Deliverable T1.3.3 «Future scenarios development for ADRION's connectivity»

FINAL REPORT

04/2020

Inter-Connect project Doc. TYPE/No/Title	T1.3.3 / « Future scenarios development for ADRION's connectivity »
WP	WPT1: Setting the scene for intermodality enhancement and rail reform in ADRION
Authors	CERTH/HIT
Contribution	All

Contents

List of Figures

List of Tables

1. Introduction

1.1 Work package 1; "Setting the scene for intermodality enhancement and rail reform in ADRION"

The first technical WP of Inter-Connect project, consisting of 3 activities, aims to capitalize on the existing knowledge in passengers' intermodal transportation and rail use deriving from policy documents and strategies (regional/national/transnational) search as well as from international real cases experience (best practices) review. WPT1 continuous with the formulation of ADRION's transnational connectivity map; starting from an in depth analysis of transnational transport flows (demand) and supply analysis and continuing with users' needs and expectations analysis along with experts opinion capturing procedures, future scenarios for ADRION's connectivity are developed (2020,2030 time horizons). Existing investments and plans for ADRION's interconnection will be taken into account during the scenarios formulation phase in order to maximize projects effects and mainstream its activities into transnational policies. RDA LUR (SL), having to present a considerable experience coming from its participation in a number of projects dealing with sustainable transport interventions ranging from the macro perspective of TEN-T corridors to regional/local projects, leads WPT1 which has as a final output the development of a strong network structure; Inter-Connect's cooperation platform, an extended list of stakeholders at all three levels in transportation examination (local/regional, national, transnational) supporting project's objectives. The bases of platform's development are placed in WPT1, transnational stakeholders are engaged and regional – national stakeholders are identified (thereinafter engaged in WPT2). The current and future situation in ADRION's connectivity, in terms of intermodality Public Transport (PuT) and rail based, as resulted from WPT1 will feed the Roadmap formulation of WPT3, consisting simultaneously a core input to the "Intermodality understanding tool" of Act. 3.3 (part of the capacity building toolkit).

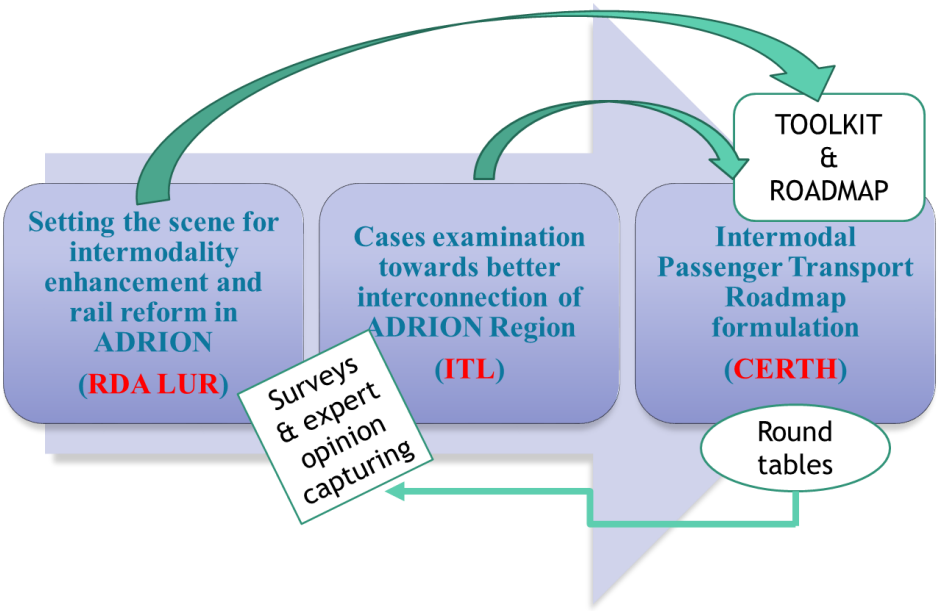


Figure 1: The technical work packages of Inter-Connect project and liaison points

The review of the policies and strategies aiming to strengthen intermodal and rail transport along with the best practices report are two outputs that can be used by every interested body across Europe since

they are the apothegm of a generalized research study not focusing only in ADRION area. As for the methodology for demand and supply analysis determining the current and future connectivity of ADRION, this can be also used to gain a common understanding for other areas too (generalized methods to analyze passengers' connectivity). Instructions on how to plan and execute users' and experts' surveys are also provided as general principles for opinion capturing mechanisms. Finally, stakeholders' identification steps and the respective engagement strategy used for the formulation of Inter-Connect's Cooperation Platform are useful tools to be used by other cases too (either addressing transport issues or projects on other fields as well).

The major output of the first technical WP is the action plan on strengthening intermodal passenger transportation for achieving better (and low carbon) connectivity in ADRION Region. The action plan is basically recommendations regarding intermodal transport interventions that can guarantee upgraded environmental performance. The recommendations will come as a result of the understanding of transport policies at European level, the respective adoption rate at national, regional and local level and the needs as expressed by experts and real transport systems users, thus travellers.

1.2 Activity 1.3; "ADRION transnational connectivity"

Act.1.3 consists of all necessary actions to formulate ADRION's current&future connectivity map; • Quantitative/qualitative analysis of transnational demand and supply under an intermodal perspective – current ADRION's interconnectivity • Scenarios (2020,2030) for the future of ADRION's connectivity • User needs & experts' opinions capturing feeding current & future ADRION's connectivity map WPT1 closes with the definition/engagement of stakeholders at transnational level to participate in Inter-Connect's Cooperation Platform, a wide forum of key actors involved directly & indirectly in mobility that supports project's results sustainability (based on a sound engagement strategy). Through best practices experience, the partnership will also define regional/national actors to be involved in the Platform (engaged in WP2). The Cooperation Platform has started being formulated already from proposal phase with 24 bodies supporting project's implementation (LoS and associated). The signing of an MoU among the partners, the associated partners and the supporting bodies as well as with the identified-engaged stakeholders (with transnational role) will launch the fruitful cooperation for improving intermodality in ADRION. Later, during the WPT2, the MoU will be enhanced with the regional - national and local engaged stakeholders that expresses their commitment in Inter-Connect's goals.

The goals of activity 1.3, served by 4 deliverables (Table 1), can be summarized at the following;

Table 1: Activity 1.3 deliverables

Deliverable	Short description
Deliverable T1.3.1 Demand and Supply analysis of current situation in ADRION	The report presents the analysis of ADRION transport demand and supply (quantitative/qualitative technical analyses of transnational flows) defining in this way region's intermodal reference network (operational positioning of hubs).
Deliverable T1.3.2 Users need surveys & experts opinion capturing	The current deliverable presents the analysis of the users' needs and experts' opinions for higher interconnectivity & accessibility at transnational level in an intermodal perspective with a special focus on PuT and rail. The deliverable is highly linked to the DT2.1.1 where mobility needs at local level are presented, however, the presentation of the results is divided into two deliverables that serve the scope of each technical WP; the first one refers to the ADRION as a whole, the second goes deeper in local needs and the 3rd presents the complementary and continuity of proposed interventions at the two levels (ROADMAP).
Deliverable T1.3.3 Future scenarios development for ADRION's connectivity	Report with the analysis of intermodal (PuT and rail based) transport scenarios (2020,2030 horizons) as derived through the examination of the captive/generating traffic poles in ADRION.
Deliverable T1.3.4	A living document describing platform's objectives, the engagement procedure to attract members'

Cooperation Platform	support, its members, the main discussion topics and the results of their activities. The current deliverable and in order to guarantee the well-cooperation and commitment among involved parties, will be accompanied with an MoU signed among them.

* Cases understanding & clustering
* Transport demand and supply data collection
    * User needs & experts' opinions capturing – surveys and interviews
    * Desktop survey
* Quantitative/qualitative analysis of transnational demand and supply under an intermodal perspective – current ADRION's interconnectivity
* Formulation of Scenarios (2020,2030) for the future of ADRION's connectivity
* ADRION's transnational connectivity map development
* Inter-Connect's Cooperation Platform formulation – MoUs signing

1.3 Deliverable T1.3.3 "Future scenarios development for ADRION's connectivity"

Deliverable 1.3.3, entitled "Future scenarios development for ADRION's connectivity", presents the development of modal split models that were based on the results of Inter-Connect's transnational stated preference survey (described in T1.3.2). *The stated preference survey is a method of finding out about the attitudes of a transport system users in case where a new alternative that users have not yet had the opportunity to try is offered [1]*. As Ben Akiva et al. (2015) mentions *stated preference elicitation methods collect data on consumers by "just asking" about tastes, perceptions, valuations, attitudes, motivations, life satisfactions, and/or intended choices [2]* and this is what happened similarly in the case of Inter-Connect project. The combination of stated preference survey and logit model is estimated to shed light to whether and how possible is for travellers in ADRION area to shift from the dominant current mode (private car) to more sustainable options – transnational model split models are not so.

2. Transnational trips mode choice; analysis & results

2.1 Overview of collected data

In total 2.515 answers were collected during the Stated Preference survey conducted in the framework of Inter-Connect Activity 1.3.2 (Figure 2).

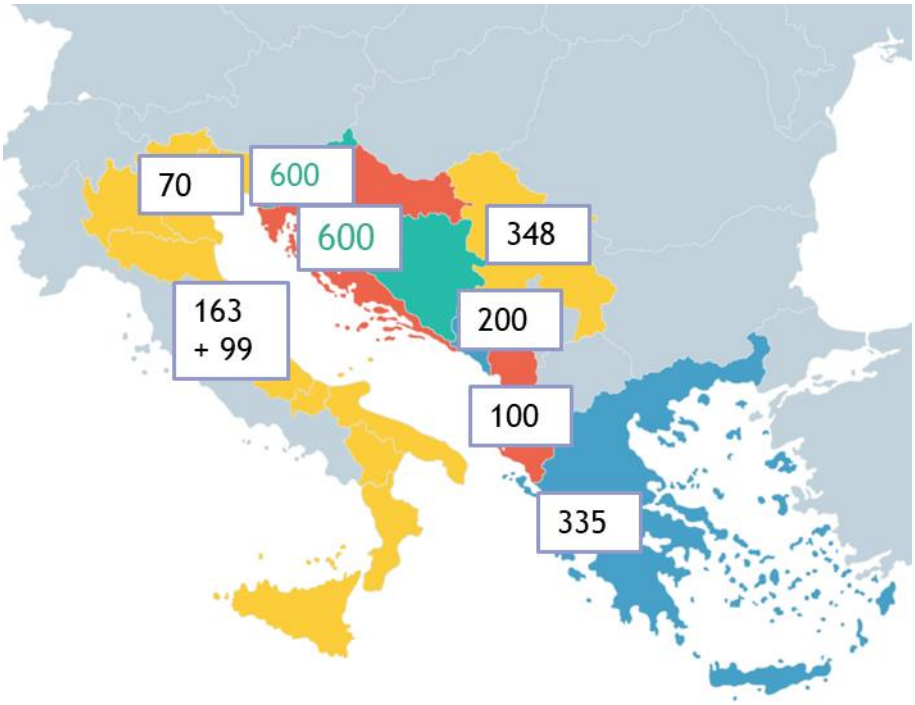


Figure 2: Number of answers in the SP survey per Inter-Connect case

The sampling goals regarding age, gender and income distribution were well achieved;

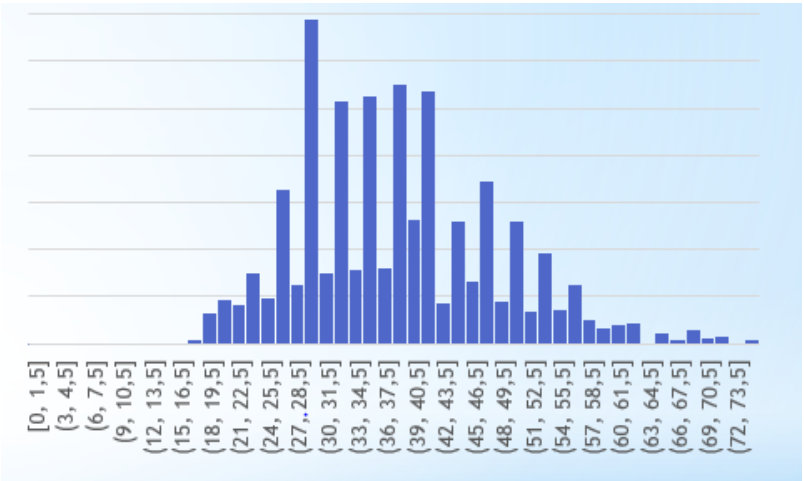


Figure 3: Age based sampling

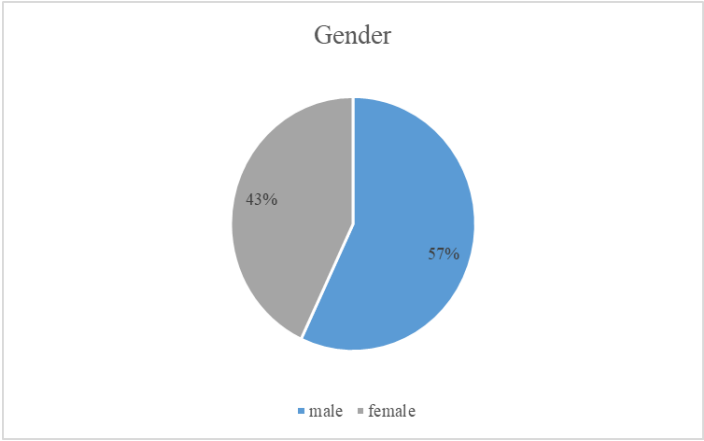


Figure 4: Gender sampling

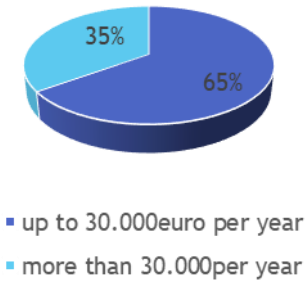


Figure 5: Income based sampling

When on the spot surveys (initial plan) were not able to be conducted, electronic tools were enabled (i.e. EUsurvey) for reaching a good total number of answers – limitations in the survey have already been discussed in T1.3.2 giving future corrective actions direction when similar transnational attempts would be scheduled (lessons learnt).

The first overview of collected data, via a basic statistical analysis, reveals the current travellers' choices – travel behaviour;

- Car and air transport consist the main choices of travellers
  - Car for short and medium distances dominates choices – road transportation is selected also in some long distance trips showing the low level of connectivity via mass transport in ADRION
  - Air transport is the most preferable way when distance is longer
- Trip travels in ADRION are mostly for leisure (92%) – Figure 6

Figure 6: Trip purpose derived from the surveys

2.2 Data Base Formulation

The initial databases were elaborated and inserted in IBM Statistics SPSS 22.0 software, in order to analyze the answers of the respondents and implement mode choice models, describing the relationship between the binary response sustainable/ unsustainable mode choice of current travelers within the wider Adriatic - Ionian region.

Transportation surveys are of major importance for most transportation models, as the data collected can be used to produce a wide range of models that represent the transportation system. Transportation surveys must follow a series of logical and interconnected steps towards the final output. Despite the fact that transportation surveys can be well – organized, human factor is possible to cause irrational data collection or organization of the database. To overcome this stage it is important to start with the process of "data cleaning".

For the purposes of this research, each database received has been checked in order to identify irrational responses, missing values or other random types of errors - random and systematic errors. The problematic responses or the controversial data have been recognized and analyzed and the process of modelling ware possible to start.

2.2.1 Data encoding

The variables extracted from the questionnaire survey are presented in Table 2.

Table 2: Socio – economic variables of the travelers from questionnaire survey

a/a	**Variable**	**Variable values**	**Type of Variable**
1	Gender	Male Female	categorical
2	Age		scale
3	Income per year	1. 0 - 10.000 euros 2. 10.000 - 20.000euros 3. 20.000 - 30.000euros 4. 30.000 - 40.000euros 5. 40.000 plus euros	categorical
4	Driving license	1.Yes 2. No	categorical variable
5	Car ownership	1.Yes 2.No	categorical
6	Employment status	1.Full time 2.Part time 3.Student 4.Retired 5.Unemployed 6.Other	categorical

7	Educational level	1.Primary school 2.Secondary school 3.Student 4.High school graduate 5.Bachelor's degree 6.Master's degree 7.Doctorate degree 8.Other	categorical
8	Trip/travel Purpose	1.Leisure 2.Work 3.Other	categorical
9	Offers	1.Yes 2.No	categorical
10	TT_ Current Mode		scale
11	TT_ Sustainable Mode		scale
12	Cost_ Current Situation		scale
13	Cost _Sustainable Mode		scale

The Travel Time and Cost of the Current Mode and of the sustainable alternative constituted the input for the Stated Preference Cards and was based on the work conducted in the previous tasks of Act. 1.3.

2.3 Stated Preference Analysis; binary logistic regression for willingness to use

Binary logistic regression models are used to predict a categorical (dichotomous) variable, from a set of predictor variables. The prediction is measured as the possibility of an event to be absent, compared to the possibility of this even to occur. In binary logistic regression models, the dependent variable regards the logarithm of the odds ratio [3].

The objective of logistic regression is to discover the best fitting model to describe the relationship between the dichotomous characteristic of interest - dependent variable and a set of independent - predictor variables. Logistic regression generates the coefficients of a formula to predict a *logit transformation* of the probability of a presence of the characteristic of interest [4].

The independent variables, which form the modal choices, are part of a utility function (a) defined by logistic regression, using the SPSS software,

$$\ln\left(\frac{p_i}{1-p_i}\right) = \beta_0 + \beta_1 X_{1,i} + \beta_2 X_{2,i} + \ldots\ldots + \beta_N X_{n,i} \quad \text{(a)}$$

this utility function, which is a measure of the attractiveness of an alternative mode of transport [5], is then introduced into a binomial Logit model (b), also implemented into an SPSS environment,

$$p_i = \frac{e^{(\beta_0+\beta_1 X_{1,i}+\beta_2 X_{2,i}+\ldots\ldots+\beta_N X_{n,i})}}{1+e^{(\beta_0+\beta_1 X_{1,i}+\beta_2 X_{2,i}+\ldots\ldots+\beta_N X_{n,i})}} \quad \text{(b)}$$

with p_i the probability of current users of an unsustainable transport mode to choose a sustainable transport mode.

To sum up and simplify the scope, a logit model can reveal **the probability to shift from the currently used mode to another one under different scenarios** e.g.

- *Is it easier to change your mode given different provision when you are younger or at a more mature age?*
- *Does offers play a role in shifting to more sustainable modes?*
- *How much travel time parameter affects your choice?etc*

2.4 Analysis of the Mode Choice Model's Assumptions

The mode choice models shaped are based on the assumption that each traveler has fully information related to available trips and makes rational choices. The traveler weighs all the elements of a trip and selects the optimal solution [5].

Mode choice models with the application of the binary logistic regression method with are probabilistic and demonstrate the possibility of choosing an alternative option, among the discrete offered alternatives.

The Adriatic - Ionian Region has been divided into three sub – regions with similar travel time (duration) characteristics – this is a clustering made by CERTH according to connectivity understanding, of course other categorizations would differentiate the results. The three sub – regions include origins and destinations of shorter, medium and longer duration. The Tables below demonstrate the classification of the trips, with duration criteria.

Shorter trips /more 'affordable'	Medium duration trips	Longer trips / not 'selectable'
0,5 – 9 hours	**11 – 15h**	**17 – 39 hours**

Figure 7: Trips clustering

The trips of shorter duration range from 0,5 h to 9 h, the trips of medium duration range from 11h to 15h and finally the trips of long duration range from 17h to 39h.

Table 3: Trips of Shorter Duration

Trip Origin – Destination (back and forth)	**Trip Duration (h)**
Bar - Igoumenitsa	9
Bar - Durres	9
Belgrade - Piran	9
Durres - Igoumenitsa	6
Bologna - Piran	4
Trieste - Piran	0,5

Table 4: Trips of Medium Duration

Trip Origin – Destination (back and forth)	**Trip Duration (h)**
Bologna - Durres	15
Belgrade - Split	14
Split - Piran	14
Bar - Split	12
Bar - Belgrade	12
Belgrade - Trieste	12
Bologna - Split	12
Trieste - Split	11

Table 5: Trips of Long Duration

Trip Origin – Destination (back and forth)	**Trip Duration (h)**
Durres - Piran	39
Durres - Trieste	37
Igoumenitsa - Piran	29
Igoum -Trieste	28
Bar - Piran	25
Igoumenitsa - Split	24
Belgrade - Igoumenitsa	21

Bar - Trieste	19
Belgrade - Bologna	18
Bar - Bologna	17
Belgrade - Durres	17
Bologna - Igoumenitsa	17
Igoumenitsa - Bologna	17

For each one of the three classification of trip duration - shorter, medium and longer- has been developed a mode choice model. In order to develop the mode choice models socio – economic data from the travelers and Stated Preference Cards were completed.

After a significant number of tests and iterations that conducted, 3 mode choice models were created. The mode choice models are presented and analyzed further in the next section.

2.5 Case Study 1: Model for Trips of Shorter Duration, Presentation and Interpretation

The first case study refer to trips of shorter duration, thus a duration between 0,5 and 9 hours. The upper limit is indeed high but can also be considered affordable when taking into account the current connectivity of ADRION.

The process of creating the model followed an iterative maximum likelihood method to fit the final model. Table 6 presents the binary logistic regression model describing the trips of shorter duration; it includes the variables that participate in the model, the Beta Estimates – coefficients- of the variables with their statistical significance and the Exponential value of each Beta Estimate calculated from the mathematical equation presented in the previous Chapter.

Table 6: Estimated Values for Logit Model Parameters → Trips of Shorter Duration Scenario

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	TT_SustainableMode	-,003	,000	304,643	1	,000	,997
	Constant	-,061	,063	,937	1	,333	,940
Step 2[b]	TT_SustainableMode	-,004	,000	359,847	1	,000	,996
	income_category(1)	,779	,090	74,379	1	,000	2,180
	Constant	-,403	,076	27,892	1	,000	,669
Step 3[c]	TT_SustainableMode	-,004	,000	238,087	1	,000	,996
	Cost_SustainableMode	-,012	,003	19,438	1	,000	,988
	income_category(1)	,734	,092	63,900	1	,000	2,084
	Constant	-,058	,109	,287	1	,592	,943
Step 4[d]	TT_SustainableMode	-,004	,000	235,231	1	,000	,996
	Cost_SustainableMode	-,010	,003	14,862	1	,000	,990
	income_category(1)	,714	,092	60,029	1	,000	2,043
	purpose(1)	,219	,095	5,355	1	,021	1,245
	Constant	-,198	,122	2,619	1	,106	,820

a. Variable(s) entered on step 1: TT_SustainableMode.

b. Variable(s) entered on step 2: income_category.

c. Variable(s) entered on step 3: Cost_SustainableMode.

d. Variable(s) entered on step 4: purpose.

The variables of this model which are statistical significant and influence the mode choice in the first case study – trips of shorter duration, refer to the travel time of the sustainable mode, the cost of the sustainable mode, the Income category of the respondent *-dummy variable from the initial variable income-* and the Age of the respondent.

As the travel time of the sustainable mode increases the possibility for a traveler to choose a sustainable mode decreases. More detailed, the increase of one unit of the sustainable mode‘s travel time leads to 0.4% reduction of the preference of a sustainable mode. Additionally, as the cost of the sustainable mode increases the possibility for a traveler to choose a sustainable mode decreases. More detailed, the increase of one unit of the sustainable mode‘s travel cost leads to 1% reduction of the preference of a sustainable mode. It is rational that an increase in travel time as well as an increase in the cost of a trip to lead to a reduction in preference.

The variable Income is divided into 2 dummy – variables, lower income (up to 20000 euros income) and higher income (more than 20000 euros per year). So, the dummy – variables low income and high income affect the choice of a sustainable mode. The travelers with lower income are almost twice more likely to choose a sustainable mode compared to the travelers with higher income.

The variable Purpose is divided into two variables work and leisure. According to the first model for trips of shorter duration, the travelers with leisure as trip purpose are 25% more likely to choose a sustainable mode for their trip compared to the travelers with work trip purpose.

After the presentation of the first model, follows the model summary and information related to the model fitting, with the use of statistical tests.

Table 7: Results of the Logit model tests → Trips of Shorter Duration Scenario

Model Summary		
-2 Log likelihood	**Predicted Probability**	**Nagelkerke R Square**
4358,99	72%	10,2%
Chi-square	Df	Sig.
285,11	5	0.000

The Chi-square test (χ^2 = 285,11) with 5 degrees of freedom and its significance level sig = 0.00 examines the null hypothesis, that adding each one of the variables to the model has not significantly increased our ability to predict the decisions made by our subjects.The result of the statistical test shows that the model's 5 independent variables contribute significantly to predicting the values of the dependent variable. In this case, the model is statistically significant because the sig.is less than .000. The value of the factor Nagelkerke R Square - pseudo R Square- shows that 10,2% of the variability of the dependent variable is interpreted by the independent variables of the model.

The predicted probability of the model demonstrates that the estimated and observed values of the dependent variable are 72% in agreement and this is the overall success rate of the model.

Ultimately, all of the independent variables are statistically significant, as we can notice from the sig. <0.05, which represents the statistical significance of the model's coefficients.

The graph below demonstrates the S – Curve of the Logistic Regression Model, for trips of shorter duration.

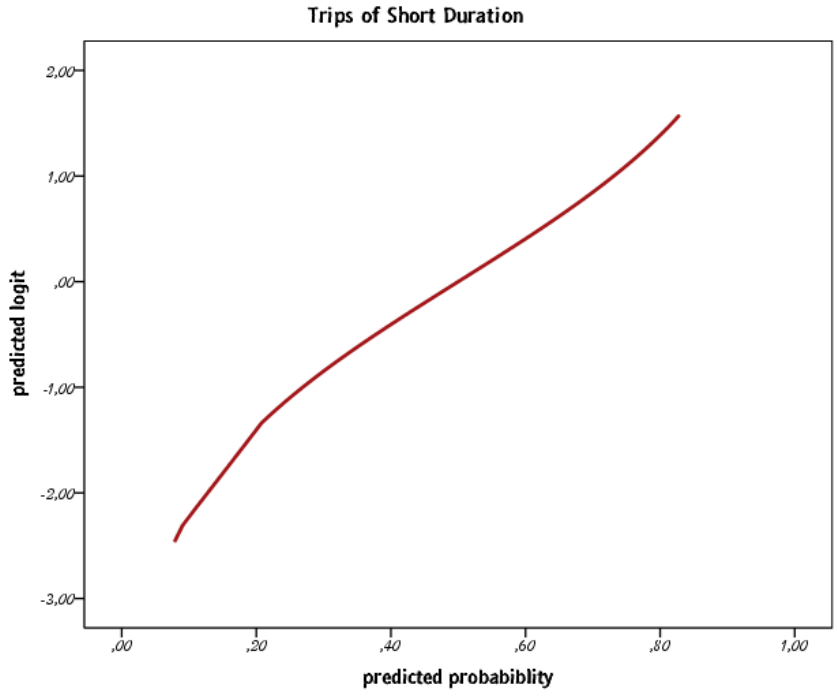


Figure 8: S – Curve of the Logistic Regression Model, for trips of shorter duration

2.6 Case Study 2: Trips of Medium Duration, Presentation and Interpretation

The second case study concerns trips of Medium duration - 11 to 15 hours. The process of creating the model followed an iterative maximum likelihood method to fit the final model.The Table below presents the binary logistic regression model describing the trips of shorter duration.

The Table includes the variables that participate in the model, the Beta Estimates – coefficients- of the variables with their statistical significance and the Exponential value of each Beta Estimate calculated from the mathematical equation presented in the previous Chapter.

Table 8: Estimated Values for Logit Model Parameters → Trips of Medium Duration Scenario

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	TT_SM	-,003	,000	117,098	1	,000	,997
	Constant	,853	,212	16,138	1	,000	2,347
Step 2[b]	TT_SM	-,003	,000	82,175	1	,000	,997
	Cost_SM	-,004	,001	30,779	1	,000	,996
	Constant	,831	,210	15,634	1	,000	2,296
Step 3[c]	TT_SM	-,003	,000	86,369	1	,000	,997
	Cost_SM	-,004	,001	29,317	1	,000	,996
	purpose(1)	,224	,078	8,255	1	,004	1,251
	Constant	,838	,210	15,939	1	,000	2,311
Step 4[d]	TT_SM	-,003	,000	87,502	1	,000	,997
	Cost_SM	-,003	,001	23,583	1	,000	,997
	income_category(1)	,217	,079	7,635	1	,006	1,243
	purpose(1)	,259	,079	10,743	1	,001	1,295
	Constant	,646	,221	8,548	1	,003	1,909

a. Variable(s) entered on step 1: TT_SM.

b. Variable(s) entered on step 2: Cost_SM.

c. Variable(s) entered on step 3: purpose.

d. Variable(s) entered on step 4: income_category.

The variables participating at the second case study concern the travel time of the sustainable mode, the cost of the sustainable mode, the Income categories of the respondents -dummy variables of the initial variable income - the Purpose of the trip and the existence of Offers.

As the travel time of the sustainable mode increases the possibility for a traveler to choose a sustainable mode decreases. More detailed, the increase of one unit of the sustainable mode‘s travel time leads to 0,3% reduction of the preference for a sustainable mode. Additionally, as the cost of the sustainable mode increases the possibility for a traveler to choose a sustainable mode decreases. More detailed, the increase of one unit of the sustainable mode‘s travel cost leads to 0,3% reduction of preference for a sustainable mode.

The travelers with lower income are 24% more likely to choose a sustainable mode, compared to the travelers with high income.

The travelers with purpose of trip work/business are approximately 30% less likely to choose a sustainable mode compared to those travelling for leisure.

Table 9: Results of the Logit model tests → Trips of Medium Duration Scenario

Model Evaluation		
-2 Log likelihood	**Predicted Probability**	**Nagelkerke R Square**
7115.05	81%	10%
Chi-square	**Df**	**Sig.**
34,674	8	0,00

The *Chi-square test* (χ^2 =34,674) with 8 degrees of freedom and its significance level sig = 0.00 examines the null hypothesis, that adding each one of the variables to the model has not significantly increased our ability to predict the decisions made by our subjects.The result of the statistical test shows that the model's 5 independent variables contribute significantly to predicting the values of the dependent variable. In this case, the model is statistically significant because the sig.is less than .000. The value of the factor Nagelkerke R Square (pseudo R Square) shows that 10% of the variability of the dependent variable is interpreted by the independent variables of the model.

The predicted probability of the model demonstrates that the estimated and observed values of the dependent variable are 81,6% in agreement and this is the overall success rate of the model.

Ultimately, all of the independent variables are statistically significant, as we can notice from the sig. <0.05, which represents the statistical significance of the model's coefficients.

The graph below demonstrates the S – Curve of the Logistic Regression Model, for trips of medium duration.

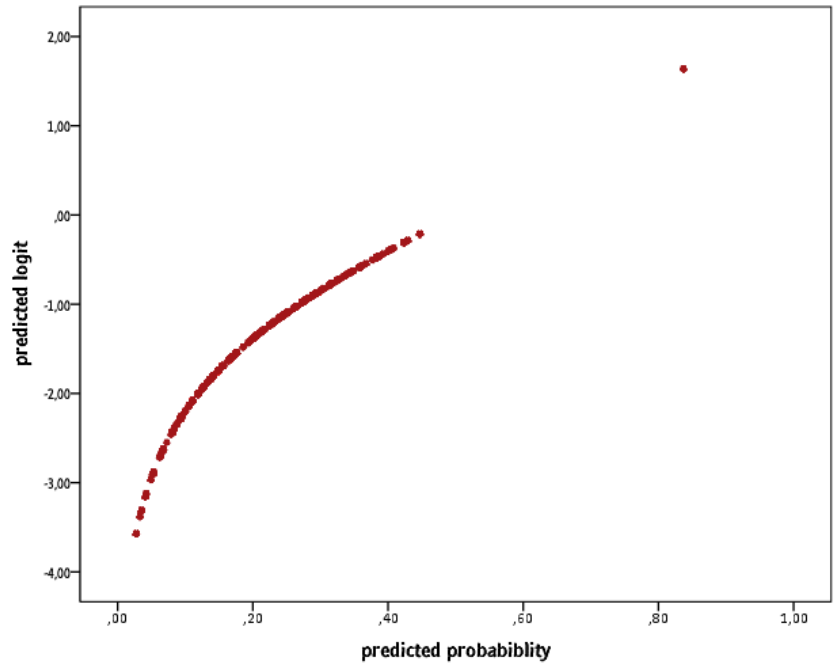


Figure 9: S – Curve of the Logistic Regression Model, for trips of medium duration

2.7 Case Study 3: Trips of Longer Duration Presentation and Interpretation

The third case study, trips of longer duration is ranging from 17 to 39 hours. The process of creating the model followed an iterative maximum likelihood method to fit the final model. The Table below presents the binary logistic regression model describing the trips of shorter duration.

The Table below demonstrates the mathematical model describing the trips of longer duration. More specifically, the Table includes the variables that participate in the model, the Beta Estimates of the variables with their statistical significance and the Exponential of each Beta Estimate calculated from the mathematical equation presented in the previous Chapter.

Table 10: Estimated Values for Logit Model Parameters → Trips of Longer Duration Scenario

Variables in the Equation

		B	S.E.	Wald	df	Sig.	Exp(B)
Step 1[a]	Purpose(1)	1,768	,068	684,680	1	,000	5,862
	Constant	-1,421	,054	688,160	1	,000	,241
Step 2[b]	TT_sustainable	-,002	,000	97,744	1	,000	,998
	Purpose(1)	1,909	,070	744,807	1	,000	6,746
	Constant	,394	,191	4,272	1	,039	1,483
Step 3[c]	TT_sustainable	-,002	,000	99,790	1	,000	,998
	Purpose(1)	1,708	,080	451,732	1	,000	5,516
	Income_category_aggretated(1)	-,394	,079	24,869	1	,000	,675
	Constant	,801	,209	14,650	1	,000	2,229
Step 4[d]	TT_sustainable	-,002	,000	98,292	1	,000	,998
	Cost_sustainable	,000	,000	16,714	1	,000	1,000
	Purpose(1)	1,740	,081	458,021	1	,000	5,697
	Income_category_aggretated(1)	-,382	,079	23,422	1	,000	,682
	Constant	,650	,213	9,338	1	,002	1,915

a. Variable(s) entered on step 1: Purpose.

b. Variable(s) entered on step 2: TT_sustainable.

c. Variable(s) entered on step 3: Income_category_aggretated.

d. Variable(s) entered on step 4: Cost_sustainable.

The variables participating at the second case study refer to the travel time of the sustainable mode, the Income categories of the respondents -dummy variables of the initial variable income - the Purpose of the trip and the existence of Offers.

As the travel time of the sustainable mode increases the possibility for a traveler to choose a sustainable mode decreases.

Travelers with lower income are 32% less likely to choose a sustainable mode compared to the travelers with higher income – this is a differentiation from the above two cases; it can be interpreted as that higher income travelers are considering large maritime or rail trips as an alternative trip experience. The link to leisure is also obvious from the exp(Beta) parameter (sixfold probability for leisure trips).

Table 11: Results of the Logit model tests → Trips of Longer Duration Scenario

Model Evaluation		
-2 Log likelihood	**Predicted Probability**	**Nagelkerke R Square**
5406.025	68.6	25%
Chi-square	**Df**	**Sig.**
936.66	5	0.00

The *Chi-square test* (χ^2 =936.66) with 5 degrees of freedom and its significance level sig = 0.00 examines the null hypothesis, that adding each one of the variables to the model has not significantly increased our ability to predict the decisions made by our subjects.The result of the statistical test shows that the model's 5 independent variables contribute significantly to predicting the values of the dependent variable. In this case, the model is statistically significant because the sig.is less than .000. The value of the factor Nagelkerke R Square (pseudo R Square) shows that 25% of the variability of the dependent variable is interpreted by the independent variables of the model.

The predicted probability of the model demonstrates that the estimated and observed values of the dependent variable are 68.6% in agreement and this is the overall success rate of the model.

Ultimately, all of the independent variables are statistically significant, as we can notice from the sig. <0.05, which represents the statistical significance of the model's coefficients.

The graph below demonstrates the S – Curve of the Logistic Regression Model, for trips of longer duration.

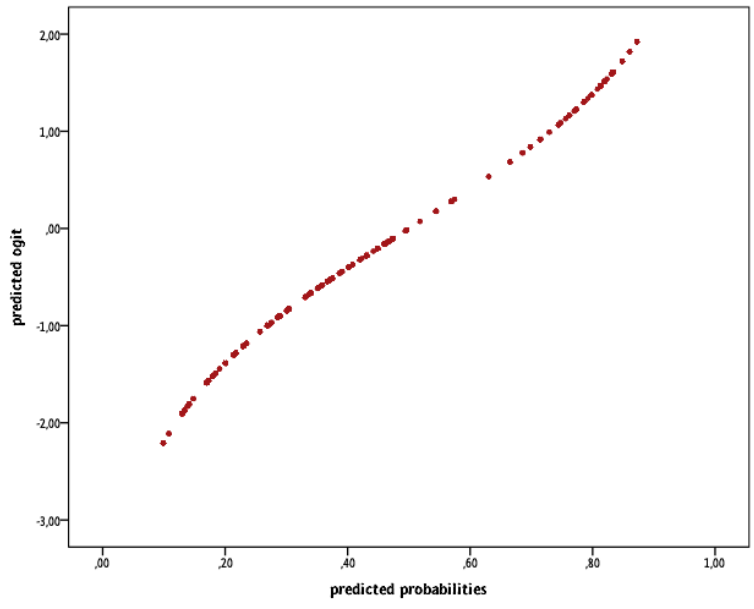
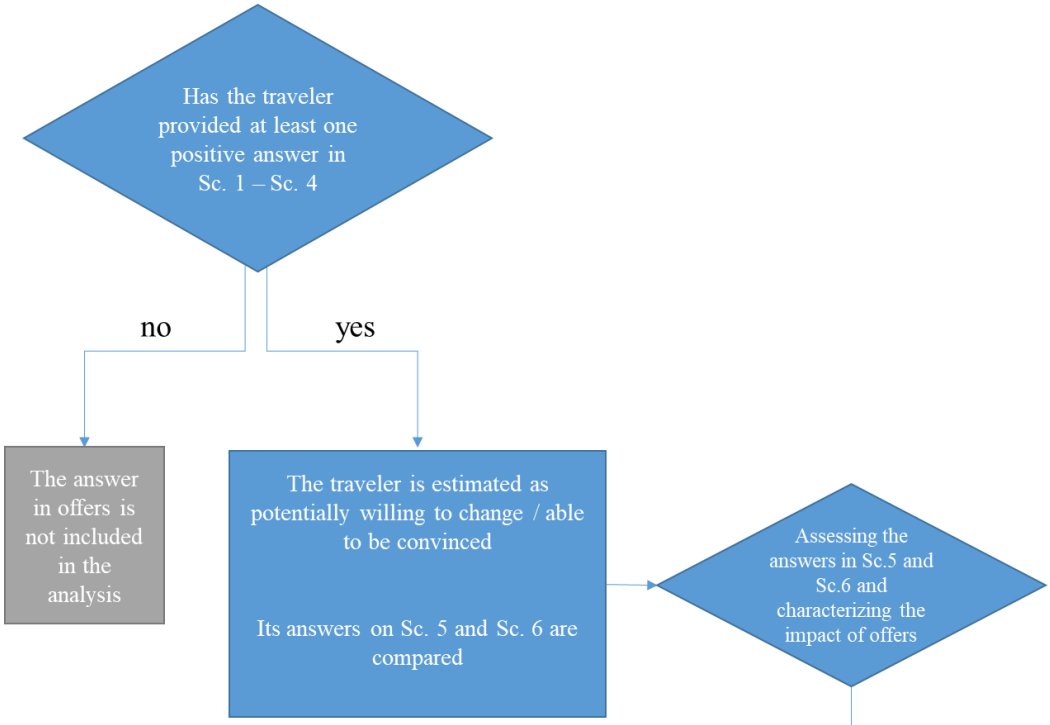


Figure 10: S – Curve of the Logistic Regression Model, for trips of longer duration

3. Treating offers

Although offers were included in 2/6 scenarios of the main SP survey, the equal treating within the logit models with the reduction of cost and travel time scenarios (main drivers of travellers' perception) will not result in correct outcomes. For this reason, a separate analysis followed as depicted in Figure 11.



Sc. 5 (large offers without reduction in cost& time)	Sc. 6 (10% reduction in travel time &cost and small offers)	Offers impact
Yes	Yes	Offers are very well perceived
Yes	No	Large offers are a critical factor and able to shift traveler's choice even when applying by their own
No	Yes	Offers are well perceived but reduction in travel time & cost is also needed

Figure 11: 'Interesting in offers' analysis

The analysis revealed that 25% of travellers will be potentially interested in offers provision;

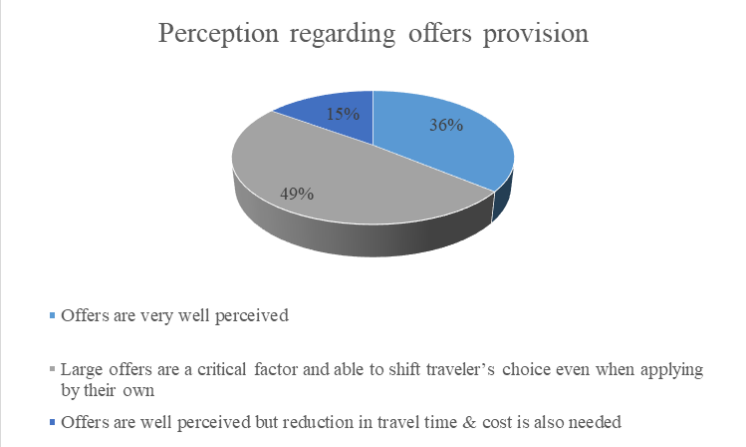


Figure 12: Travellers' view regarding offers provision at destination point

Offers, including discounts in tickets or/and integrated tickets and harmonized provisions at destination points, seem that can work for the last leg of the trip however, in order to shift to sustainable modes (sea or rail based), main interventions reducing travel time and costs should apply in principle. From the other side, it can be supported that preparing the group in the last legs, therefore ADRION cities, can act supportively in promoting the sustainability of the main (large) transnational part of the trip.

4. Focusing on specific interesting ODs for Inter-Connect project

During bilateral discussions among CERTH and Inter-Connect partners, an interest has arisen for specific connections where partners estimate that there is latent opportunities. The connections are:

1. Trieste – coastal Slovenia
2. Bar – coastal Croatia
3. Bologna – Igoumenitsa
4. Coastal Croatia – Igoumenitsa
5. Bologna – coastal Croatia
6. Bologna – coastal Slovenia

For the above connections it was decided to examine in more detail the data collected during the stated preference surveys in order to identify potential hidden information. This type of information can probably be exploited for targeting specific tourist categories while offering them the most attractive and relevant services.

- Regarding the connection among **Trieste and coastal area of Slovenia** (represented by Piran as point reference) that is a short and low cost trip both by car and by sea transport (around 30minutes travel time and 16-18€ the cost for both modes), modal split seems almost divided between the two modes (55% for maritime and 45% for road transportation). It is a connection that can dynamically support attempts towards sustainability promotion.
    - Young people (<=30) seems to be a core supporter of the maritime connection

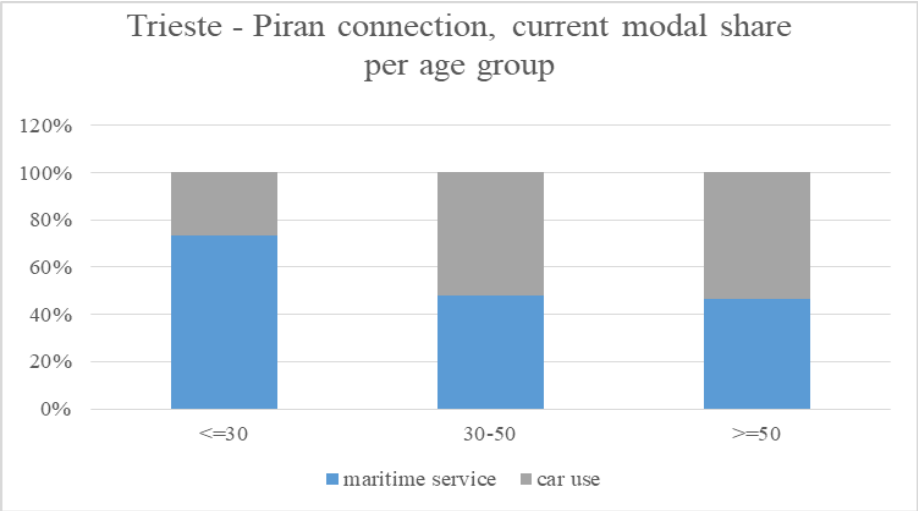


Figure 13: Trieste – Piran connectivity, modal split per age

- Females are actively supporting the maritime connection between Trieste and Piran (66%-34% for women the percentages for maritime and road respectively versus 45%-55% for men)

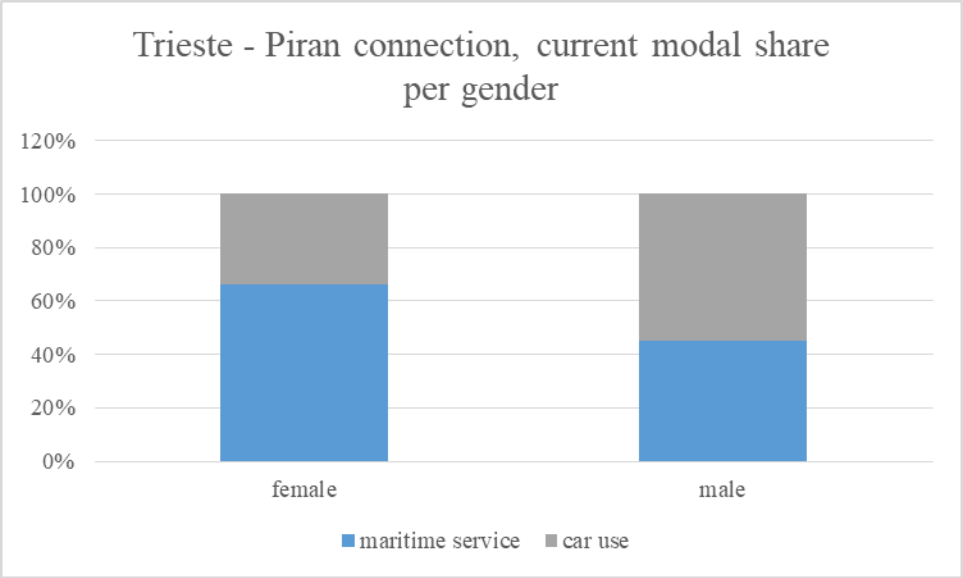


Figure 14: Trieste – Piran connectivity, modal split per gender

- Higher income travellers seem less willing to change their car lifestyle (63% chooses car versus 38% having accepted the maritime connection as an optimal way to conduct their trip)

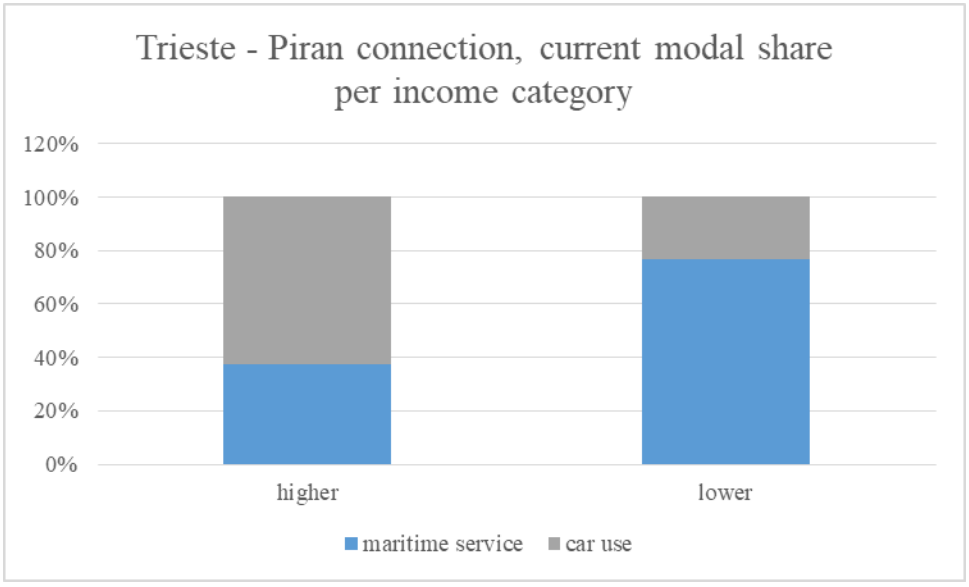


Figure 15: Trieste – Piran connectivity, modal split per income category

- Trip purpose seems not to play a pivotal role for the selection among road and maritime transportation.
- It is estimated that offers at the destination points and services such as integrated tickets and harmonized provisions would play a crucial role in further promoting the maritime transportation.

- Regarding the connection **of Bar (ME) to coastal area of Croatia** (represented by Split) that is a medium distance OD by car (6h) and relatively low fuel cost (around 50euro);
  - Car is the dominant mode selected for trips among Bar and Split (wider catchment areas) (79%) – the rest percentage refer to international bus trips or other combination of modes
  - 37% of the current road users would use a maritime service or another more sustainable option (collective transport) under specific conditions that refer simultaneously to large reduction in price and in travel time
    - Tourists seem more willing to use maritime services when leisure is the scope of their trip (50% more possibilities than when travelling for business purpose)
    - Higher incomes are far less willing to shift to maritime services

- Regarding the connection of **the c.a. of Bologna (IT) to the c.a. of Igoumenitsa (GR),** as it obvious also from the existence of a frequent maritime service, a considerably high percentage of the tourists declared that they already use sea transportation (40%) although being a long, in terms of duration, connection and also a not so low cost option. However, the things are not so encouraging when focusing on the rest 60% of which the highest proportion travels with air transport and namely low cost airlines. Low cost airlines represent a major competitor for transnational trips directly hitting also road transportation.

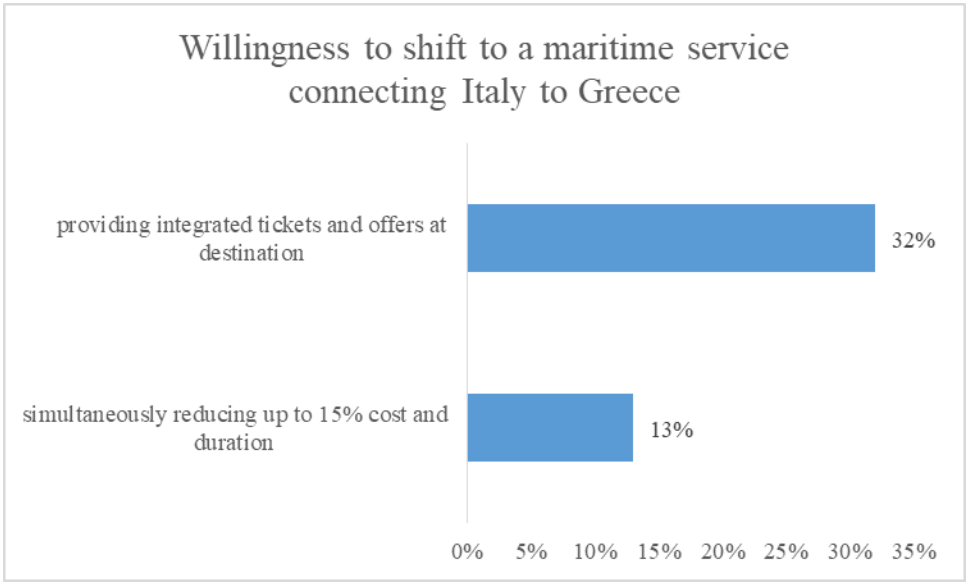


Figure 16: Bologna – Igoumenitsa wider c.areas connection, willingness to change mode

Coming back to this 60%, the willingness to shift to maritime transport is very low (not more than 7%). However, grand offers at the destination point are welcomed by travellers.

- As regards the connectivity of **Coastal area of Croatia to the ADRION gate of Greece, Igoumenitsa,** the current modal split is the one depicted in the figure below – road transportation is the main selected mode.

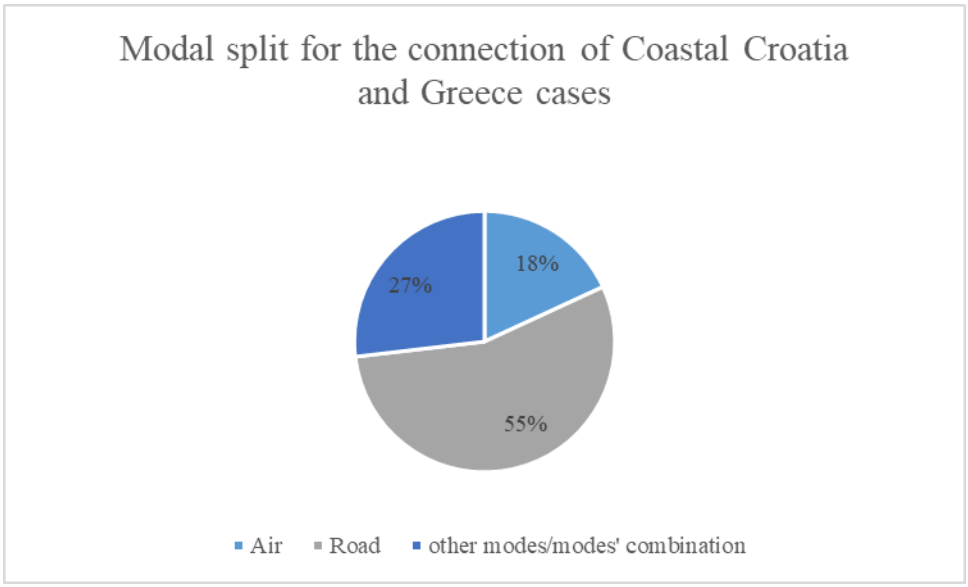


Figure 17: Modal split at Igoumenitsa – Coastal area of Croatia

  - It seems that a large percentage of travellers expressed their willingness to use a maritime service operating under satisfying quality characteristics (36%)
  - Travellers seem very interested in the provision of offers at the destination point – air travellers are the less willing to shift to a maritime service

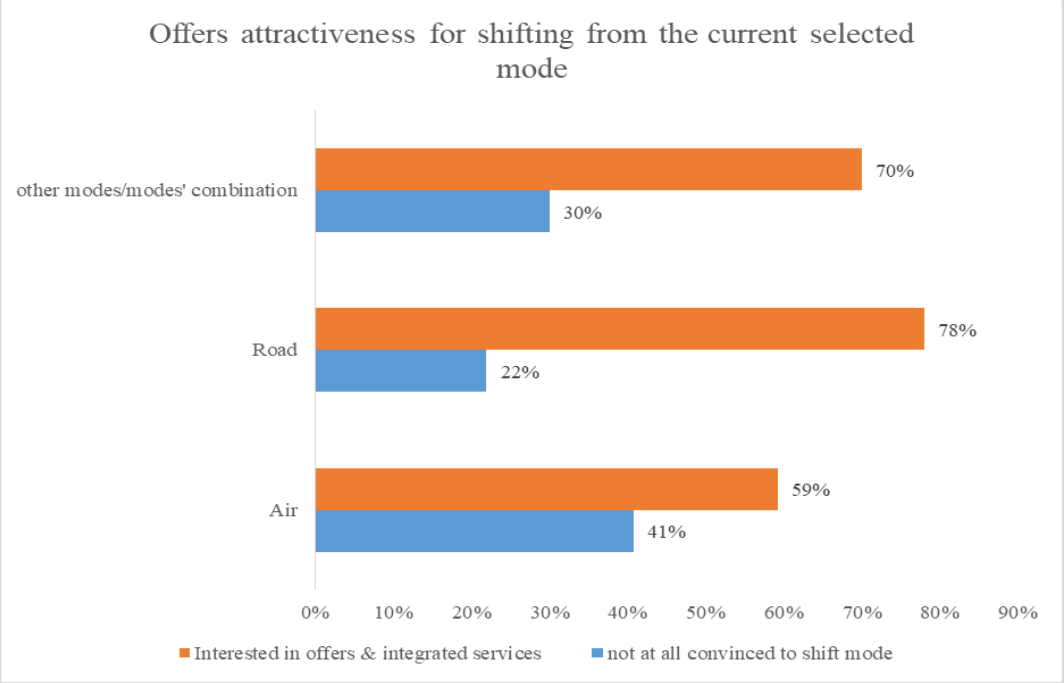


Figure 18: Igoumenitsa – Coastal area of Croatia connection; Interest in offers provision at the destination point

- Younger travellers (<=30) are the less keen to change mode compared to the other two age groups (67% - 78% - 81%)

When it comes to the connection between the **wider catchment area of Bologna with the coastal area of Croatia**, the existing maritime connection Ancona – Split is a popular choice (66%). Low cost airlines however receive a large attention from the travellers for the main part of the trip (PuT or car rental serve the last legs of the trips) and is well noticed that this percentage of travellers are not so willing to change from air transport.

Offers (including integrated and harmonized mass transport or other provisions) at the destination points present also in this connection a hidden opportunity – around 70% stated that they would potentially shift given grand offers and upgraded services provision at the destination.
For leisure trips the willingness to shift to maritime is almost double than for business related trips.
An interesting point is that high income travellers are even more open on shifting mode given the provision of offers at destination point (71% versus 65%).
Travellers over 50 years seem even more willing to change from air transport to maritime under grand offers conditions than younger travellers (66% - 80% - 65% for age groups i)<=30, ii) 30-50 and iii)>50 respectively).

Lastly, as regards the connection between the **wider catchment area of Bologna with the coastal area of Slovenia** (represented by the reference point of Piran), railway connectivity seems to have opportunities; current modal split is presented in the figure below:

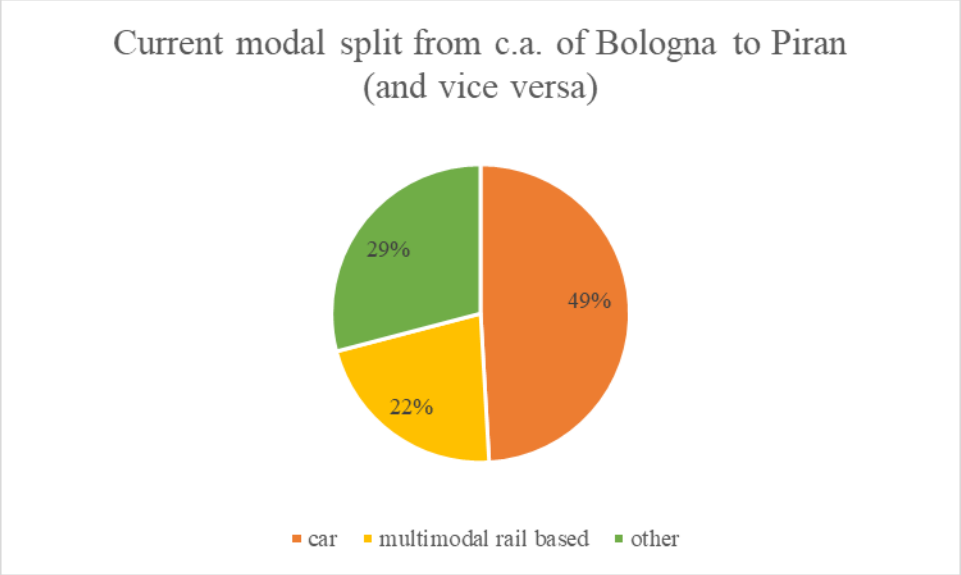


Figure 19: Wider catchment area of Bologna with the coastal area of Slovenia connection; current modal split

- The most important attribute capable of shifting travellers to intermodal rail based option is the total trip duration – seamless travel and high speed rail connection is able to shift more than 70% of the travellers to rail.
- Almost half of the travellers seem interested in offers provision and answered that they could potentially shift in rail given grand offers provision

5. Remarks

The current deliverable presents the conclusions that emerged from the creation of mode choice models describing the modal split between sustainable and unsustainable modes of transport in the wider Adriatic - Ionian region, using the method of binary logistic regression. Three models were developed, one for shorter, one for medium and one for longer duration trips (having as origin and destination point the wider areas of Inter-Connect cases).

In order to provide an insight on the role of offers in changing mode, a separate analysis took place while deepening into the collected answers in the Stated Preference surveys of specific cases, that were declared by the partners as interesting cases or cases where opportunities potentially exist, followed.

Main outcomes of the analysis as regards the future of ADRION connectivity are:

- Large reduction in travel time and cost of the more sustainable modes is required in order to attract travelers from road and air transportation (more than 15% reduction is necessary and especially for longer trips and trips with many legs – i.e. rail transfers)
- Work trips are far more inelastic – leisure trips should be taken probably taken into account when drafting a sustainable modes promotion in the current situation
- Offers at the destination points seem an interesting provision for the 25% of the travelers that participated in the survey.

References

1. Kroes, E. P., Sheldon, R. J.: Stated preference methods, Journal of transport economics and policy, 22, pp. 11-25, 1988.
2. Ben-Akiva M, McFadden D, Train K. Foundations of stated preference elicitation consumer behavior and choice-based conjoint analysis. In: 2015, Society for economic measurement annual conference, Paris, 24 July 2015.
3. Gnadelis Ch., (2006), Data Analysis with IBM SPSS Statistics 21, ISBN13, 2013, p.605 – 633, (in Greek)
4. IBM SPSS, Regression 24 Manual, p. 3-6, USA
5. Trip demand forecasting within the Transportation Planning process, Paratiritis, 2002, (in Greek) P.153 - 187