

KNOWLEDGE MANAGEMENT SYSTEM FOR IMPROVEMENT OF QUALITY OF RAILWAY TRANSPORT SERVICE

Assoc. Prof. N. Georgiev, PhD.¹

Faculty of Transport Management – Higher School of Transport, Bulgaria¹

Abstract: *In the past, the railway industry has been faced with simple technical and technological systems which included a small number of defined inputs and outputs, comprising only simple subsystems and components. Thus, a single manager could understand them almost completely and could predict failure conditions and the consequences thereof. These days, railway technical and technological systems are complex. System complexity is continuously increasing, pushing managers to better understand of how the system behaves and what its influence over transport service quality is. It should be admitted that without having a well designed, properly organized and effectively working knowledge management system with respect to factors influencing railway service quality, even the best intentions would probably be in vain. The present paper discusses the need to establish, the essence and key features of a knowledge management system in the area of the quality of transport service in railways*

Keywords: KNOWLEDGE MANAGEMENT, RAILWAY TRANSPORT SERVICE, QUALITY, OPERATIONAL RELIABILITY AND SAFETY

1. Introduction

Nowadays, due to the impact of many factors (e.g. competition in rail industry, growing demand from customers, etc.), the importance of the quality of the railway transport service is increasing rapidly. Railway companies with well-organized and properly functioning quality management systems add benefits to their performance that not only satisfy customers but also make their operations more effective and competitive. Although quality is of indisputable importance, there is a little research being done to explore this specific issue.

Researches into the field of service quality involve identification and evaluation of the significance of some particular indicators, the essence of which is characterized by the nature of the definition of quality. There are many meanings of the term “quality” but two of them have a crucial importance regarding quality management:

-Quality stands for those features of a given product (or service) which meet client needs and as a result provide satisfaction. This meaning of quality is oriented to a company’s income (a greater satisfaction of clients leads to their increased number and as a result – increased income).

-Quality means absence of deficiencies (technical failures, human errors, imperfection of exploitation process design, etc.) in a company’s functioning. In this case, there is no need for additional measures: higher quality stands for less cost.

In the past, the railway industry has been faced with simple technical and technological systems which included a small number of defined inputs and outputs, comprising only simple subsystems and components. Thus, a single manager could understand them almost completely and could predict failure conditions and the consequences thereof.

These days, railway technical and technological systems are complex. System complexity is continuously increasing, pushing managers to better understand of how the system behaves and what its influence over transport service quality is. It should be admitted that without having a well designed, properly organized and effectively working knowledge management system with respect to factors influencing railway service quality, even the best intentions would probably be in vain.

This paper discusses the need to establish, the essence and key features of a knowledge management system in the area of the quality of transport service in railways.

2. Essence of transport service quality and need for its management

Today in modern society, the daily lives and schedules of many people are more dependent on the transport service of railways than ever before. As a result, the importance of service quality is increasing rapidly.

There are a large number of definitions for quality currently being used in many industrial areas but few in the field of railway transport services, although this term is broadly used in papers, researches and regulations. In the light of the characteristics of railway operations and with adaptation of the definition of quality stated in [2], the quality of transport service could be indicated as: *a complex property of a given railway technological system (e.g. railway undertaking) to perform its functions connected with the transportation of passengers and goods properly and in accordance with certain pre-determined performance (service) standards, designed in compliance with specific criteria and operational indicators (characteristic of the system).*

On the basis of such a definition, the next five basic properties of service quality in respect of a railway undertaking functioning can be defined:

-*Duration of transportation (goods or passengers)* - determined by the speed of transport means moving from the initial to the end point of a given transportation route.

-*Convenience* - creating normal and ergonomic travel conditions for passengers in transport means, facilities for loading and unloading freights, etc.

- *Cultural services* - ethical and polite relation to customers of a railway undertaking (passengers or shippers), high level of sanitary and hygiene conditions in transport means, etc.

-*Protection of cargo* - creating conditions to prevent damage to the cargo during the transport process.

-*Reliability* - ability of a railway technological system (undertaking) to perform its required functions under stated conditions within a specified period of time. Reliability has three basic properties:

-*Punctuality* - associated with the timely arrival/departure of trains at/from stations, i.e. train delays are both qualitative and quantitative criteria to assess the reliable implementation of requirements. Punctuality is an important indicator for the accuracy of implementation of the planned timetable and usually is defined as a percentage of trains arriving on time (of total number of trains realized) within a sufficiently significant period of time.

-*Regularity* - characterized by reliable implementation of each single train route. Due to many causes a given train route

could not be entirely fulfilled (for example: an accident occurring during a train movement between initial and final stations).

-*Safety* - ability of a railway technological system to prevent hazards to the life and health of people (passengers, local population, operational staff, etc.), material damage, threat to the ecological balance of the environment, due to the influence of objective or subjective, internal or external destabilizing factors affecting the system. Occurring accidents are a measure of safety. But as the intensity of their occurrence is significantly less than the intensity of train delays, the last are key indicator of the reliability level of rail transport service.

Recently, railway transport in Bulgaria is facing tangible competition from road transport (both passenger and freight). In order to assess the situation and improve its competitiveness, railway transport as a whole should implement urgent measures. The correct understanding and evaluation of the nature of service quality and its properties is the only and correct way to identify shortcomings and improve service quality and competitiveness thereof. The above refers not only to infrastructure managers but also to all railway undertakings (operators).

In the area of railway transportation service, reference [3] proposes some minimum service quality standards. They do not cover all aspects (properties) of service quality stated above but this document gives the freedom to railway undertakings to *define service equality standards and implement a quality management system to maintain service quality*. The basis of such a system is a knowledge management system regarding all unwanted and unintended events, conditions and processes that impact negatively on one or another aspect of service quality. All properties of quality are important and should mandatorily be analyzed but safety is to be the key issue (transport service should primarily be safe) within overall knowledge management system. In other words, a safety management system of a given railway undertaking (supported by an organizational knowledge management system) is a major part of its quality management system. The nature, main components and features of such a system are discussed in the next sections of the article.

3. Nature and attributes of knowledge

Determining the importance of knowledge management amounts to answering the question of the distinction between the terms data, information and knowledge. These three terms are often used equivalently but in their essence and place within decision-making process they are quite different. The right understanding of this distinction is a basis for a successful design, establishment and functioning of knowledge management system and continuous improvement cycle (in the field of service quality) thereof. This importance is usually omitted from managers working on the problems of service quality.

Data involve facts obtained by implementing intended observation. Usually, data represent raw numbers and as a whole do not give clear picture regarding the context and essence of the investigated process.

Information is a subset of data and typically involves the processing of raw data to obtain a clearer understanding of the development trend of a given process.

Knowledge is the tip of a hierarchy comprising information at the middle level and data at the lowest level. It refers to information that enables decision-making (and actions thereof) about relationships among events and concepts relevant to investigated areas and specific processes.

Here are some examples that reveal the difference between terms data, information and knowledge.

Let us suppose that there is statistical data about serious accidents ($n_{SA,j}$), accidents ($n_{A,j}$) and incidents ($n_{I,j}$) which

occurred within the operational process of a given railway undertaking caused by j -th causal factor (from set of n possible causes of incident: $j=1, \dots, n$). It is obvious that these data are devoid of context and/or intent and in such a form they cannot be used for any profound analysis. Being just absolute safety indicators these data are not directly useful – they are not convenient to compare the performed transport service of this undertaking for different operational periods and also with the service of other competing undertakings. By contrast, that $n_{SA,j}$, $n_{A,j}$ and $n_{I,j}$ resulted from the last exploitation period are also data, but they can be directly used to compute some more useful indicators, [e.g., probability of occurrence of a given cause j ($Q_j = (n_{SA,j} + n_{A,j} + n_{I,j}) / N$), conditional probability (when cause j has already occurred) of occurrence of a given type of incident (e.g. serious accident: $Q_{SA,j} = n_{SA,j} / (n_{SA,j} + n_{A,j} + n_{I,j})$)]

and hence to make a decision (N – total number of train routes realized within investigated operational period). Therefore, when being processed properly data turn into information for decision-making. For example, the decision may be connected with the implementation of a specific mitigation measure to reduce the risk of that causal factor which has the highest probability of occurrence.

The information about Q_j and $Q_{SA,j}$ is more useful than the raw data $n_{SA,j}$, $n_{A,j}$ and $n_{I,j}$ but it does not directly help the decision-maker to make the best choice. Using the knowledge of how to compute, use further and interpret probabilities, this information can be converted into more useful information, e.g. unconditional probability of occurrence of serious accident due to

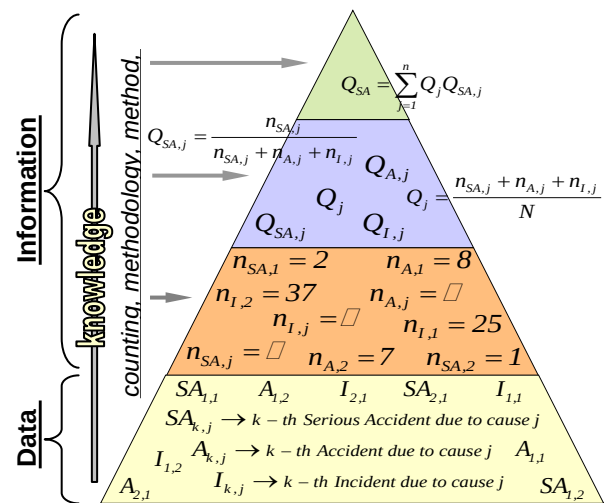


Fig.1. Relationship between data, information and knowledge

all possible causes: $Q_{SA} = \sum_{j=1}^n Q_j Q_{SA,j}$ (n - total number of

causes). In other words, knowledge involves appropriate combination of concepts, judgments, methodologies and know-how to get and process proper raw data, obtain and analyze information from them and use it for decision-making (Fig.1).

Having answered the question of knowledge attributes (data and information) another very important question arises: what must be done to get the most out of those very valuable resources? The answer here is connected with the possibility to design, organize and run appropriate knowledge management process. Virtually, the knowledge management in the field of transport service quality can be defined as *implementation of appropriate intentional activities*

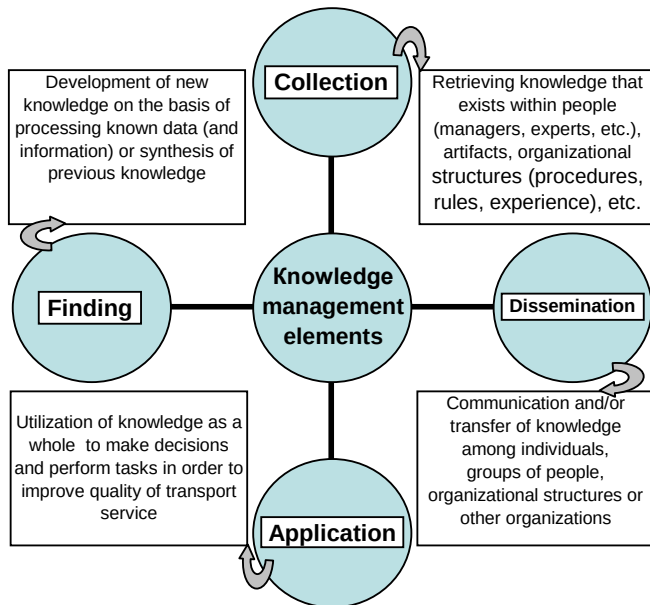


Fig.2. Key elements of knowledge management

connected with finding, collection, dissemination and application of data, information and methodology for their processing to enhance the performance of a given railway undertaking. This definition defines four key elements of the process for knowledge administration which in turn put foundations of an overall knowledge management system (Fig.2). Knowledge management system in a given railway undertaking can be defined as a permanent process of research, analysis, control and monitoring of service quality in its all properties. This is a normative and managerial system (structure) which should encompass all elements of knowledge management (described above in figure 2). Figure 3 provides a schematic description of the various aspects, subsystems and structure levels of knowledge management system.

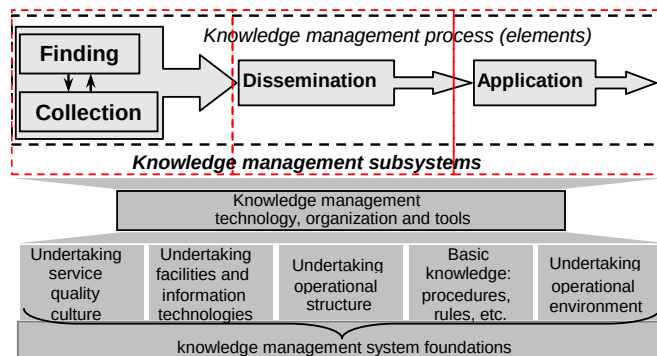


Fig.3. Structure and levels of knowledge management system

4. Role of knowledge management system within overall continuous improvement cycle in railway undertaking performance

4.1. Characteristics of continuous improvement cycle

First of all, it is necessary to define the sense of concept for continuous improvement cycle in the area of railway transport service quality. Principally, continuous improvement is a management philosophy which assumes that the improvement in a field of interest (production, services, processes, etc.) is always possible. According to this understanding, all events and processes involved in that field should be permanently analyzed and reevaluated. This analysis and re-evaluation should be used as a basis for decision-making to determine the most appropriate measures for improvement. Improvements should be implemented.

Continuous improvement is an organizational belief (culture) that effectiveness of its processes could and should always be to the attention of company's management in order to meet customers' demand. Continuous improvement relies on employees' positive involvement in finding and fixing all problems of a company's performance. Such an involvement happens only when employees are informed about company's performance deficiencies and possible ways to correct them. Only then they can improve their functioning by applying their creative faculties to their work related problems.

Continuous improvement of a given process is usually interpreted as an iterative four-step management strategy named PDCA cycle (Plan-Do-Check-Act) [1] [4]. It is also known as the Deming Cycle (named after Dr W. Edwards Deming, considered to be the father of modern science of quality). Figure 4 shows the basic details of PDCA cycle.

4.2. Railway undertaking – business and risk system

To understand the role of knowledge management system within an improvement cycle in a railway undertaking it is necessary to define the basic features of its performance, and no

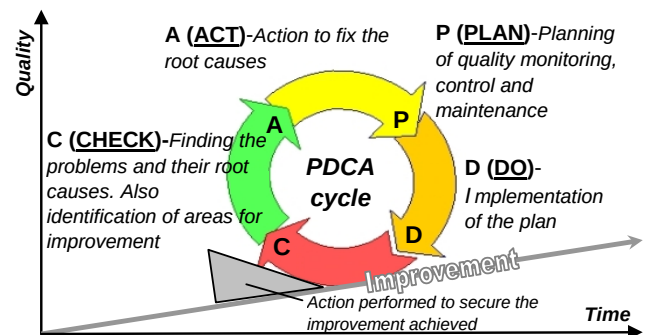


Fig.4. PDCA cycle structure

doubt that reliability and safety (as its property) are the most important of them. Therefore, it is of great use to specify railway undertaking as a risk system. This is a business system that is designed and organized to generate useful and intended outputs (conveyance of goods and people) which are realized within a specific and changeable operational environment characterized by substantial potential for the occurrence of adverse (risky) outputs (accidents and incidents). The definition above means that just as we would apply some quality management approaches and tools (e.g. organizational acquisition of knowledge) to control the quality of services from the business system, so we should apply similar tools to control the influence of incidents (as an output of the risk system) over the quality. To prevent incidents (and accidents) from occurring and to improve service quality it is necessary to have enough information regarding their characteristics, called incident learning. Incident learning is an important part of overall knowledge management system of railway undertaking. Virtually, railway staff and sometimes railway undertakings as a whole tend to hide (when possible) incidents because they are connected with liability for compensation and/or deterioration of their image to the society and state. As a result, whatever "gap" in information regarding causal factors of incidents, leads to a "gap" in knowledge management and decision-making. This is an extremely unwanted and intolerable state in a business system involved in transport service which is performed in an environment characterized by the presence of a great variety of harmful influencing factors.

4.3. Knowledge management as a powerful tool for balancing business and safety goals in railway undertaking

Principally, railway undertaking is a generic business system that is designed, organized and run to achieve a profitable output

(qualitative transport services that satisfy customers' demand). In case of not achieving the designed output due to system failures (e.g. incidents), a railway undertaking is facing some losses – system failures require time and resources for their recovery. In other words, system failures (and losses connected with them) lead to transport service gaps and performance losses.

There are many different causes for system failures but what unifies them is the fact that they are principally avoidable. The

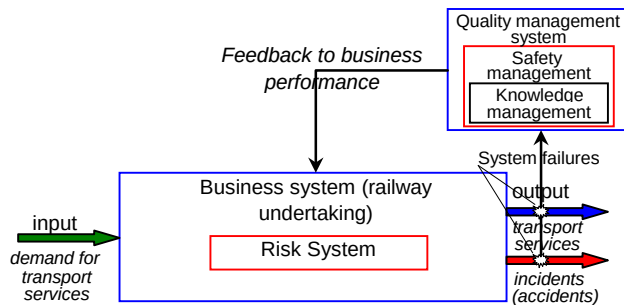


Fig.5. Business and safety management systems

avoidance of system failures is possible only when there is enough knowledge about causal factors to prevent them from occurring in the future. All this means that knowledge management is a very important tool for balancing transport service (business) and safety purposes. The relationship between the two main parts of a railway undertaking performance – system of transport process management and system of risk (safety) management, and also the role of knowledge management as a unifier of business and safety purposes are depicted in figure 5.

5. Conclusion

Railway transport service is characterized by complexity not only on the stage of design but also within its real implementation. Moreover, the functioning of a railway undertaking is realized in an environment with uncertain conditions – accidental influence of internal or external (for the organization) causal factors. Sometimes, the negative influences could fatally harm undertaking performance. This is why the knowledge about potential system failures and causal factors connected with them is a very important and powerful tool not only to support but also improve quality of transport services.

The possession of knowledge regarding potential system failures (leading to poor service quality) is quite insufficient. Knowledge should be enriched, shared and implemented for decision-making. All this is the foundation of knowledge management. The importance, structure and specifics of this foundation are discussed in this paper.

References

- [1] Basu, R. *Implementing Quality—A Practical Guide to Tools and Techniques*, Thomson Learning, London, 2004.
- [2] [EC 60050-191 *International Electrotechnical Vocabulary – Chapter 191, Dependability and Quality of Service*] International Electrotechnical Commission, Geneva, 1990.
- [3] *Regulation 1371/2007* of the European Parliament and of the Council on rail passengers' rights and obligation.
- [4] Seaver, M. *Gower Handbook of Quality Management*, Third Edition, Gower Publishing Ltd., England, 2003.