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The functionality problems of the ITS systems supporting rail transportation – survey results 2010-2012

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ABSTRACT

The paper presents the problems of design and upgrading of ITS systems, supporting the transport processes associated with the end user. It was noted that the lack of adequate participation or end-user requirements into system design can lead to two groups of problems related to the functionality of ITS systems. First group of problems is incomplete and inconsistent functionality of various systems, resulting from the rejection by the designers of end users practical knowledge and life experience. The second group of problems is not use of full features of the systems by end users such as due to lack of training, lack of comprehensive instruction manual and the lack of sufficient knowledge of users. As examples presents results of surveys conducted in 2010 and 2012 among end users of rail systems such as: ISZTP - on-line train route ordering system, SEPE - operational registry system, SWDR - train dispatcher support system and SERWO - electronic record of current warnings issued.

KEYWORDS: railway systems, ISZTP, SEPE, SWDR, SERWO

1. Introduction

ISZTP (on-line train route ordering system) is an web application supporting procedure of ordering route for train by carriers. Timetable and train orders are used to determine which train had the right of way at any point along the line. This system is on-line electronic platform between carriers as users of railway systems and infrastructure management company PKP PLK S.A. ISZTP system is available to users 24 hours a day, 7 days a week, 365 days a year and use of the system is possible from anywhere with Internet access and the use of various electronic devices (laptops, tablets, smartphones).

SEPE (operational registry system) is a system which, apart from the information about train operation, stores the information about all the disturbances to the train runs. The registration of the incidents and events is performed based on the reports from train dispatchers and is being input in the system by the line controllers. The stored information contains the data on the time of the event, time at which the event ended, on the exact location of the event, its influence on the operation of the trains (i.e. the delays) as well as the person in default of the event.

SWDR (train dispatcher support system) is a system containing all the information needed by the train dispatcher such as the timetables, planned train runs, train delays (and the reasons for these), planned and actual parameters of the trains, the trains carrying hazardous materials and trains with oversize loading gauge as well as the routes of all trains. Train dispatcher (code ISDR) is a highly skilled job position directly involved in the train operations within the relevant signalling control areas and on the adjacent routes or railway sections. Similarly as in the case

of a line controller, the dispatcher's job requires the knowledge of a number of instructions and regulations, however it is this particular position which bears a direct responsibility for the safe and regular train operations. The duties of the train dispatcher include making decisions about the correct preparation of the route, about the right sequence and direction of train despatching, in agreement with the current rules and with the timetable. Above all, the duty of the train dispatcher is to react immediately in case of a danger or a disturbance of a normal train operation due to the emergency situations and to the deviations from the timetable operations. Any decision taken by the train dispatcher has to be compliant to all instructions and to the *Technical Regulations* of a specific stop. The train dispatcher is supported in the decision making process by the SWDR system

SERWO (electronic record of current warnings issued) is an application supporting the train dispatchers in the area of registering, issuing and handling of current warnings. A part of the system is a database storing the information about the railway lines, the routes, the trains and the reasons for the warnings. It allows (among others) the printout of the orders and stores an electronic log of current warnings. It substitutes the old wire message system for sending the information on the warnings and for confirming the receipt and the recording of a warning.

2. Functionality assessment of on-line train route ordering system (ISZTP)

2.1 Survey methodology

Survey were conducted in 2012 [2]. The on-line train route ordering system called ISZTP is an application available to a small group of users. The shipping volume in rail transport was used for selection of respondents in sample survey. The survey was conducted among the following carriers – in parentheses share of shopping volume from 1st quarter of 2012):

- PKP Cargo (59,31%),
- Lotos Kolej (7,96%),
- CTL Logistics (7,05%),
- DB Schenker (6,87%),
- STK (1,57%),
- Freightliner (1,54%),
- Rail Polska (1,50%).

The total share of shipping volume of these companies is 85,8%. Data were collected using the technique such as *PAPI* (*Paper and Pencil Interview*), *CATI* (*Computer Aided Telephone Interview*) and by post.

2.2 The results of survey

The questionnaire consisted of 5 short questions – 4 of the questions were closed questions and 1 of the questions were open, allowing descriptive answer, containing the respondent's remarks and observations.

Question 1. *„Do you think that introduction of on-line train route ordering system called ISZTP improved the train ordering procedure on the lines managed by PKP PLK S.A.?"*

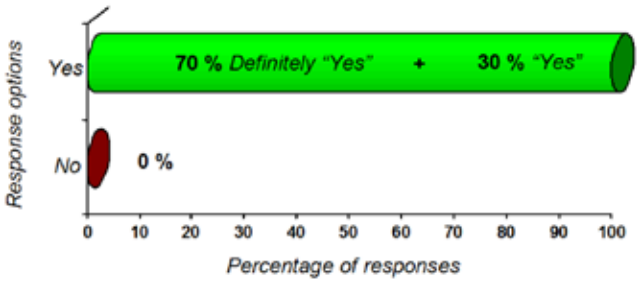

Fig.1. Distribution of the answers to question 1: „Do you think that introduction of on-line train route ordering system called ISZTP improved the train ordering procedure on the lines managed by PKP PLK S.A.?".

The results (Fig. 1) indicate a full positive rating with **30%** of answers "Yes" and **70%** of answers "Definitely Yes". Moreover in two cases given that the ISZTP system has allowed reduce steps for ordering and planning to run the train by 50%.

Application ISZTP works according to the following rules:

- right quantity – the system does not have a quantitative restriction - neither in terms of the structure of the material or product in terms of the number of its users,
- right condition – none of the respondents did not pay attention to the technical failure of the system (lack of liquidity, activity, etc.);
- right time – the system is available to users 24 hours a day, 7 days a week, 365 days a year,
- right place – use of the system is possible from anywhere with Internet access and the use of various electronic devices (laptops, tablets, smartphones),
- right price – the use of the system is free - the customer is only the operational costs such as energy, internet access, a device for manual operation of the system application,
- right customer – the system application access is granted only to licensed operators.

Question 2. *„If you could choose between the previous method of train route ordering method and present procedure, you would choose system ISZTP?"*

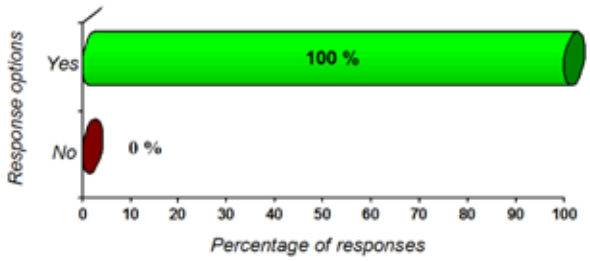

Fig.2. Distribution of the answers to question 2. „If you could choose between the previous method of train route ordering method and present procedure, you would choose system ISZTP?"

The aim of the second question was to obtain information on the whether positive solutions and willingly be used by operators/ customers in the previous route ordering system has been overlooked in the ISZTP. **100%** of respondents said "Yes" (Fig. 2).

Question 3. „*Did the introduction of the ISZTP system increase the fleet logistic in your company?*"

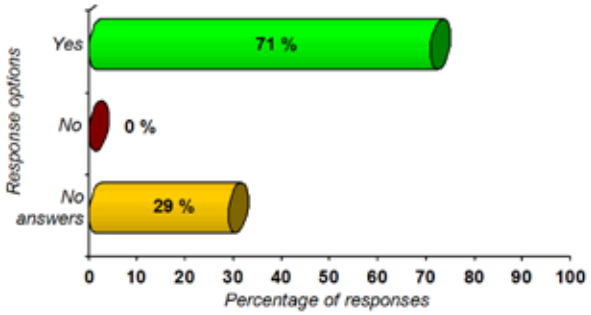

Fig.3. Distribution of the answers to question 3. „Did the introduction of the ISZTP system increase the fleet logistic in your company?"

The third question related directly to the carrier's fleet management. **71%** positive answers (Fig. 3) were justified by significant shortening or even the lack of a waiting period for the construction timetable, resulting in improved efficiency of the circulation of rolling stock.

There are no answers to this question (**29%**) was due to the lack of studies in this field, or use by carriers other internal procedures to optimize the circulation issues in bulk wagons and locomotives. One can not deny that the system ISZTP improve this state of affairs, both the information about traffic problems, as well as the simplification of the procedures for access to the route. It is also clear that carriers who had noticed the problem, implementing their own internal solutions (software systems) to improve logistics.

Question 4. „*Did the introduction of the ISZTP system in your company required training course?*"

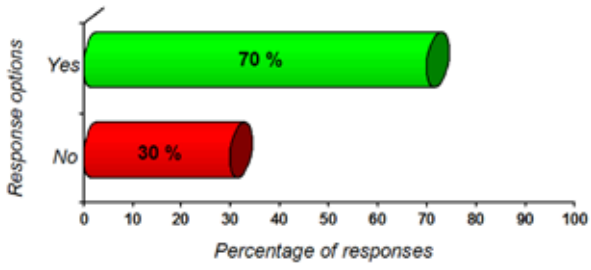

Fig.4. Distribution of the answers to question 4: „Did the introduction of the ISZTP system in your company required training course?"

The infrastructure management company PKP PLK S.A. organized a short, one-hour training of the individual carriers operating system ISZTP (web application). Users taking part in the training (**70%** of respondents) reported no need to spend time getting to know the application (Fig. 4). Users who do not take part in the training (**30%**) also coped with the assimilation of knowledge about the program, based mainly on personal experience and a short instruction manual in electronic format. This shows a good web design of online application of ISZTP system and the personal involvement of users in understanding its functional properties.

Question 5. „*What other data or utility should be included in the ISZTP system, in your opinion?*"

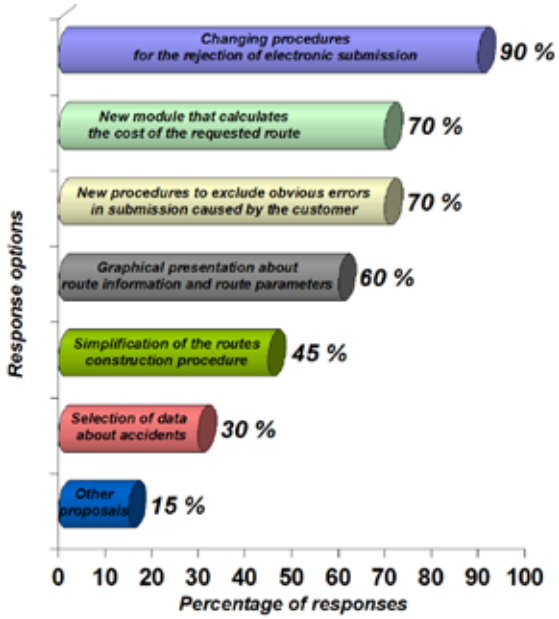

Fig.5. Distribution of the answers to question 5: „What other data or utility should be included in the ISZTP system, in your opinion?"

The aim of the fifth question was to obtain ideas and new solutions for the ISZTP system. All respondents showed a wide range of knowledge and pointed ISZTP improvements that can still be used (Fig. 5). As many as **90%** of respondents indicated the need to change the procedure in case of rejection of electronic submission by the infrastructure manager. Currently, submissions are often rejected due to minor formal errors and must be submitted again. This results in:

- carrier must submit a new proposal,
- the date of route construction begins again,
- previously constructed sections of the route are useless (unnecessarily prepared).

In addition **70%** of respondents reported the need to add a module that calculates the cost of the requested route already in the process of preparing the submission. Similar expectations of the users (**70%** of respondents) are applicable the procedures to exclude obvious errors in submission caused by the customer at each stage of the route procurement. For example, it should be indicated when in submission is train weighing 3,200 tons and a length of 50 meters by mistake. Add a graphical presentation about route information and route parameters, primarily on railway line number with prepared route, name of railway stations, allowable axle load, braked weight percentage required etc. This was reported by **60%** of respondents.

Simplification of the routes construction procedure for the carrier is another proposal of **45%** of respondents. In this regard, it is proposed to add to the automatic route indication map suggested by the system (based on provided by the carrier limit stations), whilst the information in the table at intermediate stations and the ability to modify the weight of the train in the station. Graphical view of a suggested route would also be useful for less experienced users who may don't know about specific different types of infrastructure and technology restrictions.

The need to organize the information on the impediments, accidents and events reported by the management company was indicated by **30%** of respondents. The remaining **15%** of the responses related to the various problems submitted by the carriers that do not apply the same functionality and more systemic solutions in the overall customer service by the infrastructure manager. These are mainly [2]:

- unnecessary automatic logoff function after an hour of work, regardless of whether the system is carried out active work or if the system is in standby mode,
- the system should automatically identify the right branch for station of rolling stock and train that will be run,
- limited choice of routes available in the directory paths, due inter alia to renovations and modernization over the entire rail network,
- extended processing of submissions for international carriage - but it's related to expectation of acceptance of the submissions by the foreign railways,
- problems of long waiting time for route allocation on weekends or at night, due in part to reduced staffing employees during this period.

Based on the survey results it can be concluded that the system is useful and user-friendly. In an interview with the authors of the web application of ISZTP system obtained information that this is not a final version of the application.

3. Functionality assessment of SWDR, SEPE and SERWO systems

The survey performed in 2010 allowed a functional evaluation of the SWDR (train dispatcher support system) as well as the collection of information on suggested future modifications of the system [1]. The survey concerned the functionality of the system related to the communication with the users and to the system interoperability with SEPE (operational registry system) and SERWO (electronic record of current warnings issued).

3.1 Survey methodology

In 2010 a questionnaire study was performed among the users. The aim of the study was to evaluate the functionality of the SWDR system and to collect the information about the suggested improvements to the system. The study addressed the issues of the system functionality concerning the communication with the users and of the collaboration with SEPE and SERWO systems.

The surveys were carried out mainly using the *CAWI* method (*Computer Aided Web Interview* - a questionnaire available on a Web page). The method proved to be effective due to its low cost, high availability (24/7) and to the option of addressing the survey to a selected group of respondents (Internet discussion forum). In the presented case the electronic survey was made available on the Web page of the Train Dispatcher Trade Union of the Polish State Railways and on the discussion forum, as a specific thread. The Web page and the forum are owned by the Union which is a nationwide organisation with several thousand members. The sites are visited not only by the Trade Union members but also by other staff who have daily contact with the evaluated systems.

In order to include the persons not using the Internet (or using it incidentally) in the survey, the study was performed in parallel using *CAPI, CATI* and *PAPI* methods as well as by *regular mail*. In the *CAPI* method (*Computer Aided Personal Interview*) a laptop and a palmtop with the questionnaire were made available to the training and integration event participants [1].

3.2 The results of survey

The questionnaire consisted of 11 short questions included on one A4 page. Among 11 questions 8 requires just one answer (choice) to be provided and 3 were multiple choice questions. In addition, 2 of the questions were open, allowing descriptive answer, containing the respondent's remarks and observations.

Question 1. „ *Do you think that introduction of SWDR (SEPE) system improved the punctuality of trains?"*

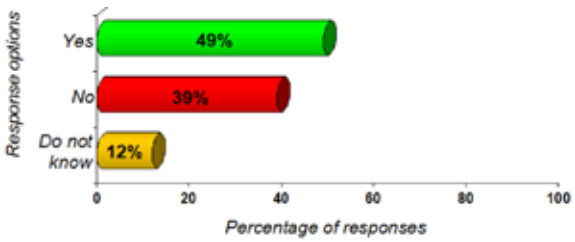

Fig.6. Distribution of the answers to question 1: „ Do you think that introduction of SWDR (SEPE) system improved the punctuality of trains?".

Answers to question 1 (Fig. 6) indicates that **49%** of the respondents have noticed an improvement in the punctuality of the trains as an effect of the implementation of SWDR-SEPE systems. But at the same time **39%** of respondents see no link between the functionality of the systems and the punctuality of the trains. May be reason for the latter answers may be low awareness of the users as to the right utilisation of the information from the system in further traffic management (this has also been confirmed by the fact that **12%** of responses were 'Do not know').

Question 2. „*Do you think the introduction of SEPE-SWDR system increased the capacity?"*

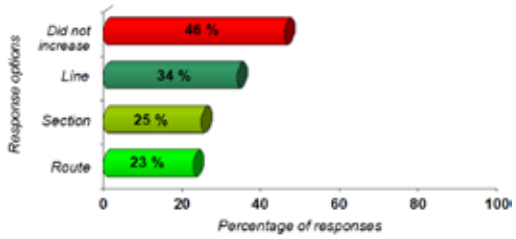

Fig.7. Distribution of the answers to question 2: „Do you think the introduction of SEPE-SWDR system increased the capacity?".

As many as **46%** of the respondents see no relation between the speed at which the information is provided and the efficiency of traffic management, leading to the high traffic smoothness and to maintaining the current capacity reserves (Fig. 7). This result may be due to two factors. The first one (and the most important one) is the lack of data in the system. The second factor is the potential inability of the users to utilise the information provided and the lack of trust for the data (indicated also in the answers to other questions). The remaining answers show that the respondents do see the opportunity of using the information provided by the system to increase the capacity of the elements of railway network (of a route – **23%** of answers, of a section – **25%** of answers and of a line – **34%** of the answers). The total percentage in not 100% as this question was of a multiple choice nature. It is worth emphasizing that while increasing of the capacity of the railway network elements may to a large extent be achieved by reducing the train run times (by means of increasing the speed and by introducing modern traffic management devices) it seems that right traffic organisation and regulation (understood as a fast information flow between the staff directly responsible for train traffic) is still not appreciated as a method of increasing the capacity reserve.

Question 3. *„Did the introduction of the system increase the speed of access to the needed information about a train?"*

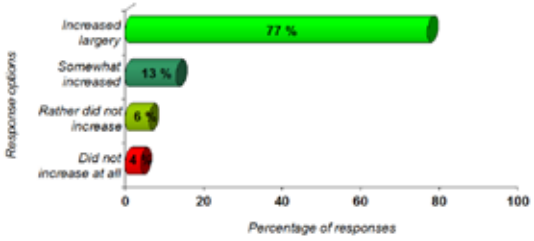

Fig.8. Distribution of the answers to question 3: „Did the introduction of the system increase the speed of access to the needed information about a train?".

The advantages of the system in this domain were appreciated by as many as **90%** of the respondents (the answers included **77%** of 'Largely Increased' and **13%** of 'Somewhat increased' answers). Unfortunately, the remaining **10%** of the respondents do not see any advantages of an efficient access to actual information (Fig. 8).

Until now a train dispatcher could obtain all the information on a specific train (route, carrier, scheduled departure, scheduled passing time etc.) by phone to a relevant line controller. In case when that information was sought after by several train dispatchers the waiting time increased even to several dozen minutes.

At present, a number of train dispatchers may see all the necessary data on the same train on a computer monitor. Presently it seems almost impossible to manage smooth train traffic (especially in cases of cargo trains) without utilising the information on the traffic situation available in the system (while almost **90%** of the trains concerned travel on the catalogue routes).

Question 4. *„Did SWDR (SEPE) system improve the comfort of your work and of the decision-making?"*

The respondents have rated the comfort of working with the system high (**82%** of respondents). The remaining **18%** of respondents were of an opposite opinion (Fig. 9). The system supports the dispatcher very well in this domain and eliminates the time consuming telephone consultations with the controllers as well as the search in printed wire messages. The conclusion may therefore be that should the problems of delayed data input into the system be eliminated, the percentage of positive answers to this question would be close to 100%.

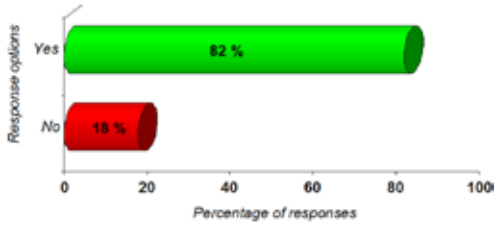

Fig. 9. Distribution of the answers to question 4: „Did SWDR (SEPE) system improve the comfort of your work and of the decision-making?".

Question 5. *„Is the level of access to various system tabs and the possibilities of their edition satisfactory at your work position?"*

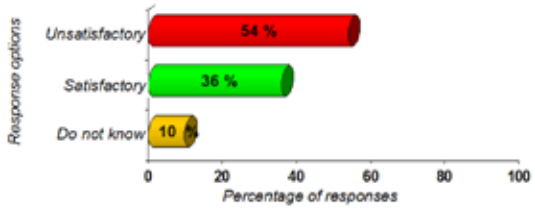

Fig. 10. Distribution of the answers to question 5: „Is the level of access to various system tabs and the possibilities of their edition satisfactory at your work position?".

The responses provided indicate that the opinions on that point are divided (Fig. 10). Only **36%** of respondents were satisfied while **54%** assessed the access to the data as unsatisfactory.

The first reason of this result may be the workplace structure of the respondents. The participants of the survey were the personnel of large traffic control area for which more access to the system would mean more efficient job, hence the 'unsatisfactory' responses were most frequent in that group. For the system users from small stations, just the basic view of the data is satisfactory. In addition some of them could fall into the group of users who responded 'do not know' (**10%**).

Another reason for the high share of the respondents claiming the access to be '*satisfactory*' is a natural resistance of an employee

towards extending his scope of responsibilities. This would mean new, additional activities of data input and data verification on top of often heavy workload related to train traffic management and train station operations.

Question 6. „*Would more access to one of the options with the possibility of editing, help you at work?*"

The results (Fig. 11) indicate that the definitive majority of respondents consider an extended access to the system to be helpful in their work **(62%** answers '*yes*' and **41%** of open answers) as opposed to **29%** of respondents being of a different opinion (the percentages do not add up to 100% as the question had a multiple answer character).

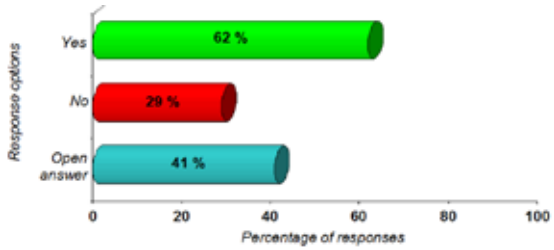

Fig. 11. Distribution of the answers to question 6: „Would more access to one of the options with the possibility of editing, help you at work?".

The analysis of the open answers has shown that [3],[4]:

- in **80%** cases *'the possibility of inputting a real train passing time'* was indicated,
- almost **67%** of respondents indicated the drawback to be *'lack of possibilities of inputting an analysis of a train dispatched'*,
- almost **10%** of respondents indicated other ideas to enhance the system, e.g. integration of SEPE and SERWO systems, to allow the input of the information on a train delay and its causes directly at the point where the delay was incurred.

Question 7. „*Does the system help you at work?*"

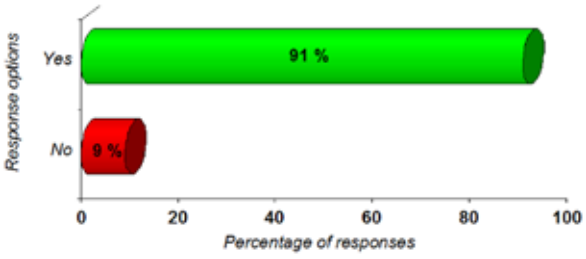

Fig. 12. Distribution of the answers to question 7: „Does the system help you at work?".

The answers provided generally confirm the usefulness of the application (almost **91%** of answers *'yes'* – cf. Fig. 12). The information allowing right process of issuing the current warnings, information about a change of train number on the route – all of these are evaluated positively.

Question 8. „*Do you think the operation of SWDR (SEPE) system and obtaining the information form it is difficult and complicated, or rather easy and intuitive?*"

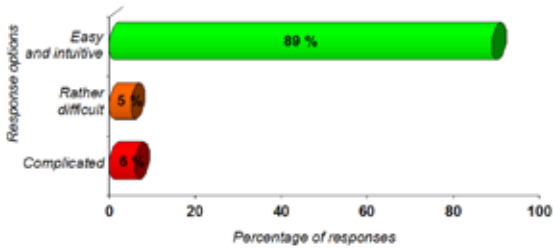

Fig. 13. Distribution of the answers to question 8: „Do you think the operation of SWDR (SEPE) system and obtaining the information form it is difficult and complicated, or rather easy and intuitive?".

The respondents (Fig. 13) have given **89%** positive answers – probably because of the clarity of the user interface and the order and good structure of data presentation. The remaining **11%** of answers were the responses claiming the system is *rather difficult* or *complicated*.

Question 9. „*Have you done any training concerning the operation of these systems?*"

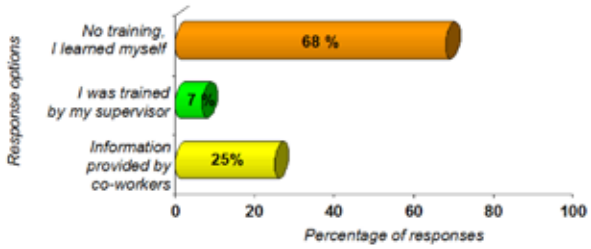

Fig. 14. Distribution of the answers to question 9: „Have you done any training concerning the operation of these systems?".

The distribution of responses (Fig. 14) indicates that only a small number of personnel trainings took place (**7%**) and in **25%** cases the knowledge on system use was being obtained from the co-workers, during the breaks in train traffic operations. The remaining **68%** of the respondents declared they have learned to use the system by themselves. Such a way of deploying a new system certainly does not help the knowledge of the way it needs to be operated and does not provide knowledge on the system functions. These facts were revealed by the answers to the following question.

Question 10. „*Do you think the system would be of more help to you if you were fully trained on the system and its features?*"

The need to be trained on the use of the system was raised by **70%** of the respondents. The remaining **30%** do not see such a need (Fig. 15). Thus, a training cycle should not be limited to passing basic information on the use of the application but also should include the studies of concrete examples of practical application of the information available in the system.

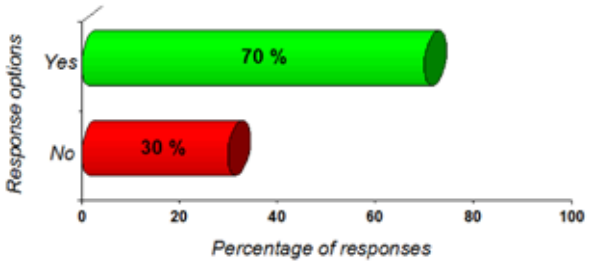

Fig. 15. Distribution of the answers to question 10: „Do you think the system would be of more help to you if you were fully trained on the system and its features?".

Question 11. „*What other data should be included in the system?*"

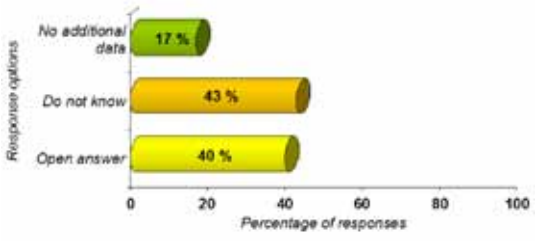

Fig. 16. Distribution of the answers to question 11: „What other data should be included in the system?".

For this question **43%** of respondents gave the answer '*do not know*' and **17%** consider the current capabilities of the system to be sufficient (Fig. 16). It is also important to stress that as many as **40%** of the users have also given open answers to the question:

- **93%** of the respondents indicated the need to provide an accurate and current information about the position of the train,
- the need to register the real times of trains passing the station was indicated in **85%** of answers,
- about **50%** of cases a need to integrate the system with the new application SERWO or the old system ROZKAZ has been pointed out as the needed system functionality.

4. Conclusions

The surveys and evaluation of the functionality of presented systems permits drawing the following conclusions. Some modifications are recommended to allow enhanced access to the systems for individual users but from the functionality point of view the systems perform well and the majority of functions available corresponds to the needs of the users [3],[4]. Data acquisition from the operating environment should be automated to a higher extent, so that the unnecessary intermediating links are eliminated. Introduction of changes in the mutual communication of traffic controllers and train dispatchers will improve the ergonomic parameters of their jobs. Another suggestion is to allow the train dispatcher to input directly the times at which the train passed the station and control areas. The intermediation of a line controller was reducing the ergonomic value and the safety of work, especially for the train dispatcher (who, while passing the required information to the traffic controller often had to take at the same time a number of other actions related to train traffic management. This situation is specifically important during freight train traffic and in many situations of delays incurred, emergency situations and other unexpected events. In extreme cases there may be situations when information about train passing is introduced into the system even after several hours. Such delayed information is of little use and may only serve formal and statistical purposes. After survey the current version of the system (2.2 of February 2011) is already meeting this postulate [3],[4]. Allowing the train dispatcher to input the analyses of the deployed trains without the intermediation of the traffic controllers was next suggestion and the new version of the system (March 2011) include the proper module. Systems integration (SWDR, SEPE and SERWO) into one application will make the operation of the system and the information processing more simple. Effective utilisation of presented systems requires that the software implementation is supported by a system of professional trainings.

The implementation of subsequent system versions should be preceded by direct consultations with the users, who possess the best knowledge about the current problems and the requirements of the system users in daily operations. Possible stages of building the funny-example system without systems engineering has been presented on figures 17 and 18. This is summary of conclusions especially above suggestion.

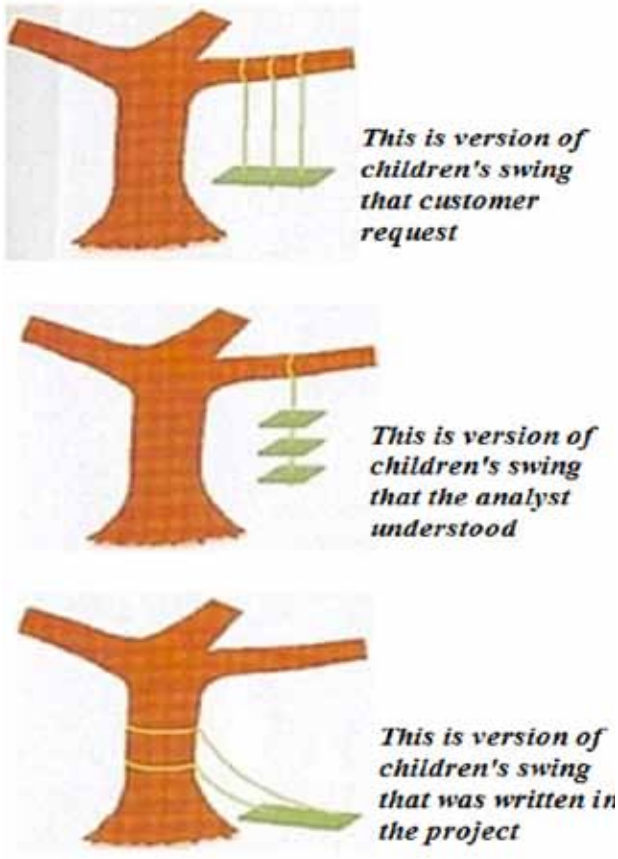

Fig. 17. Possible preliminary conceptual phase of building the children's swing without systems engineering.

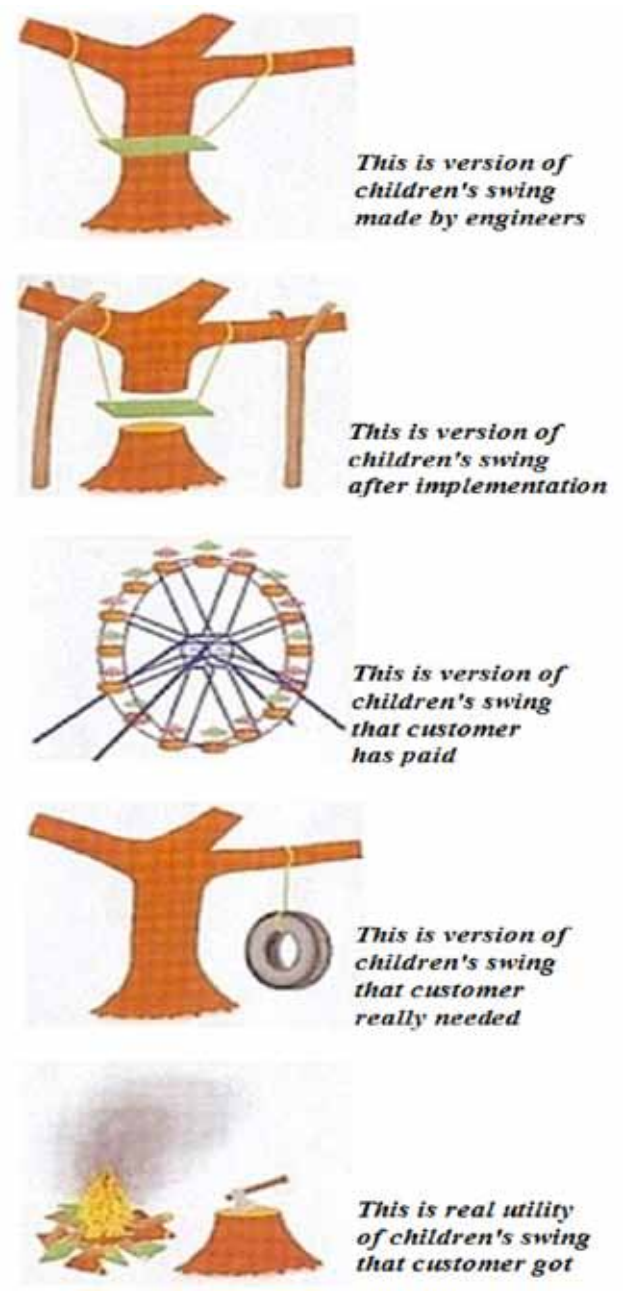

Fig. 18. Possible results of building the children's swing without systems engineering.

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