# A TOOLBOX FOR THE DESIGN AND OPERATION OF URBAN TRANSPORT INTERCHANGES – APPLICATION AT THE MIKRA INTERCHANGE IN THESSALONIKI

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## 1. INTRODUCTION

The NODES project aims at building a Toolbox to support European cities, transport authorities and operators in the design and operation of new or upgraded public transport interchanges. The tools comprising the NODES toolbox were identified, tested, validated and evaluated in terms of increasing accessibility and integration, intermodality, safety and security, enhancing environmental and energy efficiency, costs, savings, etc.

The tool testing process took place within nine reference sites distributed around Europe, where interchanges are being planned, built or upgraded. The partners validated the tools and their efficiency and provided a feedback loop for their improvement. The Public Transport Authority of Thessaloniki (ThePTA) is responsible for one of the nine reference sites, the Mikra interchange. The tools which have been identified within the project are related to five topics which cover the key functions of Public Transport interchanges. ThePTA has been testing and validating tools in three of these five topics, namely: a. Integrated land use and infrastructure planning, b. Intermodality and ICT and c. Management and business models/ business case for the local economy.

This paper presents the main findings from the two phase questionnaire survey that was carried out as part of the tool testing process. The survey was conducted using the Station Experience Monitoring (SEM) tool which was designed by the Netherlands' Railways (NS) to measure passenger station experience (van der Hoeven et al, 2013). The SEM questionnaire was enriched with additional questions aiming to assess not only user satisfaction, but also the impact that the installation of information provision equipment would have on the public transport users. The survey was carried out before and after the installation of two information totems and one VMS (Variable Message Sign) with a sample of over 300 responses for each phase, resulting to a total of over 600 questionnaires. The SEM questionnaire was used not only in Thessaloniki but also at a number of the NODES reference sites.

### 1.1 The NODES Project Approach

The NODES Project aiming at promoting more efficient urban mobility systems recognised the importance of integration at the urban level. Core elements are the

public transport interchanges which aim at the better integration of the various urban transport modes, the urban transport and land uses, the urban transport networks and the transport and non transport related services.

In the context of the NODES Project, in order to support European cities in the design and operation of new or upgraded interchanges, numerous guidelines, methodologies and other tools were identified and a Toolbox was created, covering the key functions of interchanges. For the identification of the main criteria and performance indicators an extensive review was conducted in the various sources provided by European research projects for existing key strategies, design approaches, operations and models in the development of local and regional policy frameworks, and best practices of individual urban transport interchanges.

The core product of the NODES Project is the developed Toolbox and the NODES Benchmark tool. The NODES Toolbox is a catalogue of integrated planning, design and management tools that may assist the design and the operation of modern urban interchanges. The Toolbox includes a set of tools (new developed assessment, benchmarking, technical planning and design methods) based on the most advanced practices in the urban, suburban and non-urban yet also related transport sectors (airports, high speed rail etc). The nature of the tools can be legislative,/regulatory, societal/cultural, economic/financial, organisational, technical, methodological, related to energy and environment, etc.

The main aim of the Toolbox  is to allow interchange stakeholders to use the developed tools, to identify good practice usage of the tools and to understand the performance potential of these tools for different interchanges and different situations (van der Hoeven et al, 2014). The toolbox aims at assisting the decision making process, while it also enables an integrated and balanced realisation process from the initial planning phase of an interchange, up to the actual management of the station and its surrounding area, the  provision of information to the travellers and citizens of the catchment areas etc.

In order to provide recommendations to the European Commission to make the project's results transferable to other interchanges in a greater number of cities in Europe and beyond, the NODES consortium evaluated and validated the effectiveness of the tools and methodologies for the different reference sites, in accordance with a common evaluation framework.

## 1.2 NODES Thematic Topics

The NODES approach was based on the idea that interchanges are much more than plain transfer stations. For this reason, NODES tried to cover all topics related to the planning, design, construction (or upgrading), and/ or operational management that should foster the achievement of an improved interchange. The thematic topics of the NODES Project under which the tools of the toolbox were categorised, are briefly presented in the following (NODES collaborative programme DoW, 2012).

The first topic entitled "*Integrated land use and infrastructure planning*" copes with the challenging task of joint transport and urban planning approach which goes beyond the regular scope of action of interchange developers including various authorities in the proposed approach. Taking into consideration the existing experiences, the objectives of the tools under this topic are divided into two

categories. The first category focuses on the city-regional scale, such as the position in the city and the strategic role of a node within the whole network while the second focuses on the urban environment and the public space.

The second topic entitled "*Interchange design*" refers to the design of an interchange aiming to connect "People to Places". Four main dimensions have to be considered when designing an interchange, architectural and functional design, provision of accessible and efficient journeys, high quality users experience and a connected and integrated system. The first subtopic focuses on the identification and specification on a number of key areas possible to work on while the second one on a set of technical tools for the interchange design that should assist to build interchanges in most effective environmental and energy efficiency manner.

The third topic entitled "*Intermodality and ICT*" is focused on intermodality in relation to the use of ICT. It deals with multimodal integration at interchanges and ICT, including soft modes, information to passengers at interchanges using ICT, as well as the management information and decision tools for the managers and operators allowing for coordinated service offer. The tools are divided in two subtopics, the one related to the specification of the issues of intermodality and the use of ICT and other to the intermodality and ICT development.

The forth topic entitled "*Management and business models*" refers to the involvement of a multiplicity of stakeholders (transport operators, land owners, real estate managers, retail shops, etc.) at the transport interchanges. It focuses on a number of business models internal to the interchange, such as commercial opportunities and selling points. Similarly wider business models can be considered when taking into account the developed property around the interchange station. In addition, emphasis is given to the need of coordination in day-to- day management, especially in the fields of security, cleanliness, maintenance and public information. The tools again are divided into two categories the interchange business and management models and the development of a benchmark tool and implementation guide for innovative practices.

The fifth topic entitled "*Energy and environment (E&E) in interchange design*" is dedicated to energy and environmental specific issues in the planning, design, construction, upgrading and management of interchanges. Further attention in the context of this topic is given to the inclusion of specific alternative modes, such as car sharing, carpooling and soft modes. The tools focus on the two categories of dedicated assessment of the E&E of interchange design and the development of an E&E good practice and transfer tool.

## 2. THESSALONIKI APPLICATION

### 2.1 Thessaloniki Reference Site

Mikra interchange was selected as one of the reference sites of the NODES project. The interchange is located at the eastern end of the Kalamaria extension line at an area where the dominant land use is residential and the development of a well-organized Bus/Metro interchange is foreseen. A Park and Ride facility is also planned to be constructed in the interchange. Furthermore, seaborne transport is also expected to serve the interchange. The aim of Mikra interchange is to serve a

number of multimodal trips from/to the eastern suburban areas of the Thessaloniki and the airport, to/from the city centre. The extension of the Metro Line towards the International Airport Macedonia, possibly by means of a surface fixed route transport mode, will further increase the strategic importance of the interchange (Balampekou et al, 2015). It should be noted that Mikra interchange is the only NODES reference site that is a brand new interchange currently under construction, bringing significant added value to the project and to the tool testing process.

ThePTA's initial plan was to use this under construction multimodal interchange in order to test a set of selected tools. However, due to the significant delays in the construction of the Thessaloniki Metro System, the construction of the MIKRA interchange had not commenced at the time of the tools testing phase. Despite this fact, ThePTA was able to apply and test most of the selected tools at Mikra. This was aided by the fact that ThePTA has cooperated very effectively with ATTIKO METRO, the company responsible for the design and construction ot Thessaloniki's Metro system, and had repeated discussions and meetings with the company's staff who are responsible for the designs of the interchange. ThePTA acquired the preliminary designs that ATTIKO METRO has produced for the Mikra interchange and studied the interchange's planned layout in order to use it for the tool testing where needed (Balampekou et al, 2015). The layout of the station in presented in *Figure1*.
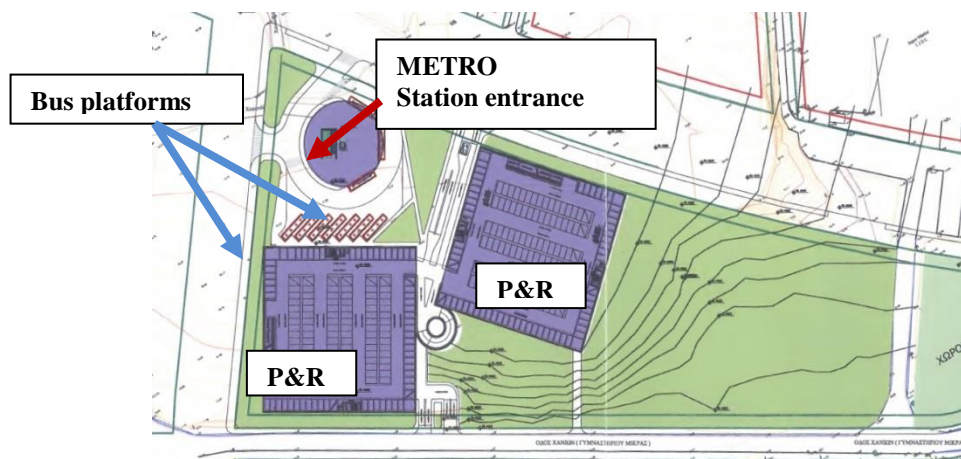


**Figure 1:** The current layout of the MIKRA interchange

The fact that there was no built interchange at the ThePTA reference site made it difficult to test some of the tools there. For this reason, ThePTA decided to apply the evaluation procedure to an interchange which is located nearby the Mikra interchange, the IKEA Interchange. IKEA Interchange is currently mainly used for intermodal bus-to-bus trips while it also serves taxis, park and ride as well as motorbike and ride trips. The mobility patterns of the IKEA interchange (as shown in *Figure 2*) are similar to those of the future Mikra interchange. The IKEA interchange is planned to be abolished after the metro completion when the bus interchange will be moved to the Mikra interchange (Balampekou et al, 2015).

It should be noted that IKEA interchange was not a reference site per se, but it was used as a "substitute site" for testing tools that needed an existing interchange in order to be tested, given that it will in reality substitute Mikra interchange until the latter is constructed and operational.
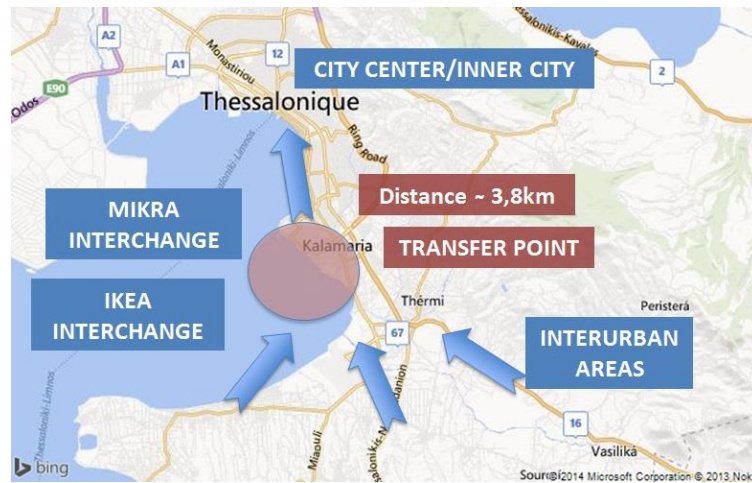
**Figure 2:** Mobility patterns for IKEA and Mikra interchanges

The IKEA interchange (Figure 3) is located at the eastern part of Thessaloniki, approximately 11km from the city centre. It was initially designed in order to provide an interchange point for bus passengers travelling from the eastern outskirts to the city centre. Hence the interchange started to operate as a bus-only interchange in 2003. The gradual use of the available parking areas for P&R purposes and the addition of the taxi stand in 2006 transformed into a bigger interchange which currently serves the following transport modes (Balampekou et al, 2015):

- urban buses: the bus interchange features 6 platforms which serve a total of 11 main bus lines and all their variations.
- taxis: the taxi stand was constructed in 2006 and it can accommodate 20 waiting taxis. It features a ramp for people with disabilities, non-slip paving, special installations for drainage and electricity, special canopies, and a chemical toilet. Also, special provisions were made for construction of sidewalks around the waiting area to enable passengers to access the taxi stand safely
- Park&Ride: the P&R facility at IKEA interchange operates informally, i.e. there are no controlled entrances and exits and no fee charged. The area used for this purpose formally constitutes part of IKEA's very large parking area, however as this area is at a rather long distance from the shop and it is adjacent to the bus interchange, many users grab the opportunity to use it for P&R.



**Figure 3: The layout of the IKEA bus interchange**

Until recently at IKEA interchange there were no displays of information on the arrivals/ departures of the next bus services at each platform; there was only static information i.e. timetables posted on the bus shelters. Moreover, regarding the Park&Ride there are no displays for the availability of spaces as its operation is not official.

As shown in Figure 3, the IKEA interchange is an open plan interchange with no substantial physical protection against weather conditions. In addition within the interchange there are no shops, there are only a few vending machines and a bank ATM. However the interchange is surrounded by a number of retailers including IKEA, supermarkets, toy stores and a big shopping centre.

## 2.2 Selection of Tools for Testing

In order to select the most appropriate set of tools for testing, ThePTA considered a variety of criteria. The main criteria that affected the final decision were the following (Balampekou et al, 2015):

- the ability to assist the planning process for the Mikra interchange through testing tools related with land use and infrastructure planning issues; the need to investigate business models for the sustainable operation of the Mikra interchange; the lack of ICT solutions for information provision at all of Thessaloniki's interchanges and the need to test the impact of ICT applications on interchange users.
- the support of the implementation of ThePTA's SUMP measure number 5 regarding the creation of appropriate spacing for multimodal interchanges.
- the availability of data and the potential limitations on data collection and data analysis
- the available expertise within the Authority for the tool testing process.
- the need to expand the Authority's knowledge and expertise by using tools that have already been applied at other European interchanges for the first time in Greece.

All the tools were tested at either IKEA or Mikra interchange using appropriate methodology. Overall, out of a total of 27 tools, 19 were tested at the under construction Mikra site and 14 at the existing IKEA Interchange. The number of site tool tests actually exceeds 27 as some of the tools were tested on both interchanges.

Among the tools that ThePTA selected for testing were three (3) cross topic tools, i.e. tools which cover aspects in all of NODES's five thematic topics. One of these cross topic tools is the Station Experience Monitoring (SEM) Tool, a tool that was applied at a Greek interchange for the first time in the context of NODES project. It should be noted that most of the NODES reference sites agreed to test this tool, creating the opportunity for useful cross-site comparisons.

## 3. APPLICATION OF THE STATION EXPERIENCE MONITORING (SEM) TOOL AT IKEA INTERCHANGE

### 3.1 The Station Experience Monitoring (SEM) Tool

The Station Experience Monitoring tool SEM is used by the Netherlands Railways (NS) to measure passenger station experience. This tool aims at providing guidance to interchange developers, designers and managers towards the delivery of interchanges that are more pleasant and effective for their users.

The scientific basis of the SEM tool is explained in the "Pyramid of Public Transport Customer Needs" to train stations (van der Hoeven et al, 2013). This tool is in use in the Netherlands since 2011, where passengers are interviewed at regular intervals about a large number of station and platform facilities (406 Dutch train stations), services and experiences. The tool is applied every three months for the larger stations, while as for the smaller ones, it is applied once a year. At each station, passengers are selected randomly when waiting at the station's platforms. In order to have a good overview of the experiences during peak and off-peak hours it is recommended to have about 300 questionnaires filled in total per station.

The tool comprises a set of questions, answers to which provide an insight in how customers (i.e. interchange users) rate the overall performance of the interchange and its facilities as well as six (6) main thematic aspects of the interchange, namely: ambience, comfort, access, orientation, staff and safety & cleanliness.

### 3.2 Application at IKEA Interchange in Thessaloniki

The application of the SEM in Thessaloniki took place at the IKEA interchange as the original reference site (Mikra interchange) is not yet operational. However, as explained in the previous sections, due to the similarity in mobility patterns between the two interchanges it is considered that the results are transferable to the Mikra interchange.

The SEM tool questionnaire was used for two runs of surveys. Both surveys were run according to the plan suggested by the NODES partners that were in charge of the surveys i.e.:

- Surveys were carried out on Tuesday, Wednesday and Thursday, from 7 am to 7 pm
- A survey team of 4 people split in 2 groups run the surveys from 7am to 1pm and from 1 pm to 7 pm respectively.
- The surveyors approached every 4th passenger and they changed platforms periodically.
- Questionnaires were completed by the interviewed interchange users as self-administered questionnaires unless the user expressed some problem in doing so (some people had problems in reading the questions without their glasses).

Following the above plan, ThePTA carried out the survey in two (2) phases, the "before" survey (or "zero" measurement) and the "after" survey (or "one" measurement. It took approximately 3 days to collect over 300 fully completed questionnaires for both survey runs. Between the two applications information equipment was installed at IKEA interchange, comprising two (2) information totems

(infokiosks) and one information display (VMS). The infokiosks provide information regarding bus schedules and bus routes for all bus lines serving the interchange as well as a journey planning service. The information display provides information about the next departure of all bus lines serving the interchange. The installed equipment can be seen in Picture 1.



**Picture 1:** Information equipment installed at IKEA interchange between the two survey rounds

More specifically, the SEM tool questionnaire was applied at IKEA bus interchange twice:

- in July 2014 when the "before" survey (or "zero" measurement) was carried out and
- in November 2014 when the "after" survey (or "one" measurement) took place.

The SEM questionnaires that were used for the "before" and "after" surveys were very similar; only minor modifications were made for the 2nd run of the surveys in order to include a few missing aspects that were detected during the 1st survey run.

The main questions of the SEM aimed to assess customer satisfaction regarding station (interchange) ambience, comfort, access, orientation, staff, safety and cleanliness and aesthetics. Additional questions aimed to gather information about travel characteristics (mode used to and from the interchange, travel purpose, frequency of using the main interchange mode) and about the users' physical condition and weather perception. Finally, there were a couple of questions aimed at gathering the main socioeconomic characteristics of the users (age and gender).

This tool was used by most of the NODES reference sites partners, among which is ThePTA, aiming to yield representative results in order to identify which thematic aspects contribute most to customers' satisfaction experience and how the various reference sites (interchanges) score on those aspects.

### 3.3 Main results from the "before" and "after" surveys ("zero" and "one" measurements)

The main results from the two surveys are summarised in Figures 4 and 5 and are analysed in the next sections.
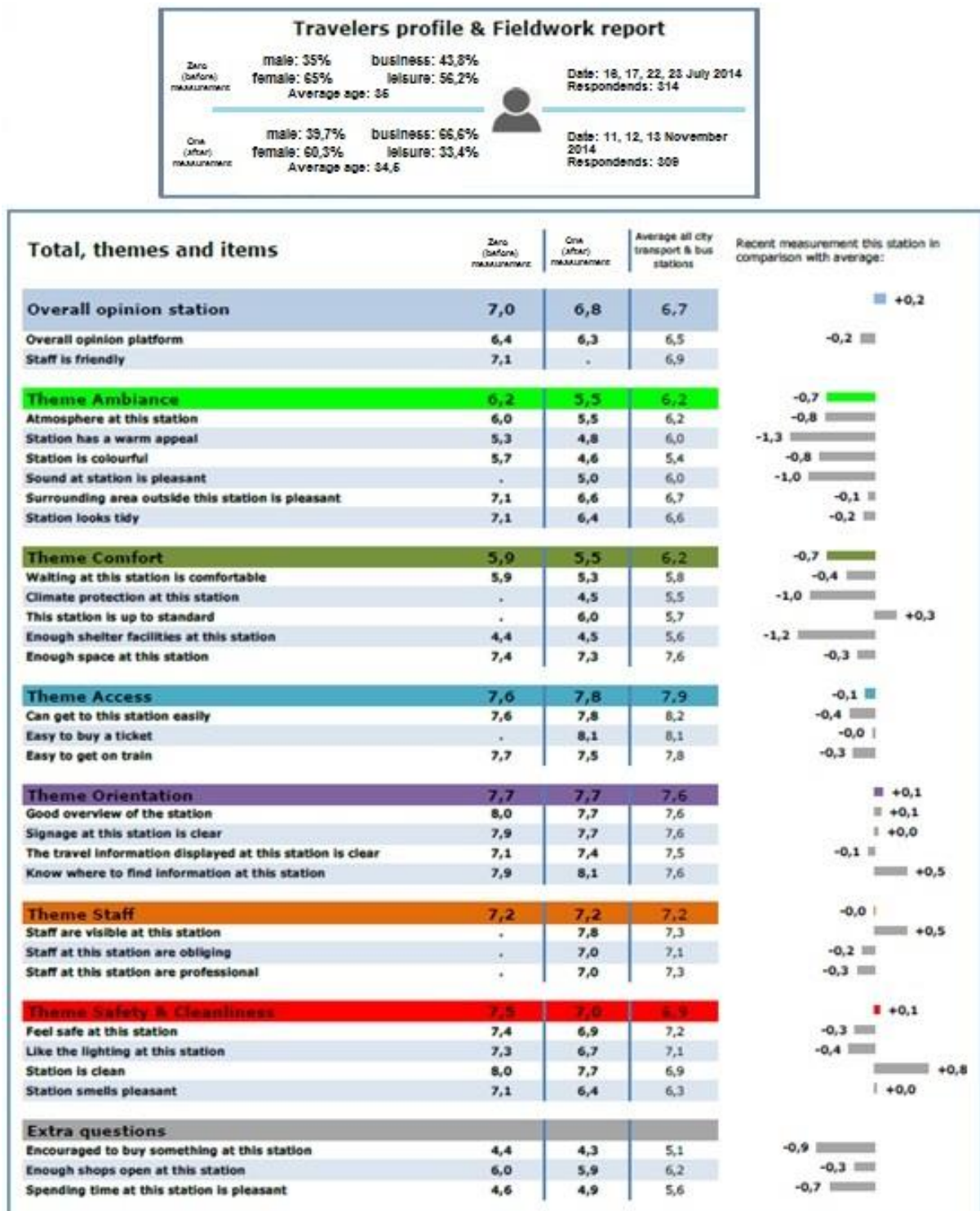


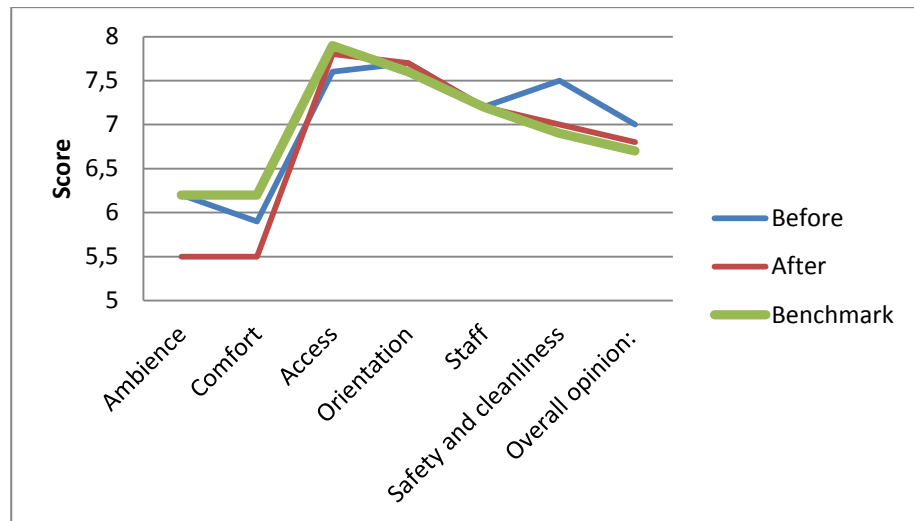**Figure 4:** SEM tool application results for both measurements

**Figure 5:** SEM tool application results for both measurements – comparison with benchmark scores

### 3.3.1 Station experience results from the "before" survey ("zero" measurement)

The total of over 300 questionnaires that were completed during the "before" survey were coded and analysed. The "before" survey was conducted in July 2014 following the methodological plan described above.

At total of 314 respondents took part in the survey, of which 110 were male (35%) and 204 female (65%) with an average age of 35 years. Out of the 314 respondents, 43,8% were travelling for business while 56,2% were travelling for leisure.

The results from the "before" survey depict the overall impression of the passengers for the IKEA interchange for each thematic aspect and are shown in Table 1.

**Table 1:** "Before" survey ("zero" measurement) results

| Theme | Score | Benchmark (Average - all other Transport & Bus Interchanges |
|---|---|---|
| Ambience | 6,2 | 6,2 |
| Comfort | 5,9 | 6,2 |
| Access | 7,6 | 7,9 |
| Orientation | 7,7 | 7,6 |
| Staff | 7,2 | 7,2 |
| Safety and cleanliness | 7,5 | 6,9 |
| | | |
| **Overall opinion:** | **7** | **6,7** |

Overall the passengers appear to have a good impression about the interchange which is clean, relatively easy to access and to orientate within, and its staff is reasonably friendly. However, the interchange scores low in terms of aesthetics and lacks facilities that enhance passenger comfort.

### 3.3.2 Station experience results from the "after" survey ("one" measurement)

The total of over 300 questionnaires that were completed during the "after" survey were coded and analysed. The "after" survey was conducted in November 2014, following the same methodology as for the "before" survey.

At total of 309 respondents took part in the survey, of which 123 were male (39,7%) and 186 female (60,3%) with an average age of 34,5 years. Out of the 309 respondents, 66,6% were travelling for business while 33,4% were travelling for leisure.

The results from the "after" survey concerning the overall impression of the passengers for the IKEA interchange for each thematic aspect are shown in Table 2.

**Table 2:** "After" survey ("one" measurement) results

| Theme | Score | Benchmark (Average - all other Transport & Bus Interchanges |
|---|---|---|
| Ambience | 5,5 | 6,2 |
| Comfort | 5,5 | 6,2 |
| Access | 7,8 | 7,9 |
| Orientation | 7,7 | 7,6 |
| Staff | 7,2 | 7,2 |
| Safety and cleanliness | 7 | 6,9 |
| | | |
| **Overall opinion:** | **6,8** | **6,7** |

The analysis indicated that the "after" survey results reflect lower user satisfaction. Such results can be rather confusing but there is justification in what caused them.

The improvements that were implemented at IKEA bus interchange during the time period between the two surveys only regarded the provision of information. No other interventions were applied.



**Figure 4:** Theme orientation – results related to information provision

The questions that were relevant to the information provision (Figure 4) were the only ones that were rated higher in the after survey, in comparison to the respective rates of the before survey. Indeed, as shown in Figure 4, for both information related questions the rate was increased in the 2$^{nd}$ survey application. All other questions were rated lower for the following reasons:

- The 1st survey was run in July when the weather was very warm and pleasant, the day was long (i.e. there was daylight at 7pm), and many of the people using the interchange were travelling for "leisure" rather than "business".
- On the contrary, the 2nd survey was carried out in November when the weather was cold and rainy, the day was considerably shorter (i.e. it was dark after 5 pm) and most interchange users were travelling to/from work.

IKEA interchange is an open plan interchange with limited protection against weather conditions and no interventions or improvements were made regarding the lighting, the sheltering facilities of the interchange etc between the two survey applications. Hence it was expected that this would be reflected by lower scores in the survey results and this is considered justifiable.

### 3.3.3 Cross site comparison

The SEM tool was applied not only in Thessaloniki, but also at a number of other NODES reference sites. Some of the sites run the survey once while others repeated the survey after applying a set of interventions. This allowed for a useful comparison among sites with similar characteristics (Bus-Tram-Metro-BTM interchanges, rail interchanges etc) for the baseline condition (zero measurement). As it can be seen from Table 3 the scores for IKEA interchange in Thessaloniki are comparatively low in terms of ambience and comfort but its overall performance in comparison with the other reference sites they are above average.

**Table 3:** Cross site comparison ("zero" measurement)

| BTM interchange | AVERAGE | Roma | Madrid | Thessaloniki | Toulouse | Ijpest Varoskapu |
|---|---|---|---|---|---|---|
| Overall opinion station | **6,7** | 6,4 | 7,2 | **7,0** | 6,6 | 6,2 |
| Ambience | **6,2** | 5,7 | 7,3 | **6,2** | 6,2 | 5,9 |
| Comfort | **6,2** | 5,6 | 7,7 | **5,9** | 5,7 | 6,4 |
| Access | **7,9** | 7,1 | 7,9 | **7,6** | 8,2 | 8,8 |
| Orientation | **7,6** | 6,9 | 7,6 | **7,7** | 7,9 | 8,0 |
| Staff | **7,2** | 6,4 | 7,2 | **7,2** | 7,3 | 6,2 |
| Safety & Cleanliness | **6,9** | 5,9 | 7,5 | **7,5** | 7,2 | 6,8 |

### 4. MAIN FINDINGS FROM THE SURVEY - CONCLUSIONS

The NODES Toolbox contains a variety of tools, some of which were not available in Greece and therefore had never been used in the country in the past. The Station Experience Monitoring (SEM) Tool developed by the NS was totally new for Greece and it was an interesting experience to apply it at the Thessaloniki reference site and compare the findings to those of the other reference sites. The results of the two surveys that were carried out at IKEA interchange using the SEM tool enriched with some additional questions that ThePTA designed in order to assess the impact of the information totems and the information display on customer's experience at the interchange, show that information provision alone cannot have a significant impact on the user satisfaction.

The SEM tool assists the assessment of interchange performance in respect to customer experience and provides and in-depth insight in what the interchange user really wants. Thus it allows managers to implement changes that will enhance interchange performance for the aspects that really matter to the users.

The periodic application of the tool is more meaningful when between each measurement changes take place, be them significant (large refurbishments,

expansions etc) or of a smaller scale. As pointed out by the tool developer, NS, sometimes even simple and low cost interventions can have a large impact on the waiting and travel experiences of the interchange users.

The application of the SEM tool at IKEA interchange in July highlighted the main problems of the interchange which regard its aesthetics and the lack of any facilities that enhance comfort while waiting. Since no particular interventions were implemented towards the improvement of these identified issues, there was not significant gain from repeating the SEM survey in November in this aspect. However, ThePTA decided to run the 2$^{nd}$ measurement because there was interest in assessing the impact from the applied enhancements in terms of information provision and because this could be done in parallel with the 2nd run of a user needs survey that would be carried out anyway.

The 2$^{nd}$ measurement ("after" survey) resulted to an important conclusion: the information provision cannot be considered as a "satisfier" mainly because passengers consider this to be a standard provision in modern interchanges. It is therefore characterised as a "dissatisfier".

This finding was also confirmed by the annual survey that was carried out by ThePTA in order to measure user satisfaction regarding the bus services and to assess service quality indicators. The survey took place at Thessaloniki's interchanges in June 2015 with a total of 401 respondents. According to the responses, even though the level of satisfaction from information provision both before and during a trip is high, the level of importance for this kind of service is low. This is attributed to the fact that passengers as well as interchange users consider this kind of service as a background pre-requisite for the good quality of the service, which is in line with the SEM's findings. There are other aspects such as service frequency, capacity and punctuality, as well as pricing policy and staff performance that are characterized as service "satisfiers", and are rated with a high level of importance.


## ACKNOWLEDGEMENTS

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