Methodological approach to assessing the effectiveness of public sector infrastructure management

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Abstract. The dynamic development of the economies of countries depends on all economic entities of various forms of ownership. In most countries, a significant share is occupied by the public sector, and its effective management affects the state of economic sectors. In Kazakhstan, a large share of the economy belongs to the state, in this regard, the article considers one of the priority sectors – the railway industry. To assess the effectiveness of railway industry infrastructure management, the authors applied an index method, based on the author's methodology, an integral index for evaluating the effectiveness of railway industry infrastructure management was calculated. This index was applied on the example of the regions of Kazakhstan. As a result of the study, regions with low, medium and high efficiency of infrastructure management were identified. This technique makes it possible to assess how effective the management of infrastructure facilities in the industry is.

1 Introduction

Today, the economy of most countries of the world has a mixed form, that is, a hybrid socio-economic system, of which the public and private sectors are part. For the successful operation of the system, a close relationship and mutually beneficial socio-economic relations between its components are necessary [1]. In Kazakhstan, a large share of the economy belongs to the public sector, which is now being reduced through privatization [2]. As you know, the public sector operates on the basis of state ownership, the efficiency of which depends on the development of infrastructure.

Each economic sector contributes to the formation of added value, which affects the competitiveness of products and the economy of the country as a whole [3]. One of such industries is transport, the efficiency of which is impossible without a developed infrastructure. In Kazakhstan, the railway industry belongs to the public sector, where currently there is a high physical deterioration of railway infrastructure facilities, a low level of suburban rail transport [4]. In this regard, it will be relevant to consider the issues...
The effectiveness of the management of the railway industry depends on both quantitative and qualitative indicators, on the basis of which, the article presents a methodology for the integrated assessment of the effectiveness of the management of the railway industry in the context of the regions of Kazakhstan.

2 Methods and materials

The infrastructure of the railway industry is understood as a technological complex that includes a railway network of main and station tracks, supply facilities, signaling and communication, as well as other objects of the traffic management system [5-6]. In the course of the study, an index method was used, with the help of which an algorithm for evaluating the effectiveness of public sector infrastructure management was built on the example of the railway industry. In statistical studies, the index method makes it possible to measure socio-economic phenomena by bringing the analyzed values to a common unity [7-9].

The analysis methodology is based on groups of coefficients that reflect the degree of influence of factors on the result of railway infrastructure management. Indicators that characterize the development of infrastructure were adopted as indicators. Integral indices are calculated as the average of the partial indicators of its components [10-11]. Table 1 presents methodological approaches to determining indicators for assessing public sector infrastructure management using the example of the railway industry.

<table>
<thead>
<tr>
<th>Indicator</th>
<th>Formula</th>
<th>Description</th>
</tr>
</thead>
<tbody>
<tr>
<td>Railway track index (Izhp)</td>
<td>$Id = \frac{Sdi}{Sd_{max}}$</td>
<td>Index of operational length of railway tracks</td>
</tr>
<tr>
<td>Railway track density index (Ipl)</td>
<td>$Ipl = \frac{Spl_i}{Spl_{max}}$</td>
<td>Density of railway tracks in the i-th region (km), $Spl_{max}$ - maximum value of railway track density in regions (km)</td>
</tr>
<tr>
<td>Investment Index (Iinv)</td>
<td>$Igos = \frac{Vgos_i}{Vgos_{max}}$</td>
<td>Public Sector Investment Volume Index</td>
</tr>
<tr>
<td>Investment volume per capital (In)</td>
<td>$lin = \frac{In_i}{In_{max}}$</td>
<td>Volume of investments per capita in the i-th region (thousand tenge), $In_{max}$ - the maximum volume of investments per capital in the regions (thousand tenge)</td>
</tr>
<tr>
<td>Volume of investments in fixed assets (Ikap)</td>
<td>$lkap = \frac{Vkap_i}{Vkap_{max}}$</td>
<td>Index of the volume of investments in fixed assets</td>
</tr>
<tr>
<td>Socio-economic development of the region (Icerr)</td>
<td>$ivrp = \frac{V_i}{V_{max}}$</td>
<td>Gross Regional product index</td>
</tr>
</tbody>
</table>

Table 1. Indicators for assessing the effectiveness of railway infrastructure management
The index of the ratio of per capita income and the subsistence minimum in the \( i \)-th region (share) is given by:

\[
I_{cdpm} = \frac{K_{cdpm_i}}{K_{cdpm_{\text{max}}}}
\]

The index of per capita income of the population is defined as:

\[
I_{cd} = \frac{S_i}{S_{\text{max}}}
\]

The Railway Freight Turnover index \((I_{gzht})\) is:

\[
I_{gzht} = \sqrt{I_g 	imes I_{zdg}}
\]

The Labor Potential Index \((I_{tp})\) is:

\[
I_{tp} = \sqrt{I_{an} 	imes I_{zn}}
\]

The index of socio-economic development of the region \((I_{cer})\) is:

\[
I_{cer} = \sqrt{I_{vrp} 	imes I_{cdpm} 	imes I_{cd}}
\]

The Railway Freight Volume Index \((I_{g})\) is:

\[
I_{g} = \frac{V_{g_i}}{V_{g_{\text{max}}}}
\]

The index of rail freight transportation in the total volume of cargo transportation is:

\[
I_{zdg} = \frac{K_{zdg_i}}{K_{zdg_{\text{max}}}}
\]

The Index of the employed population in the structure of the economically active population is:

\[
I_{zn} = \frac{K_{zn_i}}{K_{zn_{\text{max}}}}
\]

The Note is compiled by the author.

Based on the indicators presented in the table, the corresponding index is determined:

- Railway track index \((I_{zhp})\):

\[
I_{zhp} = \sqrt{I_d 	imes I_{pl}}
\] (1)

- Investment index \((I_{inv})\):

\[
I_{inv} = \sqrt{I_{gos} 	imes I_{lin} \times I_{kap}}
\] (2)

- Error index \((I_{cerr})\):

\[
I_{cerr} = \sqrt{I_{vrp} \times I_{cdpm} \times I_{cd}}
\] (3)

- Railway Freight Turnover index \((I_{gzdt})\):

\[
I_{gzdt} = \sqrt{I_g \times I_{zdg}}
\] (4)
\[ Itp = \sqrt{Ian \times Izn} \]  

(5)

\[ Ief = \frac{5}{Izhp \times linv \times Icerr \times Igzdt \times Itp} \]  

(6)

3 Results

<table>
<thead>
<tr>
<th>Region</th>
<th>2017 Investments, tng billion</th>
<th>2018 Investments, billion tng</th>
<th>2019 Investments, billion tng</th>
<th>Density of railway tracks, m/km²</th>
<th>Share of the employed in the transport sector, %</th>
</tr>
</thead>
<tbody>
<tr>
<td>Turkestan</td>
<td>925</td>
<td>222</td>
<td>2369</td>
<td>26</td>
<td>948</td>
</tr>
<tr>
<td>Akmola</td>
<td>431</td>
<td>10</td>
<td>122</td>
<td>26</td>
<td>680</td>
</tr>
<tr>
<td>Atyrau</td>
<td>552</td>
<td>7</td>
<td>5947</td>
<td>223</td>
<td>580</td>
</tr>
<tr>
<td>Pavlodar</td>
<td>431</td>
<td>412</td>
<td>2746</td>
<td>26</td>
<td>632</td>
</tr>
</tbody>
</table>

Table 2
Based on the presented Table 3.

Table 3. Generalizing integral index for evaluating the effectiveness of railway infrastructure

<table>
<thead>
<tr>
<th>Region</th>
<th>Pavlodar</th>
<th>Atyrau</th>
<th>Akmola</th>
<th>WKR</th>
<th>Turkestan</th>
</tr>
</thead>
<tbody>
<tr>
<td>WKR (Innovation)</td>
<td>349</td>
<td>09027</td>
<td>0</td>
<td>0</td>
<td>0</td>
</tr>
<tr>
<td>Per capita income</td>
<td>2840</td>
<td>758</td>
<td>594</td>
<td>744</td>
<td>0</td>
</tr>
<tr>
<td>Economically active average per capita income</td>
<td>218</td>
<td>37</td>
<td>32</td>
<td>281</td>
<td>3</td>
</tr>
<tr>
<td>Share of the average per capita income of the subsistence minimum</td>
<td>579</td>
<td>528</td>
<td>362</td>
<td>292</td>
<td>6</td>
</tr>
<tr>
<td>Share of the railway cargo volume</td>
<td>10227</td>
<td>113</td>
<td>158</td>
<td>114</td>
<td>131</td>
</tr>
<tr>
<td>Average</td>
<td>26306</td>
<td>221</td>
<td>223</td>
<td>200</td>
<td>135</td>
</tr>
<tr>
<td>Average</td>
<td>85714</td>
<td>9</td>
<td>7</td>
<td>84971</td>
<td>135</td>
</tr>
<tr>
<td>Average</td>
<td>2018</td>
<td>41</td>
<td>71</td>
<td>2019</td>
<td>951</td>
</tr>
</tbody>
</table>

Note: Compiled by the author.
Based on the calculated integral index, the level of efficiency of the regions was determined:
- with low management efficiency: Turkestan and West Kazakhstan regions;
- with average management efficiency: Akmola, Atyrau and Pavlodar regions.

4 Discussion
The railway industry is a thousand kilometers of network infrastructure and billions of dollars in revenue from cargo turnover. Resource-producing companies and machine-building plants depend on the railway, every hundredth resident of Kazakhstan is engaged in this industry. The transfer of railway industry facilities to a competitive environment can have a great impact on the development of transport infrastructure and the socio-economic situation of the regions, since private investors' investments will not be able to support infrastructure facilities at a sufficient level, taking into account their slow returns. In this regard, the state needs to carefully select private investors, monitor, and direct their efforts to help improve the efficiency of the railway infrastructure. Regions with low transport accessibility and management efficiency require special attention and targeted investments in infrastructure facilities.

5 Conclusion
The development of infrastructure increases the socio-economic development of regions, the quality of life of the population, and its effective management affects the effectiveness. The methodological approach used in the study provides an assessment of the effective management of public sector facilities, which is very important, since all strategic industries are under state control.

The results of the study showed that among the selected regions, the Pavlodar region has the opportunity to move into the category with high efficiency of managing the infrastructure of the railway industry. However, the Akmola region, having the largest transport accessibility index among the regions of Kazakhstan, according to the results of the integral index has a low value, which relates the region to the level of average efficiency of railway infrastructure management. Turkestan and West Kazakhstan regions have low values of the integral index, and minimum values of the transport accessibility index, which allows us to conclude that the management of infrastructure facilities in the railway industry is low.

![Fig. 1.](image-url)
Thus, the proposed author's method of integral assessment of the effectiveness of railway infrastructure management makes it possible to assess how effective the management of infrastructure facilities in the industry is.

The article presents the results of scientific research obtained during the implementation of scientific and technical projects on grant financing on the topic "Improving the efficiency of management of state property in post-crisis conditions" (IRN AP14972672).

References


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