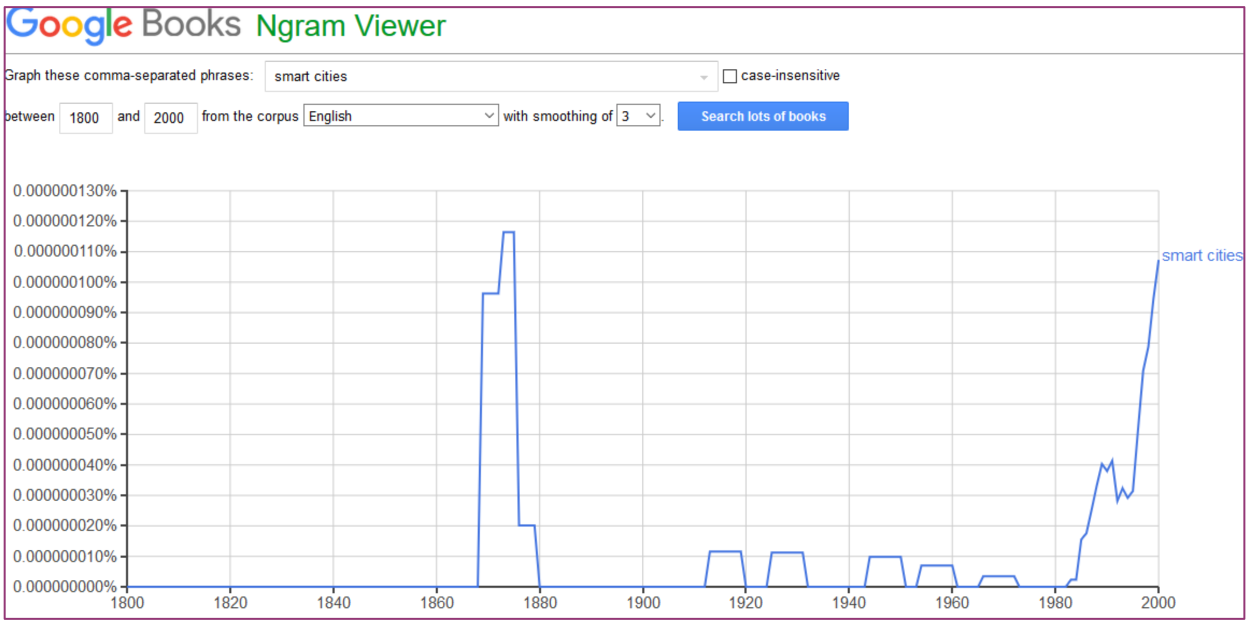

Fig. 27: Number of books on Smart Cities. Source: authors'elaboration from Google Scholar.

Data on books stops in 2018, but using Google Scholar, this time for articles in scientific journals (in all disciplines), we can see that the number of references has grown dramatically since the early 2000s (see Tab. 5): 529 in 2000-2004; 1,080 in 2005-2009; 13,100 in 2010-2014; 28,100 in 2015-2018. In the field of social sciences, JSTOR reports a similar expanding trend: 0 in 2000-2004; 64 in 2005-2009; 120 in 2010-2014; 1017 in 2015-2018.

Tab. 39: Evolution of Number of articles in scientifics journals (in all disciplines and in social sciences). Elaborated from Google Scholar and JSTOR.

Period	Number of articles in Scientifics journals in all disciplines	Number of articles in Scientifics journals in social sciences
2000-2004	529	0
2005-2009	1,080	64
2010-2014	13,100	120
2015-2018	28,100	1,017

Such an extensive focus over the last years calls for a better understanding of what a Smart City is in the extant literature, and it also helps contextualising the way in which a Smart City is defined within the IRIS project.

Definition of Smart Cities

Within the framework of the IRIS project, providing a clear and exhausting definition of Smart City becomes a task of fundamental importance. As a matter of fact, such a definition does not solely belong to the realm of the academic literature, but it has been extended as well to the industrial sector and to the government literature (Mosannenzadeh and Vettorato, 2014).

In the academic literature, there is still no common consensus on a valid and unique definition for such a term. Furthermore, if from the one hand some studies have provided extremely detailed definitions, some other studies have conversely been remarkably vaguer (see, e.g., Canton, 2011). Ben Letaifa (2014) offers an exhaustive summary of the definitions of Smart Cities which have been utilised in the academic literature, categorising the authors depending on which elements receive more emphasis in the definition; for instance, considering the degree of interconnection between the various stakeholders and the ecosystem, it is possible to find the definition of Giffinger et al. (2007), according to whom a Smart City is a city "*well performing in a forward-looking way in economy, people, governance, mobility, environment, and living, built on the smart combination of endowments and activities of self-decisive, independent and aware citizens*". On the other hand, when considering the level of resource management (with particular reference to the infrastructures), Hall (2000) defines a Smart City as the one which "*monitors and integrates conditions of all of its critical infrastructures, including roads, bridges, tunnels, rails, subways, airports, seaports, communications, water, power, and even major buildings, and can better organize its resources, plan its preventive maintenance activities, and can monitor security aspects while maximizing services to its citizens*". Then, if one focusses on information and communication technologies (ICT), it is possible to find the definitions provided by Hollands (2008), where a Smart City is the one "*using smart computing technologies to make the critical infrastructure components and services of a city (which include city administration, education, healthcare, public safety, real estate, transportation, and utilities) more intelligent, interconnected, and efficient* "; Caragliu et al. (2011) "*a Smart City implements and deploys information and communication technology infrastructures to support social and urban growth*

throughout the improvement of the economy, citizens' involvement and governmental efficiency "; and Hall (2000) for whom a Smart City is a "*safe, secure, environmental and efficient urban centre of the future, with advanced infrastructures such as sensors, electronic devices and networks which stimulate sustainable economic growth and a high quality of life*".

Furthermore, besides the proper definition of Smart City, it has been a common practice in the academic literature to utilise different denominations, such as "Intelligent City" and/or "Creative City". The latter, although representing different terms, have often a complementary and similar meaning. Examples of definitions of "Intelligent Cities" can be found in Harrison et al. (2010), according to whom an Intelligent City is *"instrumented, interconnected and intelligent*", where: "*Instrumentation*" *enables the capture and integration of live real-world date through the use of sensors, kiosks, meters, personal devices, appliances, cameras, smart phones, implanted medical devices, the web and other similar data-acquisition systems, including social networks as networks of human sensors. "Interconnected*" *means the integration of those data into an enterprise computing platform and the communication of such information among the various city services. Finally, "Intelligent*" *refers to the inclusion of complex analytics, modelling, optimization, and visualization in the operational business processes to make better operational decisions*". Then, according to Partridge (2004), an Intelligent City is the one in which *"the ICT strengthen the freedom of speech and the accessibility to the public information and services"*. Subsequently, Rios (2008) defines a "Creative City" a city *"that gives inspiration, shares culture, knowledge, and life; a city that motivates its inhabitants to create and flourish in their own lives*", whereas for Musterd and Ostendorf (2004), a city is creative when *"it wants to be innovative, to flourish and to offer wealth and employment to its inhabitants, adapting to arenas in which knowledge and creativity can develop. Culture is often added to this arena, not just as a condition to attract the creative knowledge workers, but also as a major economic sector, intricately interwoven with other sectors of the economy"*. As already stressed above, all these last definitions result to be exquisitely similar to the one of "Smart City", therefore, ultimately, there is no significant difference among all these different denominations.

With reference to the industrial sector, most of the definitions of Smart City were developed by big corporations such as ORACLE, IBM, and CISCO, which often added further elements of classification besides the ones usually employed in the academic literature. For instance, IBM views a Smart City as a "system of systems", in which different structures function in complementary within each other (e.g., the transport and the energy systems, which work together creating synergies). Particularly, in this framework, urban technologies are utilised to optimise returns from largely finite resources, making urban systems instrumented, interconnected and intelligent, where the term "Instrumented" means to digitise systems in order to make their function measurable and to create information; "Interconnected" means that different parts of a core system can communicate information to each other; and "Intelligent" refers to the ability to use information to create behavioural patterns and to anticipate, in order to establish informed actions (IBM, 2009). On the other hand, according to CISCO, a Smart City can be viewed as a set of different well-informed players acting in a strong and interconnected ecosystem, where ICT hold a major role (CISCO, 2017). Finally, a similar definition of Smart City is also provided by ORACLE, which puts a lot of emphasis on ICT in boosting sustainable urban development (e.g., in relation to infrastructure development projects) (ORACLE, 2018).

Lastly, the third strand of literature on Smart Cities involves studies developed by public authorities; the latter are usually framed in a more practical perspective, in the sense that they concentrate on guidelines and policy recommendations aiming at bringing material changes, within the urban framework, for the development of smart systems. In accordance, a major emphasis has subsequently been provided to issues related to administrative and financial aspects of Smart Cities, but also to other aspects such as energy efficiency and gas emissions reduction, since the latter exercise a direct impact on the daily life of citizens. Examples of such literature can be found in the "Smart Cities Stakeholder Platform" (SCSP), initiated by the European Commission, in order to identify and spread relevant information on Smart Cities for both practitioners and policy makers. In this framework, Smart Cities are meant to "*enhance the quality of life of citizens, increase the efficiency and competitiveness of the local and EU economy, and move towards the sustainability of cities by improving resource efficiency and employing emission reduction targets*" (European Commission, 2015).

From this preliminary exposition, it emerges how a common and widespread definition of Smart City does not yet exist, since different actors may want to stress different aspects (being them etymological and/or methodological), when developing the definition. In extreme synthesis, from what has been exposed above, it is possible to notice how:

- The academic literature tends to maintain a more multifaceted approach, highlighting how the goal of Smart Cities is mainly oriented towards the improvement of sustainability through the enhancement of governmental, social and environmental aspects of urban life.
- Conversely, the industrial literature puts emphasis on the economic side, stressing important aspects such as competitiveness, efficiency and innovation brought about from ICT.
- The governmental literature is mainly addressed to more macro-oriented issues including topics such as economic growth, life quality, energy, long-term sustainability, health, safety, mobility, and environment.

Despite this difference of views, a common thread running throughout all of these definitions can be detected; that is, Smart Cities must become sustainable urban environments, placing at the center of their attention the needs and issues of citizens. As a matter of fact, the latter constitute the most crucial figure, since ultimately every stakeholder is constituted by citizens. Furthermore, another essential and related element within this framework is represented by the degree of citizens' involvement in smart projects. Indeed, the development and implementation of smart projects is not a sufficient condition *per se*, as in order to achieve successful outcomes, citizens have to be informed and involved in smart initiatives, at best committed or co-creator; therefore, information sharing and the interactions among the various stakeholders represent key elements for a long-run viable path, as well as an effective implementation of monitoring tools and strategies by the urban authorities (Hall, 2000).

Indicators defining a city "smart"

In order to go deeper into the analysis for the definition of Smart City, it becomes necessary to investigate with more precision which can be the indicators qualifying a city as smart. Following Ben Letaifa (2014) and Albino et al. (2015), six indicators can be listed:

- Smart economy
- Smart people
- Smart governance
- Smart mobility
- Smart environment
- Smart living

The first indicator, Smart economy, includes those elements promoting a favourable environment for economic growth, as well as a high value integrated economy. Particularly, a smart economy is related to economic competitiveness and involves innovation, knowledge diffusion, dynamic entrepreneurship, a flexible labour market, integration in local and international markets, as well as the ability of the city to transform and to adapt. A prerequisite of major importance in order to achieve such goals, is represented by the presence of innovation clusters and mutual cooperation between the various stakeholders (namely firms, research institutions and citizens), with the aim of developing, implementing and promoting innovation throughout these networks. In this context, an extensive and integrated usage of ICT constitutes a key ingredient for the development and diffusion of knowledge (Caragliu et al., 2011). Further indicators of a smart economy may include as well the promotion and creation of green companies, the employment of renewable energy sources, and the adoption of policies increasing energy efficiency and promoting cost reduction (Schaffers et al., 2011).

The second indicator, Smart people, defines the social dimension of the city and mainly refers to the degree of human capital accumulation and diffusion within the city. In fact, the levels of education and qualification of citizens (i.e., the components of human capital) represent fundamental factors for city growth, as vastly demonstrated in the literature (see, e.g., Teixeira and Queiros, 2016; Ashan and Haque, 2017; Thompson, 2018). In this context, the term Smart people refers to the ability of the city to promote efficient education programs, with reference to both formal learning (compulsory schooling and higher education) and vocational training. Once again, the creation of human capital *per se* constitutes a necessary but not sufficient condition for a sustainable city growth; indeed, a further condition is represented by policies designed to promote the dissemination of knowledge, such as the establishment of innovation clusters between the various stakeholders, joint collaboration programs between research centers and firms, a vast diffusion of ICT among citizens, and so on.

The third indicator, Smart governance, involves the method of interactions across all the stakeholders operating within the city, with particular reference to the quality and effectiveness of such interactions and the emergence of a mutual consensus in relation to projects and goals. Factors such as e-services, e-government, social media, and crowdsourcing, usually affect in a positive way the interaction of a multitude of different actors, in this way promoting more transparent and shared decision-making processes (Barns, 2018).

The fourth indicator, Smart mobility, refers to the establishment of efficient and sustainable modes of transportation, both collective (for instance improving bus and train lines, expanding the overall capacity of the road system, etc.) and individual (incentivising the usage of electric cars, models of car sharing, and so on) (Docherty et al., 2018). Also in this context, the dissemination of ICT may constitute a powerful tool to improve the mobility system, since the former can incentivise the usage of feedback and reviews by users.

The fifth indicator, Smart environment, broadly refers to the degree of development of eco-friendly activities and tools adopted within the city, such as the usage of renewable resources (solar panels, biogas, windmills, etc.) and innovative technologies in general, which contribute to respect and enhance the natural environment (Colldahl et al., 2013).

Finally, the sixth and last indicator, Smart living, measures the efforts undertaken in order to improve the quality of life of citizens, in terms of services, increase in the attractiveness for tourists, the promotion of social cohesion, and safety. Practical examples include cultural facilities, e-health, public safety tools (such as surveillance systems and inter-emergency service networks) and social services (Toppeta, 2010).

Lombardi et al. (2012) have elaborated a synthesis for these six indicators, relating each indicator to a specific aspect of the urban environment (Tab. 40).

Tab. 40: Components of Smart City and related aspects (Source: Albino et al., 2015; adapted from Lombardi et al., 2012).

Indicators of Smart City	Related aspects of the urban environment
Smart economy	Industry and ICT
Smart people	Education
Smart governance	E-governance
Smart mobility	Logistics and ICT
Smart environment	Efficiency and sustainability
Smart living	Security and quality of life

In particular, the Smart economy indicator relates to the presence of industries in the field of ICT, or to the use of ICT in production processes. Smart people emphasises the crucial role of educational programmes; indeed, as stressed before, investments in human and social capital, together with ICT infrastructures, are likely to generate a sustainable growth path and enhance life quality. Smart governance entails that several stakeholders are engaged in a mutual decision-making process, where ICT-mediated governance (also called “e-governance”) is fundamental in bringing Smart City initiatives to citizens, and to maintain the decision process transparent. Moreover, always in this context, citizens represent the spirit of e-governance in a Smart City. Then, Smart mobility is associated with the usage of ICT in modern transports to improve urban traffic. Finally, Smart environment is linked to the degree of efficiency and sustainability within the smart activities and projects developed in the city, whereas Smart living relates to the concepts of security and quality of citizens’ lives.To briefly sum up, whereas traditional city management mainly involves mere urban planning, Smart City management entails the establishment of a strategic coordination plan among different stakeholders (who interact in different subsystems such

as transportation, health, education, environment, etc.) within a single smart macrosystem that integrates the full usage of ICT with the city's resources and local characteristics, in this way leading to a sustainable path of socio-economic development. In this context, ICT acquire a crucial element within the Smart City framework, since they deeply affect, directly and/or indirectly, all the six indicators. For instance, as highlighted by Hollands (2008), tools such as e-government applications, enhance cost efficiency and effectiveness in the public sector, bringing transformational changes in public service provision, administration, and engagement with the other stakeholders. Therefore, technology represents an essential element to qualify a city as "smart", since ultimately the usage of ICT affects drastically stakeholders' lives and working activities within the urban environment in significant and fundamental ways, offering practical and immediate solutions when addressing political, managerial, environmental, economic and social issues.

Smart City rankings

Globalisation, increased population growth and a constant search for competitiveness, have put pressure in cities ecosystems. As urban centers grow in size, so does their influence; recognising the importance placed upon cities, several rankings have emerged to measure and to rate different aspects of the latter. In fact, city-rankings have become a central instrument for assessing the attractiveness of urban regions over the last 20 years (Gilffinger et al. 2007). As an indication of the importance that rankings have obtained, while conducting this report, we were able to identify over 70 indicators for cities. The latter vary in methodology and scope and differ on attributes and results; nevertheless, it is undeniable that there is a strong drive to assess and rank cities all over the world. According to Cities in Motion by IESE (2014, 2017), even though there is such intention, so far, few rankings have been sustainable in the medium term. The reason why they make this statement is because they have observed that most studies depend very often on a political agenda or on private actors' strategies, and are limited in time and/or financing. For these reasons, they could be conceived for a predetermined scope, or to highlight specific information. For the purpose of our study, however, when speaking about rankings, it is important to differentiate among ranks, indicators and indices; the difference might be subtle, therefore a simplification of the operational definition of each one of them is helpful to contextualise the scope of our discussion. As pointed out by the EU project CITYKeys (Grant agreement 646440, H2020-SCC-02-2014[37]), an index is a quantitative aggregation of many indicators that aims to provide a simplified view of a system; when calculated periodically, it indicates whether the system is becoming more or less smart, and can highlight which factors are more responsible for driving the system itself (Mayer, 2008); a ranking, on the other hand, is the relationship between a set of items; i.e., indices that make it possible to do rankings. As described by Tanguay et al. (2010), an index is a synthesis of indicators, meaning that the aggregation of several data or variables will ultimately result in an index. When elaborating an index, the first choice to be made is which indicators are to be included in its construction, as it emerges from a research on 17 studies that apply indicators related to sustainable development of cities; as pointed out by Tanguay et al. (2010), "*the 17 studies use between 10 and 86 Sustainable Development Indicators (SDI), which reveal a lack of consensus on the optimal number of indicators*". Another interesting aspect that arises is the very low frequency by which the same indicators appear in the various indices. The choice of indicators depends also on which aspect of Smart Cities or sustainable development is wished to be

emphasised. Lazaroiu and Roscia (2012) well describe the most common method to build indices used in Smart Cities context, highlighting the possible unsatisfactory results due to this methodology; the first necessary step is to make different indicators comparable through their standardisation; after that, indicators can be aggregated. Defining the aggregating values is a decisive phase for the construction of an index, because it can considerably influence the final result. First of all, one must choose if attributing the same weight to every indicator or, on the contrary, imputing different ones (and in this case, justify the choice). It is very important to give the proper attention to this aspect because from the same input data it is possible to obtain different (and even contrasted) outputs, and at this point it would be difficult to determine which is the most realistic and balanced representation of reality. By definition, an index is a collection of components combined in an arbitrary way; in fact, there is an inevitably degree of subjectivity in the architecture of an index (which indicators to consider, with which weights, which frequency, etc.), and this is the reason why it is necessary to analyse how information is synthesised. Moreover, proposing a universal accepted method to measure the performance of Smart Cities is difficult due to, first of all, the intrinsic complexity in defining Smart Cities (as it has been shown above). Academics agree on the fact that the "*development and implementation of appropriate measures is still at a nascent stage, and that a generally accepted measurement model is still lacking*" (Albino et al., 2015).

With reference to rankings, referred to as a marketing strategy and a way to attract investments and talents to the cities by some academic authors (Gilffinger, 2007; Reiner et al., 2017; Rodriguez-Pose and Ketterer, 2012) and a way to validate the status of "smart" other than simply auto denomination, it is believed that a city well-ranked will improve the chances of attracting the best talents, as well as an array of business, such as large enterprises, innovative start-ups and research & development. In this context, "*rating systems through synthetic quantitative indicators are receiving increasing attention among city managers and policy makers to decide where to focus time and resources, as well as to communicate city performance to citizens, visitors, and investors*" (Berardi, 2013a, 2013b). On the other hand, although they are quite common in recent time, rankings are very different in their approaches or methods. Due to different interests behind rankings, indicators, and methodological approaches used, it can happen that one city may be ranked significantly differently in different rankings" (Gilffinger et al., 2007). Indeed, even though it is a common believe that a city well-ranked will harvest constructive results, it is argued that there is no concrete evidence that indeed these rankings do help achieving actual economic growth (Gilffinger et al. 2007). In the EU project CITYKeys, the authors go even further by saying that "*theoretically, both from a policy and scientific perspective, a "ranking" is not desirable. Relative positions among the spatial entities do not tell us whether they are sustainable or not. Even though a country is considered sustainable in a relative evaluation, it may be non-sustainable in absolute terms. Measuring relative performance is meaningless if all countries are on unsustainable trajectories*" (Mori and Christodoulou, 2012).

However, in the end, rankings remain widely used and referred to, even though they present some limitations; this is pointed out by an analysis conducted by Schönert (2003), where the author identifies five disadvantages caused by city rankings, such as: a tendency to neglect complex interrelations in regional development; a shallow discussion based on the bare rank itself; the threat that the search for an immediate result might negatively impact the development of a long-term strategy; the strengthened

notion of stereotypes; and finally, that some badly ranked city use those rankings in a way to improve themselves but at the same time ignoring the associated results of the rank. Hence, in the end, the relevance of rankings cannot be overlooked, and one should pay attention to all their limitations.

A reflection on Smart City ranking

In the field of Smart Cities, ecosystems cannot be considered in isolation or disconnected from one another, since they are recurrently assessed, compared, and ranked with potentially great implications on their capacity to attract actors and investors. The influence of how Smart Cities are defined and ranked in the current urban environment is thus of crucial significance to the definition of baseline, ambitions, barriers and drivers. Rankings and overviews are powerful tools influencing policy makers, business leaders and citizens worldwide alike. When developing a project as ambitious as IRIS, in which the analysis of the weakness and strengths of the ecosystem represents the setting stone, the role that rankings have gained cannot be neglected. Knowing the impact of such rankings, as well as their limitations, gives access to clearer prospects within the scope of the IRIS project, and also a chance to be prepared for what lays ahead. Ideally, the organism or company in charge of the elaboration of the Smart City ranking should collect data from disclosure documents, press releases, web sites, and interviews, while communicating the different attributes of key indicators used in calculations. As a counterpart, the ecosystem considered for inclusion in the Smart Cities ranking should be able to provide comments about the collected data, and correct/update the same data, if necessary. In reality, this process is often more complex and less transparent.

A case demonstration: Nice in rankings

In view of proceeding with a better understanding of how Nice LH (together with the other IRIS LH cities) could progress in terms of rankings, the key step is to go through a detailed analysis of the strengths, weaknesses, opportunities and threats of the local ecosystems, relying on surveys and interviews of experts. The way in which key actors in the ecosystem report and assess their own experience further constitutes a key input to characterise the baseline, ambitions and barriers of the ecosystem. Our ambition is to achieve a better qualification of both the supply and demand side of the Smart City as they are still under construction/in progress. By collecting data from key actors involved at the local level, and using a combination of quantitative and qualitative approaches, we can provide a picture of how Smart Cities technologies and consumers' preferences are articulated and should be better aligned. As a first step, we need to rely on the definition of Smart Cities provided by the academic, industrial and governmental literature; this would indeed enable us to place the IRIS project in a more global context. Second, we mobilise Smart Cities rankings to provide a visualisation of how Nice and other LH cities are performing in rankings, and the trend that is followed by these cities in rankings over time; this step also gives us the opportunity to explain the importance of the SWOT approach, in view of performing better and realising new achievements. To such aim, we utilise the analysis of the IESE report, called Cities In Motion Index (CIMI). The reason why we chose this report, is because this rank is one of the most comprehensive and referred to by the actors of the Smart City ecosystem worldwide; in addition, its time horizon encompasses four years, which display an interesting evolution over time, including two of the three Lighthouse cities of the IRIS project (the city of Nice and the city of Gothenburg)[38]. The authors of

the IESE/CIMI report support adequately their work by illustrating the applied methodology, their assumptions and estimates. Nevertheless, some variations occur throughout the years, but they are not properly explained. In the next paragraph, we briefly describe the structure of the CIMI and then we draw attention to the index evolution trough the period 2014-2017.

The creation of CIMI is based on the weighted aggregation of indicators representing 10 dimensions "*selected to describe the reality of the cities in terms of their sustainability and their inhabitants' standard of living*" (Cities in Motion Methodology and Modeling Index, 2014). The dimensions are the following: Economy; Human Capital; Social Cohesion; Environment; Public Management; Governance; Urban Planning; International Outreach; Technology; Mobility and Transportation. Each one of these dimensions is quantified taking into account different sub-indicators (each indicator is the result of at least three sub-indicators) weighted among them. The sources vary from Institutional Organisations (as the World Bank or the World Health Organisation) to consulting firms or online-platforms of data. In some cases, the problem of the availability of data has occurred, so that the authors have effectuated an interpolation (or extrapolation) of the data at country or city cluster level, or from another period of time. Concerning the calculation methodology, more techniques have been considered. The selected one is called "DP2 Technique", which is a methodology based on the distance *"between one given value of an indicator and another value used as a reference or target*. *The correction consists of applying the same factor to each partial indicator, assuming a linear dependence function"* and *"the correction factors are determined by the complement of the coefficient of determination (*R^2*) of each indicator with respect to the remaining partial indicators"* (Cities in Motion Methodology and Modeling Index, 2014). The calculation is imputed twice: first, to determine the synthetic indicators representing the 10 dimensions on the basis of sub-indicators collected; then, from the indicators obtained in the first phase, to define the CIMI itself. In each report, the weight associated to each indicator is provided.

Analysing more in depth the Index proposed by the IESE, it is possible to note its evolution, and the fact that, over the course of time, more information has been added. With regard to ranked cities, the 2014 version of the report considered 135 cities, which became 148 in the following year, 181 in 2016, and 180 in 2017, covering 55 countries in 2014 and 80 in the (last) 2018 report. As stressed above, the final index is the result of weighted indicators, which have also changed throughout those four years. Different outlooks or perceptions might come out from analysing such ranks. For instance, the latest IESE CIMI report already classified two of the Lighthouse cities as being smart; both the cities of Nice and Gothenburg were ranked as smart, ranked 79th and 33th respectively. This should count as a positive result; nonetheless, if we consider the history of the rank, different paths emerge for the two cities. As a matter of fact, if both Nice and Gothenburg experienced a falling trend in their rankings since 2014, the latter city has withnessed a dramatic shift upward (of 55 positions) in the last year (2018).

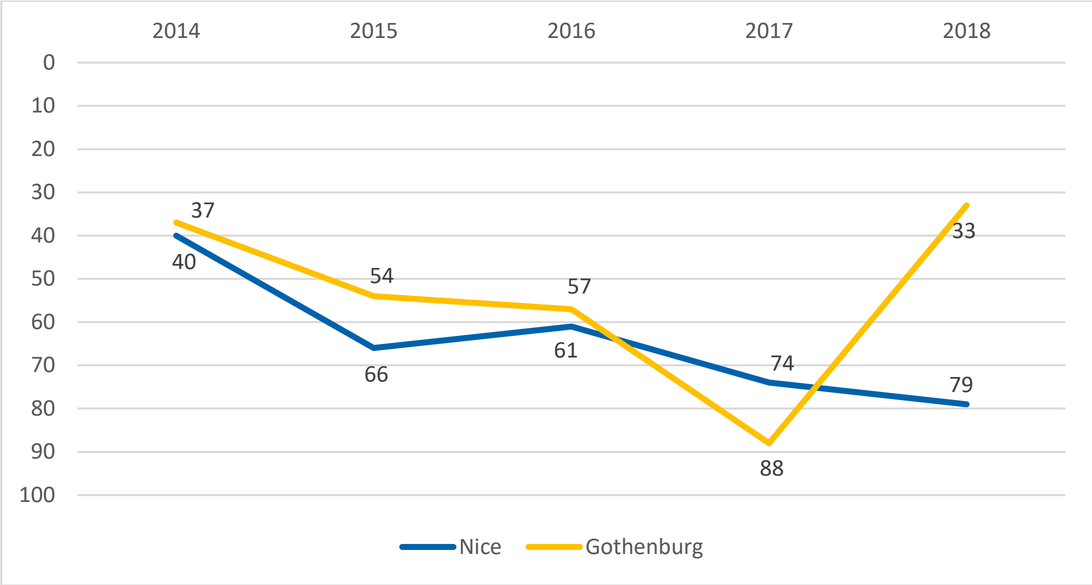

Fig. 28: Ranking and years; evolution over time (elaborated from IESE).

Broadly speaking, however, the report invites their readers to not only take into account the result of one specific year, but their evolution over time: "*our perspective is that the value of the CIMI lies not only in its ability to identify strengths and weaknesses, but also in its temporal component, which enables the identification of the direction in which each city is moving. In this regard, our recommendation to urban managers is that they pay more attention to the trend (dynamic analysis) than to the position.".* We also know for a fact that the weight attributed to each dimension to build the index has changed over the years, and this may constitute one of the reasons causing such unusual trend for the city of Gothenburg; in fact, the city of Gothenburg has improved some of its mobility issues tremendously during the past few months, and the reason behind such a dramatic increase in its ranking, might be due to the fact that among the key dimensions evaluated by the CIMI, the one related to mobility has carried out a considerable weight in 2018.

Eventually, despite the fact that the attention in evaluating the rank of a city should be place over a long-term horizon, we are also aware of the risk that some people will not analyse the information at this level, but rather, they will rely on the city placement in one specific point in time. We deem the latter option as a risk, and from this, it clearly emerges the importance of the IRIS project, as well as the construction of a SWOT analysis, in order to truly investigate the real direction towards the cities are moving to.

Endnotes

[1] https://europa.eu/capacity4dev/evaluation_guidelines/minisite/en-methodological-bases-and-approach/evaluation-tools/swot-strenghts-weakness-opportunities.
[2] A table comprehensive a detailed description of each of the 7 functions is provided in Annex 3.
[3] A detailed description for each of the five Transition Tracks is provided in Annex 4.
[4] Mainly information and communication technologies adoption literature.
[5] The text of the questionnaire is reported in Annex 5.
[6] When responding to a Likert item, they specify their level of agreement or disagreement on a symmetric agree-disagree scale for a series of statements. Thus, the range captures the intensity of their feelings for a given item (Burns and Burns, 2008).
[7] At least once a week, at least once a month, at least once a trimester, less than once per trimester.
[8] These steps do not necessarily follow a precise sequential order. In addition, it can be the case that, in relation to some domains, not every step is required.
[9] PCA is a statistical method used to reduce the amount of available information when the latter results to be excessive, trying to isolate the main (fewer) drivers explaining the features of a certain variable. In our specific case, PCA results indeed to be a rather powerful instrument, due to the notable number of information we have from the questionnaire.
[10] Specifically, the multinomial logit model allows to quantify the effect exercised by a certain (explanatory) variable on the probability of selecting each of the items belonging to a certain set (outcome variable).
[11] The technical results associated to the inclination to change for mobility and to the other domains (i.e., energy, ICT and environment) are available upon request from the authors.
[12] See table of definitons on page 10
[13] The detailed analysis to assess the correct degree of association between variables is carried out in the technical Annex A 4.
[14] The detailed description of the PCA methodology comprehensive of all the test statistics is carried out in the technical Annex A 5.
[15] The detailed methodology implemented for the multinomial logistic model (comprehensive of all the test statistics and robustness checks) is carried out in the technical Annex A 6.
[16] In order to refine the estimates (and above all to avoid consuming an excessive number of degrees of freedom), the variable Age category was derived from Age class. Specifically, the various age ranges included in Age class were clustered into three categories (included in Age class) as follows: 18-25 into the “student” category; 26-34, 35-49, 50-64 into the “working” category and 65-65+ into the “retired” category. These three categories were further purged by individuals who, although resulting in the age range for a specific category, do not belong to that category (namely, individuals in the 18-25 range who do not study, nor work; individuals in the 26-64 age range who do not work, and individual in the age range 65-65+ who are not retired. For further details, see Annex A3).
[17] Following the results from the LR and Wald tests statistics for combining alternatives in the outcome variable, the two alternatives: city life improvement and carbon footprint reduction were merged into one single alternative (city life improvement).
[18] In order to derive such estimates, a multinomial logistic regression for ordered responses was implemented. The latter constitutes a model which is slightly different from the multinomial logit model implemented previously for categorical responses. For the ease of the exposition, technical details on the ordered multinomial logit model were not reported. Nonetheless, if interested, one can find useful references on this model in Williams (2006), and Long and Freese (2014).
[19] Endogeneity occurs when one or more regressors are correlated to the error term, making the econometric estimates bias.
[20] With reference to Q6, the latter solely considers citizens living in separate and individual houses, therefore, in this case, the issue of unobserved variables related to collective consensus does not hold. Nonetheless, for this question, an extremely reduced sample has been utilised (only 163 individuals), and this could possibly generate issues to the

asymptotic properties of the estimator; because of this reason, we decided not to consider Q6 for econometric analysis neither.

[21] The usage and degree of utilization of internet (through devices such as personal smartphone and/or personal computer) represent undoubtedly the main proxy for measuring ICT behaviour by citizens. As a matter of fact, the usage of any sort of smart application (related energy, mobility, but in general related to every aspect of everyday life), the access to smart information (e.g., e-newspaper, online information, etc.) and smart interaction (e.g., social networks) require necessarily the availability of an internet connection by users.

[22] The logit model is essentially a multinomial logit model with the outcome variable encompassing only two alternatives (like in this case).

[23] Specifically, Cramer's V is computed as follows; $V = \sqrt{\frac{\chi^2}{n\min(k-1,r-1)}}$, where χ^2 in the numerator is the chi-squared statistic, and in the denominator n expresses the total number of times the two variables of interest were observed, with k and r representing, respectively, the total number of columns and rows of the contingency table associated to the pairwise variables.

[24] Kendall's τ is computed as follows: $\tau = \frac{C-D}{\sqrt{N-\sum_{i=1}^{N_1} u_i(u_i-1)/2}\sqrt{N-\sum_{j=1}^{N_2} u_j(u_j-1)/2}}$, where *C* and *D* are the number of total concordant and discordant pairs respectively; N is the total number of pairs, N_1 is the number of sets of tied *x* values, u_i is the number of tied x values in the i^{th} set, N_2 is the number of sets of tied *y* values, and u_j is the number of tied *y* values in the j^{th} set.

[25] Since our sample is relatively large (more than 1,000 observations), the asymptotic standard errors shall provide rather good estimates.

[26] For the ease of exposition, the horizontal labels report the enumeration, from the questionnaire, of each variable exposed in the vertical labelling.

[27] The Bartlett's test of sphericity follows a chi-squared distribution with $[n(n-1)/2\,]$ degrees of freedom, and is computed as follows: $\chi^2 = -\left\{N - 1 - \left[\frac{2n+5}{6}\right] log_e|R|\right\}$, where N is the sample size and n the number of items.

[28] The KMO measure ranges from 0 to 1 and is computed as follows: KMO = $\frac{\sum_{i=1}\sum_{j=1} r_{ij}^2}{\sum_{i=1}\sum_{j=1} r_{ij}^2 + \sum_{i=1}\sum_{j=1} a_{ij}^2}$, where r_{ij} $(i \neq j)$ are the elements of the variables' correlation matrix and a_{ij} the elements of the partial correlation matrix. Values closer to 0 indicate that the sum of the partial correlations is large relative to the sum of the correlations and therefore, performing principal component analysis is not feasible. Conversely, values closer to 1 indicate a good degree of suitability to carry out principal component analysis. As a rule of thumb, a threshold level of 0.5 is required to carry out principal component analysis.

[29] The eigenvalues of the covariance matrix express the portion of the total variance of the matrix which can be explained by a linear combination of the variables in a factor.

[30] This criterion is based on the fact that any retained component should account for at least as much variation as any of the original variable.

[31] As stated above, given a set *X* of *n* variables, $X = \{x_1, x_2, \dots, x_n\}$, using principal component analysis it is possible to express every variable as a linear combination of a lower number of factors *f* (belonging to a set $F = \{f_1, f_2, \dots, f_k\}$, with *k≤n*), each one assigning a different loading (or weight), ϕ, to the variable of interest: $x_i = \phi_{i1}f_1 + \phi_{i2}f_2 + \dots + \phi_{ik}F_k$. In our case, after applying the Kaiser's rule for eigenvalue retention, we have that *i* = 5 and *k* = 2.

[32] Usually in the literature, it is recommended to retain factor loadings > 0.4 (see, e.g., Steven (2009)). Moreover, in order for factor loadings to be unique, there should be a difference of at least 0.2 between them. In this case, all these two conditions are satisfied.

[33] In case of alternative-variant regressors, the multinomial logit model is not indicated. Rather, it is suggested to utilise the conditional or the mixed logit models. In our case, however, all the covariates are alternative-invariant, therefore, the usage of the multinomial logit model appears a proper choice.

[34] Please notice that even if an individual belongs, e.g., to the working age category, this does not necessarily mean that the individual is employed; he/she could indeed also be unemployed. Rather, this category simply indicates that the individual belongs to the age range associated to the working age. The same logic applies with reference to the other two age categories (retired age and student age).

[35] The variable *Number of children per household* (RS5) represents the only socio-demographic variable which was excluded from the analysis. We decided so, due to the high level of correlation of this variable with the *Number of*

members per household (RS4). The Kendall's τ coefficient between the two variables is indeed of 0.6383, entailing the presence of severe collinearity between these variables when performing regression analysis.

[36] This assumption says that the inclusion of additional alternatives should not change the preference of the individual over the alternative which was selected. In our case, e.g., if an individual has chosen as mode of transport the bus, the inclusion of an alternative mode of transport in the set of alternatives (let's say, a helicopter) should not change the original choice made by the individual.

[37] This is a EU H2020 project funded under the programme "Foster European Smart Cities and Communities", aimed at developing a framework for common, transparent data collection and performance measurement to allow comparability and replication between solutions and best-practice identification.

[38] The city of Utrecht is not mentioned in the report; the explanation on how cities are chosen is also not completely clear.