FORMALIZATION OF DECISION-MAKING PROCEDURES REGARDING THE EXTENSION OF THE OPERATION TERM OF RAILWAY ROLLING STOCK IN THE CONDITIONS OF POST-WAR DEVELOPMENT OF UKRAINE

Halyna Holub
PhD, Associate Professor
Department of Automation and Computer-Integrated Transport Technologies,
Kyiv Institute of Railway Transport
State University of Infrastructure and Technologies
9 Kyrylivska str., Kyiv, Ukraine, 04071

Oles Haidenko
Corresponding author
PhD, Lecturer
Cycle Committee (Department) of the Bachelors Education
Kyiv Electromechanical Professional Pre-Higher College
35 Pivotroflotsky ave., Kyiv, Ukraine, 03037
haidenko11@gmail.com

Summary: Today, the vast majority of the railway transport fleet in Ukraine has reached the end of its service life, set by the manufacturer. One of the ways to solve the problem of aging rolling stock, along with the purchase of new wagons and locomotives, remains the extension of the service life of passenger wagons due to the restoration of their resource during appropriate repairs. However, the extension of the service life of rolling stock in Ukraine is regulated by a large number of documents (more than a dozen). Since information is scattered in various sources, the need to consider many criteria regarding the possibility of extending the service life of various types of railway rolling stock units creates certain difficulties in perceiving information and takes time to make a decision on the appointment of the necessary type of repair. One of the solutions to the problem of decentralization of the regulatory framework, along with its change, is its formalization for further development of automated decision-making systems in this area. The paper proposes the classification of passenger wagons of locomotive traction (as the most difficult case) by type and place of production from the point of view of the issue of continuing operation beyond the period established by the manufacturer. An algorithm has been developed for the exact calculation of the difference between dates (construction, repair history, and the maximum period of operation), ensuring compliance with regulatory documents, and based on it, software that allows to determine the existence of grounds for extending the term as quickly as possible in the conditions of technical diagnostics using a smartphone operation of the load-bearing structures of locomotive traction passenger wagons and calculate the type of repair that must be scheduled according to the calendar period.

Keywords: rolling stock, Ukrainian Railway, operational lifespan, regulatory documents, algorithm, passenger wagons.

1. Introduction

The renewal of the wagon fleet of Ukrzaliznytsia, which took place before the full-scale invasion of russia on the territory of Ukraine, did not fully meet the needs of both passenger interregional transportation and cargo transportation [1–4].

The war shifted the focus of freight transportation in Ukraine. Thus, in 2022, there was a critical need for grain wagons and tank wagons due to russia's blockade of Ukraine's Black Sea ports and missile attacks on Ukrainian oil refineries.

The war also had a drastic effect on passenger transportation. The railway was the basis of the possibility of evacuating millions of people from war zones, which also created a great need to provide passenger wagons and locomotives for them.

In a period of instability, it is very important to respond quickly to such needs. russia's war against Ukraine continues, therefore the need for effective exploitation of the existing fleet of railway rolling stock and its renewal remains relevant.

Today, the vast majority of rolling stock units are those that have reached the end of their service life set by the manufacturer [1–5]. One of the ways to solve the problem of aging for all units of rolling stock of railway transport, along with the purchase of new wagons, locomotives or special rolling stock, remains the extension of the service life due to the restoration of their resource during appropriate repairs [6].

A forced measure is balancing between meeting the needs of the transportation process and ensuring safe operation.

To extend the service life of certain types of railway rolling stock units in Ukraine, serious tests of their residual resource were conducted. Based on the results of such tests, reports were drawn up, which are regulatory documents regulating the issue of further operation of a railway rolling stock unit.

Thus, the extension of the service life of rolling stock in Ukraine is regulated by a large number of documents. Industry professionals have to consider them all in order to make the right decision. At the same time, despite the strict regulation of decision-making, the responsibility for their adoption still remains with the human specialist.

Under such conditions, the need to transfer technologies from the information industry becomes obvious, as was the case with the sphere of public service provision in Ukraine, when, based on the experience of Estonia, a number of public services were digitized with the aim of leveling the influence of the human factor on the quality of their provision.

The formalization of decision-making procedures is the initial stage of digitalization of management processes of the strategic branch of railway transportation, which will ultimately lead to an increase in the operation efficiency of the existing fleet of wagons and locomotives in conditions of their shortage.

2. Materials and Methods

An analysis of the regulatory documents governing the issue of extending the service life of railway rolling stock units in Ukraine has been conducted, as a result of which it has been found that the most significant decision regarding the extension of the service life depends on the regulatory documents for locomotive traction passenger wagons. The framework of adopted technical decisions in such a case is so rigid that it depends more on normative documents than on the decision of a specialist.

In total, there are eight regulatory documents regulating the extension of the service life of locomotive-hauled passenger wagons that have served the period specified by the manufacturer.

The basis for further operation of rolling stock units that have served the term set by the manufacturer is a qualitatively performed repair.

The regulation on maintenance and repair of locomotive traction passenger wagons [7] provides for six types of repair and maintenance for such wagons, which only increases both the complexity of making technical decisions and the complexity of formalizing this process.

The technical decision to extend the service life of a rolling stock unit is influenced by the date of construction, the dates of previous repairs, mileage between repairs (measured in thousands of kilometers or years and months) [7] and the maximum allowable service life (measured in years) [7, 8].

Standard methods of finding the difference between dates in programming turned out to be unsuitable for correct calculations of technical solutions with an accuracy of up to one day, that is, for them to fully comply with regulatory documents. In this regard, it became necessary to develop an algorithm for

finding the difference between dates that would satisfy these requirements.

3. Results

For the formalization of regulatory documents, rolling stock units have been classified according to the criteria that depend on the repair that should be assigned for continued operation beyond the period specified by the manufacturer and the maximum permissible period of operation.

It is advisable to classify freight wagons by the type of cargo they can carry [9].

Locomotives and rolling stock – by models that can be grouped together if they have the same service life.

Passenger wagons of locomotive traction (the most difficult case) are proposed to be grouped by type and place of production in the following classifications.

By type:

1) compartment, non-compartment (reserved), interregional and sleeping wagons;

2) "RIC" gauge wagons;

3) luggage and wagons of the "ZAK" type (for the transportation of special contingents);

4) wagons of the children's railway and other wagons with a gauge of 750 mm;

5) service, workshops, simulators, tour and wagons of other enterprises and organizations;

6) dynamometric, brake testing, defectoscopes, track gauges, other laboratories and special purposes;

7) recovery and fire trains, track inspection and bridge inspection laboratories of railway services;

8) salons;

9) wagon transporters;

10) restaurants;

11) wagons of the National Bank.

By place of production:

1) German Democratic Republic, Polish People's Republic;

2) Tver Wagon Building Plant.

Software selection of the wagon according to the above classifications has been implemented using the multiple selection operator.

To formalize regulatory documents, an algorithm for finding the difference between dates, dateDifference, has been proposed, presented in the form of a pseudocode (Listing 1).

```
dateDifference (diagnosticDate, XDate)
1. if Month of diagnosticDate=Month of XDate
2.     then diff := 0
3.     else if Date of diagnosticDate–Date of XDate>0
4.             then diff := 1
5.     else if Date of diagnosticDate–Date of XDate<0
6.             then diff := -1
7.     else diff := 0
8. return (Year of diagnosticDate–Year of XDate)*12+
+Month of diagnosticDate–Month of XDate+diff
```

Listing 1. Procedure for subtracting dates dateDifference

The starting point for all calculations is the date of the technical diagnosis diagnosticDate, as a rule, this is the current date.

To characterize the difference in the days of the month, a local variable diff is introduced, which, depending on the value ("1", "–1", or "0") means 1 month to be added (diff=1) or subtracted (diff=–1) in further calculations and takes the value if the month of the date of diagnosis coincides with the month of the subtractor date XDate, and the number of the month in these dates does not coincide.

4. Discussion

The generally accepted way of finding the difference between two dates turned out to be unsuitable for formalizing regulatory documents because it counts the difference in milliseconds, which in the next step is converted to seconds, then to minutes, hours, and days (Listing 2).

In regulatory documents concerning the continuation of the operation of rolling stock units beyond the period specified by the manufacturer, the time duration is indicated in years and less often in months. Converting days to months is possible, but not so easy, due to their different durations. In addition, counting years is complicated by leap years. Implementation of the calculation, based on the generally accepted method for C-like programming languages [10], would make the algorithm more complex and less efficient than the dateDifference algorithm (Listing 1).

Based on the dateDifference algorithm (Listing 1) and using the classifications of locomotive traction passenger wagons proposed during the study, software has been developed that assigns repairs to the wagon needed to extend its service life and checks this very possibility, taking into account all the regulatory grounds for this. The test version (in Ukrainian) can be found at the link: https://prod.dezr818xx9obq.amplifyapp.com.

Automation of decision-making regarding the appointment of the necessary type of repair to extend the service life of rolling stock units minimizes the possibility of making mistakes and reduces the time spent by specialists on calculations and reconciliation of technical decisions with the regulatory basis for their adoption.

5. Conclusions

The classification of locomotive traction passenger wagons by type and place of production from the point of view of extending their service life beyond the period set by the manufacturers has been proposed. An alternative algorithm for finding the difference between dates has been developed, which is necessary for the formalization of regulatory documents regulating the extension of the operating period of rolling stock units.

Conflict of interest

The authors declare that they have no conflict of interest in relation to this research, whether financial, personal, authorship or otherwise, that could affect the research and its results presented in this paper.

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Data availability

Manuscript has no associated data.

Use of artificial intelligence

The authors confirm that they did not use artificial intelligence technologies when creating the current work.

References

1. General information about railway transport. Ministry for Communities, Territories and Infrastructure Development of Ukraine. Available at: https://mtu.gov.ua/en/content/informaciya-pro-ukrainski-zaliznici.html
2. Radkevych, M., Sapronova, S., Braikovska, N., Tkachenko, V. (2021). Improvement of methods of technical diagnosis of passenger railway cars. Collection of Scientific Works of the State University of Infrastructure and Technologies Series "Transport Systems and Technologies," 1 (38), 80–87. doi: https://doi.org/10.32703/2617-9040-2021-38-80-7
3. Kalabukhin, Y., Martynov, I., Trufanova, A. (2022). Systematization of economyko-technological stations of passenger cars in operation. Collection of Scientific Works of the State University of Infrastructure and Technologies Series "Transport Systems and Technologies," 39, 73–82. doi: https://doi.org/10.32703/2617-9040-2022-39-8
4. Vernyhora, R., Okorokov, A., Zolotarevs'ka, O. (2020). Evaluation of the investment project for updating the rolling stock for the organization of grain cargoes rail transportation. Transport systems and transportation technologies, 19, 43–54. doi: https://doi.org/10.15802/tstt2020/208695
5. Sulym, A., Safronov, O., Strynzha, A. (2022). Justification of the need for state protectionism of the freight wagon building industry in Ukraine. Railbound rolling stock, 25, 7–19. Available at: https://ukrndiv.com.ua/wp-content/uploads/2023/01/Zbirnyk-25.-12.01.pdf#page=3
6. Yezhov, Yu. V., Pavlenko, Yu. S., Vojtenko, O. I. (2018). Overhaul repair of passenger cars with locomotive traction as a means of providing railways with rolling stock. Collection of scientific works. Rail rolling stock, 17, 51–61.
7. Polozhennia z tekhnichnoho obsluhovuvannia ta remontu pasazhyrskykh vahoniv lokomotyvnoi tiahy [Provisions on maintenance and repair of locomotive traction passenger cars] (2022). Kyiv: Ukrzaliznytsia.
8. Metodyka tekhnichnoho diahnostuvannia pasazhyrskykh vahoniv, shcho vysluzhyly pryznachenyi termin, z metoiu yoho prodovzhennia [Methods of technical diagnostics of passenger cars that have served the appointed period, in order to extend it] (2008). CL-0070. Kyiv: Ukrzaliznytsia.
9. Nakaz Ministerstva infrastruktury Ukrainy «Pro zatverdzhennia Poriadku provedennia kompleksu diahnostychnykh, remontnykh ta reiestratsiynykh operatsiy, spriamovanykh na prodovzhennia stroku ekspluatatsiyi vantazhnykh vahoniv (krim vantazhnykh vahoniv pidpryiemstv tekhnolohichnoho zaliznychnoho transportu, shcho pryznacheni dlia peremishchennia vantazhiv u vyrobnychykh tsiliakh v mezhakh terytoriyi takykh pidpryiemstv), ustanovlenoho vyrobnykom, strokiv prodovzhennia ekspluatatsiyi takykh vahoniv» vid 30.11.2021 # 647. Available at: https://zakon.rada.gov.ua/laws/show/z1677-21?lang=en#Text
10. Calculating elapsed time. Available at: https://developer.mozilla.org/en-US/docs/Web/JavaScript/Reference/Global_Objects/Date#calculating_elapsed_time

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