Managing Human Factors Related Risks

The Advanced Training Model in Dangerous Goods Transport on Roads

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Abstract—This paper studies the methodological essence of dangerous goods (DG) training courses for drivers and dangerous goods safety advisers (DGSA). The research aims to advance existing teacher-centered course model in Estonia with learner-centered methods that best suit specific objectives and meet expected learning outcomes, as well as to improve DG training model with the integrated use of interactive teaching methods.

The paper presents a qualitative development research strategy based on studies regarding ADR regulations training courses in Estonia as well as on the analysis of teaching methods applied in the professional training of adults. The data is collected in two steps: firstly by implementing questionnaires for consignors/ consignees, freight forwarders carrier companies and drivers, secondly during in-depth interviews/ focus group meeting with DG regulations training companies' providers. Implementing methodology of qualitative comparison analysis (QCA) combination of best suitable teaching methods is identified. After following in-depth interviews and performing a focus group, these combinations are further used as input for developing existing course model with integrated use of blended learning alternatives, where digital media meets with traditional classroom methods. Results of this research contribute coming up with interactive methodological approach within ADR regulations training courses that meet the best trainees' expectations and fulfills the risk management aim.

Keywords—DG training courses, teaching methods, qualitative comparison analysis, blended learning

1 Introduction

The transportation of DG on the road always involves risks. If substances are mishandled, injury and property damage risks are increased. From the perspective of road transport, this concerns primarily main parties of a transportation chain, *i.e.*, consignors/ consignees and carrier companies (including drivers), but also freight forwarders, and third parties. A transport containing DG can have an impact on the environment if an accident occurs and these often incur a higher cost for the society than non-dangerous goods accidents. This is one reason why it is essential to focus on

improving the efficiency and security of DG transport and avoid potential accidents [41].

Training courses for drivers and DGSA involved into dangerous goods transport (DGT) are based accordingly to the European Agreement concerning the International Carriage of Dangerous Goods by Road (*i.e.* ADR, Chapter 8.2) and the European Commission Directive (96/35/EC) on the appointment and qualification of Safety Advisers for the transport of dangerous goods by road, rail and inland waterways [43, 45]. In addition to these documents, there is the Adult Education Act that sets additional requirements for adult education in Estonia on a national level [31]. The role of DG training courses has an essential impact on the human factors aspect that reveals during DG handling and transportation processes as the human factors are crucial why accidents occur within a transportation chain.

The role of educational technology in teaching today has importance due to combining the amount of information and communication technologies [41]. What comes to in-service training with the focus on practice, it is complicated to implement suitable interactive teaching methods and techniques effectively. In the scope DGT by roads, there is no doubt that adequate training of drivers and DGSA may affect the safety aspects in peculiar transportations, such as the one of DG. Training may not only include regulations, technical and procedural elements, but also important psychophysical aspects such as how to manage fatigue [3, 33].

The provider of training may be different according to national legislation. It can be the role of the employer (in the US and Canada) to ensure appropriate truck-driver training for the transportation of DG. In Sweden and the Netherlands, as well as in Estonia, a competent national authority must accredit training institutions or trainers and monitor the examination of truck drivers [20]. However, all training system approaches to pursue the same goal: to ensure appropriate training and prevent the accidental release of DG during transportation. By implementing specific interactive teaching methods, remarkable improvement of course participants' learning can be achieved. Moreover, operational risks related to human factors' issues can be reduced within entire transportation chain of DG.

When considering an approach to instruction, teachers are aspired to use methods that are most beneficial for all of their students. Using both approaches, teacher-centered as well as student-centered together, learners can sense the positives of both types of education. By implementing interactive teaching methods to support existing teacher-centered ADR training course model in Estonia remarkable improvement of course participants' learning can be achieved. To implement the procedural approach, a designer has to understand the contents of the whole system, its structure, the principle of operation and behaviour [21] fully. It becomes very difficult to describe complex systems using only procedural techniques. The reason lies in the nature of a modeled object because any procedural model implies a one-sided, incomplete, and prejudiced glance on the original [27]. In the scope of this paper relation between concepts of a training system, training model, training process and training requirements is visualized as shown in Figure 1.

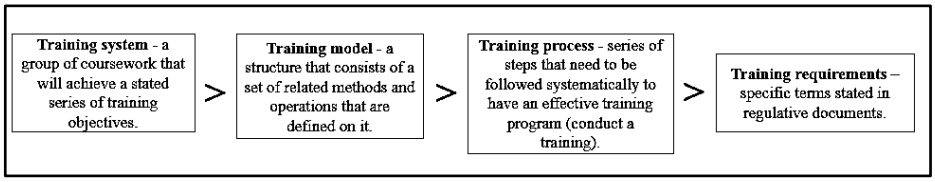

Fig. 1. Conceptual relation. Source: Authors.

In Estonia, ADR regulations training courses are formed based on teacher-centered course design mainly. This methodological approach is outdated as the concept of the learner is changing rapidly. The problem discussed in the scope of this paper is a part of a broader study and refers to an outdated methodological approach in carrying out DG training in Estonia, both for drivers and safety advisers. Based on conducted survey research among representatives of different parties of a DG transportation chain in Estonia, best suitable interactive teaching methods are studied. From developed combinations of techniques, advanced training course models are created with the implementation of blended learning elements. As this methodological approach is in the scope for discussion of a focus group with DG training provider companies and the representative of Estonian Road Administration, it finally represents a comprehensive training model that considers human factor risk managing elements of all parties. Results present readily handled ADR regulations training course model that could be implemented by DG training provider companies of Estonia in the coming years. All this will contribute to improved human risk management of DGT by road.

2 Background

2.1 Literature review

The global trend of increasing traffic due to globalisation leads to a higher number of DGT [11]. Several studies have focused primarily on the critical analysis of ADR implementation concepts in European countries [*Ibid.*]. What comes to performance indicators supplemented regarding the transport and handling of dangerous goods, the number of DGSA as well as the number of ADR training certificates, are critical controlling the performance of handling dangerous goods in green transport corridor [36]. Chances and challenges coming along with the ADR ratification were illustrated, and the concept / recommended procedures of how to train involved people in the framework of DG was developed from in-depth analysis and critics of current training methods.

The broader approach with regards to blended learning issues within in-service training, in general, has been studied a lot. These studies focus mainly on training school teachers with implementing different types of blended (mixed) learning scenarios of information and communication technology (ICT) related subjects. When modeling practical scenarios based on a combination of different face-to-face interactive approaches (such as problem-based learning, collaborative and project-based approaches, and diversity of e-learning activities and resources within), it is funda-

mental to take into account learner's previous experience and ICT skills. Better results in acquiring the content of the course are in a healthy relationship with learner's previous experience in ICT [22].

Specific models, methods, and technologies have also been studied in the scope of support the training of drivers involved in the transport of DG [5]. Italian developed online training environment (TIP – Transport Integrated Platform) is addressed to operators in the transport sector and combines classroom-based training with online self-learning possibilities on a distance. The platform has been continuously upgraded with innovative tools and presents a component of blended learning model where online digital media meets with traditional classroom methods [5, 39, 40]. Implementing blended learning methodology within classes keeps students active not allowing them to disconnect from the subject. This leads to a better attitude to improve learners' thinking and writing, motivating them for further study and development of new thinking skills [13, 22].

Training of safety and DG topics is essential for a risk and accident minimisation in the handling of DG and their transports. According to previous research studies on DGT the awareness of different parties of transportation chain in Estonia, there is a lack of professional knowledge among personnel on the national level [17]. According to a comparative analysis of teaching methods of ADR driver training courses of France, the Netherlands, and Estonia, remarkable differences were identified [18]. In Estonia, a significant lack of learning tools and no ARD based activities to endorse training courses and to increase the proportion of practice are so far in use [*Ibid.*].

Human-related risk preventive mean lies in efficient staff training. In following parts of this paper, the methodology of QCA is implemented in to analyse specific methods as cases due a set of relations and assess of their consistency. Existing teacher-centered DG training model will be completed with blended learning approach and evaluated within focus group meeting to define its' relevance toward risk management of human factors related risks when transporting DG by roads.

2.2 Dangerous goods regulations training courses

As DG and their transport need special handling and attention due to their risk for the environment and health of people, the training of any persons having to deal with those goods is essential for safe processing [15]. Common legal requirements (ADR) states in details that drivers when transporting DG (with small exceptions) shall undergo training in the form of a course approved by the competent authority. Concerning chapter 1.3 of the ADR, every employee, which has to commit the duties of DG regulations, needs to be specially trained [1]. Other parties involved within operations with DG can be: manufacturer or owner of DG, owner of tank containers, persons carrying out forwarder duties, persons writing and preparing transport documents, persons working for the DG receiving, persons committing packaging procedures, filling personnel of tanks, vehicle drivers, who do not need an ADR certificate, persons carrying out carrier and vehicle owner duties [2, 23].

Persons mentioned above often carry obligations of DGSA as they are involved in operations with DG in road transportation. A DGSA is a consultant or an owner or

employee of an organisation appointed by a company that transports, loads or unloads DG in the European Union and other countries [38]. There is no specific classification regarding DGSA courses. However, ADR driver training courses can be classified according to two aspects. Figure 2 visualises the content of training programs and training courses, highlighting common and distinctive elements of ADR driver training courses.

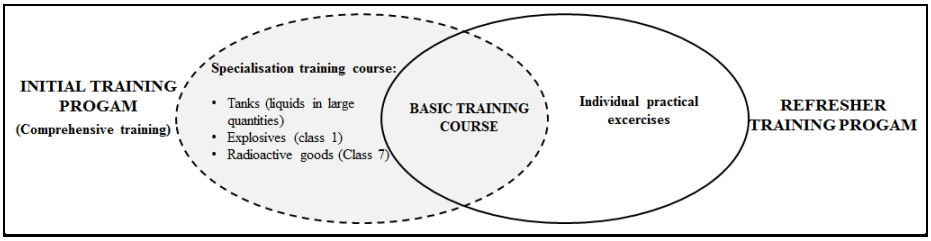

Fig. 2. The content of ADR driver training programs. Source: [18]; adapted by authors.

Firstly, training programs are identified by the level of the training program (initial or refresher training program), and secondly, training courses within programs are divided according to specificity (basic or specialisation training course). The minimum duration of the theoretical element of each initial training course or part of the comprehensive training course is set according to common legal requirements. The overall length of the comprehensive training course may be determined by the competent authority, which shall maintain the duration of the basic training course and the specialisation training course for tanks, but may supplement it with shortened specialisation training courses for Class 1 (explosives) and Class 7 (radioactive materials) [25]. Refresher training has to be undertaken by drivers (as well as by DGSAs) at regular intervals in every five years. As the form of a training program is defined by compulsory topics and minimum learning hours only (according to ADR), it is free to choose the methodological approach to conduct the training itself [18].

2.3 Interactive teaching in adult training

Today classrooms challenge traditional, teacher-centered curriculum to meet the increasingly diverse needs of students and make the required increases in achievement gains [7]. The fact that the adult teaching method is to a great extent different from the system in which students of various ages are schooled is felt in the assimilation of knowledge, in the means which they put into practice and understanding at a conceptual level of the theories and models proposed in the course program. Moreover, what comes to in-service training with a focus on practice, it is much more complicated to implement suitable interactive teaching methods and techniques efficiently.

Today, adult learning theories have series of characteristics that differentiate adult learners. These determine the teaching methods that will most successfully promote

learning in an older population of students[1] [37]. According to theories and practices on adult learning these characteristics are as follows:

1. Selective learning - adults determine what is meaningful to them.
2. Self-directed learning - adults take responsibility for their education.
3. Previous knowledge and experience of adult learners.
4. Problem-centered approach – adults are interested in content that has a direct application to their lives.
5. Anxiety and low self-esteem due to possible negative previous experiences with school [14, 16, 32].

The impact of these characteristics on adult learning is not limited to the face-to-face classroom as they also affect the way that adult learners will approach learning in the online environment as well [24]. Named characteristics have to be considered when training personnel within ADR regulations training. From the perspective of a diversity of methods in use and resulting approach to adult learner's peculiarity within ADR training courses, the United Kingdom can be highlighted as a best-practice. The existing models of ADR related training in the UK apparently differentiate learners by their category – drivers and DGSA. When registering for the training course the learner can select among different approaches how to study. Due to the preferences traditional classroom learning, full or partial e-learning, as well as webinar-based learning options, are possible. The training model of existing ADR training provider companies of Estonia is alike and methodologically outdated as it doesn't take into account learners' unique features nor their preferences.

Rapid development of ICT has facilitated an approach to traditional face-to-face and technology-mediated learning environments, which is called "blended/hybrid learning." In the scope of this paper blended learning methodological approach, where digital media meets with traditional classroom methods is brought into focus as appropriate for Estonia's case to start with the methodological development of an existing model of ADR regulations training courses. In following parts of this paper alternative, learner-centered training model is proposed for efficient ADR regulations training courses with the integrated use of interactive teaching methods.

3 Methodology

3.1 Problem description

The primary purpose of teaching at any level of education is to bring a fundamental change in the learner [42]. Due to the high risk of DG, there is a must to learn be-fore doing in the content of ensuring safety. The ADR implementation and the knowledge transfer concerning DG are complex.

Existing learning model of DG training courses in Estonia today is standard for all learners without differentiating them into categories: drivers and DGSA. Moreover,

[1] According to the statistics during the period from 2012-2016 (*i.e.,* currently valid certificates) the total number of issued ADR driver licenses in Estonia was 30 539 and the number of issued DGSA training certificates during the same period 118 [8, 44].

ADR regulations training courses are formed based on teacher-centered course design mainly, i.e., learning activity is performed during classroom lectures supported by the slideshow presentation. ADR regulations training courses are mostly in-class and theoretical proceedings, even in cases, where a practical example would be considered necessary, as in the case of fire confronting and first aid issues. In most cases, in-class training is followed by the use of books, issued by the training companies, slide presentations and internal tests [18].

Today this methodological approach is outdated as the concept of a learner with its needs is changing rapidly. Moreover, existing learning form does not meet efficient risk management within the transportation chain that is evolving more complex due to the number of parties involved as well as due to additional risks concerned new DG and their danger characteristics. The methodological approach of professional training should be student-centered and focused on developing learner autonomy and independence by putting responsibility for the learning path in the hands of learners [12]. This approach ensures the fact that after completing the training course a trainee can handle problems in practice independently. This is essential in the scope of DGT. The present paper aims to perform the analysis and identification of teaching methods suitable to be integrated into existing ADR professional training courses in Estonia with the scope to increase the proportion of practice and thereby to minimise operational risks related to human factors in further studies.

3.2 Data collection and analysis

A research design is the set of methods and procedures used in collecting and analysing measures of the variables specified in the research problem research study [10]. The research problem defines the research design of this study according to which the methodological approach of ADR regulations training courses in Estonia is outdated as the concept of a learner is changing rapidly. In the scope of this paper primary data collecting on learners' attitude regarding the current format of courses is collected from all main parties who operate with DG on a daily basis, i.e. consignor/ consignee, freight forwarder and carrier company. Respondents were divided into clusters according to the type of ADR regulation training course type which is aimed at them. Clustering was performed as follows:

1. CLUSTER 1 (truck drivers; ADR driver training course),
2. CLUSTER 2 (consignors/ consignees, freight forwarders, carrier companies, other participants; ADR DGSA training course).

Truck drivers have been separated from carrier role to identify their preferences individually. The primary objective is to understand attitudes and preferences by clusters toward specific teaching methods respectively. The essence of specific methods that were focused on was explained to respondents. A structured questionnaire with close-ended ordinal-scale questions has been prepared as main data collecting form, where respondents were asked to decide where they fit along a scale continuum regarding the use of particular teaching method within ADR training classes.

Implementing methodology of qualitative comparison analysis (QCA) combinations of suitable teaching methods are identified that are effective both in the scope of operational risk management as well as from the perspective of learner's needs and expectations. QCA is a means of analysing the causal contribution of different conditions (*e.g.*, aspects of an intervention and the broader context) to an outcome of interest [28]. QCA starts with the documentation of the different configurations of conditions associated with each case of an observed outcome [29, 34]. These are then subject to a minimisation procedure that identifies the simplest set of conditions that can account all the observed outcomes, as well as their absence. Results are typically represented in statements expressed in ordinary language or as Boolean algebra. According to formula (1) expressed in Boolean notation combination of Condition A AND (*) condition B OR (+) a combination of condition C AND (*) condition D will lead to an OUTCOME (→) E [*Ibid.*].

$$A * B + C * D \rightarrow E \tag{1}$$

The paper presents a qualitative development research strategy based on studies regarding ADR regulations training courses in Estonia as well as on the analysis of teaching methods applied in the professional training of adults with the implementation of ICT possibilities to contribute to effective human factor risk management. Upon the results of QCA analysis and in-depth interviews with DG training companies' representatives, preliminary models of training courses are developed for further validation during the focus group with selected experts from DG training activity. Focus group research involves an organised discussion with a selected group of individuals to gain information about their views and experiences on a topic [19]. Within this research stage, the initially developed training model for drivers and DGSA are in focus. The participants of a focus group influence each other through their answers to the ideas and contributions during the discussion by assessing advanced training model with regards to human risk management.

3.3 Research design

Within the process of developing research, the study can be broken down into 3-4 distinct stages. Firstly it is establishing a research type, secondly naming research strategy and finally determining a research design by defining specific methods and research procedures [10]. The research design refers to the overall strategy that is chosen to integrate different components of the study in a coherent and logical way, thereby, ensuring the effective address to the research problem [*Ibid*.].

The research problem defines the research design of this study according to which the existing course model in Estonia is teacher-centered and the role of using interactive teaching methods within ADR regulations training courses are underestimated by trainees. In the scope of this paper, the research object is the existing model of ADR regulations training courses in Estonia, methodologically the same both for drivers and for DGSA. The research design for this study is built upon the principle of qualitative development research as it is seen in Figure 3.

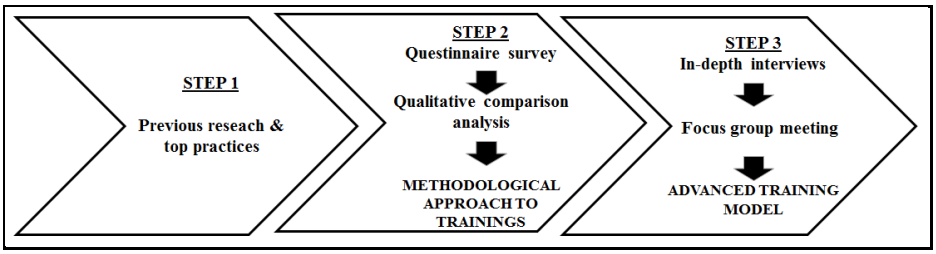

Fig. 3. Research design. Source: Authors.

The first step in a complete research design of this study involves identifying top previous research on a topic related and reviewing the published empirical articles to diversify possible methods. At this stage, the best practice is identified (the training models of the UK) and results of previous studies on the example of Estonia [18] are brought together.

The second step presents a combined questionnaire survey on learners' attitude and preferences concerning the methodological format of courses. QCA analyses collected data. Hence, the methodological approach to training is developed respectively for ADR course training for drivers and DGSA separately.

Individual in-depth interviews with ADR training provider companies within the third stage of the research is a data-collecting phase mainly. According to the information from Estonian Road Administration, there are altogether five trainer companies that have a license to train drivers and one that prepares DGSA [25]. Based on some trainees per trainers in 2016 four interviewee trainer companies that provide ADR training for drivers is chosen. Regarding training DGSA interview with the single representative business was carried out (share of 100%). The results of interviews are structured with the implementation of comparative analysis methodology and commented by contrasting them with the best practice on an example of the UK training course models. Focus group with DG training provider companies and the representative of Estonian Road Administration gives an objective assessment to the advanced ADR regulations training model that considers human factor risk managing elements of all parties.

4 Results

4.1 Learners' methodological approach

The data collecting on learners' attitude and preferences concerning the methodological format of courses was performed during the period from February 3 – May 3, 2017. The online survey was prepared using Google Forms both in Estonian and in Russian. The distribution of the questionnaire was provided via email invitations (60 companies that work with DG on a daily basis) and social media channels addressed directly to specialty-focused groups (e.g., Estonian truck drivers with an estimated number of 1800 ADR licensed drivers). Altogether 189 replies were gathered

(CLUSTER 1 – 151 respondents, CLUSTER 2 – 38 respondents). By theory, the sample must represent the population as well as possible. Current sub-samples are not statistically representative enough to draw accurate conclusions concerning population. To ensure the representativeness, the sub-samplings were formatted in a non-probability sampling technique where the samples are gathered in a process that does not give all the individuals in the population equal chances of being selected [4]. In the scope of this study, samplings are also qualified as purposive samplings where sub-jects are chosen to be part of the sample with a specific purpose in mind that sufficient to draw objective conclusions concerning the methodological approach of some subjects are fit for the research compared to other individuals [*Ibid.*]. This is ARD regulations training courses but is insufficient to give an accurate picture of attitudes and preferences of all DG transportation chain participants in details.

Within the structured questionnaire, interactive teaching methods were firstly explained thoroughly and then proposed to be evaluated in contrast to leading existing methodological approach today - classroom lecturing with the support of slideshow. These methods were selected into the study mainly based on the practice of other countries (i.e., France, the Netherlands). See Table 1 and Table 2 that present respondents' attitude and preferences by clusters concerning different methods that learners have experienced or are willing to undergo when taking ADR regulations training courses. Results are given in some respondents and percentage share of the total cluster.

Table 1. Teaching methods evaluation (CLUSTER 1)

Evaluation scale / **Teaching/ learning method (Category)**	**1 (most inefficient)**	**2**	**3**	**4**	**5 (most efficient)**
E-learning on a distance (A)	54 (36%)	57 (38%)	28 (18%)	6 (4%)	6 (4%)
Peer-learning (B)	29 (19%)	19 (13%)	73 (48%)	21 (14%)	9 (6%)
Practical tasks (C)	28 (19%)	17 (11%)	19 (13%)	40 (26%)	47 (31%)
Solving case studies in groups (D)	23 (15%)	27 (18%)	26 (17%)	35 (23%)	40 (27%)
Watching, analysing teaching videos (E)	28 (19%)	9 (6%)	20 (13%)	48 (32%)	46 (30%)
Reading individually materials (F)	29 (19%)	38 (25%)	34 (23%)	27 (18%)	23 (15%)
Listening to lectures with assistance of slide presentations (G)	19 (13%)	12 (8%)	34 (22%)	71 (47%)	15 (10%)

Source: Authors

Table 2. Teaching methods evaluation (CLUSTER 2)

Evaluation scale / Teaching/ learning method (Category)	1 (most inefficient)	2	3	4	5 (most efficient)
E-learning on a distance (A)	5 (13%)	10 (26%)	15 (40%)	3 (8%)	5 (13%)
Peer-learning (B)	4 (11%)	7 (18%)	10 (26%)	12 (32%)	5 (13%)
Practical tasks (C)	5 (13%)	3 (8%)	12 (32%)	10 (26%)	8 (21%)
Solving case studies in groups (D)	3 (8%)	6 (16%)	7 (18%)	10 (26%)	12 (32%)
Watching, analysing teaching videos (E)	4 (11%)	6 (16%)	10 (26%)	8 (21%)	10 (26%)
Reading individually materials (F)	20 (52%)	7 (18%)	4 (11%)	4 (11%)	3 (8%)
Listening to lectures with assistance of slide presentations (G)	16 (42%)	5 (13%)	6 (16%)	8 (21%)	3 (8%)

Source: Authors

By implementing QCA methodology best, suitable combinations of teaching methods were studied. As learners' operational risks within DG transportation chain differ, as well as expectations toward training courses, two separate truth tables were formed. According to methodological approach, categorical variables (conditions) were defined as following: e-learning on a distance (A), peer-learning (B), practical tasks (C), solving case studies in groups (D), *etc.* As a result combinations of conditions A-G were combined that would lead to the outcome. Effective methodological approach (outcome W) for ADR regulations training courses for drivers (W1 for CLUSTER 1) and DGSAs (W2 for CLUSTER 2) in Estonia are expressed in Boolean notation below in the form of formulas (2) and (3).

$$(C * D * F + B * E * G) - A \rightarrow W1 \quad (2)$$

$$E * (D * A + B * C * G) - F \rightarrow W2 \quad (3)$$

The results underline that methodological approach differs by learners' category. Empirical results indicate that traditional lecturing with the support of slide presentation is still adequate and suitable teaching method concerning drivers training. Learner-centered interactive methods are expected to be implemented within classroom lessons, and individual theoretical learning is clearly outdated with regards to DGSAs training. Hence, interactive methods differ greatly on a national level. Well-implemented blended learning methodological approach on the example of Italy (TIP) is not suitable for Estonia's case according to results of this study. This leads to the stand-point that trainees clearly underestimate the attitude towards the possible use of blended learning methodology at this point within ADR regulations training courses.

4.2 Advanced methodological approach

This chapter gives an overview of results of analysed data collected during in-depth interviews with four ADR training provider companies for drivers and one training company which is responsible for training DGSA in Estonia.

Table 3. Main findings of in-depth interviews.

Researched aspects	Trainer A	Trainer B	Trainer C	Trainer D	Trainer E
Design of existing training course	Teacher-centered/ student-centered	Teacher-centered	Teacher-centered	Teacher-centered/ student-centered	Teacher-centered/ student-centered
Active-learning methods in use	Discussions	Discussions	Discussions	Discussions	Discussions / Q&A
Current use of ICT	No	No	No	No	Not significant use
Comments on results of previous studies	A great contribution of a trainer are expected	More practical aspects should be included; active-learning methods can be implemented without ICT usage	Existing approach supports learners' expectations	DG related information has to be introduced within occupational training of drivers	Important information in scope of further developments
Changes in existing training	Partial e-learning	Improving handout materials	Improving handout materials	Provide additional voluntary DG related training to companies	Involvement of more expert lecturers
Comments on further developments of training system	Focus on knowledge; license issued to trainers individually (not to a training providing company)	Ask for systematic feedback on training course	Changes in supervision of an ADR regulations training system	Greater emphasis on DGSA training	Audio lecturing possibilities should be studied; slow transition onto blended learning

Source: Authors

As in-depth interviews are useful when the focus is on getting detailed information about a person's thoughts and behaviors or the aim is to explore new issues in depth on the particular matter [6], this method was chosen suitable for collecting data within the third stage of the research. Table 3 gives a summary of essential findings of interviews that are relevant input for improving training models with the integrated use of interactive teaching methods and implementing blended learning. Results are presented summarised in the form of table where training provider companies' names are left hidden (named as Trainer A, B, C, D for driver training companies, Trainer E for DGSA training company), as the intention of comparability analysis is not to compare companies or their services, but to identify opinions and views regarding integration of ICT opportunities and interactive teaching methods into existing ADR regulations training course system in Estonia.

The result of individual interviews confirms the aspect that ADR regulations training courses in Estonia are primarily teacher-centered since the only mainly used learners-centered method is a discussion according to main findings presented in Table 3. However, some points indicate on the fact that training providers are interested in implementing new approaches to carry out training courses, including with support of ICT possibilities. At the moment none of the interviewed trainers in Estonia are taking advantage of ICT opportunities with-in ADR training course for drivers. On the other hand, implementing partial e-learning is considered as further development within the existing course model. Such topics as first aid, basic knowledge of the use of protective equipment, *etc.* can be presented in the form of e-learning already soon.

Considering results of QCA of this study and results of in-depth interviews, preliminary training model for ADR regulations training courses for drivers and DGSA with the implementation of interactive and e-teaching methods were developed. This was presented as an interim result of research during a focus group meeting with ADR training provider companies and a representative of Estonian Road Administration to collect opinions on the relevance of the methodological approach in the scope of applicability in training and the possible effect on managing human-related risks. Considering remarks made by focus group participants the advanced training model for the model for ADR regulations training courses for drivers and DGSA was developed as it is presented in Figure 4.

When developing models for ADR related training courses in Estonia following principles and additional remarks made by focus group participants were taken into account:

1. Teaching methods make a difference with regards to human-related risk management.
2. Transition to blended learning course model has to be slow and step-by-step to take into account both trainers' possibilities as well as learners' readiness for a renewed approach to learning.
3. The DGSA trainee is more independent learner than the trainee who is undergoing ADR training course for drivers. Therefore methods that support independent

learning (e-learning opportunities) are included in training model for DGSA (seen in Figure 4).
4. Due to personal learning habits and preferences, learner needs for different learning options.
5. Learners' ICT skills have to be considered.
6. During self-assessment as well as final-assessment the use of materials (Internet) should be allowed. The assessment has to be more integrated in the learning process and, learners will also take responsibility in it [35].
7. Implementation of the advanced methodological approach of ADR related training courses in Estonia should begin with DGSA training.
8. Further development of training course model with the implementation of virtual reality solutions with the variety of specialised simulations for education and training purposes. [2]

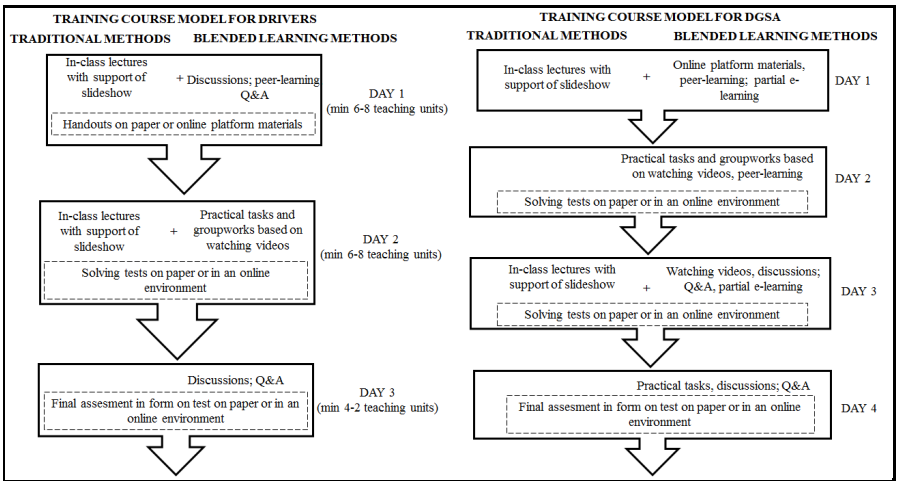

Fig. 4. Blended learning training course models. Source: Authors

Within this research finally developed training course model is final and considered ready to be implemented in practice for piloting. Herein opinions of all parties have been viewed with regards to applying blended learning techniques into ADR regulations training courses. Developed blended learning training course model is considered to be a good starting point for piloting and for establishing specific conditions and metrics on its' effect with regards to managing human-related risks when transporting DG by roads.

[2] Simulating complex incidents and accidents with DG on roads may have a positive effect on managing risks, as drivers/ DGSA may never face similar situations in practice unlike the awareness of a danger that is acquired through simulation. Similar simulations are in use for training of fire and medical emergency situations on example of German Chemical Industry. Firefighters can train their behavior on complex transport accidents with dangerous goods on motorways, rails, and country roads. Most of the firefighters have not been called very often to those accidents in their daily business. Within virtual training spaces, it is possible to train staff's behavior and to cope with complex operations [31].

5 Conclusions

There are many prescriptions, which need to be followed by different parties within the transportation chain of DG to ensure safe transport and handling operations as well as to minimise operational risks related to human factors. The change in existing teaching practice today regarding ADR training courses is necessary due to many aspects. Due to the continuously increasing number of the possible harm to the health of people and the environment in general, it is essential that all parties being involved are trained accordingly.

Educated and competent personnel is the critical factor that defines the competitiveness and efficiency of a system. What comes to competitive and efficient transportation chain of DG this all refers to a minimised level of risks; hence it is essential that personnel involved is capable of managing these risks properly when arranging or performing DGT. Due to possible risks with high consequence and the fact that trainees are adults, the training of employees of transportation chain of DG has to be detailed and practical giving a learner the opportunity to acquire the knowledge using different methods. Integration of ICT and implementing blended learning methodology within existing ADR regulations training courses were studied within this research.

According to collected and analysed data as well as to results in the form of developed training courses model conclusions have didactical and regulative nature. Didactical findings are directly related to principles on which improved training models are developed. Regulative conclusions refer to an overall ADR regulations training course system in Estonia. These are as following:

1. The trainer's qualification requirements are questionable – review and, if necessary, change conditions.
2. The trainer's knowledge of the methods used is insufficient
3. The control system of trainees has to be improved.

Conclusions presented above on regulative issues of ADR regulations training courses system rises next questions that need attention on a national level. Further researches related to this issue will focus on testing improved ADR regulations training course models in practice.

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