

# Vehicle transportation route

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Transport processes take place in space. In order to achieve minimal costs and/or maximum productivity, it is necessary to determine the optimal transport route of vehicles (itinerary, route) within transport tasks. Route optimality can be defined based on a single criterion, for example distance (length), or multiple criteria at the same time, such as distance, transport time, costs, etc.

Transport routes of fleet vehicles have different characteristics because transport demands are diverse. There are several basic forms:

- repetitive transport route,
- ring transport route, and
- collection (pickup and/or distribution) transport route.

Some of these route forms have different variants and specific variations.

# REPETITIVE TRANSPORT ROUTE OF VEHICLES

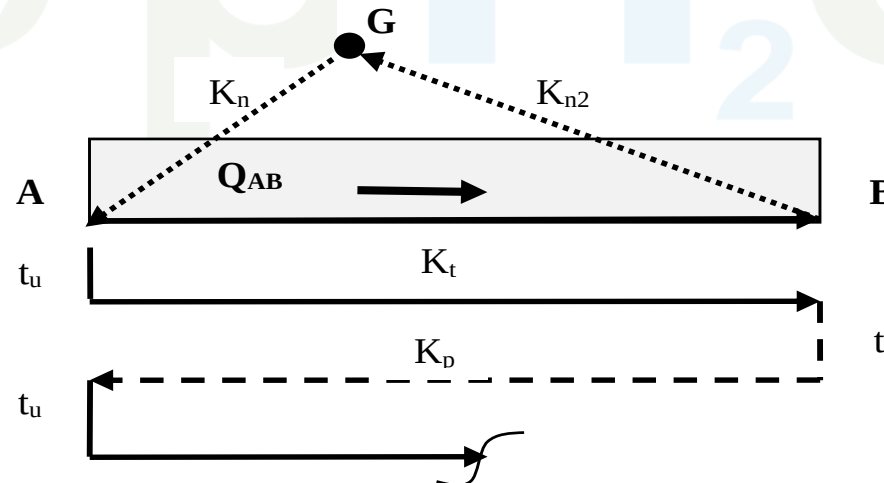
A repetitive transport route occurs in multiple realizations of transport processes when a vehicle moves along the same paths in the form of repeated cycles. This type of route can have several variants: transport in one direction, transport in both directions, as well as partial transport in one or both directions.

In addition to the route form, for the organization of the transport process, and therefore for calculating performance indicators, the position of the vehicle's parking location (depot, garage) relative to its movement route is also important. The location of the parking point affects the occurrence and magnitude of empty mileage (AKn), as well as certain organizational factors.

# Vehicle transport route with one-way transport

A repetitive itinerary with one-way transport is characteristic of short-distance routes and routes where vehicles with special superstructures are used.

A repetitive transport route with one-way transport and vehicle parking outside the itinerary, between the terminal points, represents a cycle with a single simple trip. The notation  $A$  represents the loading point,  $B$  the unloading point, and  $G$  the vehicle parking location (garage). Furthermore, the symbols  $K_n$ ,  $K_t$ , and  $K_p$  represent empty mileage, loaded mileage, and empty (non-loaded) mileage of the vehicle, respectively. Finally,  $t_u$  and  $t_i$  are the loading and unloading times of the vehicle.



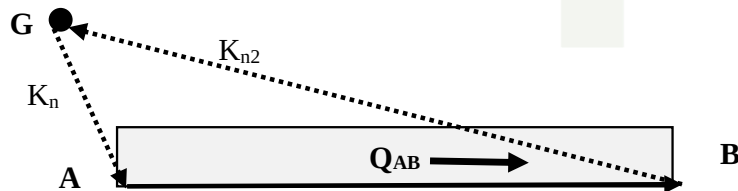
# Vehicle transport route with one-way transport

If empty mileage at the end of the working day is performed by a direct trip on the B–G route, then the number of loaded trips ( $Z_\lambda$ ) is greater than the number of complete cycles ( $Z_o$ ), i.e. the following relation applies. The cycle duration ( $T_o$ ) can be expressed as:

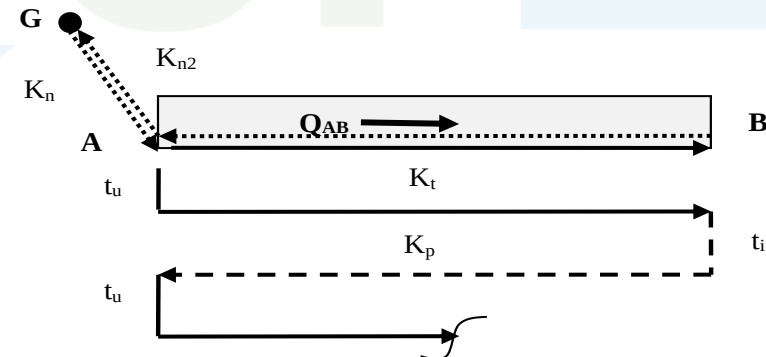
$$Z_\lambda = Z_o + 1 \quad (1)$$

$$T_o = t_u + \frac{K_t}{V_s} + \frac{K_p}{V_s} + t_i = \frac{2 \cdot K_{st\lambda}}{V_s} + t_u + t_i(h) \quad (2)$$

A repetitive transport route with one-way transport and vehicle parking outside the itinerary and outside the terminal points is shown in the following figure. The formation of empty mileage depends on the position of roads relative to the terminal points. In the case of a direct connection between the unloading point and the garage (B–G), the organization of the transport process, as well as the analysis and calculation of performance indicators, are carried out as in the case shown in Figure 1. If the return to the depot (garage) is performed via B–A–G (3), then the last cycle is also considered a complete cycle, i.e. the number of loaded trips ( $Z_\lambda$ ) is equal to the number of cycles ( $Z_o$ )).



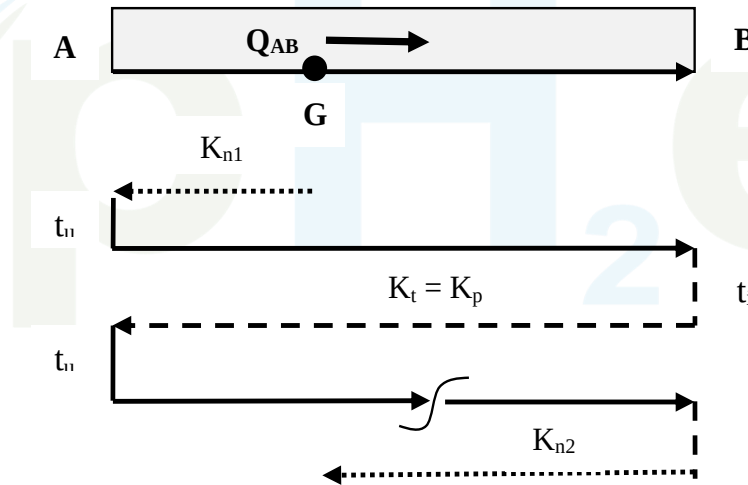
The return to the garage is carried out via B–G



The return to the garage is carried out via B–A–G

# Vehicle transport route with one-way transport

The position of the vehicle parking location within the transport route allows empty mileage to be treated in two ways. The first approach is when empty mileage is used to complete the last cycle. Cycle completion (or cycle supplementation) is a common practice and is used for several reasons, for example better organization of the transport process, cost and revenue calculation, invoicing, and payment. This approach is based on changing the treatment of empty mileage (and empty time), by considering them as non-loaded mileage. In this case, empty time is not deducted from working time because empty mileage is treated as loaded-unloaded mileage.

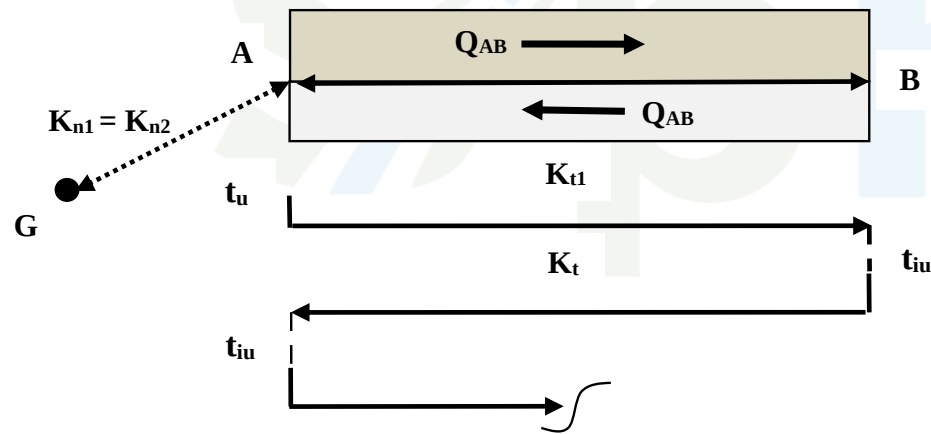


One-way transport with a garage located on the itinerary

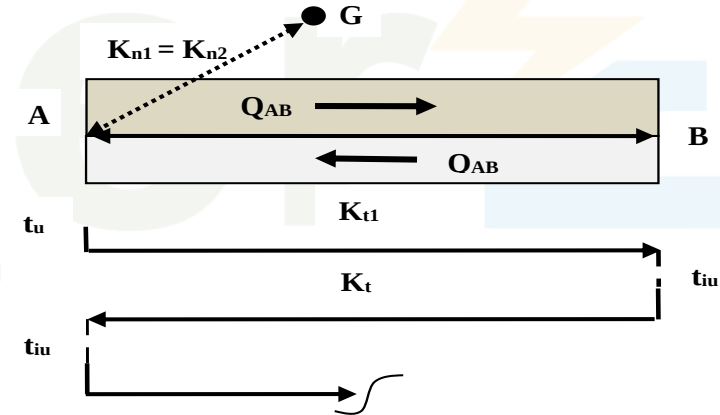
# Vehicle transport route with two-way transport

Transport on a repetitive itinerary with two-way transport refers to full utilization of the traveled route in both directions, or partial utilization of the route in the outbound and/or return trip. Different vehicle parking positions are possible, and they influence the organization of the transport process.

A repetitive itinerary with two-way transport and full utilization of the traveled route implies the realization of two trips within one cycle. Empty mileage is always equal to twice the distance from the garage to the first loading point.

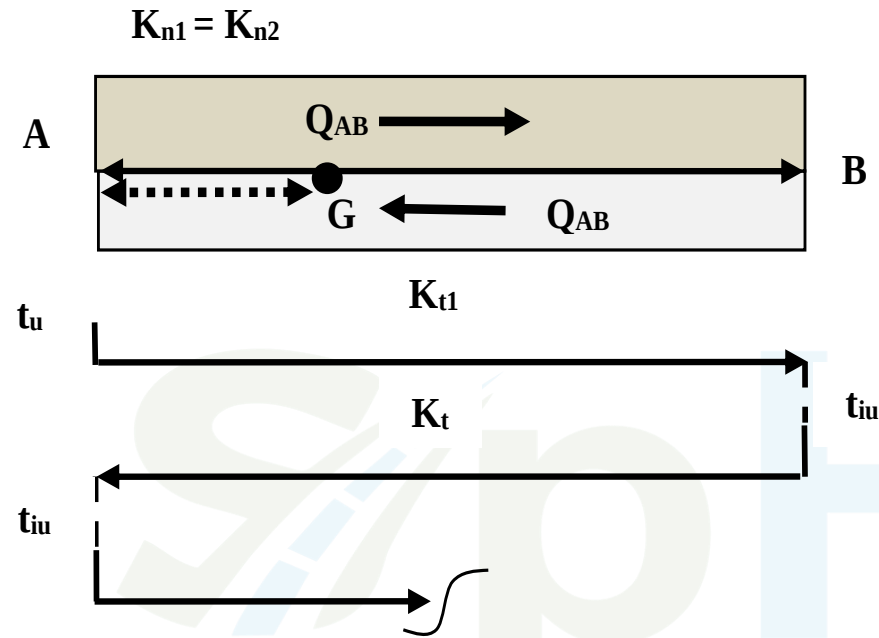


Two-way transport with vehicle parking outside the itinerary and outside the terminal points

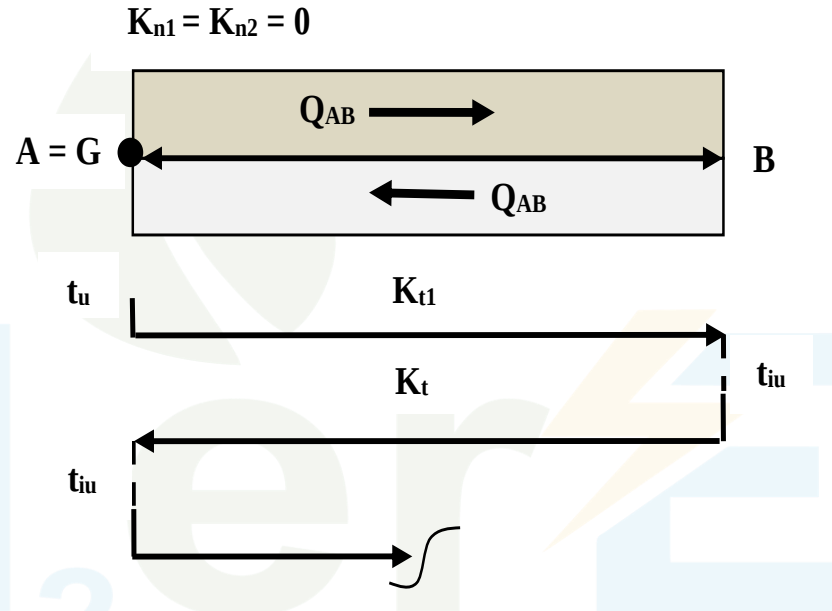


Two-way transport with vehicle parking outside the itinerary and between the terminal points

# Vehicle transport route with two-way transport



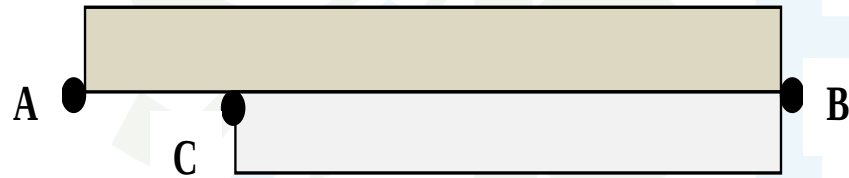
Two-way transport with vehicle parking located on the itinerary between the terminal points



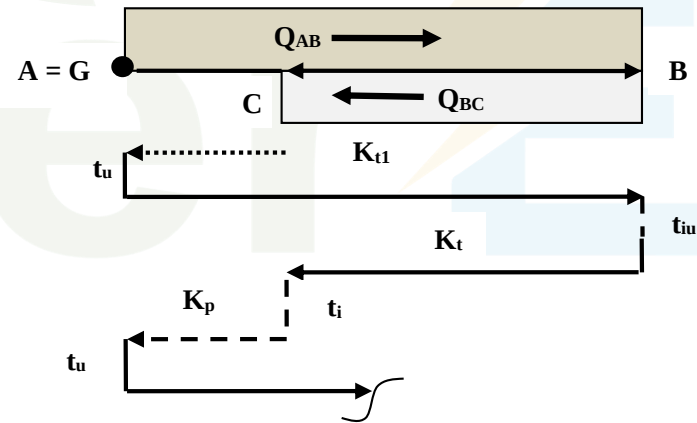
Two-way transport with vehicle parking located at the end point of the itinerary

# Vehicle transport route with two-way transport

Two-way transport with partial utilization of the return trip can have different variants of the parking location (G) in relation to the transport route. Thus, G may be located at the starting point (A), at the end point (B), at the return trip end point (C), between points A and C, between points B and C, outside the transport route and outside the terminal points A and B, as well as outside the transport route and between the terminal points A and B. It is assumed that transport starts from point A.

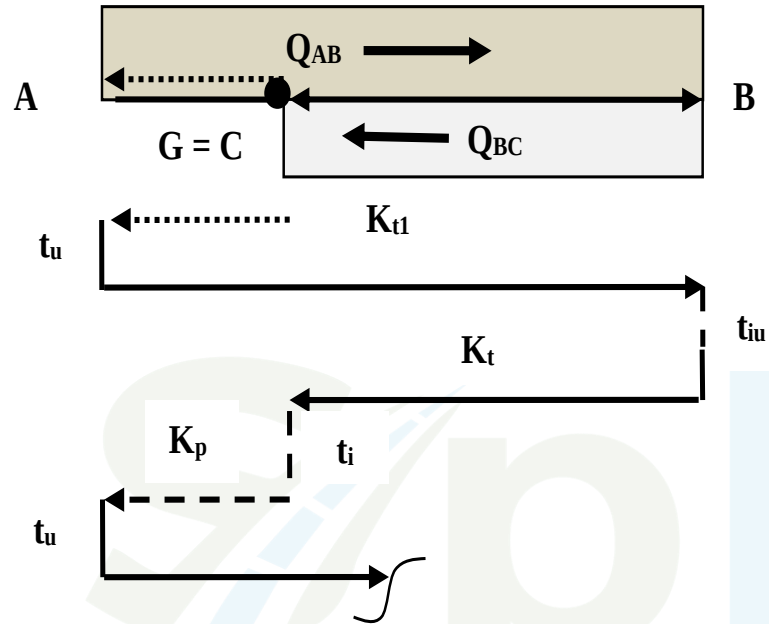


Two-way transport with partial utilization of the return trip

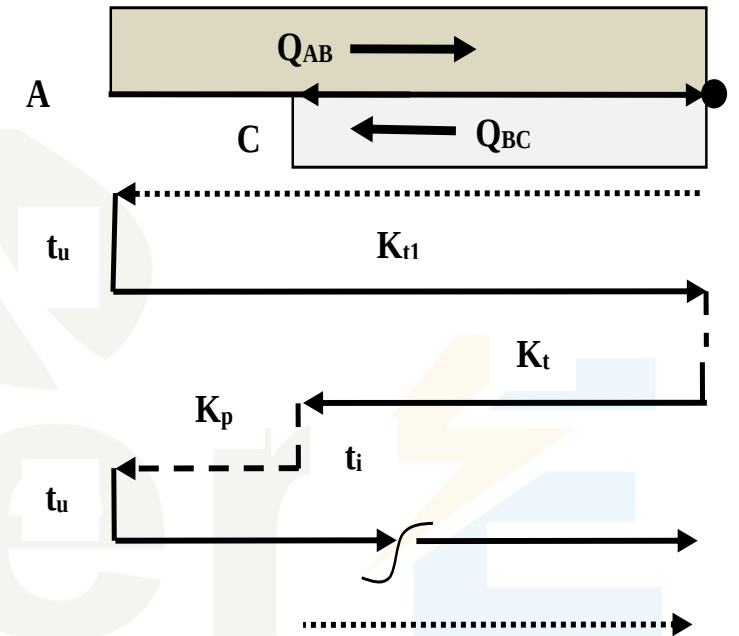


Transport route with partial utilization of the return trip and vehicle parking (G) located at point A

# Vehicle transport route with two-way transport



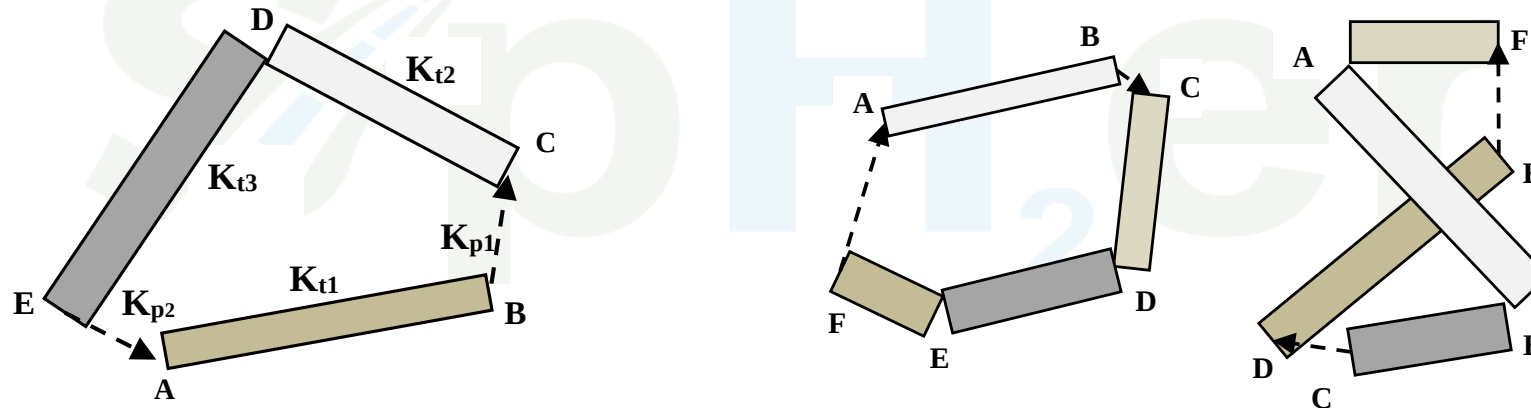
Transport route with partial utilization of the return trip and vehicle parking (G) located at point C



Transport route with partial utilization of the return trip and vehicle parking (G) located at point B

# RING TRANSPORT ROUTE OF VEHICLES

A ring transport route refers to transport processes carried out when a vehicle moves along a closed path. It consists of several loaded trips, which may also be connected with empty trips. This means that a ring transport route includes several loading and unloading points. In practice, a ring itinerary is usually applied in conditions where a higher degree of route utilization is aimed for ( $\beta > 0.5$ ). This type of route is characteristic of long-distance transport, where relevant transport demands may refer to one or more relations within a cycle.

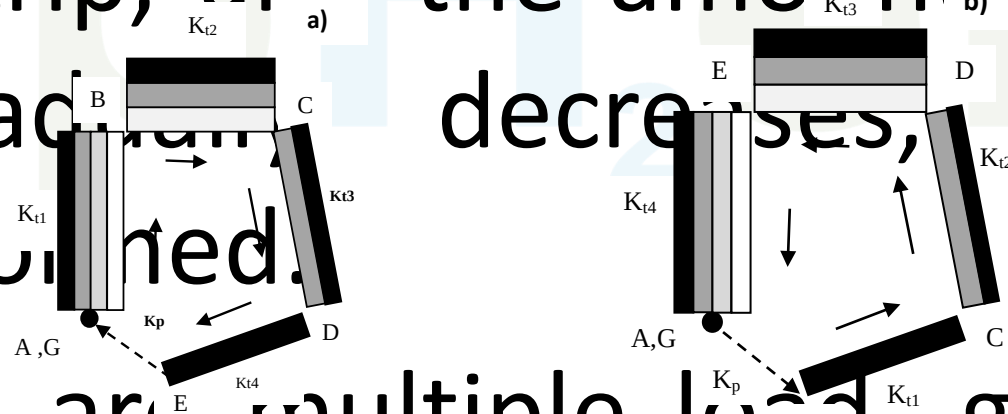


Different forms of ring transport routes

## Collection transport route of vehicles

A collection transport route occurs when a single complex trip is performed within a closed path.

In the case where one loading operation and multiple unloading operations are carried out during the trip, and the amount of freight in the vehicle gradually decreases, a distribution itinerary is formed.



Distribution (a) and collection (b) itinerary

When there are multiple loading operations and one unloading operation, and the amount of

## Collection transport route of vehicles

In general, each specific case of transport process organization on a given itinerary requires the following steps:

- to identify the transport task itself on individual routes (trips), with spatial and temporal characteristics (routes, quantities, dynamics),
- to identify the relevant parameters of the task,
- to form a scheme of the task and vehicle