

Abstract

It is currently a pressing problem to identify quality not only before the start of transportation and during it but also after the end of transportation. Apparently, in the area of service provision in railway transport, it is important to take into account the fact that customers' requirements change over time, and thus a new software approach is required. Therefore, this paper is focused on the newest solution to monitoring process quality applied to railway companies by using various types of appropriate software. This approach is particularly significant within the whole transportation chain and also through division into its single constituent stages. In comparison with previously used methods, the established research methodology is unique, universal, and applicable to various types of companies in the context of the introduction of new trends in process-oriented quality management. Consequently, it was supported by software solutions using various quality areas defined within the research and software support, namely through Business Process Modelling Notation, Event-Driven Process Chain, and Unified Modelling Language with links to brand-new software. This focus, therefore, involves more than just knowing what customer requirements are about, but understanding how it is possible to accomplish quality targets and which operational failure should be solved in the first place.

Keywords

railway transport, quality management, process, software solution, methodology, customer, requirement

1 Introduction

There is a need to explain the problem of quality in railway transport. Goetsch and Davis's definition of quality process is applicable in the conditions of railway transport and means that 'acceptable levels of quality are not fixed, but change with customers' experiences and view of the transportation' (Knowles, 2011). According to this claim, quality is defined by the customer, and as such it will change over time, often in unpredictable ways. It is associated with creating customer value (Chesbrough et al., 2002). Due to this fact, a quality of railway service should meet or exceed the whole range of customer expectations. As a complex concept, quality can only be addressed by the whole process, with railway management and employees working together (David, 2013).

According to Brnjac et al., a high level of quality is one of the strategic factors in any plan for company health. As shown by Chesbrough and Rosenbloom (Antony et al., 2002), viewing quality from a societal perspective within transport is significant, because it includes customers, carriers, manufacturers, and the community (UIRR, 2015).

If 'quality' is the end point, then 'quality management' is the approach and process for getting there (Bianchi, 2001 and Majerčák et al., 2010 and Nedeliaková et al., 2013). Accordingly, a railway company also needs to develop an appropriate understanding of what this idea means in its conditions. In this context, there is no simple definition that encapsulates the area; instead, the railway company needs to recognise the key principles that are midmost to the topic.

Fergusson and Ryan (Majerčáková, 2012 and Sujanova et al., 2012) found that providing 'value' to customers needs to consider how railway companies can improve processes. There are numerous principles that are central to the practice of quality management in railway transport, such as customer focus, people focus, strategic focus, leadership, scientific focus, systems thinking, and process focus (Jurkovič et al., 2015 and Nedeliaková et al., 2015).

Process improvement in a railway company is not simply about responding to problems, although this is necessary; it is about proactively seeking to learn about customers, processes,

¹ Department of Railway Transport,
Faculty of Operation and Economics of Transport and Communications,
University of Žilina,
01026 Žilina, Univerzitná 1, Slovakia

² Department of Railway Transport,
Faculty of Transport and Traffic Engineering,
University of Zagreb,
10000 Zagreb, Vukelićeva 4, Croatia

* Corresponding author, e-mail: michal.panak@fpedas.uniza.sk

and behaviors (Šatanová et al., 2004). This relationship between improvement upon existing practices and innovation in developing new markets, processes, and practices has been studied during the solved research.

The results of other studies, (Brnjac et al., 2010 and Klapita et al., 2013 and Nedeliaková et al., 2014) have shown a higher affinity of competitiveness in the transport market with innovative trends in process-oriented quality management within railway transport.

However, quality cannot be inspected in a product; it has to be built into each process, which is the basic idea of this research topic (Juran, 2015). The achievement of true success lies in the ability to predict future trends and embrace them successfully, rather than letting them affect business adversely. This is also true in the case of transport (Nedeliaková et al., 2014 and Zabaha et al., 1998). Adapting to change is particularly difficult for transport with its long historical basis, assets that last for decades, and the dominance of various means of transport. Some kinds of transport tend to react slowly and consequently lose their good position in the transport market (Klementová, 2014).

Nowadays, the main approach generally focuses on processing. In accordance with the above-mentioned facts, it is essential to provide services within transport with integrated planning and process organisation, which is the activity of developing the products and processes required to meet customers' needs (Pfohl, 2008 and Vetráková et al., 2013). It involves a number of universal steps, as defined by Juran and DeFeo (Brown, 1992 and Nedeliaková, 2015):

- define the customers,
- determine the customer needs,
- develop product and service features to meet the customer needs,
- develop processes to deliver the product and service features,
- transfer the resulting plans to operational personnel (Brown, 1992).

As Juran intended and experience has shown, the term 'universal' implies that the activities can be applied across any organisation at various levels, so they are applicable to the transportation chain (Coronado et al., 2002). As Drucker said, strategic planning is the continuous process of making present entrepreneurial decisions systematically and with the greatest knowledge of their futurity, organising systematically the efforts needed to carry out these decisions and measuring the results of these decisions against the expectations through organised, systematic feedback (Knowles, 2011).

In this paper, we consider a particular need for efficient process management through various quality management tools with software support. These trends have been identified within the research in cooperation with 12 European railway operators (Nedeliaková, 2015).

2 Description of the methodology steps

For the needs within the frame of research, in collaboration with foreign European railway companies, a methodology was applied that takes into account the parameters of transportation by linking the perception of service quality in ordinary and extraordinary operations (Chong et al., 2011 and Sekulová et al., 2013).

2.1 Quality dimensions – two types of operations

The first step specifies the partial processes necessary during the valuation of the service quality offered by a railway company, whereby two different dimensions of quality are distinguished:

- the routine dimension, which involves normal operation without irregularity,
- the dimension of special conditions, which takes into account failures caused by railway operators, infrastructure managers, or a third party (e.g. the public)(Nedeliaková et al., 2015).

Both are also possible to observe after the realisation of transportation (Nedeliaková et al., 2014).

The routine dimension is typical of normal operations, when the service is provided in normal conditions. At that time, the expected process of transportation is followed, so this process is known. The process of service provision is a routine matter for employees and is standardised (Nedeliaková et al., 2015 and Pyzdek et al., 2013).

Customers expect the parameters of the dimension of special conditions in special situations only (Poliak et al., 2014). These situations may be caused by weaker performance, a mistake made by the transporter as the service provider, a mistake caused by the manager of infrastructure, or exceptionalities arising in connection with the need to provide unusual access to a customer with unique requirements (Skrinjar et al., 2015). This dimension simultaneously includes supplementary performances in customer care, which the customer does not expect, such as after completion of the transportation itself. Generally, according to the research, the expectations of the customer that his or her special requirements will be met quickly are relatively low (Drucker, 1999 and Nedeliaková et al., 2014). In that case, an opportunity arises for the transporter to exceed the expectations and leave the impression of good quality and a high degree of competence in solving problems, even after the end of transportation.

2.2 Quality parameters and algorithm for process-oriented quality management in railway companies

The second step of the methodology was focused on the definition of parameters (criteria) for normal operation and for special conditions, and a new algorithm for process-oriented quality management was found and applied to railway companies (Hudakova et al., 2015 and Nedeliaková et al., 2015).

The selection of parameters within the frame of the research markedly came from practical operation; experience with contact with customers regarding their interests, requirements, needs, and the factors that are attractive to them; observations of the decisions about the utilisation of railway transport; and the purpose-built unit structure in a formally organised railway company (Nedeliaková et al., 2015).

The selection of parameters for ordinary and extraordinary operations was realised within the frame of the research by considering the interconnection with their possibilities of assessment by means of objective and subjective quality methods, including Six Sigma methods, because the set of parameters is varied, and some parameters are demanding in their qualifications (Nedeliaková et al., 2015 and Poliak et al., 2014).

For assessment, the resulting level of quality is necessary to connect the results of the measuring and rating by both types of methods (eventually with the use of a combination of several methods) (Nedeliaková, 2015).

All these principles were based on a correctly defined goal of quality in the transportation chain of railway transport, as well as the expectations and needs of customers resulting from the research conducted (Nedeliaková et al., 2014 and Youssef et al., 1996).

The selection of parameters was made in accordance with the algorithm shown in Fig. 1. The figure documents the activities that were within the frame of the research conducted and served for the identification of customers and the determination of the needs of customers and processes, which are necessary to be able to reach the required quality.

After detailed findings and searching, this scheme was used as a so-called map of quality planning, because the quality planning underway follows these systematic steps (Nedeliaková et al., 2014 and Poliak et al., 2014).

For the transportation chain, six basic parameters of quality were defined in the research in six quality areas:

- Information = systematic provision of knowledge about the system of railway transport, which assists in the realisation of acts after the execution of transportation.
- Availability = scope of the process in terms of time, frequency, geography, and suitability of railway operation techniques.
- Reality = temporal, spatial, and informational security of the phase after transportation, including ensuring the intactness of the consignment after transportation.
- Flexibility = speed of handling complaints in the case of additional customer requirements after transportation, including exact invoicing of fees for transportation.
- Customer care = reinsurance of operations related to unloading of consignment in the destination station, solving the problems that arise after the end of the transportation.
- Understanding and knowledge of customers = help and support customer needs, knowledge of customer needs (Nedeliaková et al., 2015).

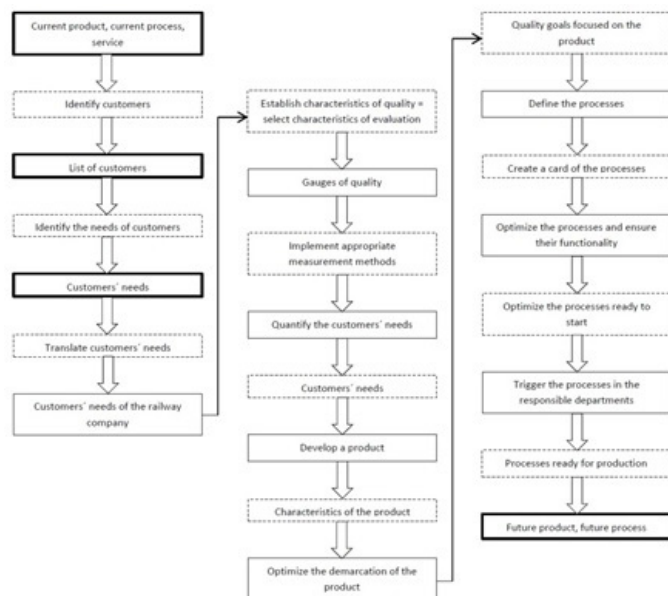


Fig. 1 Methodology for process-oriented quality management with selected areas of evaluation

This methodology allows the monitoring of process quality provided throughout the transportation chain, thus encompassing the quality before, during, and after the end of the transportation.

2.3 Software support

The third step included the connection of previous steps into software solutions using various quality areas defined within the research and software support through Business Process Modelling Notation (BPMN), Event-Driven Process Chain (EPC), and Unified Modelling Language (UML) (Nedeliaková et al., 2015). These approaches were fulfilled with band-new software. Furthermore, their connection has significant benefits, including:

- gaining a better understanding of the processes,
- making managers' work easier,
- these software tools have never been used in railway companies before,
- this research allowed the use of innovative trends to obtain clearer management attitudes (Heidari et al., 2014 and Nedeliaková, 2015).

Figure 2 shows the fragment of the software support, including the modelling of one of the processes using the BPMN application. Figure 3 demonstrates the fragment of UML application. The numerical abbreviations used in the pictures (e.g. RP 03.05) are the code names of the processes (Hudakova et al., 2015 and Nedeliaková et al., 2014).

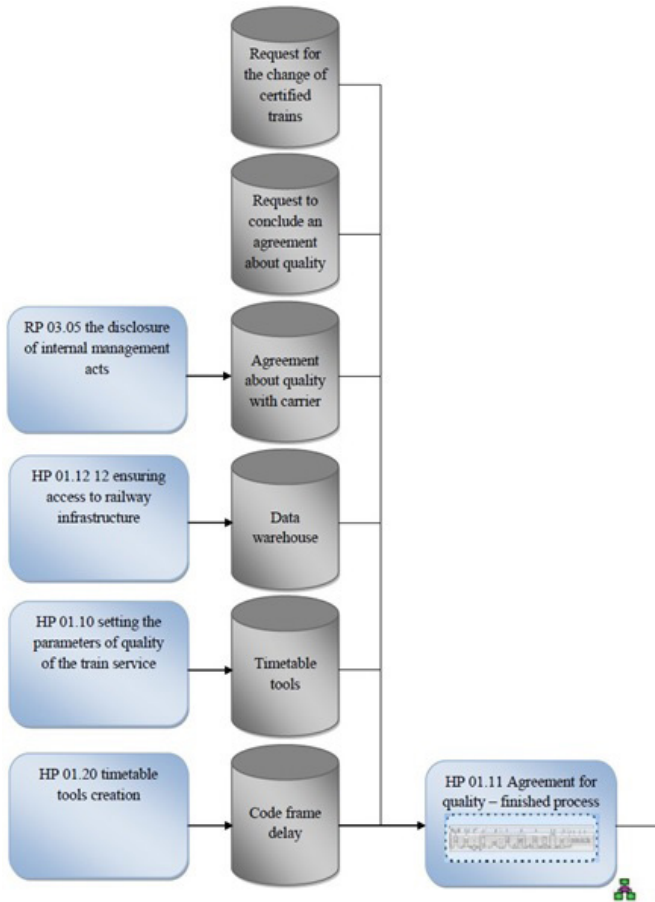


Fig. 2 The fragment of process modelling using the BPMN application, a part of the process ‘Quality contract between railway operator and infrastructure manager’. The partial process HP 01.10 included new quality parameters that were established for routine operations and, on the other hand, for special operations, which takes into account various failures, such as locomotive failure, infrastructure failure, and personal failure (Nedeliaková, 2015).

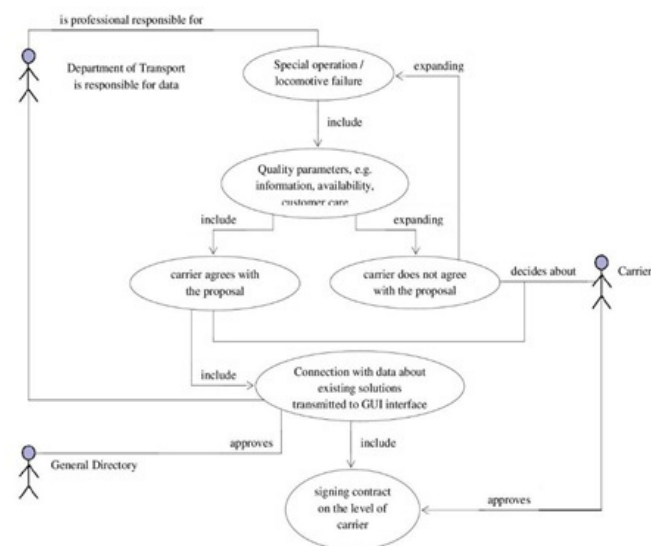


Fig. 3 The fragment of process modelling using the UML application, a part of the same process ‘Quality contract between railway operator and infrastructure manager’ that emphasises established quality parameters

3 Connection of software solutions

Improving quality in these areas is difficult in practice, as it is subject to financial claims, access of the state, and the managers of railway companies. To be able to proceed to improve the quality, knowledge of the constraints that affect the quality of services negatively is necessary (Nedeliaková et al., 2015).

Therefore, a connection of software solutions was launched, namely connection of EPC, BPMN, and UML diagrams with a new solution using a GUI. The above-mentioned diagrams create the dynamic basis (dynamic models) for modelling quality processes, but it is most important to find all possible constraints through the connection of these diagrams to one data application (Nedeliaková, 2015).

Simple steps to connect software solutions are as follows:

- Choose train, track, whole train route, quality criteria (parameters), and operation failure,
- Go to dynamic models (diagrams) – automatically create each diagram (select which is the easiest for users to understand and best fits the description of routine or special operations) according to defined quality parameters,
- Identify and analyse all constraints through each part of transportation or within the whole chain with the help of software,
- Assessment of all constraints using selected quality methods,
- Communication through all participants in the transportation chain,
- Continual improvement using this software connection, as shown in Fig. 4.

The final version of this application can be used for the needs of passenger transport and freight transport (Nedeliaková, 2015).

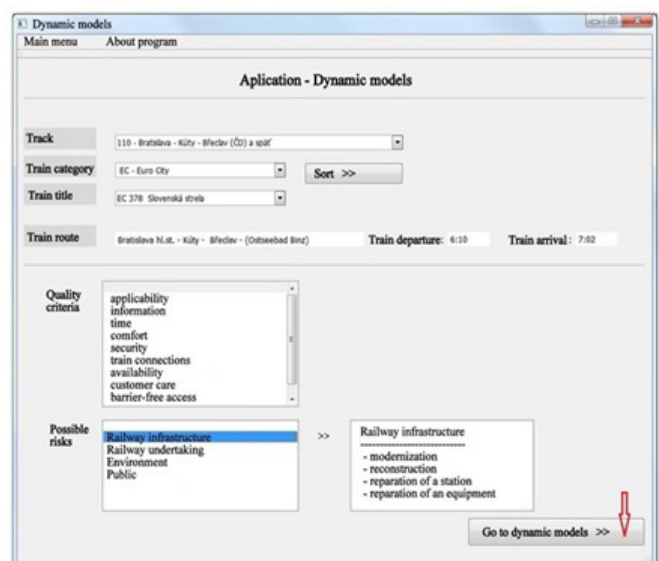


Fig. 4 The fragment of GUI

This version was verified in the conditions of three railway operators, but it is applicable to the whole transportation chain and in accordance with the specific conditions in different companies; nevertheless, it is difficult to fulfil data connected with a whole company, so the database should be filled continuously (Nedeliaková, 2015). After these activities, the methodology becomes convenient and comprehensible for users. The methodology was created for managers of railway companies and dispatchers, and it allowed monitoring of constraints and optimisation of processes.

4 Conclusions

Well planned and executed process-oriented management, including follow-up actions, can deliver significant benefits, such as gaining data on what has been achieved and what still needs to be done, thus enabling managers to prioritise action based on facts and identified needs (Knowles, 2011). Finally, the methodology is a practical tool for driving continuous improvement and data on improvements over time for an objective review of progress (Drucker, 1999). Providing a common innovative approach to use all departments of a railway company and on all sites accordingly methodology minimising the effort needed to develop assessment methods at different sites (Knowles, 2011).

The research revealed that the biggest problems occur in technical securing within the evaluated services, but they are also related to insufficient equipment or insufficient conditions and the number of certain types of wagons (Nedeliaková, 2015).

These problems interfere with the phase of the transportation chain after the end of the transportation and play an important role in normal and extraordinary operations. A suitably chosen methodology for identifying the level of quality of transportation services must meet the requirements in the transportation market and, in specific examples, those of the selected stations and track sections in order to provide relevant results (Nedeliaková, 2015).

In addition, the benefit of the research is a newly created methodology, with exact definitions and detailed quality characteristics designed for the management of railway companies.

In essence, it was created to be universal and therefore with the possibility of application to the whole transportation chain and in accordance with the specific conditions in different companies.

Acknowledgement

The project presented in this article is supported by the project KEGA 026ŽU-4/2015 Innovative approaches in system of teaching management in the study program Railway transport with a focus on application the dynamic quality models in the railway transport.

References

- Antony, J., Banuelas, R. (2002). Key Ingredients for the effective implementation of Six Sigma Program. *Measuring Business Excellence*. 6(4), pp. 20-27. <https://doi.org/10.1108/13683040210451679>
- Bianchi, A. J. (2001). Management indicators model to evaluate performance of IT organizations. In: Proc. of the 1st International Conference on Management of Engineering and Technology, Portland, pp. 217-229. <https://doi.org/10.1109/PICMET.2001.952021>
- Brnjac, N., Abramovic, B., Maslaric, M. (2010). Forecasting intermodal transport requirements on corridor X. *Promet-Traffic & Transportation*. 22(4), pp. 303-307. <https://doi.org/10.7307/ptt.v22i4.195>
- Brown, A. (1992). Industrial experience with total quality management. *Total Quality Management*. 3(2), pp. 147-156. <https://doi.org/10.1080/09544129200000016>
- Coronado, R. B., Antony, J. (2002). Critical success factors for the successful implementation of Six Sigma Projects in organizations. *The TQM Magazine*. 14(2), pp. 92-99. <https://doi.org/10.1108/09544780210416702>
- Chesbrough, H., Rosenbloom, R. S. (2002). The role of the business model in capturing value from innovation: evidence from Xerox Corporation's technology spin-off companies. *Industrial and Corporate Change*. 11(3), pp. 529-555. <https://doi.org/10.1093/icc/11.3.529>
- David, A. (2013). Innovation of handling systems in the world container ports and their terminals. In: Proc. of the 17th International Conference on Transport Means, Kaunas University of Technology, Lithuania, pp. 250-253.
- Drucker, P. F. (1999). *Management Challenges for the 21st Century*. HarperCollins Publishers, New York.
- Heidari, F., Loucopoulos, P. (2014). Quality evaluation framework (QEF): Modeling and evaluating quality of business processes. *International Journal of Accounting Information Systems*. 15(3), pp. 193-223. <https://doi.org/10.1016/j.accinf.2013.09.002>
- Hudakova, M., Buganova, K., Dvorsky, J., Belas, J., Dana, L.-P. (2015). Analysis of the risks of small and medium-sized enterprises in the Zilina region. *Communications*. 17(1), pp. 34-39.
- International Union for Road-Rail Combined Transport. (2015). Annual Report of the World Transport Scientific Congress, New York.
- Jurkovič, M., Dávid, A. (2015). Technological and educational requirements for inland navigation simulator in the Danube region. *Nase More*. 62(1), pp. 13-19.
- Klapita, V., Majerčáková, E. (2013). Application of RFID technology in rail freight transport in Slovak Republic. In: Proceedings of the 17th International Conference on Transport Means, Kaunas University of Technology, Lithuania, pp. 133-136.
- Klementová, J. (2014). Analyses of the processes of storing and supplying in companies of the wood industry with utilization of natural drying. Proc. of the International Scientific Conference: New trends in logistics - lean logistics, Zvolen. pp. 52-59.
- Knowles, G. (2011). *Quality Management*. Graeme Knowles & Ventus Publishing.
- Majerčák, J., Nedeliak, I. (2010). Practical experiences with modeling of IT systems and business processes. In: Proc. of the 6th Forum of Rail Transport, Bratislava. pp. 81-84.
- Majerčáková, E., Majerčák, P. (2012). Railway transport market and factors of its development, enterprise economy and management. *Electronic Scientific Magazine about Enterprise Economy, Management, Marketing and Logistics*, No. 2.
- Nedeliaková, E., Dolinayová, A., Nedeliak, I. (2013). *Methods of evaluation of the transportation services quality*. 164 p. EDIS, University of Zilina.
- Nedeliaková, E., Sekulova, J., Nedeliak, I., Majercak, P. (2014). Services in railway passenger transport and its evaluation by dynamic models. In: Proceedings of the International Conference on Transport means, Kaunas University of Technology, Lithuania. pp. 227-230.

- Nedeliaková, E. (2015). Innovative approaches in the system of teaching management in the railway transport study programme with a focus on the application of dynamic quality models in railway transport, KEGA 026ŽU-4/2015.
- Nedeliaková, E., Nedeliak, I., Majerčák, P. (2014). Research of services quality after the end of transportation in railway freight transport. In: Proc. of the 2nd Int. Conf. on Management innovation and business ICMIBI 2014. Singapore Management and Sports Science Institute, Singapore. pp. 54-61.
- Nedeliaková, E., Panák, M. (2015). New trend in process-oriented quality management. *Procedia Economics and Finance*. 34, pp. 172-179. [https://doi.org/10.1016/S2212-5671\(15\)01616-0](https://doi.org/10.1016/S2212-5671(15)01616-0)
- Nedeliaková, E., Sekulová, J., Nedeliak, I. (2015). Application of dynamic models as a new trend in quality management. *Procedia Economics and Finance*. 34, pp. 180-186. [https://doi.org/10.1016/S2212-5671\(15\)01617-2](https://doi.org/10.1016/S2212-5671(15)01617-2)
- Pfohl, H. C., Gallus, P., Köhler, H. (2008). Konzeption des Supply Chain Risikomanagements. In: *Sicherheit und Risikomanagement in der Supply Chain: Gestaltungsansätze und praktische Umsetzung*. Pfohl, H. C. (ed.), pp. 7-94. Deutscher Verkehrs-Verlag, Hamburg. (in German)
- Poliak, M., Semanova, S., Varjan, P. (2014). The importance of the risk in public passenger transport financing. *Communications*. 16 (2), p. 92-97.
- Poliak, M., Kryzanova, A., Semanova, S., Stefanikova, L. (2014). The influence of contract form choice of the transport services ensuring on performance contracting entity requirement. *Transport Problems*. 9(4), pp. 153-161.
- Pyon, C. U., Woo, J. Y., Park, S. C. (2011). Service improvement by business process management using customer complaints in financial service industry. *Expert Systems with Applications*. 38(4), pp. 3267-3279. <https://doi.org/10.1016/j.eswa.2010.08.112>
- Pyzdek, T., Keller, P. (2013). *The Handbook for Quality Management. A Complete Guide to Operational Excellence*. The McGraw-Hill Companies, Inc., New York.
- Sekulová, J., Nedeliak, I. (2013). Utilization of GAP model in providing of services in the railway freight transport. *Perner's Contacts*. 8(4), pp. 67-75.
- Skrinjar, J. P., Abramovic, B., Brnjac, N. (2015). The use of game theory in urban transport planning. *Tehnicki Vjesnik-Technical Gazette*. 22(6), pp. 1617-1621. <https://doi.org/10.17559/TV-20140108101820>
- Sujanova, J., Gabris, P., Licko, M., Pavlenda, P., Stasiak-Betlejewska, R. (2012). Aspects of knowledge management in Slovak industrial enterprises. In: Proc. of the 13th European Conference on Knowledge Management, Univ. Politecnica Cartagena, Spain. pp. 1135-1144.
- Šatanová, A., Potkány, M. (2004). Controlling: Modern tool of company control. *Economic Journal*. 52(2), pp. 148-165.
- Vetráková, M., Potkány, M., Hitka, M. (2013). Outsourcing of facility management. *E&M Economics and Management*. 16(1), pp. 80-92.
- Wood, J. C., Wood, M. C. (eds.) (2005). *Joseph M. Juran: Critical Evaluations in Business and Management*. Routledge, London, New York.
- Youssef, M. A. (1996). The impact of total quality management on firms' responsiveness: an empirical analysis. *Total Quality Management*. 7(1), pp. 127-144. <https://doi.org/10.1080/09544129650035098>
- Zabaha, C., Rivers, P. A., Munchus, G. (1998). Obstacles to the application of total quality management in health care organizations. *Total Quality Management*. 9(1), pp. 57-66. <https://doi.org/10.1080/0954412989261>