

# ASSESSMENT OF AN ALTERNATIVE MODE OF TRANSPORT IMPACT ON ACCESSIBILITY IN POLAND – “SAT226” IN 2030

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## Abstract

The paper outlines an application of the Accessibility Model for Evaluation of Transport Infrastructure Policy (AMETIP) [1] using a graph for the domestic transport system in Poland defined on 2015 data and the assumptions for 2030 complemented with a novel, alternative mode of travel. This alternative transport policy with respect to the European Union cohesion goal – “90% of inhabitants able to complete their journey within 4 hours of a door to door travel” – was evaluated. To the predefined graph emulating Polish transport system and including road, rail and airline layers, edges and vertices of a small aircraft transport system layer were added. The new mode is equivalent of the visions of Warsaw Institute of Aviation projects: EPATS, STMS and SAT-Rdmp. The visions assumed services which would offer (regular scheduled or on-demand) transport at a speed of 226 km/h from/to 56 airports. If Poland and the EU are supportive and facilitate in creating such a system, this scenario (SAT226 2030) enables to completely achieve the cohesion policy goal until 2030 in Poland.

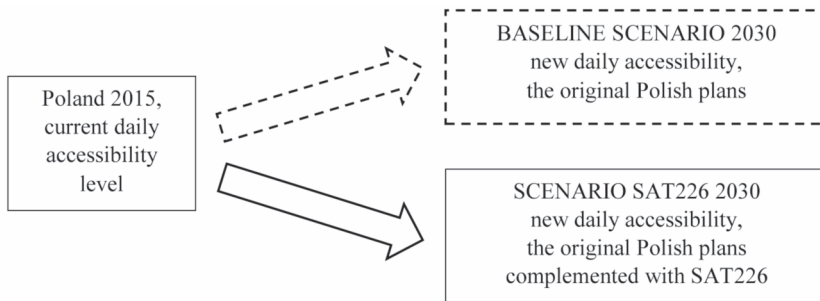
Keywords: transport policy, daily accessibility, European Union policy cohesion goal.

## 1. INTRODUCTION

Further expansion of traditional modes of transport, despite the planned heavy efforts, are not going to lead to the complete European Union policy cohesion goal [2]. Development of some alternative scenario complementing the expected transport system improvements with a novel mode proportionally accessible all over the country would be desirable.

Several ideas for new modes of travel have been recently highlighted as for example small aircraft transport system (passengers) [3] [4] [5] [6] [7], hyperloop (passengers) [8] or re-emergence of airships (cargo) [9].

In further chapters, an alternative transport policy in Poland is presented and evaluated. The alternative policy central point is complementing the original transport system improvement plans with a novel transport mode – a small aircraft transport system. To evaluate this new scenario (SAT226 2030 scenario), the “SAT226 system 2030” layer for the graph generalising transport system was prepared. The Accessibility Model for Evaluation of Transport Infrastructure Policy (AMETIP) [1] was applied and the total daily accessibility of this scenario was compared with the total daily accessibility of the baseline scenario 2030 [2].



Chapter 2 briefly describes small aircraft transport system composed of the characteristics of service providing in the economy of sharing [10], the small aircraft transport system (STMS) definition of 2009 [6] and recalls major investigation challenges of such a system identified in 2010 (EPATS) [10] [11]. Input for modelling could be found in Chapter 3 and the results – in Chapter 4.

## 2. SMALL AIRCRAFT TRANSPORT SYSTEM

The novel transport mode used for desktop experiments here was assumed to be operational in the SAT226 2030 scenario. It was based on the phase one of the STMS (*System Transportu Małymi Samolotami* – Small Aircraft Transport System) definition [6]. The system definition assumed providing passenger air transport using:

- the existing small (underutilised) and large airports;
- a fleet of aircraft with a maximum operational passenger seating configuration (MOPSC) of 4 to 19 seats in regular or on-demand services supported by air navigation services;
- ICT (information and communication technologies) and logistics systems.

The STMS assumed, both, centralisation and flexibility of business models.

The SAT226 overlaps the STMS service and adjust it to the incoming wave of the economy of sharing. A sharing economy model fundamental concepts are the following [10]:

- converting goods into services and converting underleveraged service assets into more valuable ones;
- on-demand availability anywhere, anytime;
- pay-as-you-go pricing;
- pricing for usage not for ownership;
- price targeting occasions not people (no flat rates);
- expected immediate realisation;
- service comes to customer (not the other way round);
- real-time rating reputation track;
- growing reliance on robotics and Artificial Intelligence
- marketing channels shift towards lifestyle, entertainment and social context.

The system model is supposed to be similar to road ridesharing (or ridesourcing) which is already winning its market in urban travel (for example in 2014, in San Francisco there were, daily, 47,000 trips by ridesourcing and only 22 000 trips by traditional taxi) [11]. What is more, important for this paper, ridesharing begins to win customers in intercity travel with 9 million users in 12 countries (in 2014) [12]. Transport business joins the general shift in economy from owning to ‘renting’.

Similarly to the STMS, the analysis focus was limited to the transport system in Poland. However, only one type of small aircraft of performance class B was considered, not a fleet of various

sizes. This class, categorised by the EU regulations (Air Operations – OPS), includes “aeroplanes powered by propeller engines with an MOPSC of 9 or less and a maximum take-off mass of 5,700 kg or less” [15].

Flight is still more complex than car travel. The major investigations challenges for small air transport identified in 2010 [13] [14] are still valid in most of the areas of infrastructure, aircraft, aircraft systems and training. (See table 1).

Table 1. Major investigation elements of small aircraft transport system identified in 2010

<p><u>Infrastructure.</u> ‘Smart’ airports with higher utility and safety in more weather conditions, along with free flight procedures for expanded capacity, and airport utility, including:</p> <ul style="list-style-type: none"> <li>• Satellite navigation approaches to all landing areas, without requirements for control towers and radar, and fully digital flight, traffic, and destination information systems;</li> <li>• Free Flight in the European Airspace System architecture for EPATS airports;</li> <li>• Flight Information Services (FIS), broadcast by terrestrial or satellite systems;</li> <li>• Traffic Information Services (TIS), including Automatic Dependent Surveillance, broadcast by aircraft, terrestrial, or satellite systems;</li> <li>• Destination Information Services (DIS) for intermodal connectivity, and vehicle and operator/passenger services, via terrestrial or satellite systems;</li> <li>• Near-all-weather operations at non-towered airports without radar coverage. 3,500 to 5,000 feet runways, with marking and lighting;</li> <li>• Airports within a 15 minute drive of communities served;</li> <li>• Safety services;</li> </ul> <p><u>Aircraft.</u> Aircraft technology objectives are planned to achieve advancements in affordability, safety, ease-of-use, airport utility, and includes the following:</p> <ul style="list-style-type: none"> <li>• Simplified and intuitive flight controls, including decoupling;</li> <li>• Envelope limiting ( Active load control) and ride smoothing concepts;</li> <li>• Active flow control for improved cruise &amp; low speed performance. The objective is to use control surfaces of an a/c wing to adapt its configuration to the various phases of the flight mission for increased efficiency and to gust and manoeuvres for reduced loads;</li> <li>• Aircraft fineness ratio and lifting enhancement (higher cruising speed – lower stalling speed);</li> <li>• Useful weight to take-off weight enhancement. Multi-layer/multi-function architectures should be used to decrease the negative impact on weight deriving from ancillary functions requested to the structure (lightning protection, electrical grounding, thermal insulation);</li> <li>• The following sensors technologies are envisaged for consideration: Fibre Bragg grating (FBG), sensitive coatings (SCS), environmental degradation monitoring sensors (EDMS), micro-wave sensors, acoustic-ultrasonic (AU), acoustic emission (AE), imaging ultrasonic (IU);</li> <li>• Airframe modular design, highly integrated processes, one shot process for example, by manufacturing a one-piece fuselage section;</li> <li>• New concept configuration (plan form) to accommodate other systems integration;</li> <li>• Crashworthy airframes;</li> <li>• Comfort improvement (ride quality, noise level, cabin space, convenience);</li> <li>• Minimum maintenance labour;</li> <li>• Automotive synergies in manufacturing, including automation in integrated composite structures;</li> <li>• Per passenger cost operations competitive with automobiles on day trips of 300 miles or more;</li> </ul> <p><u>Aircraft systems.</u></p> <ul style="list-style-type: none"> <li>• Highway in the Sky (HITS) graphical flight path operating systems, including graphical weather, navigation, traffic, terrain, and airspace depictions.</li> <li>• Hazardous weather and ice-tolerant avoid and exit operating procedures;</li> <li>• Advanced pilot vehicle interface systems, including artificial/synthetic vision for “electronic” visual meteorological conditions;</li> <li>• Satellite based communications, navigation, and surveillance for ubiquitous flight and destination information systems;</li> <li>• On-board access to travel information for seamless air/ground and mass/personal transportation intermodal connectivity;</li> <li>• Mission management and trajectory control;</li> <li>• Improve safety, handling, and ride quality while reducing pilot workload and maintenance costs;</li> </ul>
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- Potential advanced technology applications include fly-by-wire or fibre optics controls, gust-load alleviation technologies, low-cost icing protection, and improved navigation and guidance equipment;
- One Network of “Sensors & Actuators” to Actively Manage the Airflow and Loads Across the Whole Flight Regime of the Product;
- Embedded health monitoring systems that will allow the airplane to self-monitor and report maintenance requirements to ground based computer systems;

Aircraft propulsions. New engines, burning unleaded fuel, with single-lever power controls, intuitive diagnostics, and longer TBOs:

- Next generation propulsion systems, including non-hydrocarbon and hybrid concepts;
- Quiet non-hydrocarbon propulsion, low emissions combustion system & alternative fuel;
- New small turbine and compression-ignition engines. Acquisition price: Piston < 10,000 EUR, Turbine < 100,000 EUR;
- Advanced propellers;

Training. Simplified and affordable pilot training through advanced technologies, including:

- Unified instrument private pilot training curriculum;
- On-board, embedded training capabilities;
- Training time and cost commensurate with Public School implementation of “Fliers education” along with drivers education;
- Internet based, and simulation enhanced training systems;
- Pilots are able to maintain all necessary competencies and proficiencies for EPATS Highway in the Sky system flight operations, within constraints imposed by typical professional and personal time schedules.

### 3. MODEL INPUT FOR THE “SAT226 SYSTEM” LAYER

56 airports given by AIP VFR Polska [16] were assumed as access nodes to the “SAT226 system” graph layer, Inhabitants of each of the Polish 2,479 communes are assumed to reach access nodes using ridesharing services according to the routes available in baseline scenario 2030 [2]. Because FIR EPWW lower aerospace consists of prohibited or restricted areas it means it is not fully available for users. (See figure 1).

Vertices were created by determining constant navigation points in the available parts of lower aerospace of FIR EPWW, at a chosen average altitude. The navigation points in reality do not exist, but they reflect the aerospace availability and they were required to keep the graph structure simple. Thus, the shortest flight paths were limited to FL 100 and to 587 itinerary vertices. (See figure 2).

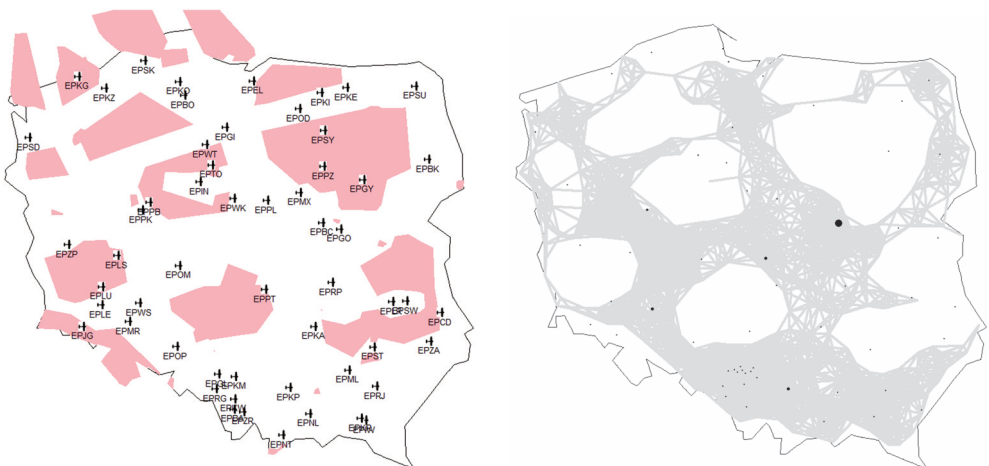


Fig. 2. 56 airports and assumed available aerospace at FL 100 and “SAT226 system” layer of the graph [Mączka, 2016]

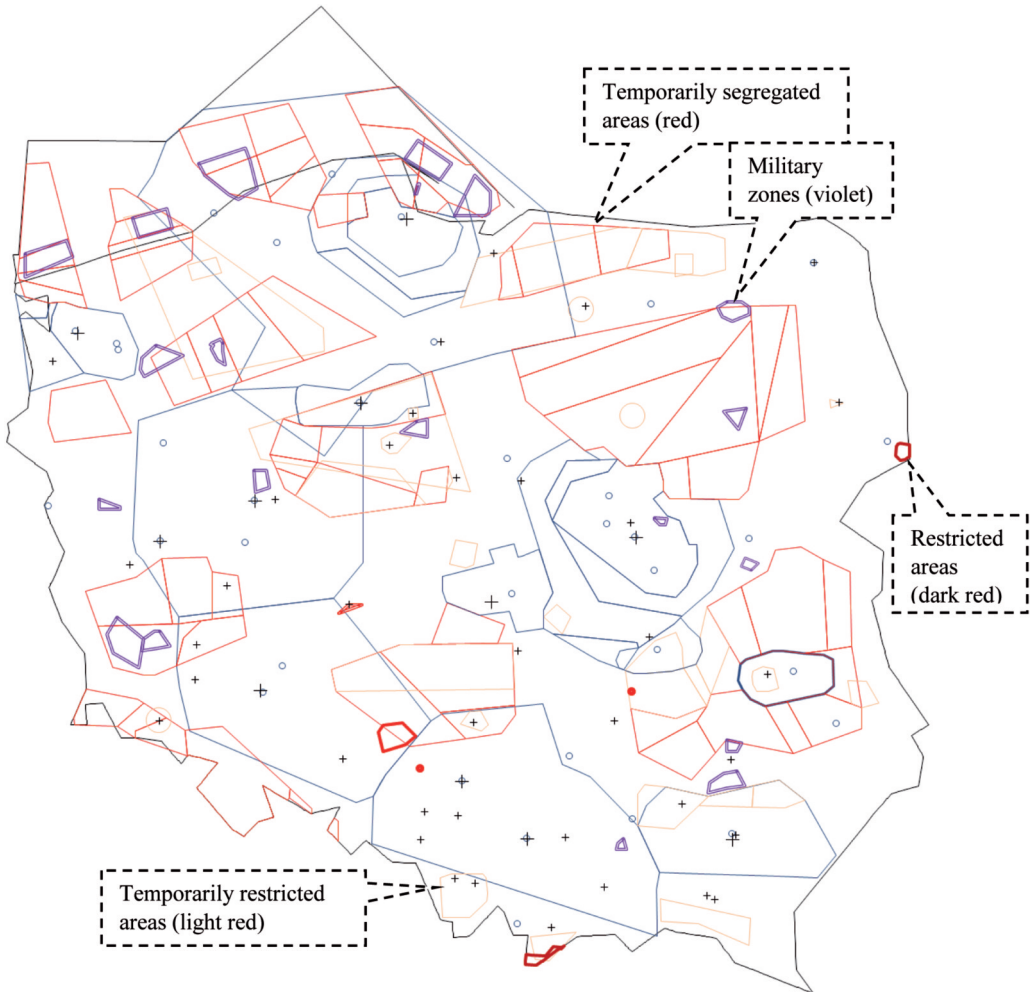


Fig. 1. FIR EPWW lower aerospace simplified map developed using AIP VFR Polska [11] of a certain point in time. The unavailable areas – red and violet, “crosses” – small (underutilised) and large airports, “circles” – VOR DME [Mączka, 2016]

All speeds of the fleet were averaged to one value of 226 km/h. This is a cruise speed of the older Cessna 172 Skyhawk aircraft [17], which is a significant example of “aeroplane powered by propeller engines with an MOPSC of 9 or less and a maximum take-off mass of 5 700 kg or less” - the definition given in a key regulation for air operations in the EU Member States – the EASA “Air Operations – OPS” [15].

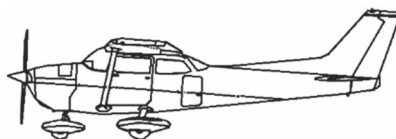
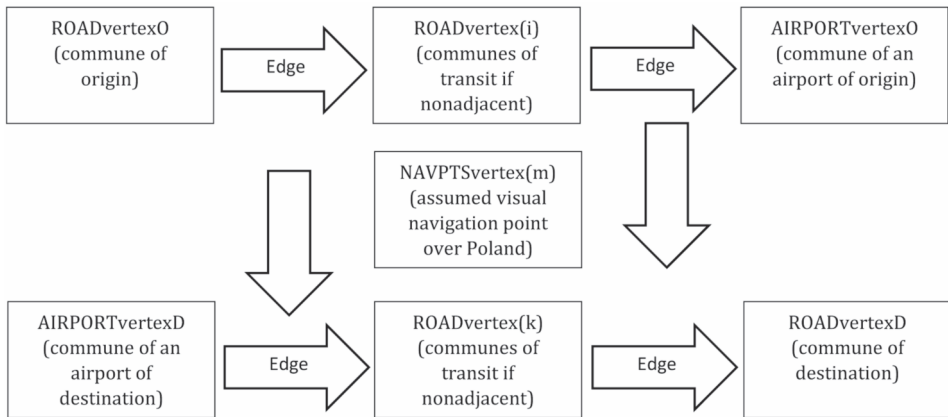


Fig. 3. Cessna 172 Skyhawk  
[Mączka, 2016]

The speed and distances were used together with the “road system” layer times to obtain shortest paths time matrix using Floyd-Warshall algorithm [18] for all communes in Poland. Total origin-destination travel was assumed as the following:



Finally, the assumptions lack of legal barriers for commercial passenger air transport using Cessnas, full information on weather, full information on services availability on the market, an infinite capacity of infrastructure, fleet, maintenance and fuel availability were added. Costs of operation were ignored since AMETIP method [1] does not require costs input.

#### 4. ALTERNATIVE MODE OF TRANSPORT IMPACT

**Scenario SAT226 for 2030 – all national transport infrastructure improvements plans are completed and, additionally, small aircraft transport system is implemented.** The small aircraft transport was added to the graph defined for 2030 multimodal transport [1] as a fourth mode. The AMETIP daily accessibility was recalculated. (See figure 4).

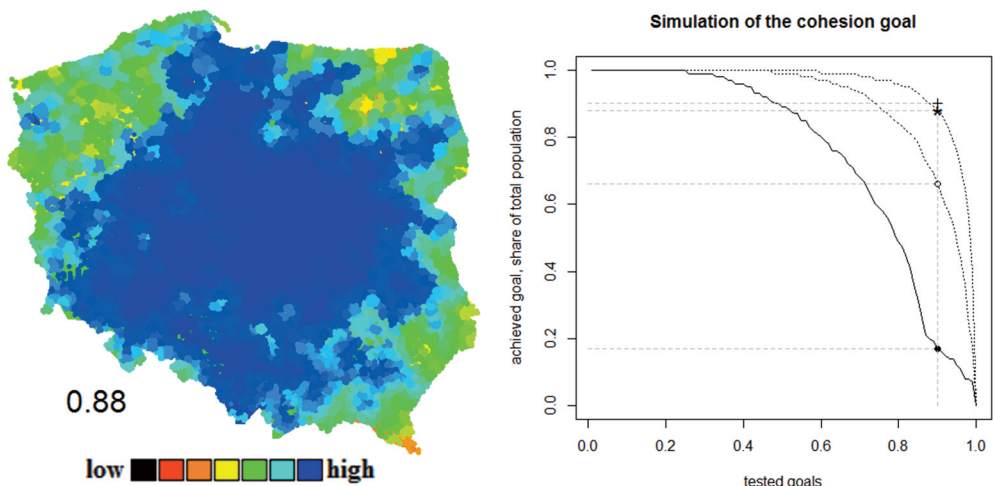


Fig. 4. 2030 - the expected multimodal daily accessibility levels with SAT226 operating left: 88% of 2479 communes is able to reach 90% of population within 4 hours of door-to-door travel; right: “the point” – 2015 situation with respect to the cohesion goal; “the cross” – the cohesion goal; “the circle” – the transport policy agenda expected result; “the star” – the implementation of SAT226 expected result) [Mączka, 2016]



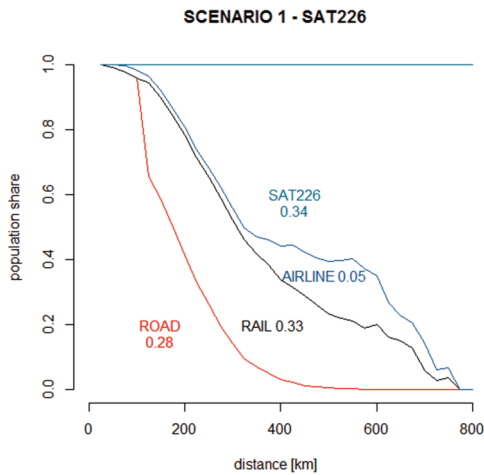


Fig. 5. Modal split of 2030 (SAT226 scenario)  
[Mączka, 2016]

## 5. CONCLUSION

Bearing in mind all the assumptions of the AMETIP method, the infrastructure-based accessibility measure [1], the assumptions of the national transport graph (and its improvement trends) [19] [2] and the small aircraft transport system vision, it may be concluded, that the impact of SAT226 2030 scenario on transport system in Poland is:

- a critical increase of total daily accessibility (baseline scenario 2030: 66% [1], SAT226 2030: 88%)
- complementing all other modes in Poland over longer distances (>200 km)

Calculation results seem to indicate that some form of a new mode of travel proportionally available all over the country, using a point to point model of operation and embedded in the economy of sharing [10] is crucial for Poland. Providing a new value, pushing the competitiveness upwards, enabling more efficient use of scarce resources, it could help support Polish economy in joining the avant-garde countries in an economic development.

The general conclusion is in concord with previously published recommendations calling for completing airports system in Poland with additional airports, upgrading and equipping them to standards, creating legal consent and preparing safety system as well as launching a novel transport system with local government support [20].

Implementing a small aircraft transport system using even a fleet of old Cessnas Skyhawk among 56 airports would be a good step towards the EU cohesion goal – most likely, **“90% of inhabitants able to complete their journey within 4 hours of a door to door travel”** [18] target would be reached in Poland.

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Total daily accessibility in Poland (0.88) would be nearly the one required by the EU cohesion goal (0.90).

The SAT226 system would be the quickest mode for 34% of potential travels in Poland. In comparison to the baseline scenario 2030 [2], SAT226 would decrease shares of all other modes (road: 0.46 to 0.28, rail: 0.41 to 0.33, airline: 0.13 to 0.05). (See figure 5).

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## OCENA WPLYWU NA DOSTĘPNOŚĆ TRANSPORTOWĄ ALTERNATYWNEGO ŚRODKA TRANSPORTU W POLSCE (SAT 226)

### Streszczenie

Artykuł przedstawia zastosowanie poprzednio opisanej metody nazwanej jako Model Dostępności Transportowej do Testowania Założeń Polityki Infrastrukturalnej (AMETIP) wykorzystującej graf krajowego systemu transportowego w Polsce zdefiniowany przy użyciu danych z 2015 roku i założeń dla roku 2030 uzupełnionych potencjałem nowego, alternatywnego środka transportu. Dokonano oceny polityki transportowej z punktu widzenia celu spójności w polityce regionalnej Unii Europejskiej – „90% mieszkańców ma możliwość ukończenia podróży od drzwi do drzwi w ciągu 4 godzin”. Do poprzednio zdefiniowanego grafu odzwierciedlającego polski system transportowy i zawierającego warstwę drogową, kolejową i lotniczą dodano krawędzie i wierzchołki warstwy systemu transportu małymi samolotami. Nowy środek podróży jest ekwiwalentem wizji pochodzących z projektów Warszawskiego Instytutu Lotnictwa: EPATS, STMS i SAT-Rdmp. Wizje zakładały usługi które oferowałyby (regularny rozkładowy lub na żądanie) transport z prędkością 226 km/h z/do 56 lotnisk. Jeżeli Polska i UE będą wspierały i ułatwiały stworzenie takiego systemu, ten scenariusz (SAT 226 2030) pozwoli na pełne osiągnięcie celu spójności w polityce regionalnej Unii Europejskiej.

Słowa kluczowe: polityka transportowa, dzienna dostępność transportowa, cel spójności polityki regionalnej Unii Europejskiej.