

АВТОМОБІЛЬНИЙ ТРАНСПОРТ

УДК 656.13

doi: 10.31498/2225-6733.42.2021.240703

© Burlakova H.Y.¹, Bukina M.D.²**RATIONALE OF THE «SAFETY» INDICATOR DIFFERENTIATION
AND ITS IMPLEMENTATION INTO THE DCRE SYSTEM**

The article considers the «safety» indicator and its components to determine the importance of each component of the indicator in the system assessing the quality of services in automobile transportation. The degree of the necessity of the indicator components in the system assessing the quality of passenger automobile transportation, as well as the degree of influence of each component on the quality of the services for the passenger transportation has been determined.

Keywords: quality assessment, indicators, transport service, transportation process, passenger traffic, differentiation, components.

Бурлакова Г.Ю., Букіна М.Д. Обґрунтування диференціації показника «безпека» і імплементація його в систему ВАДС. У статті наведено детальний розгляд показника «безпека» та його компонентів для визначення важливості кожного компонента показника в системі оцінки якості надання послуг з перевезення пасажирів автомобільним транспортом. Визначено ступінь необхідності компонентів показника в системі оцінки якості пасажирських перевезень, а також ступінь впливу кожного компонента на якість надання послуг по перевезенню пасажирів автомобільним транспортом. З аналізу робіт вчених, які досліджували показник безпеки, не представляється можливим скласти класифікацію елементів показників, тому що відсутнє дроблення суцільного показника «безпека» на елементи. Але єдиний показник недоцільний, тому що безпека повинна розглядатися в симбіозі трьох видів безпеки (безпеки транспортного засобу, безпеки водія, безпеки пасажирів). На підставі проведення анкетування пасажирів і перевізників м. Маріуполя з визначення наявності та використання запропонованих компонентів показника «безпека» в оцінці якості перевізного процесу при пасажирських автомобільних перевезеннях була розглянута і визначена динаміка змін цих компонентів. В результаті експертної оцінки працівниками автотранспортних підприємств і пасажирами по визначенню наявності і використання запропонованих компонентів показника оцінки якості перевізного процесу при пасажирських автомобільних перевезеннях можна зробити наступні висновки: динаміка збільшення всіх компонентів показника «безпека» свідчить про те, що безпечні умови пересування пасажирів поліпшуються (по наявності збільшення коефіцієнтів безпеки). Ґрунтуючись на загальнонауковій системі «Водій–Автомобіль–Дорога–Середовище» ВАДС, застосовуючи її до перевезення пасажирів, в даній роботі пропонується ввести в систему ВАДС складовий компонент П (пасажир) і розглянути її з точки зору безпеки людського життя. У якості прикладу одного з елементів складеного компонента П може служити професіоналізм водія, який може оцінюватися, виходячи з підтвердженого числа ДТП за минулий рік, і визначити його як критерій «професійна придатність» (ПП) виконавців транспортних послуг. Визначено додатковий

¹ Cand. Sc. (Engineering), associate professor, SHEI «Priazovskyi state technical university», Mariupol, ORCID: 0000-0003-1873-5518, galochkagoogl@gmail.com

² PhD student, SHEI «Priazovskyi state technical university», Mariupol, ORCID: 0000-0003-3977-6714, masha.bukina3006@gmail.com

компонент П для системи ВАДС при пасажирських перевезеннях, який мотивує дослідників на перерозгляд цієї системи при дослідженні її в сфері безпеки пасажирських перевезень. Отже, розгляд компонентів системи ВАДСП дає можливість скласти більш детальну динаміку змін наявності і застосування компонентів показника «безпека» в системі оцінки якості перевезення пасажирів. Аналіз розглянутих компонентів показника «безпека» в системі оцінки якості транспортного обслуговування пасажирів дозволяє зробити наступні висновки: 1) фахівцями з оцінки якості послуг міського пасажирського транспорту (МПТ) по-різному представляється значимість показника «безпека», і сам показник не ділиться на окремі компоненти; 2) розглянутий авторами показник «безпека» різний по своїй змістовній суті; 3) показник «безпека» при пасажирських перевезеннях повинен розглядатися диференційовано для зваженої оцінки безпеки всіх компонентів в системі оцінки якості пасажирських перевезень.

Ключові слова: оцінка якості, показники, безпека, перевізний процес, пасажирські перевезення, диференціація, компоненти.

Description of the problem. Based on the results of the previous study, the main indicators for assessing the quality of passenger traffic have been identified and grouped, which are correlated from the point of view of the passenger and the carrier and the most clearly describe the quality of passenger transport services.

Most groups of indicators according to these standards are identical; therefore, having analyzed and systematized groups of quality indicators specified in DSTU R 51004-96 and DIN EN 13816:2002, it is possible to make classification of quality indicators of work of buses proceeding from the following indicators: indicators of information service, indicators of comfort, speed indicators, timeliness indicators, safety indicators.

But researchers in their work have determined that the general indicators of the quality of passenger transportation should include the following indicators: accessibility, reliability, comfort, information, safety, regularity, efficiency.

Analysis of recent research and publications. Considering the indicators presented in scientific works, according to state and international standards for assessing the quality of passenger transport services, in the hierarchical system of indicators or by the level of ranking, the general groups of indicators are defined [1]: (1) Accessibility; (2) Reliability; (3) Regularity; (4) Timeliness; (5) Speed; (6) Informativeness; (7) Cost-effectiveness; (8) Comfort; (9) Preservation of luggage; (10) Contact; (11) Safety; (12) Efficiency; (13) Ease of use.

From the analysis of foreign experience in the organization of municipal transport, it has been determined that the quality of service is constantly monitored and is as close as possible to the needs of passengers [2-7]. However, a number of issues, namely: quantitative measurement of the quality of public transport services, forms, methods and techniques of its control and improvement, etc., remain to be solved.

The indicator, which is the ninth in the ranking list (from the point of view of the scientists studying the problems in this area), is not significant; it being safety. Here is a more detailed consideration of the indicator «safety» to determine the importance of each of the components of this indicator in the system of assessing the quality of services for the transportation of passengers by motor transport.

Purpose of the article is to determine the degree of necessity for the component «safety» in the system of indicators for assessing the quality of passenger transportation; consideration of the feasibility of each component of this indicator, determining the degree of the component «safety» influence on the quality of passenger automobile transportation.

Presentation of the main material. Safety indicators characterize [8] the features of passenger traffic, which determine the safety of passengers. Transportation safety is one of the mandatory requirements. There are several types of safety in passenger transportation, namely: vehicle safety, driver safety, passenger safety. Passenger safety is the main quality requirement for all types of passenger transportation and is formed taking into account special sectoral documents and regulations.

Safety is one of the most complicated categories to assess the quality of public transport ser-

vices. The main problem is that in addition to objective (technical) parameters, such as: accident-free travel, technical characteristics of the vehicle, the availability of emergency exits, there are also psychophysiological factors that influence the sense of safety of passengers and drivers in passenger transportation [9].

In English-language sources, two terms are used to describe the term «safety», namely «safety» – safety, which means a low probability of an accident and «security» – which means a low probability of becoming a victim and witness of a crime.

If the parameter «safety» is considered in conjunction with other characteristics of the transport service (eg, speed, accessibility), the consumer usually does not single it out and may even reduce the importance of this parameter, not perceiving it as a parameter influencing the choice of means of transportation. This is because public transport is initially perceived by the consumer as relatively safe. However, when assessing safety as a separate factor, passengers single it out as one of the most important [10]. For example, when the speed is increased by the driver on the route, the passenger feels the danger, but not in the fact that he will not be able to reach the destination, but in the fact that increasing the speed results in a danger to his life. The same refers to the feeling of security at bus stops [11].

From the analysis of the works of scientists who studied the safety indicator [12-14], it is impossible to classify the elements of indicators, because there is no fragmentation of the integrate safety indicator into elements, but it is not appropriate, because safety should be considered simultaneously in a symbiosis of the three types of safety (vehicle safety, driver safety, passenger safety).

In case of correlation of these three types of safety it is possible to make classification of the elements of safety in passenger transportations:

- reliability of buses operation (coefficient of technical preparedness of a vehicle ($\alpha_{T,r}$) etc.);
- safety while waiting for getting on the vehicle (equipping the stopping points, etc.) – S_w ;
- safety at embarkation and disembarkation of passengers – S_{e-d} ;
- safety during transportation – S_t .

Through the questioning of passengers and carriers of Mariupol with the aim of determining the availability and use of the proposed components of the indicator «safety» in assessing the quality of the passenger automobile transportation, the dynamics of changes in these components has been considered and defined (Fig. 1).

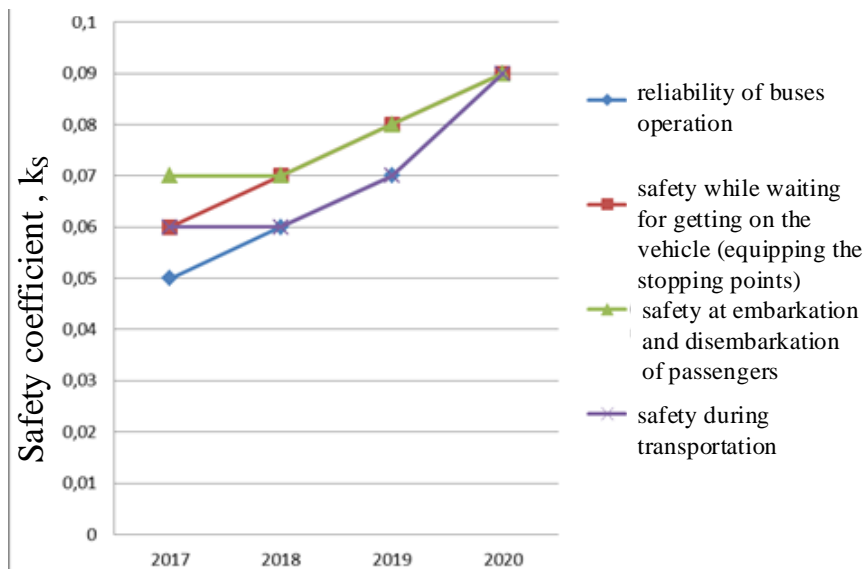


Fig. 1 – Dynamics of changes of «safety» indicator components

As a result of expert assessment by employees of motor transport companies and passengers with the aim of determining the availability and use of the proposed components of the indicator «safety» in assessing the quality of the passenger automobile transportation it has been concluded: all the components of the indicator «safety» increase and the dynamics of changes in these components points to the fact that safety in passenger transportation improves (the coefficients growing) (Fig. 1).

The authors [12] have identified the first component of this indicator as the reliability of buses, and consider it to be the coefficient of technical readiness of the bus ($\alpha_{t,r}$). But this component is identical to the component of the probability of trouble-free transport operation. The author [13] relates this indicator to the created complex indicator of the level of passenger service in terms of the indicator that characterize the importance of the corresponding indicator of the service level; it may refer to the indicator «reliability» in the system of assessing the quality of passenger automobile transportation.

It should be noted that the criterion of readiness of the vehicle to perform that very particular transportation, which is considered in the given work [12], namely: staffing with skilled workers, availability of rescue equipment, first aid equipment, equipment and inventory, normative documents, route maps, etc., can be related to the first component of the indicator «safety».

In the work [8] the author defines the fourth component of the safety indicator, as safety while waiting for getting into the vehicle (embarkation) (equipping of stopping points), as the appropriate phase of passengers stay time in the transportation system, that creates safe conditions while waiting for the vehicle.

The following fifth and sixth criteria of the indicator «safety» are assessed in the same way, namely: safety at embarkation and disembarkation of passengers and safety during transportation, as the appropriate phase of passenger participation in the transportation process, which creates safe conditions for passengers.

When assessing safety related to road accidents, such indicators as the number of accidents per 1000 km, the number of accidents per 1 million of the transported passengers are often used. For example, the professionalism of the driver is assessed based on the confirmed number of accidents during the past year, the result being compared to the average factor over the route over the last three years. Other researchers, for example, Nathanail E., professor at the University of Thessaloniki [14], use a comparative scale for the average number of fatal accidents over the past five years.

For example, 0 points are assigned to the carrier that more than doubled the average number of accidents, while 10 points are assigned to the carrier if the number of accidents is below average. Intermediate points are distributed proportionally. Similar assessment methods are used in the calculation of security indicators related to crimes. In particular, the value of the indicator can be assigned based on the calculation of the number of registered crimes for a certain period of time. In addition, not only cases involving law enforcement are taken into account, but just complaints from passengers as to dangerous situations, anti-social behavior of individuals, etc. as well. Survey methods can also serve as a basis for the formation of an indicator of passenger satisfaction with the safety of public transport services. As a comparative base, it is necessary to use statistical data, for example, data from satisfaction surveys or transport crime statistics over the past few years and to make comparisons with the current indicators.

Based on the general scientific system «Driver–Car–Road–Environment» (DCRE) [15], applying it to the passenger transportation the work proposes to introduce the component P (passenger) into the DCRE and consider it in terms of human safety (Fig. 2).

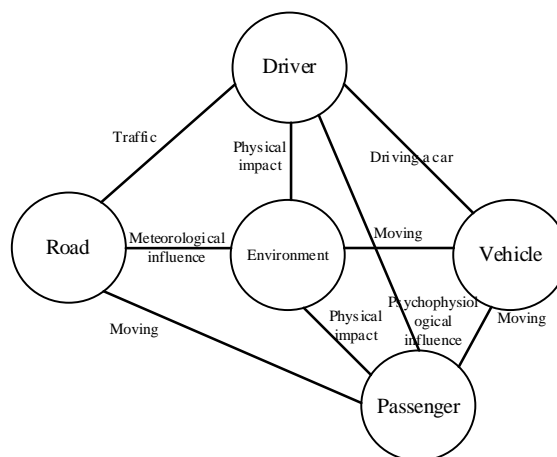


Fig. 2 – Scheme of the proposed DCREP system

Professionalism of the driver, which can be assessed based on the confirmed number of accidents over the past year, may serve as an example of one of the elements of the component P (passenger); and it can be defined as the criterion «professional suitability» (P_s) of transport service providers. The elements of the component P are considered in table.

Table

Components of the proposed system DCREP

Driver	Car	Road	Environment	Passenger
1. Experience 2. Preparation 3. Abilities 4. Psychophysiological state 5. Age 6. Traffic Rules	1. Technical condition 2. Passive safety 3. Active safety 4. Post-accident safety	1. Coating 2. Road conditions (signs, markings, etc.) 3. Traffic intensity	1. External environment (climatic conditions) 2. Internal environment (exhaust, dust, vibration, etc.)	1. Timeliness 2. Comfort 3. Security 4. Fatigue 5. Reliability

The identified additional component P (passenger) for the DCRE system in passenger transportation urges researchers to reconsider this system when studying it in terms of passenger transportation safety. Thus, consideration of the components of the DCREP system makes it possible to compile a more detailed dynamics of changes in the availability and application of the components of the indicator "safety" in the system of assessing the quality of passenger transportation.

Thus, the indicator «safety» develops a composition of its main components and thus the indicator becomes more significant than the other indicators in the system of assessing the quality of passenger automobile transportation.

Conclusions

The analysis of the considered components of the indicator «safety» in the system of assessment of quality of transport service of passengers makes it possible to draw the following conclusions:

1. Specialists in assessing the quality of urban passenger transport services (UPT) differently represent the importance of the indicator «safety» and the indicator itself is not divided into separate components.
2. The indicator «security» analyzed by the authors is basically different in its substantive essence.
3. The indicator «safety» in passenger traffic should be considered in different ways for a balanced assessment of the safety of all components in the quality assessment system of passenger transportation.

References:

1. Burlakova G.Y., Bukina M.D. Sistematizatsiya otsinki yakosti perevızhnogo protsesu pri pasazhirs'kikh perevezennyakh [Systematization of the quality assessment of the transportation process during passenger transportation]. *Visnik Priazovs'kogo Derzhavnogo Tekhnichnogo Universitetu. Seriya: Tekhnichni nauki – Reporter of the Priazovskyi State Technical University. Section: Technical sciences*, 2019, no. 39, pp. 166-174. doi: 10.31498/2225-6733.39.2019.201071. (Ukr.)
2. Johansen, Larsen O.I., Norheim B. Towards achievement of both allocative efficiency & X-efficiency in public transport. *Journal of Transport Economics and Policy*, 2001, vol. 35, no. 3, pp. 491-511.
3. Hensher D., Stopher P., Bullock P. Service quality – developing a service quality index in the provision of commercial bus contracts. *Transportation Research*, 2003, vol. 37, no. 6, pp. 499-517. doi: 10.1016/S0965-8564(02)00075-7.
4. Hensher D., Stanley J. (2003). Performance-based quality contracts in bus service provision. *Transportation Research*, 2003, vol. 37, no. 637, pp. 519-530. doi: 10.1016/S0965-8564(03)00006-5.
5. Friman M. Implementing quality improvements in public transport. *Journal of Public Transportation*, 2004, vol. 7, no. 4, pp. 49-65. doi: 10.5038/2375-0901.7.4.3.

6. Bates J., Polak J., Jones P., Cook A. The valuation of reliability for personal travel. *Transportation Research Part E: Logistics and Transportation Review*, 2001, vol. 37, no. 2/3, pp. 191-229. doi: 10.1016/S1366-5545(00)00011-9.
7. Swanson J., Ampt L., Jones P. Measuring bus passenger preferences. *Traffic Engineering and Control*, 1997, vol. 38, no. 6, pp. 330-336.
8. Maximkin V.N., Spirin I.V. Upravlenie kachestvom perevozk passazhirov gorodskimi avtobusami [Quality management of passenger transportation by city buses]. Moscow, ACETS Publ., 1998. 38 p. (Rus.)
9. Burlakova G.Y., Bukina M.D. Obgruntuvannya stupenya neobkhidnosti pokaznikiv yakosti v sistemі otsinyuvannya pasazhirs'kikh perevezen' [Justification of the degree of necessity of quality indicators in the passenger transportation evaluation system]. *Komunal'ne gospodarstvo mist. Seriya: Tekhnichni nauki ta arkhitektura – Municipal economy of cities. Series: Engineering science and architecture*, 2020, vol. 4 no. 157, pp. 152-157. doi: 10.33042/2522-1809-2020-4-157-152-157. (Ukr.)
10. Solomon K.M., Solomon R.J., Sillien J.S. Passenger psychological dynamics: sources of information on urban transportation. New York, 1968. 181 p.
11. Eboli L., Mazzulla G. Performance indicators for an objective measure of public transport service quality. *European Transport*, 2012, iss. 51, pp. 1-4.
12. DSTU ISO 9000-2001. *Sistemi upravlinnya yakistyu. Osnovni polozhennya ta slovník* [State Standard ISO 9000-2001. Management systems. Basic position and vocabulary]. Kiev, Derzhstandart Ukrainy Publ., 2001. 33 p. (Ukr.)
13. Shabanov A.V. *Regional'nye logisticheskie sistemy obshchestvennogo transporta: metodologiya formirovaniya i mekhanizm upravleniya* [Regional logistic systems of public transport: formation methodology and management mechanism]. Rostov-na-Donu, SKNC VSHCH Publ., 2001. 205 p. (Rus.)
14. Nathanail E. Measuring the quality of service for passengers on the hellenic railways. *Transportation Research Part A: Policy and Practice*, 2008, vol. 42, iss. 1, pp. 48-66. doi: 10.1016/j.tra.2007.06.006.
15. Stepanov I.S., Pokrovsky Yu.Yu., Lomakin V.V., Moskaleva Yu.G. *Vliyaniye elementov sistemy voditel'-avtomobil'-doroga-sreda na bezopasnost' dorozhnogo dvizheniya* [Influence of elements of the system driver-car-road-environment on road safety]. Moscow, MSTU «MAMI» Publ., 2011. 171 p. (Rus.)

Перелік використаних джерел:

1. Бурлакова Г.Ю. Систематизація оцінки якості перевізного процесу при пасажирських перевезеннях / Г.Ю. Бурлакова, М.Д. Букіна // Вісник Приазовського державного технічного університету. – Маріуполь, 2019. – № 39. – С. 166-174. – (Серія: Технічні науки). – Режим доступу: <https://doi.org/10.31498/2225-6733.39.2019.201071>.
2. Johansen K.W. Towards achievement of both allocative efficiency and X-efficiency in public transport / K.W. Johansen, O.I. Larsen, B. Norheim // *Journal of Transport Economics and Policy*. – 2001. – Vol. 35, № 3. – Pp. 491-511.
3. Hensher D. Service quality – developing a service quality index in the provision of commercial bus contracts / D.A. Hensher, P. Stopher, P. Bullock // *Transportation Research Part A: Policy and Practice*. – 2003. – Vol. 37, № 6. – Pp. 499-517. – Mode of access: [https://doi.org/10.1016/S0965-8564\(02\)00075-7](https://doi.org/10.1016/S0965-8564(02)00075-7).
4. Hensher D. Performance-based quality contracts in bus service provision / D.A. Hensher, J. Stanley // *Transportation Research Part A: Policy and Practice*. – 2003. – Vol. 37, № 6. – Pp. 519-530. – Mode of access: [https://doi.org/10.1016/S0965-8564\(03\)00006-5](https://doi.org/10.1016/S0965-8564(03)00006-5).
5. Friman M. Implementing quality improvements in public transport / M. Friman // *Journal of Public Transportation*. – 2004. – Vol. 7, № 4. – Pp. 49-65. – Mode of access: <https://doi.org/10.5038/2375-0901.7.4.3>.
6. The valuation of reliability for personal travel / J. Bates, J. Polak, P. Jones, A. Cook // *Transportation Research Part E: Logistics and Transportation Review*. – 2001. – Vol. 37, № 2/3. – Pp. 191-229. – Mode of access: [https://doi.org/10.1016/S1366-5545\(00\)00011-9](https://doi.org/10.1016/S1366-5545(00)00011-9).

7. Swanson J. Measuring bus passenger preferences / J. Swanson, L. Ampt, P. Jones // *Traffic Engineering and Control*. – 1997. – Volume 38, no. 6. – Pp. 330-336.
8. Максимкин В.Н. Управление качеством перевозок пассажиров городскими автобусами / В.Н. Максимкин, И.В. Спирин. – М. : АЦЕТС, 1998. – 38 с.
9. Бурлакова Г.Ю. Обґрунтування ступеня необхідності показників якості в системі оцінювання пасажирських перевезень / Г.Ю. Бурлакова, М.Д. Букіна // *Комунальне господарство міст*. – Харків, 2020. – Т. 4, № 157. – С. 152-157. – (Серія: Технічні науки та архітектура). – Режим доступу: <https://doi.org/10.33042/2522-1809-2020-4-157-152-157>.
10. Solomon K.M. Passenger psychological dynamics: sources of information on urban transportation / K.M. Solomon, R.J. Solomon, J.S. Sillien. – New York, 1968. – 181 p.
11. Eboli L. Performance indicators for an objective measure of public transport service quality / L. Eboli, G. Mazzulla // *European Transport*. – 2012. – Iss. 51. – Pp. 1-4.
12. ДСТУ ISO 9000-2001. Системи управління якістю. Основні положення та словник. – Введ. 2001-06-27. – К. : Держстандарт України, 2001. – 33 с. – (Національний стандарт України).
13. Шабанов А.В. Региональные логистические системы общественного транспорта: методология формирования и механизм управления / А.В. Шабанов. – Ростов-на-Дону : СКНЦ ВЦ, 2001. – 205 с.
14. Nathanail E. Measuring the quality of service for passengers on the hellenic railways / E. Nathanail // *Transportation Research Part A: Policy and Practice*. – 2008. – Vol. 42, iss. 1. – Pp. 48-66. – Mode of access: <https://doi.org/10.1016/j.tra.2007.06.006>.
15. Влияние элементов системы водитель-автомобиль-дорога-среда на безопасность дорожного движения : учебное пособие / И.С. Степанов, Ю.Ю. Покровский, В.В. Ломакин, Ю.Г. Москалева – М. : МГТУ «МАМИ», 2011. – 171 с.

Reviewer: A.M. Berestovyy
PhD in Engineering, associate professor, SHEI «PSTU»

The article was admitted on 16.03.2021