

Modal shift ambitions and perspective of Bosnia and Herzegovina: QFD method analysis of quality combined transport

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Abstract

The modal shift represents one of the most important elements that participate in the creation of a sustainable transport system. Insurance of energy supply, climate change, and rising demand for transport services are some of the main issues that the world is encountering. Creating solutions for these challenges will request, in a couple of next decades, that railway transport overtake a big part of transport demand. The primary goal of this paper is to fundamentally change the way of understanding transport services, not just as a service of individual modes of transport but as a service in a continuous intermodal chain of transport supply. The perspective of the railway sector in B&H is to increase the quality of transport services through combined transport. Selecting the way of transport is a typical multi-attribute problem. In this paper, the House of Quality (HOQ) was used as a tool for analyzing relevant decisions that represent QFD (Quality Function Deployment) information. By raising the quality of service of combined transport with the usage of the QFD method, through quality houses, the railway sector in B&H will be able to ensure a bigger market position, supporting greening of transport and the Single European Railway Area.

Keywords: *Modal shift, Combine transport, Greening of transport, Sustainability, HOQ, QFD*

1 Introduction

The efficiency of intermodal transport is observed through the efficiency of the transport network, terminals, and the efficiency of freight transport services. The paper contributes to determining intermodality as a qualitative indicator of the level of use of economic efficiency of combined (road-rail-road) transport through a systematic approach to the problem where the reform processes in Bosnia and Herzegovina, ie the Federation of BiH and Republika Srpska in this area will be considered through the house of quality.

The aim is to analyze the quality of modes of transport by applying the method, which transmits the house of quality (HOQ-house of quality) in the approach to the quality function deployment (QFD). By identifying the possibilities that transport should have (internal variable "WHAT") in order to meet the needs of the customer of the transport service, certain criteria for evaluating service providers (external variables "HOW") are established in order to make the final ranking. The whole procedure is carried out by correlating the importance of

"WHAT" due to the weight of "HOW" and the impact of each mode of transport. This paper shows that the analysis of the quality of combined transport is an essential step not only in defining the potential of the market but also in the formation of policies, technical operational strategies, and commercial approaches to realize this potential.

2 Concept of modal shift

The term we hear more and more often is "modal shift," which is one of the important elements that participate in creating a sustainable transport system. a transportation system that will benefit everyone. In its context, the term "modal shift" means a change from one mode of transport to another. Climate change as well as the energy crisis have led to the need for significant changes in the way we live, work, and travel if we want to embark on an environmentally sustainable path. This doesn't have to be a "doom" scenario. History tells us that we often develop our best innovations in times of greatest danger. Thus, the

thinking of transport users about changing the mode of transport in the current circumstances can lead to a more efficient, productive, and sustainable transport system.

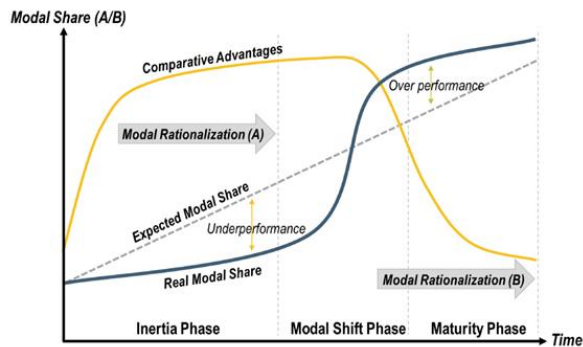


Fig. 1. Principles of modal shift [1]

The modal shift occurs when one mode of transport has a comparative advantage in a similar market over another. Comparative advantages can take many forms, such as price, capacity, time, flexibility, or reliability. Depending on what is being transported, the significance of each of these factors varies. Within the distribution chain in the book "The Geography of Transport Systems", Jean-Paul Rodrigue, Claude Comtois, and Brian Slack first edition 2006 [2] are identified four different cyclical phases of functional integration of different modes of transport (initial part, expansion, and interconnection, standardization and integration, integrated demand). Based on research [1], [2] the principles and theories of the modal shift are defined as three phases: inertia phase, modal shift phase, and maturity phase (Fig. 1).

1. **Inertia phase:** Initially, a high level of inertia makes modal shift a slow process and is sometimes difficult to detect. Only a few beneficiaries can experience a modal shift, often as part of a government-subsidized initiative. Negotiating new procedures and new contracts are tasks that companies are reluctant to undertake if the benefits are not obvious
2. **Modal shift phase:** This phase represents a rapid transition from one mode of operation to another as the industry recognizes its strengths. The new mode of transport is evolving from a situation of insufficient performance to a situation of progress.
3. **Maturity phase:** At this stage, the market potential is achieved by a new balance in modal shares. Their comparative advantages

are less variation, which implies limited incentives to shift goods or passengers. The focus becomes more efficient use of modal means.

3 Road-Rail combined transport

The European Union as well as the European Conference of Ministers of Transport (ECMT) and the United Nations Economic Commission for Europe (UN/ECE) have accepted the following definition of Combined transport (CT) [3]:

“Intermodal transport where the major part of the journey, in Europe, is by rail, inland waterways or sea, and any initial and/or final legs carried out by road are as short as possible.”

Union for Road-Rail Combined Transport (UIRR) actively promotes Combined Transport while also supporting the daily functioning of this ecologically and economically sustainable mode of long(er) distance freight transport. The combination of road and rail brings together the advantages of both rail and road in two concepts [3]:

- **unaccompanied CT**, the goods travel in swap bodies, standardized containers, or semi-trailers. These are efficiently transferred at transshipment sites, also called terminals, which are conceived to act as the link between these methods of transport.
- **accompanied CT**, the whole road vehicle is involved, i.e. the traction cabin too, which is driven onto a special wagon, and the driver accompanies it in a specially fitted couchette wagon.

4 The path to be followed

Current transportation systems come with a wide range of issues, including global warming, environmental degradation, health implications (physical, emotional, mental, spiritual), and greenhouse gas emissions. In fact, 23% of global greenhouse gas emissions from fossil fuel combustion are attributed to the transport sector [4]. Road transport has a share of 75% of total greenhouse gas emissions. All this puts a lot of pressure on national governments to develop policies to reduce greenhouse gas emissions. A specific solution is the greening of transport, which means the use of any type of transport

service that is environmentally friendly and has no negative impact on the immediate environment.

The European Commission's 2001 Transport White Paper [5] aims to shift 30% of road freight over 300 km to other energy-efficient modes of transport, such as rail or waterborne transport by 2030. The increased demand for rail transport promoted by public authorities may be a challenging target for the rail freight sector due to the large volume of goods it entails. Moreover, the growth of rail freight transport could lead to the need to expand the railway network, which includes environmental effects. EU transport policy calls for standards to be defined to reduce the harmful effects of traffic on the environment. Fully in line with The European Commission's Transport White Paper, Bosnia and Herzegovina is working with all relevant actors to create a political environment that supports the following three pillars:

- 1) improving the infrastructure financing policy,
- 2) improving infrastructure capacity and
- 3) establishing fair conditions of competition between different modes of transport.

This was not an easy mission, but B&H adopted a long-term transport policy and strategy through its institutions (2016-2030) [6], [7] thus accepting the fact that railways are the cornerstone of today's and even more future European supply chains. through the development of combined transport.

5 Ambitions and perspective of modal shift in B&H

Practically in B&H, in combined transport, the flexibility achieved by road freight vehicles can be naturally and inseparably combined with the efficiency resulting from the transport of bulk cargo by rail over long distances. In order to effectively consolidate and develop the position of combined transport on the BiH market, various actors (carriers, freight forwarders, shippers...) will have to think in a more European way and act in accordance with market economy regulations.

The advantages of the combined transport system will not be fully realized until the competition between combined (rail-rail-road)

and clean road transport becomes only a subject of the comparison of comparative conditions and without favoring one mode of transport over another. All previous experience has shown that the minimum requirements defined by the directive on the separation of infrastructure and transport into purely administrative parts are not enough. Only a complete institutional separation into two independent companies can guarantee equal conditions for all railway companies.

5.1 Problems with using combined transport

Combined transport in B&H is almost non-existent, however, container transport (especially maritime) has been growing rapidly in the world over the last 30 years (exponential function). Therefore, significant growth rates can be expected in the coming years. Thus, B&H must build a multimodal infrastructure in order not to be excluded from international transport flows and thus hinder its economic development. Earlier forecasts have shown that it is more dangerous to underestimate the increase in containerization than to overestimate it. The current situation in combined transport in B&H is characterized:

- low intensity and consolidation of goods flows on the main transport routes, which makes it impossible to establish regular block trains;
- transport flows are unbalanced and relate mainly to the import of goods, which is why containers are often returned empty;
- the organizational framework is complex and characterized by unclear relationships and undefined roles of participants in combined traffic,
- there are no financial incentives in favor of combined transport, which relate to the purchase of special vehicles, handling equipment, transport vessels, and containers.

Table 1. Container transport by ŽFBH

Year	CTR "20"	CTR "40"
2017	6044	216
2018	5995	1304
2019	5519	796
2020	4623	483
2021	4832	204

Source: ŽFBH

Republika Srpska (RS) railways do not have data on the transport of containers on its network, which is one of the major shortcomings for monitoring the participation of railways in combined transport. Data for the period 2017-2021. of container transport for ŽFBH are given in Table 1.

In order to achieve the goals of the development of combined transport, it is necessary to harmonize the integration between modes of transport, infrastructure, hardware (cargo units, vehicles, telecommunications), operations, and services, as well as the regulatory framework.

5.2 Perspectives for the development of combined transport

With the adoption of the Transport policy [6], and through the action plan given in the Transport Strategy for B&H [7], the emphasis was placed on the equal development of all modes of transport and equal participation in the transport chain through combined transport which will be shown in HOQ (House of Quality).

The following types of goods imported or exported from Bosnia and Herzegovina could be containerized in the future:

- steel and iron scrap (Mittal Steel) in part, depending on size and quantity,
- fertilizers (GIKIL Lukavac), 100%,
- hydrated alumina and zeolite (product of the company Birač from Zvornik and raw materials of the company Aluminij Mostar), partially,
- alumina (Aluminij Mostar) partially, depending on size and quantity,
- salt (Tuzla Saltworks), 100%,
- soda and derivatives mainly for export (Sisecam Lukavac), 100%,
- construction materials (except cement), in part,
- wood: untreated, partially sawn; wood products (wood-based panels, etc.), 100%,
- paper, mainly for bags (Natron Maglaj), 100%,
- cellulose (SHP Celex), 100%,
- metal processing products, including the automotive industry in part, depending on size and quantity
- miscellaneous, including consumer goods, one hundred percent.

Table 2. Combined transport routes

Combined transport routes for which the FBiH has expressed interest	
Brčko border	Čapljina border Lukavac
Semizovac	Čapljina border
Sarajevo Cargo	Čapljina border
Maglaj	Čapljina border
Čapljina border	Lukavac Konjic Visoko
Lukavac	Šamac border

Every year, the Government of the Federation of Bosnia and Herzegovina expresses the FBiH's interest in providing rail passenger and combined transport services [8]. The interest is determined that the ŽFBH provides passenger and combined rail transport services on certain routes (Table 2).

Based on that decision, the Federal Ministry of Transport and Communications concludes an agreement with the ŽFBH on co-financing the provision of public railway passenger and combined transport services on these routes.

The development of the transport network and combined transport infrastructure in B&H takes place through active participation in the work of The Transport Community as an international organization in the field of mobility and transport, consisting of 33 participants - the EU and six Western Balkan countries. It is very important that the transport network of B&H is part of the unique transport network of Southeast Europe.

According to the positive example of air transport and the European telecommunications sector, only free access to the network for all qualified candidates is the key to the liberalization and revitalization of rail freight.

6 QFD method analysis of quality

The choice of individual forms of transport or combinations of modes of transport for the transport of goods in BiH is a limited number of factors related to transport infrastructure, nature of transported products, transport decision-makers, transport service providers, and the

prevailing environmental factor (greening transport).

Quality Control (QC) tool for continuous quality management with Quality Function Deployment (QFD) method to define the "voice of the customer" will establish a quality relationship between transport users, carriers, and the community, which will affect the success of the service combined transport market. An example of the application of the QFD method in intermodal transport is given in [9] and takes place through three "quality houses" where they are defined:

1. through the first "quality house", the requirements of intermodal service users;
2. through another "house of quality", important features of intermodal service;
3. through the third "house of quality", the way of providing intermodal service.

In this paper, we will focus only on the presentation of the first quality house, where the input variables of the question "WHAT" will be the strategic goals set in [7], and the answers "HOW" will be the action plan for railways given in [7].

6.1 House of quality

The basic tool of the QFD method is the House of Quality (HOQ). It consists of the whole concept of developing a new product or service starting from the needs of the customer, determining the relative importance of each of these requirements. The result is a network of matrices that allows a clear view of the design process and its outcome (Fig. 2). Matrix construction vertically represents customer/user expectations and horizontally specifications.

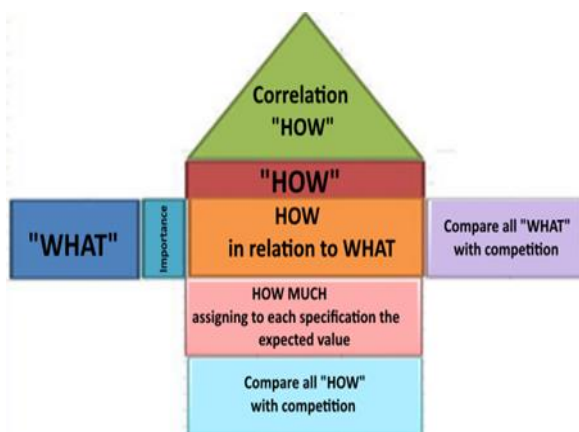


Fig. 2. "HOQ" construction

The QFD method takes place in two phases: step-by-step construction of the "quality house" and development of the "quality house" (Fig.3).

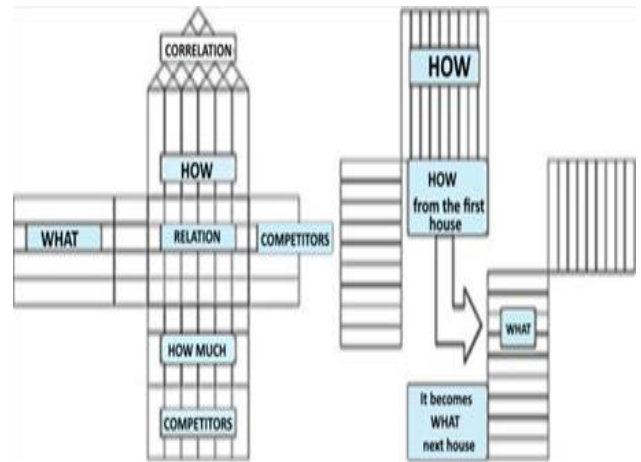


Fig. 3. Development of "HOQ"

6.2 Application of QFD method in combined transport

Combined transport is a concept that has been applied with greater or lesser success for years. The story and idea of combined transport have two segments:

- users and their desire to transport goods;
- the ability of combined transport to satisfy the wishes of users.

The point is to satisfy these two sides, and that can be achieved by the function of quality distribution, ie the QFD method that allows this connection to be in the function of the requirements of both the individual and society and service providers in combined transport. A method that can help to establish a link between users, carriers, and society in order to develop combined transport is the quality function deployment (QFD).

6.3 "WHAT" requirements

User requests can be stated and not expressed, ie there are conditions that are implied even though they are not expressed by the user. Using data from [7], the basic requirements of "WHAT" are:

WHAT-1: Adapted transport pricing system;

WHAT-2: Financial Sustainability: define stable sources of funding for the maintenance of railway infrastructure;

WHAT-3: Compliance with EU standards and laws: these are legislative interventions;

WHAT-4: Minimum allowable impact on the environment;

WHAT-5: Security and Information: Meeting security and information needs;

WHAT-6: Meeting the needs in terms of maintenance, improvement, and development of transport infrastructure;

WHAT-7: Service Integrality.

The price of transport is not explicitly a parameter of quality, but it is an important parameter when choosing a carrier for users of transport services. There must be a user-friendly pricing system with respect to external traffic costs.

From the Pareto diagram of the “WHAT” requirements (Fig. 4) it can be seen that the basic user requirements are arranged according to their importance as follows:

WHAT-3: compliance with EU standards (21%),

WHAT-7: service integrity (19%).

WHAT-4: minimum environmental impact (19%)

6.4 Answers “HOW”

On the one hand, there are users of transport services and their basic requirements, and on the other hand, the ability of combined, road, conventional rail to meet the requirements of users.

The function of quality distribution, ie the QFD method, enables this connection to be in the function of the requirements of the individual, the company, and the service provider. To the defined requirements of “WHAT” users of transport services, the quality matrix gives the answer “HOW”:

HOW-1: Number and structure of cargo handling units: Sufficient number of containers of different sizes (small, medium, large) and appropriate purposes (universal and special);

HOW-2: Technical improvement and modernization of railway infrastructure, existing infrastructure to increase speed and safety in order to EN and TSI;

HOW-3: Defining models for financing railway infrastructure;

HOW-4: Complete implementation of the Law on Financing of Railway Infrastructure by allocating total maintenance costs from the budget;

HOW-5: Introduction of excise taxes on fuel or tobacco products to finance railway maintenance;

HOW-6: Business modeling of a railway company, restructuring;

HOW-7: Defining a long-term scenario for opening the railway market;

HOW-8: Adoption of EU directives on interoperability and security (2016/797, 2016/798);

HOW-9: Align existing legislation with EU legislation; EU acquis

HOW-10: Commitment to greening transport;

HOW-11: Development of a railway terminal/intermodal freight terminal (combined and conventional);

HOW-12: Define incentive schemes for CT.

Analyzing the results of the “house of quality” (Fig. 4), we notice that there is not a single request “WHAT” that does not have the answer “HOW”, which is one of the prerequisites for the construction of the “house of quality”.

Also, the roof of the “house of quality” or the correlation “HOW-HOW” shows that there are no answers “HOW” that are in contradiction with each other, ie the execution of one would prevent the execution of the other.

The Pareto “HOW” response diagram (Fig. 4) set out the priorities that need to be improved in order to increase the quality of the combined transport service:

HOW-1: number and structure of cargo handling units (16%),

HOW-8: adoption of the EU Directive on Interoperability and Security (15%),

HOW-2 and HOW-5: technical improvement and modernization of infrastructure as well as the introduction of excise taxes (10%)

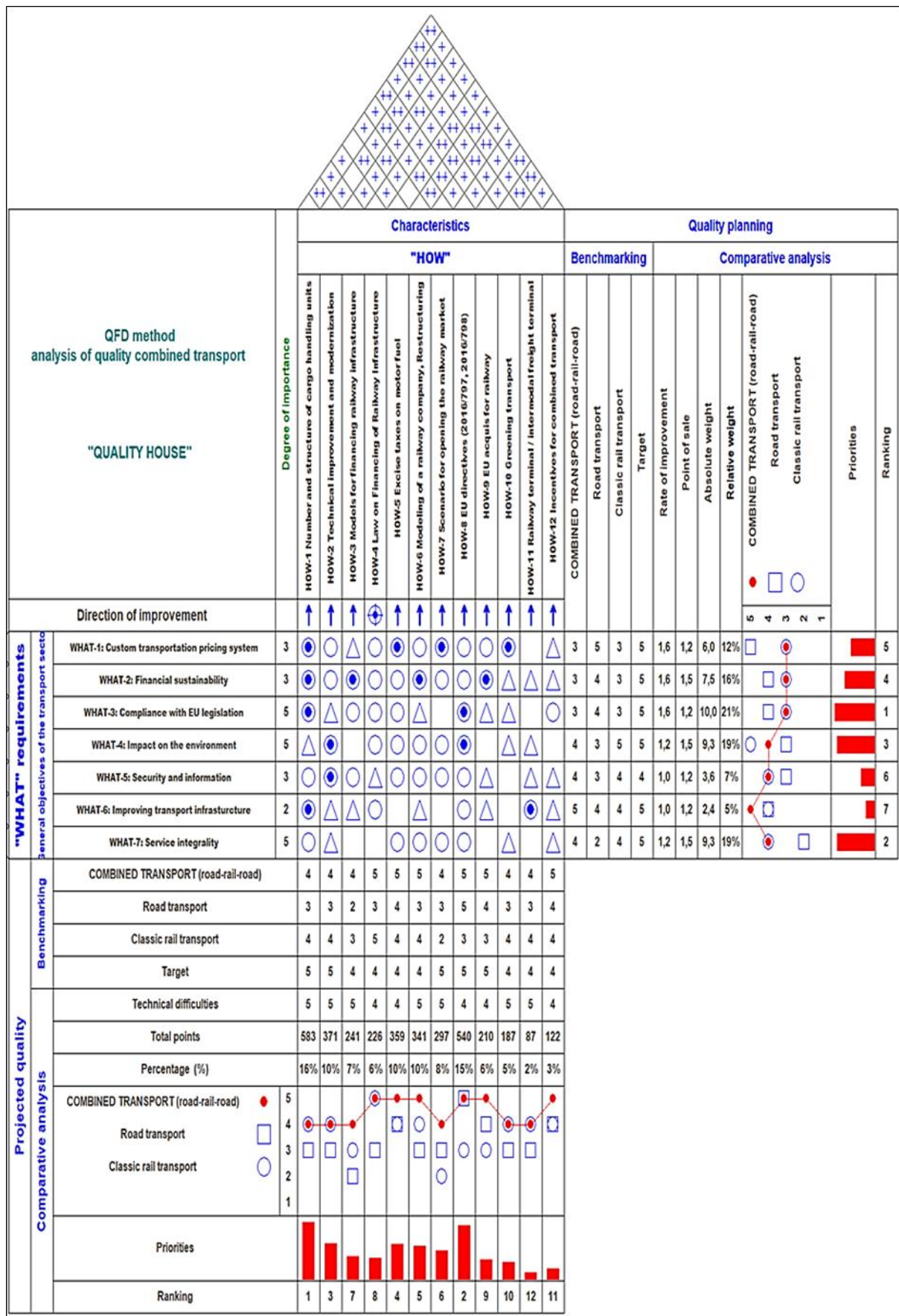


Fig. 4. House of Quality "HOQ" (Program "QFD - Quality Function Deployment Versao 1.1 - Free")

7 Conclusion

There is no absolute superiority of some modes of transport, but based on the given guidelines and through the growing awareness of public opinion regarding environmental protection, renewing the commitment and efforts of state governments to develop intermodal transport through certain subsidies is a clear sign that priority is given to combined transport. Combined (road-rail-road) transport maintains a balance between road and rail transport by ensuring regular competition and linking the development goals of these two modes of transport. It is necessary to control the growth of road transport and fight for the development of rail transport and other ecological modes of transport in order to enable them to be a competitive alternative in the development of combined transport services.

The quality of combined transport is the key in its competition with different modes of transport. Quality is considered a very important factor of competition as it has been recognized that the lack of quality is a clear source of costs in performing combined transport, which cannot be accepted by users or operators. Questions: what constitutes the quality of combined transport; demand-side quality requirements and supply-side quality indicators; how the quality of combined transport can be improved, were the subject of analysis of this paper using the QFD method. The "HOW" answers in the quality house showed that a sufficient number and appropriate structure of freight handling units, modernization of railway infrastructure, the introduction of excise taxes on fuel to finance railway infrastructure, and commitment to greening transport can increase the quality of combined transport services.

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