Maintenance in a Passenger Transportation Company in Poland and in the Republic of South Africa

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The maintenance of devices is now a critical element in the functioning of manufacturing enterprises. The situation is similar in the transport industry. The technical condition of the vehicles is dependent upon operational procedures that affect the quality of services, comfort and the amount of incurred operating expenses. The aim of this paper is to compare the standards in vehicle service companies which deal with passenger transport in Poland and South Africa. In this study particular attention is paid to the influence of the human factor (passenger expectations, cultural conditions, required standards) in the implementation of this service. The authors based their research on available literature, newspaper articles, direct observation, surveys among Wroclaw's inhabitants, and interviews with the residents of Johannesburg and the management staff of transport companies.

Keywords: urban transport, maintenance, human factor.

1. INTRODUCTION

The maintenance of devices is now a critical element in the functioning of manufacturing enterprises. It was estimated that more than once this area of enterprises' activities can strongly influence their competitiveness on the served market [1]. Without well-maintained equipment, a factory cannot achieve the expected results such as lower production costs, increased efficiency of the used equipment, and to manufacture products with specified quality.

The situation is similar in the transport industry. In this case, vehicles are the devices used by transport firms, and the adopted maintenance policies are often defined as a key success factor for management. The technical condition of the vehicles is dependent upon operational procedures that affect the quality of services, comfort and the amount of incurred operating expenses.

The aim of this paper is to compare the standards in vehicle service companies which deal with passenger transport in Poland and South Africa. In this study particular attention is paid to the influence of the human factor (passenger expectations, cultural conditions, required standards) in the implementation of this service.

The authors based their research on available literature, newspaper articles, direct observation, surveys among Wroclaw inhabitants, and interviews with the residents of Johannesburg and the management staff of transport companies.

2. LITERATURE REVIEW

The subject of the authors' study is the passenger transport systems operating in Poland and in South Africa. These systems are anthropotechnical (a combination of man and machine (technical object)). The technical object is defined as the object of human activity designed to perform specific tasks, which deliberately was given certain features and functions by a man [2]. In the transport systems that have been analysed, the vehicles used for transporting passengers, as well as the equipment used for their maintenance and operation, are the primary technical objects. The anthropotechnical system is a set of components and the relationships between them [3]. A man in this system acts as a part of the system, and on the other hand, they act as operators of a technical system that is in relation to the environment.

The main decisions in transportation systems may be classified into three groups [4]:

- maintenance tasks which include the definition of transportation infrastructure maintenance strategies, system elements, or operation control systems,
- technical systems safety tasks (e.g. the protection against the occurrence of hazards, the avoidance of the consequences of undesirable events),
- transportation tasks performance (transportation processes management).

As it can be seen the decisions concerning maintenance affect one of the key elements for the effectiveness and efficiency of the transport system.

In the literature, various definitions of the term 'maintenance management' can be found. Following the European Standard PN-EN 13306:2010 [5] maintenance management may be defined as *all activities of the management that determines the maintenance objectives, strategies, and responsibilities and implementation of them by means such as maintenance planning, maintenance control and supervision, improvement of methods in the organization including economic aspects*. In [6] the authors define the maintenance management as *all maintenance line supervisors, other than those supervisors that predominantly have crafts reporting to them*. Following these definitions, maintenance objectives may be classified into five groups [7]:

- ensuring technical objects functionality (availability, reliability, product quality, etc.),
- ensuring technical objects achievement of their design life,
- ensuring technical objects and environmental safety,
- ensuring cost effectiveness in maintenance,
- effective use of resources, energy and raw materials.

Management operation is based on the specific knowledge regarding the operation of the object, time, and other elements of the technical system, i.e. the system resources (technical-material, financial, human), or space in which actions are realised [8]. This knowledge may be considered in terms of the gained information. Under what conditions can the system operator effectively control the system?

Driessen et al. distinguish three types of maintenance [9]:

- Preventive maintenance: maintenance that is conducted in order to prevent failure. Usually this maintenance is planned some time in advance and must be conducted within a registered time frame during which the asset is in non-operating condition.
- Corrective maintenance: maintenance that is conducted after a failure has occurred. Corrective maintenance can be partially planned when it involves a non-critical part whose maintenance can be delayed.
- Modificative maintenance: maintenance conducted to improve the performance of the capital asset. This maintenance can usually be delayed until all resources are available.

It should also be noted that the operation of the technical facilities is currently recognized as a key feature in ensuring the long-term viability for the organization [10; 11]. Maintenance is also increasingly seen as an activity that adds value and not a forced necessity [12; 13]. Therefore, there are numerous maintenance policies that have been developed in order to streamline this process in the enterprise. Maintenance policies can be grouped into various classes according to the way it deals with breakdowns and maintenance. Variety of maintenance policy classification is widely analysed in scientific literature: Wang [14], Bevilaqua and Braglia [15], Swanson [16], and Khazraei and Deuse [17].]. An interesting literature review regarding this subject can be found in [18].

3. CHARACTERISTICS OF THE RESEARCH

The research conducted by the authors refers to the services of collective passenger transport enterprises in selected urban areas. As noted above, when speaking of the passenger transport system we refer to an anthropotechnical structure. Various road transport means (mainly buses and minivans) are the technical objects of this research. In contrast, the human elements of the system under research have been restricted to drivers and passengers. A driver simultaneously acts as an element of the system under scrutiny, and as the operator of a technical object (a vehicle), while a passenger is treated as an element of the system, which nevertheless has a significant impact on its components.

The research on passenger transport systems in Poland has been conducted on the basis of cooperation with the transport company that provides urban transport services. The company carried out a series of direct interviews with senior managers responsible for maintenance management, transport management and drivers. This allowed the authors to become familiar with the applied maintenance procedures and operation of the service depot. The article also refers to the research on passenger preferences carried out by the students from the University of Wroclaw in courses conducted by A. Tubis, PhD.

The passenger transport system in South Africa has been characterized on the basis of surveys conducted with passengers of public transport in different parts of Johannesburg. The surveys take into account such factors as place of residence, customer income, the most frequently chosen route, number of family members using public transport etc. The research on public transport development policy in South Africa that was conducted by the team led by Professor Jackie Walters from the Department of Transportation and Supply Chain Management at the University of Johannesburg has also been taken into account.

The authors chose for their study the largest urban agglomeration in South Africa, namely Johannesburg and Soweto, which collectively are inhabited by 11 million people.

4. MAINTENANCE IN THE POLISH TRANSPORT COMPANY

In the paper the authors focus their research analyses on the municipal transport services provided by a public carrier who operates in one of the biggest cities in Poland. This company employs about 2000 workers in various positions from human resources, research department to transport and operation department. The company transports nearly 200 million passengers per year, and has about 330 buses. During the year, the buses pass about 34 million kilometres along the bus network that covers almost the whole area of the city and is supplemented by one service depot.

The bus depot is equipped with a new service hall and automatic car wash. The maintenance hall has four lines on which vehicles pass the necessary inspections and vehicle service. Special arrangements allow for quick replenishment of consumables and minor repairs. The petrol station's fuel dispensers have been upgraded to allow one to refuel the tank at a rate of 120 litres per minute.

In the company, two main types of maintenance tasks can be defined:

- daily maintenance – activities performed daily by drivers to ensure technical readiness of the buses,
- periodic maintenance – specific actions taken when a bus reaches a defined time between maintenance action performance and activities performed before winter and summer times.

During the daily service performance, a driver is responsible for checking the bus for the following:

- the level of fluids exploitation (including fuel and engine oil levels),
- efficiency of the fire suppression system for the engine compartment,
- tire pressure and their condition,
- brakes,
- exterior and interior lighting,
- efficiency of all electrical devices,
- cleanliness of windows, external cleanliness of the vehicle and passenger area,
- fire extinguishers reliability,
- completeness of vehicle and operational documents.

In the case of periodic maintenance performance, the type and quantity of inspected vehicle's elements depend on the type of maintenance action performance (resulting from travelled kilometres or season). The list of maintenance activities also results from the service manual which is prepared by the manufacturer for every bus.

In the research of the passenger requirements conducted through direct interviews with 547 commuters within the studied agglomeration, the results show that passengers predominantly stressed punctuality and safety of passage as their top priority [19]. The high importance of punctuality is also consistent with most research that has been conducted in Poland in recent years (e.g. [20]). Passenger safety is usually viewed within two aspects - personal safety, and the state of road construction. Comfort was another important factor found among the assessed passenger demands in the continued research. [21].

Despite intensive promotional activities in the European Union, public transport in Poland still needs to compete strongly for customers and undertakes intensive research in order to convince

commuters to resign from individual transport and 'change' to public transport. The research results indicate that passenger transport requirements are increasing in their demands on the public transport services. For passengers, a service consisting in the implementation of the transport from point A to point B, is no longer sufficient. They expect more and more services to ensure their comfort, safety and reliability of travel, at minimum at the level found in individual transport. Only such standards motivate them to leave their cars at home.

Opposite these demands the tasks formulated in the context of daily maintenance come out. Maintenance items such as cleanliness of windows, external cleanliness of the vehicle and passenger area interior lighting also affect the comfort of travelling. However, the remaining part of this manual determines the safety of passengers and reliability of the provided services. Bus drivers undergo training in the delivery of this service, under which they are made to be aware of the important role played by these activities. That's because a driver, based on daily maintenance, determines whether a bus can leave the depot.

The reliability of the vehicle is significantly affected primarily by periodic maintenance. The correct action in this area reduces the risk of failure and faults, and thus reduces the probability of a temporary exemption of a vehicle from use. This limits the situations in which, due to breakdowns of a vehicle, the service cannot be completed in a timely manner and is delayed or failed. And yet these are the events that most negatively affect the assessment of the quality of services from the passengers' point of view.

In the [22] study the residents repeatedly stressed that punctuality is important for them and has a significant impact on their lives in situations when they must arrive on time. The study also showed how passengers' psychological comfort is important in that it can affect both his/her behaviour and their behaviour toward other public transport users. This comfort is built primarily by a punctual and safe journey. Lack of such a comfort lowers the assessment of the quality of life in the agglomeration in the subjective assessment of its inhabitants. For this reason, a passenger transport company in Poland realizes the increasing importance of effective maintenance management as it can determine its competitiveness in the transport market.

5. SOUTH AFRICA AND SAFETY OF PUBLIC TRANSPORT

Public transport in developing countries is also generally characterized by a lack of adequate financial resources to fund operational subsidies – it is not an issue in any other country, but it seems to be exacerbated in the developing world. The demands of affordable housing, education and health services are just so great that they limit the amounts that the fiscal authorities can set aside for public transport development and support. This gives rise to issues such as lack of timely capital investments to replace rolling stock, lack of integrated transport planning, absence of a firm commitment to public transport etc. On the other hand, most of the captive public transport users are generally not in a position to contribute significantly towards the fare box due to low levels of income and unemployment [23].

In 2008, one of the most well known mottos in RSA was: 'Arrive Alive - use public transport, not black taxis!' It was a part of the government campaign, aimed at reducing the number of accidents caused by inefficient taxis. Technical inspections and services were made. It turned out that none of the vehicles were fit for use, all posed a danger on the road, and up to 80 per cent of drivers did not have a driving license.

These studies did not result in the withdrawal of the clunkers. However, the government mobilized to create so-called public transport, namely the purchase of buses and construction of stops.

The South African government decided to adapt Western models of public transport, thus recognizing that they would work in South Africa. However, the cultural, social, economic and political conditions meant that despite the primal assumptions about the attractiveness of public transport, the implementation deviated from the western standards [24].

Two cultural aspects should be mentioned: the sense of time and planning.

First of all - African sense of punctuality is far from 'western norms'. According to the traditional way of thinking of Africans that survived the twenty-first century, time passes only when something transpires. Time spent waiting, regardless whether it is 15 minutes or 3 hours, does not count. The "timer" only starts when something begins to happen, that is, we analyse situations – e.g. the transport arrives to take the passengers. Africans are not opposed to that situation and do not write complaints (not insignificant in this case

is the fact that nearly 40% are still illiterate), since this is socially and culturally accepted. The situation is similar in cases regarding transport routes. The choice is entirely at the discretion of the decision-making driver of the vehicle. Depending on his family situation (e.g. a family wedding imposes certain obligations, both for the transportation of many cousins to the place of marriage, and the corresponding earnings) the route will be on one hand unpredictable, and on the other - dangerously fast [25].

A similar situation, often understood by Europeans with difficulty, is the lack of prospective thinking. This represents a problem throughout sub-Saharan Africa, where during the decolonisation processes, efforts were made to educate the middle class that would take over the offices and institutions established by Europeans in the country. As it turned out, it was impossible. For example, on large farms, supplying citrus to South Africa, black farmers were introduced. Within 2 years they tried to introduce them to the process of planting and collecting fruit, explaining that without the current sowing, next year there will be no harvest. The answer was the same: 'But now there are. Next year will be next year' [26]. The same problem can be applied to public transport. The minibuses do not do service work, the tires do not meet basic safety standards, the lights are smashed, and the steering wheel can be a sufficiently large hydraulic wrench, which can be twisted to turn the vehicle. The replacement of equipment takes place at a time when the old vehicle definitively no longer fits into use, which is often far too late. The problem of technical inspections should not be mentioned, because, according to the African lack of prospective thinking "as long as it goes, it works" [27, 28]

The factor that probably is the most responsible for the state of public transport in South Africa, at least directly, is the relatively widespread acceptance of the existing state. The period of the rule of "racism" elicited protests, the struggle for independence, the struggle for the rule of Africans. On the other hand, that 'nothing works' was adopted by the state norm. Africans for a long time fared in systems where state institutions were not functioning. Hence, the introduction of private 'black' taxis, which are extremely dangerous transport means, has gained public acceptance. There is no reason to change this state. This way of thinking applies to the whole society, including the ruling elites. In an interview offered within 2010, Transport Minister Sibusiso Ndebele said that 'the black taxi transportation passed the exam so well in replacing public transport, that it does not make sense to change it. It is typical for Africa. The only change - minibuses can be purchased separately from the government ' [29].

Criticism of the existing state, the expected increase in the number of tourists in 2010 FIFA World Cup, and the attempt to limit the crime meant that an attempt was made to improve public transport.

Therefore, legalized taxi companies that were supposed to unify the system of 'black cabs' developed the so-called urban bus system (the metro bus lines) and built a city bus rapid Rea Vaya. All this took place in the largest city in South Africa, Johannesburg.

The Ministry of Transport in South Africa blamed the racial segregation policy spanning over half a century for the problem with public transport. In 2005 a study was conducted that showed that almost 2/3 of households in South Africa do not have access or the ability to use public transport [30; 31]. In 2011 it was still nearly 45% [32].

The Department of Transport inherited a lot of difficulties with public transport, brought about by past governmental policies of segregated development. The National Household Travel Survey (released in 2005) revealed that nearly two-thirds of households in South Africa do not have access to public transport [33].

- There are approximately 3.9 million public transport commuters. The 2.5 million taxi commuters account for over 63 per cent of public transport work trips, bus services account for another 22 per cent of public transport commuters and the others go to work by train. In addition to the 2.5 million commuters who use minibus-taxis as the main means of travel, there are another 325,000 commuters who use taxis as a feeder mode to other public transport services.
- 30 percent of households in the RSA spend more than 10 per cent of their income on public transport.
- Minibus taxis as an informal transport system make 67.9% of a total number of trips. This highlights the important role that a well-managed minibus taxi system can play as the core focus of public transportation, and the new transportation subsidy regime of government is shifting towards the direction of supporting this sector.

- The South African Bus Operators Association (SABOA) has a membership of more than 20,000 buses spread around the country; 15,000 of those buses are used for public transport and 5,000 are used by companies to transport their employees free of charge.
- Lack of convenient public transport has been identified as a serious obstacle for tourists to visit the city of Johannesburg.

Race Relations report released in 2012, the minibus taxi death rate was 27 deaths per 10,000 vehicles and three times higher than 9 deaths per 10,000 for motor cars. Yet, they are still statistically safer than cars.

The same research pointed out the fact that 59% of drivers killed in road accidents were under the influence of alcohol.

The 'black taxi' business rules derived from

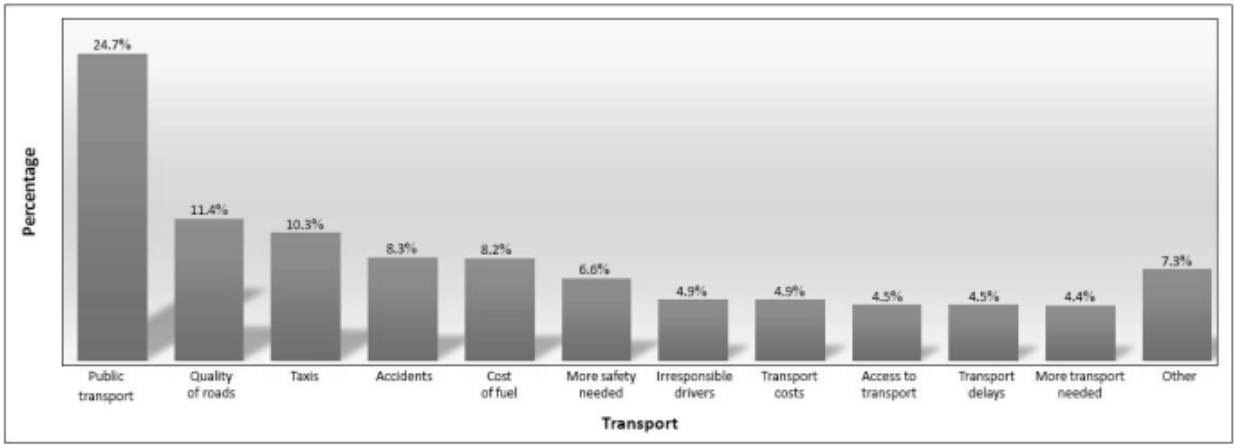

FIGURE 6: Highest transport issues.

Fig. 1. What are the highest public transport issues in South Africa? Origin: Luke, R. & Heyns, G., 2013, 'Public transport policy and performance: The results of a South African public opinion poll', *Journal of Transport and Supply Chain Management* 7(1) http://dx.doi.org/10.4102/

- Conventional metered taxis, unlike in other countries, do not cruise the streets in search of passengers, and must generally be ordered by telephone.
- Railway infrastructure in most cities covers only the older parts of the cities and has not kept up with a new city development.
- Small bus operators outside the formal subsidy system struggle to raise capital and to recapitalize their bus fleet.
- Many instances of fraudulent bus operators have complicated the process whereby contracts and subsidies are awarded.
- Fraudulent operators are also the ones neglecting their responsibility to maintain roadworthy vehicles.

According to the South African National Taxi Council (Santaco), taxis transport approximately 15-million commuters daily and this consists of 60 to 70% of the commuting public and workforce.

Yet, this industry is plagued with health and safety issues and a track record of death and poor driving.

According to the South African Institute of

mob traditions rather than the capitalist market. In cases where taxi drivers killed every year about 400 people, twice as many are injured, which according to the statistics of road deaths in South Africa is a fraction of a per cent [34]. The statistics do not take into consideration, however, those who died during the taxi drivers' wars. The taxi transport operates, and even grows, as it is the cheapest form of public transport. At the same time this is the only form of transportation that reaches the informal settlements, which, in metropolitan areas such as Johannesburg, are inhabited by over 3 million people. At the same time black taxi transport is one of the biggest traffic dangers. The used vehicles are in poor condition, not fit to drive, do not pass technical inspections, they often lack the proper brakes, lights and tires which may be damaged at any time. Drivers aim at minimizing travel time to maximize the revenues. Often, when this does not comply with the existing traffic rules, for example, it is popular to pass the road during red traffic lights and U-turns on the highway. There is no functioning road transport infrastructure in the form of designated stops; it makes drivers stop wherever they may take the passengers - even in

the middle of an intersection. In South Africa, taxis arrive when ... they choose to. They depart, when they are full, and a driver decides whether he wants to leave. They end their route at the point which is acceptable for the majority of passengers. If a failure occurs, then passengers have to push the taxi to the destination demanded by a driver. Vehicles carrying passengers provide no information on the route ahead. Only a driver knows in which direction they shall travel. A passenger wishing to use the transport stands on the street and uses his finger to indicate the direction in which he/she wishes to travel in. If a taxi driver is going in that direction, he stops so that a passenger can climb aboard. In order to travel by Minibus taxi, it is necessary to learn the symbols and pictures shown with fingers [35].

Alongside the “black cabs”, Johannesburg develops a network of city buses, so-called Metrobus (Johannesburg Metropolitan Bus) [36]. They advertise themselves as the second largest transport company, becoming increasingly popular among residents of Johannesburg. Management of the enterprise emphasizes the availability and versatility of Metrobus and a wide range of services: 'Getting vast numbers of people from one part of the city to another - safely, quickly and affordably - is the job of Metrobus, the Johannesburg Metropolitan Bus Service. Metrobus transports about 90,000 passengers daily fulfilling its primary task - transporting commuters using a scheduled bus service. Set up as a company in 2000, it is wholly owned by the City of Johannesburg. It is also the second largest municipal bus operator in South Africa, with 532 buses covering 80 scheduled routes and 130 school routes'. They also highlight the good quality of services along with the transport safety associated with the timely servicing stations. However, the survey of passenger questionnaire’s results says something completely different.

Johannesburg Rea Vaya [37] Rapid City bus is the last of these urban passenger transport systems. It was aimed at enabling the movement in the centre of Johannesburg and Soweto, mainly between the two football stadiums. They even have a special lane separated for the buses (by the concrete wall on the road) and secured point infrastructure as bus stops. However, since the end of the championship the drivers spend more time on striking than running buses. Residents of the studied agglomeration also observed that a special bus lane resulted in an increased number of road accidents. At the same time, according to the notice given to the official website Rea Vaya during the year under review (2012) Rea Vaya did not work for 9 months. Strikes continue every year. 2 years of rapid urban bus networks have expanded several times and there are no new directions or targets. The assumption is that the buses arrive on time, the reality that the drivers are often on strike and traffic jams in the city centre prevent fast access to destinations. In addition, the cost of the journey is too high in relation to the earnings of an average South African.

The results of the surveys on public transport passengers are clear - public transport is not working. Taxi transport is considered to be the most organized one, as they commute everywhere. The fares are tailored to earnings. Lack of stops or timetables weren’t the main respondents' problems. They complained about the poor condition of the taxis, the fact that they are overloaded, and frequent incompetence of drivers. Metrobuses cover only 80 major roads and do not reach the poorest districts which cannot afford their own transportation. In addition, people who tried to use the services of this bus network complained about the lack of timetables, lack of punctuality of buses. Middle class people, who were surveyed, stated that they use public transport occasionally, choosing their own car. Unsuccessful attempts to introduce 'The day without a car' to South Africa ended in a day when most respondents tried to use public transport. Standing long hours in traffic jams in the city centre; they reported that the dirt inside the buses and transport failure are the main mentioned disadvantages. They also complained of, besides unpunctuality, the increased number of robberies of which they became victims [38].

'There is a lot happening in public transport but it's fragmented and not co-ordinated," says Jack van der Merwe, the executive chief of the Gautrain Management Agency.

"It is also a mode of force because many people who use public transport have no other option. It needs to become a mode of choice and the clever thing to do' [39].

When the advantages of public passenger transport come into question, one was mentioned only by the poor group that uses the transport "the need for communication" and "lack of alternatives".

6. SUMMARY

In the case of public transport, vehicles are the devices used by transport firms with the adopted

maintenance policies which are often defined as a key success factor for management. The technical condition of the vehicles is dependent upon operational procedures that affect the quality of services, comfort and the amount of incurred operating expenses.

The authors decided to compare the situation and acceptance of passenger transport in the two metropolitan areas - in Poland, as the country meets the EU standards, and the Republic of South Africa, where the same standards were declared to be adopted.

The authors based their research on available literature, newspapers' articles, direct observation, surveys among Wroclaw inhabitants, and interviews with the residents of Johannesburg and the management staff of the transport companies.

It is worth noting that in both countries the passengers are looking for similar values in public transport in order to resign from purely relying on their cars. They pay attention to punctuality, convenience and comfort. In the case of South Africa passengers highlight one thing - security. In contrast to the EU countries, in South Africa an abandoned car passenger is exposed to the loss of property or life. Unfortunately, for the vast majority there is no possibility of having such a choice. They must decide to use public transport and accept the conditions that are available.

REFERENCES

[1] Swanson L., (2003), *An information-processing model of maintenance management*, International Journal of Production Economics 8, pp. 45-64

[2] Smalko Z. (2010) *Studium terminologiczne inżynierii bezpieczeństwa transportu*, Navigator 2, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław

[3] Smalko Z. (2010) *Studium terminologiczne inżynierii bezpieczeństwa transportu*, Navigator 2, Oficyna Wydawnicza Politechniki Wrocławskiej, Wrocław

[4] Fricker, J. D., Whitford, R. K. (2004) *Fundamentals of Transportation Engineering. A Multimodal Systems Approach, Pearson Education*, Inc. Upper Saddle River, New Jersey, USA

[5] PN-EN 13306: 2010 Maintenance terminology

[6] Gulati, R., Kahn, J., Baldwin, R. (2010) *The Professional's Guide to Maintenance and Reliability Terminology,* Reliabilityweb.com, Fort Myers

[7] Darabnia, B., Demichela, M. (2013) *Data field for decision making in maintenance optimization: an opportunity for energy saving,* Chemical Engineering Transactions. 33, pp. 367-372

[8] Kaźmierczak J. (2000) *Eksploatacja systemów technicznych dla studentów kierunku Zarządzanie*, Wydawnictwo Politechniki Śląskiej, Gliwice

[9] Driessen M., Joachim A., van Houtum G-J., Rustenburg J.W., Huisman J. (2014) *Maintenanace spare parts planning and control: a framework for control and agenda for future research,* Production Planning & Control: The Management of Operations, pp. 1 - 21

[10] Al-Sultan K.S., Duffuaa S. (1995) *Maintenance control via mathematical programming*, Journal of Quality in Maintenance Engineering 1(3), pp. 36-46

[11] Pintelon L., Parodi-Herz A. (2008) *Maintenance: An Evolutionary Perspective* [w:] Complex System Maintenance Handbook Kobbacy K.A.H., Prabhakar Murthy D.N. (red.), Wydawnictwo Springer, pp. 21-48

[12] Ben-Daya M., Duffuaa S. (1995) *Maintenance and quality: the missing link*, Journal of Quality in Maintenance Engineering 1(1), pp. 20-26

[13] Liyanage J.P., Kumur U. (2003) *Towards a value-based view on operations and maintenance performance management,* Journal of Quality in Maintenance Engineering 9(4), pp.333 - 350

[14] Wang W. (2012*) A stochastic model for joint spare parts inventory and planned maintenance optimization*. European Journal of Operation Research 216(1), pp.127–139

[15] Bevilacqua B., Braglia M. (2000*) The analytic process applied to maintenance strategy selection*. Reliability Engineering & System Safety 70(1), pp.71–83

[16] Swanson L. (2001) *Linking maintenance strategies to performance*. International Journal of Production Economics 709(3), pp.237–244

[17] Khazraei K., Deuse J. (2011) *A strategic standpoint on maintenance taxonomy*. Journal Facil. Management 9(2), pp.96–113

[18] Ding S-H., Kamaruddin S. (2014) *Maintenance policy optimization- literature review and direction,* International Journal of Advanced Manufacturing Technology 79, pp. 1263-1283

[19] Tubis A., Wyrobek N. (2015) *Pomiar terminowości przewozów w komunikacji miejskiej i jej wpływ na życie mieszkańców*, Logistyka No.6

[20] Mikulska A., Starowicz W. (2015) *Analiza preferencji i satysfakcji pasażerów transportu publicznego w Kielcach*, Transport Miejski i Regionalny No. 3, pp. 23-29

[21] Tubis A., Wyrobek N. (2015) *Pomiar terminowości przewozów w komunikacji miejskiej i jej wpływ na życie mieszkańców*, Logistyka No.6

[22] Tubis A., Wyrobek N. (2015) *Pomiar terminowości przewozów w komunikacji miejskiej i jej wpływ na życie mieszkańców*, Logistyka No.6

[23] Walters Jackie (2008) *Overview of public transport policy developments in South*

*Africa,*http://ses.library.usyd.edu.au/bitstream/2123/6040/1/thredbo10-plenary-Walters.pdf
[24] Barret J. (2003), *Organizing in the informal Economy: a case study of the minibus taxi industry in South Africa,* SEED working paper, no.39
[25] Guhrs V. (2010) *The Trouble with Africa*, Penguin Books, Johannesburg
[26] Guhrs V. (2010) *The Trouble with Africa*, Penguin Books, Johannesburg
[27] Guhrs V. (2010) *The Trouble with Africa*, Penguin Books, Johannesburg
[28] Vorbrich R. (2012) *Plemienna i postplemienna Afryka: koncepcje i postacie wspólnoty w dawnej i współczesnej Afryce,* Poznań
[29] Interview with Transport Minister Sibusiso Ndebele, etv-news, April 2010
[30] NHTS (2005) *Our Nation's Travel*, Johannesburg
[31] Walters Jackie (2008) *Overview of public transport policy developments in South Africa,*http://ses.library.usyd.edu.au/bitstream/2123/6040/1/thredbo10-plenary-Walters.pdf
[32] Statistics South Africa (2012) *Census 2011,* Statistics South Africa, Pretoria
[33] NHTS (2005) *Our Nation's Travel*, Johannesburg
[34] Sekhonyane M., Jackie Dugard J. (2004) *A Violent Legacy: the taxi industry and government at loggerheads,* SA Crime Quaterly, no. 10, p.14-15
[35] Sekhonyane M., Jackie Dugard J. (2004) *A Violent Legacy: the taxi industry and government at loggerheads,* SA Crime Quaterly, no. 10, p.14-15
[36] Johannesburg Metropolitan Bus Services annual report 2010/2011, from http://www.joburg-archive.co.za/2011/annual_report_1011/metrobus_annual_report11.pdf
[37] Information from the official site: http://www.reavaya.org.za
[38] Hensher, D. & Daniels, R. (2011) *Monitoring community views on transport confidence over time: The quarterly Transport Opinion Survey* (*TOPS*), from http://www.atrf11.unisa.edu.au/Assets/Papers/ATRF11_0009_final.pdf
[39] Oxford T. (2013) *The state of SA's public transport,* „Mail and Guardian" no 4/2013

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