

AUTHOR REPRESENTATION OF DOCTORAL (PhD) THESIS

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The authorial review and the official critics of the doctoral (PhD) thesis of

Opportunities of reducing environment safety risks of public drinking water supply and system of relations of the drinking water safety planning

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Opportunities of reducing environment safety risks of public drinking water supply and system of relations of the drinking water safety planning

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1. WORDING OF THE PROBLEM

The properly operated adequate water supplies - including water production, water treatment and with the help of the water distribution systems delivering to the end point of the customer - could work properly on its own. The goal is on the consumer endpoint, from the view of public health, adequate quality and quantity of water should be delivered to the consumer. However, in the drinking water supply chain, such kind of threats and risks may arise in case of their improper take into account and observation and manage, the water quality could deteriorate, and its appropriate quantity reduces. Although water providers must have different regulations, and instructions, and for its operation a certain quality management system is required, the practical experiences show that these standards and instructions are good, but always they can only solve a certain part of the encountered problems. In addition, they do not have preventive attitude. To solve these problems, the so-called, drinking water safety planning was created

The drinking water safety planning is such an extensive risk analysis and assessment, which has to be prepared for each element of the water supply chain, from the water sourcing to the consumer. By getting through the main elements of the water supply system, the necessary data, possible dangers, the method of risk assessment, opportunities to intervene and monitoring system shall be fixed in the water safety plan. Drinking water safety planning shown the complexity of the solutions in connection with qualitative and quantitative risk factors may occur.

Knowing, that the adaptation of the water quality improvement strategy is a key on international professional policy level, the World Health Organization was the first to recognize the beneficial opportunities hidden in the water safety planning. The organization issued the so-called "Guidelines for Drinking Water Quality" (2004) document, which firstly contained the drinking water safety planning supply chain opportunities on the international level. Worthy of mention, the work of the International Water Association (IWA), where the so-called. Bonn Charter document was accepted, which also contributed the creation of water safety planning.

The European Community recognized the potential positive effects of the drinking water safety plan and from 2005, the Working Group of the European Network of Drinking Water Regulators ENDWARE - with the co-operation of Hungary - worked out a proposal for a

Directive on Drinking Water (Directive 98/83 / EC on the quality of water Intended for human consumption) for the supplement of drinking water safety plan program on the bases of risk assessment and management.

At present there is no such community legislation, which should oblige the EU's water utility providers to prepare water safety planning program, but in the majority of Member States, operating practices are widely used based on preventing the water supply, water quality, threatening events. In Hungary, on the legislative level, creation of the drinking water safety plans became mandatory from 2009 and their permission by the public health authorities. The year number, however, shows that the preparation of the plans and then their use is still fairly new.

Although most of the plans include in the requirements of the Government Regulation in force, but because of their novelty, their preparation is not easy. Studying the plans provided a good opportunity for the observation of frequent failures, errors may arise in these. According to my observations, there are general deficiencies that affect most of the drinking water safety plans. These deficiencies may appear primarily, because the task was resolved by not applying the novel, strict regulations, without having any tradition. These comments and proposals are presented in my thesis.

2. HYPOTHESIS

- 1. The proper and in my dissertation detailed water safety planning, complying with the requirements, plays an important role in the reduction of the environmental safety risks of the public drinking water supply.***
- 2. The existing, effecting legislation on water safety planning - 201/2001. (X. 25.) Government Regulation – obligates the water utility company to prepare the water safety plan, but its content requirements are not sufficient to create a water safety plan. It contains such legislative gaps, inconsistencies, which could affect the water safety planning process.***
- 3. During the water safety planning, most of the planners rely on the quality management systems compulsory applied in the drinking water supply. Indeed, these systems may also contain such kind of elements, which can be incorporated into the water safety planning. However, none of these quality management systems are unable to separately hold its***

own, in relation to the entire drinking water supply chain, because none of these has its own comprehensive approach that the utility systems and water supply and sewage systems have, regarding to the water service.

4. The two-dimensional risk matrix method used for water safety planning is the most commonly used and recommended one by the WHO to assess identified risks. In the case of water safety planning, the risk matrix means the product of the probability of occurrence and the severity of occurrence. *In the water safety planning, to the risk value is not always assigned by a number, but a range. Giving the numeric risk values, on the one hand could give relevant results, on the other hand, would facilitate giving more precise risk management measures, followed by the risk assessment.*
5. *During the water safety planning, the risks associated to disasters, arising from safety, caused by the temporary water supplies, quantitative water, fire water, the risks of transfer point and the consumer point and the matter of communication are neglected and or not sufficiently dealt with. The recited, however, are closely linked to the drinking water supply. The risk matrix can be useful for semiquantitative evaluating those risks and thus their practical visualization in the water safety planning.*
6. The water safety planning should follow the *approach of prevention*. It is difficult to uncover risks and threats that have not yet occurred in the operation of water supply system, but these emergencies still shall be prepared for. The *disaster- hazardous events* such as extreme weather conditions, the possibility of any third persons, *as well as the topic of water quantity issues pose the risks, of which risk analysis are rarely carried out in the water safety planning. The principle of prevention is only ensured for the water security planning if such threats are revealed, of which probability of occurrence is very low*, but their severity can be even catastrophic.
7. There is legislative, and application consistency between to ensure proper water quality and *the sizing of sufficient distribution network needed to ensure sufficient fire water to extinguish fire*. In the sizing, the use of fire water shall be taken into consideration as larger diameter pipes lay down is needed. It mostly causes problem for small water supply systems, due to the logging water forms in insufficiently used water pipes, in which microorganisms are therefore more likely to appear. *In my view, this problem also*

appears in the water safety planning. In the water safety plans made for small water supply systems, taking them into account becomes even more important.

8. The risk analysis made for the consumer points shall be a part of the water safety planning. The water utility company is in charge of drawing up the plan, whose responsibility extends *to the water delivery point but not to the consumer point* and has effect on the right quality and quantity of drinking water. On the one hand, it refers to the legislative gaps. *As I can see, this problem also affects the water safety planning.* It complicates the task of the planner, as it has, no accurate data, knowledge about the illegal connections and the pipe networks within buildings, for which the risk assessment also should be carried out.

9. On national level, such guidelines, instructions have not been made yet, which by keeping track of the situation and possibilities of the domestic water supply, would have revealed all potential hazards for *a complex water supply system*, and would have made the corresponding risk analysis for each danger. Such a *guide would help greatly the work of the planners, as it also would show a practical application.*

(The hypotheses marked with number has the corresponding objectives signed with the same number, followed by the the new scientific results.)

3. OBJECTIVES

1. My goal is by revealing the risk factors of the public drinking water supply, and by reviewing each step of the water safety plan and further *on creating the development proposals, facilitating the water safety planning to verify that the drinking water supply risks with the application of a well-prepared plan can be reduced.*

2. My goal is *to find* in the effective Government Regulation referring to the obligations of the water safety planning, *the legal gaps, and contradictions that complicate the water safety planning process.* My further aim is *to explore* the current regulation, *additional legislations that will promote the water safety planning.*

3. My aim is *to review* of the management systems of ISO 9000: 2005, ISO 9001: 2008, ISO 14001: 2004, ISO 22000: 2005 used for the drinking water supply and system of relations of water safety plans, *as well as to prove that the detached application of the existing management systems is not enough anymore to create water safety plans.*
4. My aim is *to prove the importance of the numerically given risk values* received with the risk matrix applied *in the water safety plans.*
5. My aim is to study, the risks of *disasters*, risks arising from *safety*, risks caused by the *temporary water supplies*, risks of *quantitative water*, risks of *fire water*, the risks of *transfer point and the consumer point* and the *matter of communication* in the water safety planning. These territories and their risks *in the current practice, do not form an integral part of the water safety planning, although risks are not negligible for the water supply.* My further aim is *for the exploration of these risks and their appropriate representation in the water safety planning to examine application possibilities of the risk matrix.*
6. My point is, *to call for the attention to the importance of risks and to prove from the disaster risk events and risks emerging from the quantitative scope of problems, which seldom appear in the plans, although during the water safety planning they are essential to fulfill the principle of prevention.*
7. *Due to provision of the fire water, the pipe lines have larger diameter than it would be necessary for daily water distribution.* This often leads to stagnation of water, as an effect of it, microorganisms appear in degrading the water quality in the water network. *My aim is to reveal this problem in the water safety planning. Also to confirm that it affects to the risk analysis as a whole, especially in the case of small water supply systems.*
8. The consumer point and the transfer point is different from each other. This greatly complicates the water safety planning. The water provider, who is also preparing a water safety plan has no realistic data about the pipeline networks within the building, neither as well about the consumer connection points, because it takes the responsibility only as far as the transfer point. My aim is taking into account the score of problems of *the transfer*

points and consumer points and its appropriate application possibility in the water safety planning.

9. As a member of the Working Group convened by the Hungarian Water Utility Association (Mavíz), I took part in carrying out the modeling of a water safety plan. It is a fictional water distribution system model, of which goal is to reveal all the risk for system and the implementation of its risk analysis. *On domestic level, we are creating the first attempt for the work out and implementation of such a water safety system model.* During making the model, the members of the group undertook various subtasks. *My submodeling task is to reveal all of the risks belonging to the process of disinfecting of the model water works and their risk assessment for risk management, implementation of the intervention measures, giving the preventive and corrective measures.*

4. RESEARCH METHODS

During my research connected with the subject, I used a variety of methods, such as *analysis, synthesis, induction, deduction and modeling*. By using the method of analysis, I have explored variety of environmental safety factors. In the collection of different legislations, I also applied the method of analysis, in order to find the legislation which can be associated with the water safety planning. By applying the synthesis method, after exploring a variety of laws I coupled those laws into a common system - currently into the water safety system planning - for which the existing legislation, referring to the water safety planning does not cover.

During the deployment of the quality management systems used in the drinking water service, also the method of analysis realized. By the application of the induction, I could achieve the accomplishment of the meeting of the quality management objectives.

The exposition of some steps of the supply chain of the water, and the process steps of the water safety planning was executed by analysis.

In the exploration of the different types methods, used for the analysis of risk I also analyzed. But when I specifically dealt with the risk matrix, then the induction method was realized. The risk matrix used for the assessment and analysis of disaster risk, I have pointed that in the case of further scientific areas being overlapped with this, this two-dimensional matrix can be successfully applied, such as safety hazards, risks arising from the temporary water supplies, the risks of fire water score of issues or for the quantity hazards assessment,

which are non-negligible, compliance with the water safety planning. Determination of the overall use of the risk matrix for other areas is taken by the induction method.

Revealing the quantification problem of the risk matrix solved by the implementation of the deduction method, when I generally dealt with the usage of the number 0 value at the risk matrix, as the generally discovered scores of problems occurs in each sub-area, as well as at the subject of the disaster risk topic. Finally, by the application of the modeling method, I created a submodeling task for a water treatment process of a fictitious water supply system.

5. A BRIEF SUMMARY OF THE PERFORMED TEST BY CHAPTERS

At first, in my dissertation, I reviewed the different environments safety factors that affect the public drinking water supply.

In the second chapter, I investigated the water safety planning, fitting into the legal system. The current laws have no references to other water safety planning facilitating legislation, therefore, I revealed the legislation promoting it. I also highlighted to such regulatory gaps that also making an impact on the water safety plan. For bypassing, not legally, but also risk analysis method of the water safety planning was applied by me to look for a solution for them.

In the third chapter, I reviewed the relation of the quality management systems used in the drinking water supply to the water safety planning, looking for the common connectivity opportunities of the two different systems. I found that the ISO 2200 standard, integrated in the HACCP risk-analysis system, is the most appropriate support for water safety planning. Conversely, I think that neither this nor any other management system are not able to fully regulate the water supply process from the water sourcing to the consumer point in the abstract. Mainly because they can take less into the account the reduction of the health risks. On the other hand, the obligation of the water supplier does not extend to the consumer point. Thus, any control system is used for the water supply by the water supply company, will not be able to regulate the entire process as far as the end point.

In the fourth chapter I present each step of the water supply chain, as in the water safety planning process for the four-step process - for the sourcing of water, water treatment, distribution network and ultimately to the consumer endpoint - demand to make the risk assessment.

In the fifth chapter, the water safety planning as its planning process was described by me. Beyond the general description of the individual design steps, I drew the attention to the great

deal of room for improvement. The risk assessment and the risk management should be considered to be the main design momentum, for which the principle of prevention is required to be kept in sight. The opportunities of the risk matrix applied for the risk assessment and water safety planning as well as the quantification opportunities of the risk values is also detailed by me, in the water safety planning.

In the sixth chapter, I dealt with certain segments of water safety planning, which were not or only partially included in the already completed plans. They are the following topics: risks of disaster events, safety and object protection risks, volume risks of drinking water, risks of temporary supply of drinking water, the fire water-related risks, risks of takeover and consumer points, and finally, I deal with the score of the communication issue. Each segment was served with practical examples for the opportunities of risk analysis, using the two-dimensional risk matrix effectively. In addition, I emphasized and proved their importance in the water safety planning.

In the seventh chapter, I made within the framework of a sub-modeling task, a complete risk analysis for a water treatment process of a fictitious water supply system.

6. CONCLUSIONS

Belonging to the hypotheses set up in the dissertation, I examined different segments of the water safety planning.

First of all, the risk factors of the public water supplies were identified, separately grouped the affecting factors of the amount of water and the water quality. During my research, it proved that the use of a well prepared water safety plan reduce the emerging risk factors in the supply of drinking water. As the water safety planning is a very complex task, because all possible risks are to be revealed, taking into account every step of the water supply, and followed by the principle of prevention, risk analysis must be prepared.

To create a water safety plan requires considerable expertise. Preparing it, primarily the 201/2001. (X. 25.) Government Regulation should be considered, which regulates the WSP. The Government Regulation spelled out the mandatory content elements of the water safety planning, however, further on it fails to offer essential proof for the designer. During my work I have studied the legal background of the water safety planning, and associated more legislation with the facilitation of the water safety planning. The already existing legal gaps in the legislation even more crop out in the water safety planning. In one respect, I examined the

uncompleted regulation of the legal level of the role takers' professional qualification in the plan-making.

On the other hand, for the transportation of the fire water, the water pipe line diameter, specified in the 54/2014. (XII. 5) of Regulation BM are oversized for normal consumption, therefore the requirements of the drinking water quality standards of 201/2001. (X.25th) Government Regulations are only partly satisfied. Thirdly, I detailed the legal gap arising from differences between the water transfer point and the consumer end point. The service provider is obliged to make risk assessment for the entire water supply system as far as the consumer end - under the legislation. However, the service supplier has authority in the legislative sense - and so its real insight - only as far as the water transfer point.

Many designer take the particular water supply quality management system documents for bases. Therefore, I analyzed the quality management systems used for water service alignment to the WSP, revealing the corresponding connections. I think that these quality management systems - primarily which also include specific risk analysis system - can well serve as the basis for planning, they do not cover so many things, which are in the supply process, therefore in the risk analysis of the water safety planning are essential.

Examining the risk matrix used in the water safety planning, I revealed how it can be used the most effectively in the water safety plans. To do this, I used the possibilities of quantification of the risk matrix. I introduced the possibility of fitting the human factors in a two-dimensional matrix of risk as well.

The water safety planning is a dynamically improving model today. Thanks to the dynamics of it, I had the opportunity to incorporate such scientific areas into the water safety planning, which can be closely associated with a topic of water safety planning, which is currently only sometimes or not at all included in the plans. In my view, they are not incorporated, either due to the novelty of the water safety planning process, or the shortcomings of the legislation describing the water safety planning, or they were not given due attention in the water safety planning, or they did not get the right attention in the water service quality management systems, used in the water service, but on which the planners cannot rely on. However, the successful incorporation of them are additional safeguards for further development opportunities of the water safety plans. These are the follows:

- Taking into consideration the natural and man-made disaster risks. Although the probability of their occurrence is very little in a water supply chain, while their severity can be greater.

- In my view, for the prevention effectiveness of the approach of the water safety planning, their risk analysis are essential.
- I dealt with the scores of issues of the temporary water supply, which is also fraught with risks, for which in the water safety plans should be dealt with.
- Separately, I took into account the quantitative issues of drinking water because the water safety plans at first put more emphasis on the risks of the water quality and the quantitative risk factors get into the background.
- I also coordinated the water safety planning with the professional fields of the safety and object protection.
- The scores of problems arising from the firewater pipeline scaling is separately considered to be important to emphasize, as since the 1-th of July of 2016, plans prepared for small water supply systems are required to be permitted, in which the problem will still occur more relevant.
- I also cast light on the differences between the takeover point and the consumer points and the difficulties of the risk assessment associated with them.

The presented listed different areas in water safety planning was introduced by the application of the risk matrix method. Overlap between the areas is also possible due to the identity of the individual risks.

During the communication, the common work of experts of various professional fields, the common coordination of the operator and the authorities, as well as how to inform the public was taken into account in relation to water safety planning. This professional field could receive greater emphasis in the water safety planning as well.

Finally, by the application of the submodeling, I wanted to demonstrate the practical applications of water safety planning.

7. NEW SCIENTIFIC RESULTS AND THESES

- 1. I have verified that the environmental risk factors of the public water supply can be reduced by applying a carefully prepared and operated drinking water safety plan. The recommended **development proposals**, in my thesis, which are used in water safety planning, could further serve to decrease the environmental risks of public water supply.***
- 2. I have proved that in formulating the water safety planning obligations, 201/2001 Government Regulation (X.25) currently in force, on legislative level does not provide***

full support for water safety planning. In addition, *it has been proved that there are legal gaps* in the Government Regulation *that affect the water safety planning.* On the one hand, it is the lack of requirement of the planners' qualifications. On the other hand, the legal differences must be mentioned due to consumer end point and transfer point, which cause the planning difficulties. Thirdly, In the Fire Protection Regulations, the tube diameters required to the firewater and the compliance with requirements of the 201/2001 Government Regulation (X.25) referring to the adequate drinking water supply cannot be satisfied at the same time. *I revealed to the Govt. Regulation* those of the legislations, which provide additional support for the preparation of drinking water safety plans.

3. *I have proved that none of the management applied* in the water supply service *is able to regulate in itself completely the quality and quantity of drinking water from the water sourcing through the water treatment system and the water distribution to the consumer endpoint.* Even if they integrate a risk analysis system too, *they do not place the health protection of the drinking water of the users, and the reduction of the health risks at the center.*
4. *I have proved by the application of the risk matrix in the water safety planning, that likelihood of occurrence and the severity of the consequences are to be quantified* in order to the more accurately estimate of the health risk, so that the risk value obtained by multiplying the two, should be specific numerical value. *The practical application of quantification of the risk matrix was described in the modeling water safety as a part of the submodeling task.*
5. *I have verified that the application of the semiquantitative risk matrix is the most appropriate method for the risks assessments of the water safety planning.* With the help of this risk matrix, *risks arising from disasters, safety, temporary water supplies, firewater, water quantity issues caused by scope of the problems given by the risks of the consumer takeover and consumer points could be easily revealed.*
6. *I have proved that* water safety planning following the principle of prevention, in any case, must *take into account, the risks arising from variety of natural and man-made catastrophe events, and the risks of drinking water* quantity as well.

7. The pipe lines of the distribution networks are oversized due to the application of the design and official guidelines of the current fire water, which has a negative impact on the water quality. In my dissertation, *I studied the problems of fire water and called attention to this fact, that this affects the risk assessment of water safety planning, and -its analyzes. I confirmed that in the assessment of the risks, in the case of small water supply systems the higher risks are recommended to give.*
8. *The differences between the transfer point and the point of consumption, which hinder the risk analysis of the water safety plans, was taken account and I explored appropriate potential applications in the water safety planning. I highlighted to the bidirectional communication between the consumer and the water supply service company could ease the aimed at the consumer endpoints risk analysis.*
9. *I created the part model, in which the risk analysis of the disinfection process - namely, the exploration of hazards, risk assessment, monitoring process, the steps of intervention, as well as the preventive and corrective activities - were revealed and introduced by me. Using my researches, as a member of the working group of MAVÍZ, I have participated in the creation of such a water safety planning model, which is considered so far the most detailed water safety instructions on domestic level.*

8. PRACTICAL USE OF THE RESEARCH RESULTS

In my dissertation, primarily I draw your attention to notices in connection with the water safety planning, which were not given emphasis in the home and international guides, or not at all occurred. Application of these observations, in the water safety planning, could contribute to a more dynamic design. Putting research results into practice, primarily they can be linked to analysis of the risks:

- In my dissertation, referring the development of water safety I highlighted such kind of areas that are only marginally or not at all occur in water safety plans, although such risks are related to those that should be proposed to be taken into account very much. I have demonstrated that the risk matrix can be used simply to assess these risks in terms of water safety.
- The application of the human factor, firstly introduced by me - used in the water safety planning - in risk matrix as its new (multiplication) factor, could reveal new perspectives in the practical application of the risk matrix.

- For one of the steps in the water treatment, for the disinfection, a complete risk management and risk assessment was drawn up by me. My risk assessment for any water safety plan, can be well-used and easily applied.

9. RECOMMENDATIONS

I recommend the results of my work primarily for designers of the drinking water safety plans. In addition to the already existing guidelines, this thesis could serve as a mainstay even at the beginning of the preparation of the plan as well. My findings and observations could help ensure that the nascent plans with fewer defects and errors could be submitted with the purpose of getting expert advice then for approval. During mandatory review of the existing plans, the review of my thesis could serve as some advice and observations as well.

I offer with special regard my dissertation to the application of various types of mobile purification equipment, used in military missions, which do not require to make obligatory water safety plan. With the help of a water safety plan, it would be easier and faster to reveal, analyze and manage the quantitative and qualitative potentially developed risks of the drinking water, even for the mobile water purification units used by military.

I also recommend my dissertation for the tutors, who give lectures at higher education institutions, in relation with water safety planning.