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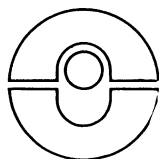
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**Calculation of
railway productivity**

The attention of the railways is drawn to the fact that the methods set out in this leaflet cannot be used for comparing the productivity of different railways.



International Union of Railways



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Leaflet to be classified in Volume :

III - Finance, accountancy, costs, statistics

Amendments

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Part 1 : THE MEANING OF PRODUCTIVITY

The term «productivity» is an economic concept which, despite its entry into everyday usage, remains vague in meaning. The diversity and complexity of its various facets frequently give rise to confusion, and it often appears to be impossible to measure.

Etymologically, productivity means the productive character or faculty of producing a thing or activity. As economic considerations have made it necessary to seek the most efficient use possible of resources to attain a given level of production, the term «productivity» has gradually become virtually synonymous with «effectiveness of utilisation of the factors in a production process», and it has become necessary to be able to measure it as a control process in management.

In the latter sense, productivity may for example be expressed by the ratio :

$$\frac{\text{production (output)}}{\text{factors of production (input)}}$$

which shows clearly that productivity takes the enterprise's internal behaviour into account ; and we may derive from this the following equation :

$$\text{production} = f(\text{factors of production, productivity}).$$

Measurement of this ratio, which we shall call «overall» productivity, since it relates to all the factors of production, is only useful for the purpose of comparison over a certain length of time, which presupposes that the data taken into consideration be available in the form of chronological and homogeneous series. The need for homogeneity often gives rise to problems which are difficult to overcome.

Because of these problems, it is frequently considered sufficient to evaluate productivity in relation to a single factor of production, which we shall describe as «partial» productivity.

Numerous partial productivity indices may thus be devised, relating either to one of the three essential production factors acknowledged by classic economic theory (labour, capital, natural resources) or else to a part only of each of them (means of production, financial capital, raw materials, energy etc). Evaluation carried out in this way, which is based on a wish to take better account of the technicalities involved in running an enterprise, may be extremely useful. *It also, however, has a serious disadvantage, in that it is impossible to determine a causal relationship between variations in production as a whole and those in one of the factors of production.* For example, an investment which will result in better utilisation of manpower has the effect of increasing productivity specific to the latter, which however has nothing to do with it. *This system for evaluating partial productivity should therefore only be used if certain precautions are taken, and in any case subject to serious reservations.*

«Overall» measurement of productivity does not contain these inherent disadvantages since it takes account of the complementary nature of the factors of production, and by providing for a more objective interpretation of the results, it would seem to constitute a valuable tool to be used for organising the management of an enterprise.

Although this overall approach is more accurate as regards the interpretation of results, it necessitates the determination of a common unit of measurement for production and for all the factors taken together. In practice, this common unit can only be money, which requires a number of precautions to be taken :

- unless price developments have been the same for both production and its factors, the distorting factor caused by monetary depreciation must be eliminated by using magnitudes expressed as constant prices ;

- as it is not impossible that increased productivity has been included in production costs or in remuneration, this risk may be avoided by expressing the quantities produced or consumed as values according to the price system in force at the time taken as a basis.

The values of some factors of production are, moreover, difficult to calculate, particularly in the case of the value to be attributed to fixed productive capital used at different times.

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Because of the problems posed by «overall» measurement of productivity, the Railways originally devoted their interest to a number of partial productivity indices, and subsequently to a method of productivity evaluation described as «in terms of value added», which amounts in practical terms to a first step towards overall measurement : many of them proceeded to make their calculations on this basis. Part two of this leaflet will therefore be concerned with describing practical methods for the calculation of the «partial» productivity indices selected, and also of productivity in terms of value added, using the statistics published by the UIC as a basis.

Lastly, Part 3 is devoted to a number of evaluation methods for overall productivity which have evolved from recent research but whose field of application where the Railways are concerned is still very limited. These methods are likely to be of great value in defining and developing management criteria.

Part 2 : PRACTICAL CALCULATION METHODS

I - Partial productivity : productivity indices

A) Definitions

A productivity index is defined as the quotient of two figures :

$$\frac{\text{production}}{\text{a factor of production}}$$

In order to measure production and production resources of the Railways, the following data items are normally used :

1) PRODUCTION

a) Traffic services provided :

passenger-kilometres	vk
tonne-kilometres	tk
unit-kilometres	uk (=tk + vk)

b) Operating services provided

gross tonne-km hauled	tkbr
seat-km provided	pko
tonne-km provided	tko

2) PRODUCTION RESOURCES

- number of hours actually worked	h
- energy consumption in calorie equivalents (1)	ec
- weighted installed power of powered units	pp
- seats provided	po
- tonnes provided	to

Two different kinds of productivity index may be derived from these :

- <i>economic</i>	$\frac{\text{traffic service provided}}{\text{a factor of production}}$
- <i>technical</i>	$\frac{\text{operating service provided}}{\text{a factor of production}}$

It should be noted that to change the technical into the economic index for the same factor of production, we multiply it by the ratio

$$\frac{\text{traffic service provided}}{\text{operating service provided}} \quad \text{which is known as «utilisation factor»}$$

(1) It will be seen later on that the value of this production resource varies according to whether a fixed or sliding equivalence coefficient is used.

1) PRODUCTION

a) Traffic services provided

Passenger-kilometres (vk) and tonne-kilometres (tk) are obtained directly from the statistics.

Unit-kilometres (uk) are obtained by means of the formula :

$$u k = t k + v k$$

b) Operating services provided

Gross tonne-kilometres hauled (tk br) are obtained directly from the statistics.

Seat-kilometres available (pko) are obtained by means of the formula :

$$p k o = V 1 \times V 3$$

Tonne-kilometres available (tko) are obtained by means of the formula :

$$t k o = \frac{W 1}{W 2} \times W 5$$