Development of a Specification for Computer-Based Microscopic Evacuation Analyses and Simulations

Identification of Success Factors Based on Case Study Research

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***Abstract*—Public security is constantly tested by new threats. Standards for public security are missing in many technical aspects as well as the area of security management. Several research gaps related to these fields exist, particularly regarding R&D stage standardization. The German project InfraNorm aims to initiate the development of security standards and specifications. By using case study and participant observation methodologies, this paper gives insight into the development of such a specification for simulation and modeling based on R&D stage standardization and unveils new success factors. The identification of success factors is based on a preliminary survey among security researchers which determined potential problems they should solve. Application fields of the findings include, in particular, fast track standardization procedures with voluntary implementation of the results, standardizations of R&D results and standardization projects from small groups.**

Keywords-specifications, standards, civil security, case studies, simulation, modeling

I. INTRODUCTION

A. Public security, standards and standardization needs

Public security is constantly tested by new threats. Therefore, innovations for public security are of great importance. Additionally, several recent studies highlight the need for security-related standards, e.g. [17], [20], [21] and [30].

Standardization is 'the activity of establishing and recording a limited set of solutions to actual or potential matching problems directed at benefits for the party or parties involved balancing their needs and intending and expecting that these solutions will be repeatedly or continuously used during a certain period by a substantial number of the parties for whom they are meant' ([13], p. 13).

Numerous benefits of standardization have been described by [2], [33] and [34]. For example, standards help to build focus and critical mass in the formative stages of a market and facilitate network externalities. They also reduce transaction costs and risks as perceived by producers and customers and they codify and diffuse state of the art technology and best practice. Specific advantages of standard setters are, for example, shown by [5], [6], [15] as well as [36].

Although some researchers are closely involved in standardization processes, the vast majority of scientists (not only in the security field) rarely regard standardization as a high priority (see [6]). As a result, many researchers do not use the special opportunities standardization can offer them. Standards can often facilitate the development of a much larger market for a technology than a company as an individual can realize solely based on proprietary specifications. Some R&D managers know this, but they are still too few (see [6]).

InfraNorm is a joint project between the DIN German Institute for Standardization and the Berlin University of Technology (duration: March 2010 – February 2013). It belongs to the research area 'Protection of transport infrastructures' of the German Framework Programme - Research for Civil Security and is funded by the German Federal Ministry of Education and Research. Its goal is to initiate the development of standards and specifications based on R&D stage standardization.

InfraNorm collaborates with ten associated project consortia, intending to improve the protection of airports, train stations and ports as well as the protection of railways, bridges and tunnels. They are comprised of approximately 80 partners overall. A specific work package aims to develop a standardization manual for the participants of the German security research program. Its completion relies on a multi-method approach including several case studies of security standardization projects.

B. DIN Specifications (DIN SPECs)

Funded by the European Union, the project INTEREST examined the barriers that prevent researchers from getting involved in standardization. Three categories of barriers were discovered: lack of resources, the standardization process itself and the lack of awareness and visibility of standards and standardization processes, which includes the lack of awareness of the potential benefits of active participation in standard-setting (see [6] and [24]).

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Standardization organizations have developed different types of processes and products to address the need to save time. For example, the international standardization organization ISO introduced publicly available specifications (ISO/PAS). On a national level, the DIN German Institute for Standardization, for example, created the new instrument 'DIN Specification' (DIN SPEC). Several kinds of DIN SPECs were created. This article focuses on DIN SPECs based on procedures to develop publicly available specifications, DIN SPEC (PAS) – DIN SPEC as the abbreviation.

While German DIN standards (DIN Norms) are developed based on full consensus decisions of all stakeholders, the development of a DIN SPEC does not require the involvement of all stakeholders. Therefore, the work leads to quicker results. In contrast to the development of a DIN Norm which may take up to several years, a DIN SPEC is released several months after its submission to the DIN. Its development takes place in existing standards committees or in project-related committees (see [38]).

II. Microscopic Evacuation Analyses

Evacuation analyses can be conducted using computer-assisted simulations on the micro- or macroscopic level [28]. While the latter focuses on the behavior of crowds, microscopic simulations assess individual behaviors and movements in evacuation scenarios [28], [39].

By focusing on flows of people as a whole, macroscopic analyses are comparably static [39]. Hence, they only function properly under comparably steady conditions. An advantage of macroscopic simulations is the reduced amount of information needed, which is particularly important in case of limited data processing capacity of computers.

Being able to 'track the fine detail of individuals' [28], including attributes such as position, route choice or speed, microscopic simulations are most appropriate for analyzing scenarios which feature uncertain conditions or dynamic environments as random events to reflect irrational human reactions in case of an emergency [23] can be easily incorporated [28].

The current need for security-related simulation and modeling standards was shown by a survey completed within the project InfraNorm among the members of the German security research program.

The standardization project described in this paper addresses the need for standards for modeling human behavior.

III. Literature Review And Research Gap

Based on their economic function, four types of standards can be distinguished: (1) semantic standards; measurement and testing standards (2); quality and variety reducing standards (3) and interface and compatibility standards (4) [2]. With regard to the position in the product cycle, [31] identified three types of standards. According to its classification, standards can be anticipatory, participatory, or responsive.

Anticipatory standards are standards 'that must be created before widespread acceptance of devices or services'. Participatory standards 'proceed in lock-step with implementations that test the specifications before adopting them' and responsive standards 'occur to codify a product or service that has been sold with some success' [31]. R&D stage standardization is a specific kind of participatory standardization used in practice (see e.g. [15]). It is a proactive approach to questions of standardization very early on in the overall innovation process, which can then benefit from the timely formulation of recommendations on structural aspects of the product/system that is to be developed (see also [38]).

Investigating success factors is of great scientific interest in many fields (see e.g. [9], [10], [12] and [19].

Related to projects, efficiency and effectiveness are important goals (see e.g. [26]). Specific success factors research in this field is, for example, done by [8], [9] and [32]. While [9] defines success as the effectiveness of a project, [8] investigates factors that lead to the efficiency of organizations. Therefore, we define success factors for the purpose of this study as a number of characteristics that has an impact on both the efficiency and effectiveness of a project or organization.

Regarding the establishment of formal standards, success factors research is not so common. Examples for success factors research in the broader sense are given by [27], [29] and [32].

[32] identified six dimensions which are important or even essential for the success of a project. The list includes the dimensions scope management, time management, quality management, cost management, resource management and documentation management.

While [27] investigates negotiation strategies, [29] shows that the homogeneity of interests facilitates a standardization process, whereas the heterogeneity of organization types in a standardization project raises the acceptance of a standard. The author also shows that the size of a standardization group is important. Small groups facilitate decision making while more effort may be needed to influence the target group to adopt the results. Regarding the stages that follow the standardization process [4] investigates factors influencing the lifetime of telecommunication and information technology standards. Success factors in particular are not investigated. Pioneering research concerning formal security-related standards and standardization was done by [3]. Yet, there is little empirical insight into the field available so far (see [38]):

- Little is known about the establishment of security standards, particularly in the field of R&D stage standardization.
- Although [31] identified three standard types with regard to different positions of standards in the technology cycle, there has not been much research on R&D stage standardization and related anticipatory and participatory standards.

- Little is known about the standardization of common results of joint research projects.
- The development of DIN SPECs and its success factors have not yet been investigated.

InfraNorm aims to provide new scientific insight into that field.

IV. Research Objectives

Based on the identified research gap the central question of the case study series for the standardization manual is: how can security researchers establish standards and specifications successfully? Three sub-questions were derived:

1. Which success factors characterize the development of the standard or specification?
2. Which challenges occurred?
3. Which solutions could be found?

The identification of success factors needs a preliminary analysis of potential problems they should solve.

For assessing the standardization presuppositions of German security researchers as well as perceived problems and risks, a survey was conducted. The questionnaire used consisted of 14 questions in 8 topic areas and was sent to approximately 300 German researchers in the field of civil security. Completion of the questionnaires took place between May and July 2011. 48 persons participated in the survey.

In order to offer insight into the barriers that prevent researchers from getting involved in standardization investigated by [24] the German security researchers were asked their opinion on what barriers prevent participation in the security-related standards. They were asked to rate the importance of eleven barriers in total. The three most significant barriers include the use of other forms of exploitation of R&D results, the time required and the necessary costs. All findings support the results of [24].

Of particular interest was the aim of revealing perceived risks in security-related standardization. Therefore, the participants were asked to give a risk assessment. Specific risks related to security-standards were identified, for example ethical risks including privacy-related risks and the risk of misusing the security-standards information for criminal purposes.

Another question dealt with the risks of conflict in the standardization process. Six central aspects were identified: identification of mutual benefits, consensus-building, Intellectual Property Rights (IPR), administrative problems and delays, specific aspects in an international context, such as the users' resistance and problems of acceptance.

A following question focused on the risks of conflict within the different stages in the standardization process. Typical stages of the standardization process include the initiation of the project (Phase 1), the development (Phase 2), the release of a standard (Phase 3), its utilization (Phase 4), as well as the revision (Phase 5). On the basis of those, the participants were asked to develop a ranking of the phases according to the perceived conflict potential in each of these stages. Phase 2 was ranked first, hence viewed to bear the biggest potential for conflict, followed by Phase 1, Phase 5 and Phase 4. The stage 'release' (Phase 3) is associated with the least conflict potential (see [38]).

Based on the survey, seven issues were selected for investigating success factors to overcome potential problems: resources and time required (related to Phase 1), consensus-building, IPR, specific problems related to security-related standards (related to Phase 2); acceptance of a specification (related to Phase 4); as well as the further development of the standard as an issue of Phase 5.

All issues relate to the two dimensions of success: efficiency and effectiveness. Issues related to the efficiency of a standardization project are time required as well as the occurrence or absence of conflicts regarding consensus-building. Problems influencing the effectiveness of a standardization project are resources, specific problems related to security-specific standards, acceptance of the specification as well as questions regarding its further development. IPR-specific problems are related to both dimensions.

V. Research Design

Qualitative research has become a popular form of research in many academic and professional fields (see [41]). A case study is a qualitative research strategy 'which focuses on understanding the dynamics present within single settings' [18]. An advantage of qualitative research is that it facilitates insight into new fields e.g. based on case studies. Case studies are particularly suitable if 'how' or 'why' questions are to be answered [40]. According to [11] the inclusion of case studies in learning and training materials is very valuable. Publications in the field of standardization based on case study research include for example [1], [7], [25] and [35].

As mentioned before, seven issues were selected for in-depth analysis. The preparation of the InfraNorm standardization manual includes the task of providing in-depth information about standardization processes to develop DIN SPECs based on the specific standardization activities within the project. This task was easily combinable with the research methodology 'participant observation'. Participant observation is a field research method and offers a specific methodology for case study research. It simultaneously combines 'document analysis, interviews (...), direct participation and observation as well as introspection' [22]. Researchers go directly to the social system under investigation and collect data (see [8]).

During the project minutes of the meetings were kept; relevant information was extracted and categorized. The focus was on activities related to the specific categories defined previously. Additionally, a final interview with the chairman of the project was done. The minutes were used in the same way.

VI. Description of the Standardization Project

A. Introduction

The development of the specification for computer-based microscopic evacuation analyses and simulations included five steps: initiation of the project, creation of the first and second internal draft, approval and publication. In addition to their presentation below the causal conditions are described and a preview of further steps is given.

The developed DIN SPEC according to PAS procedure defines goals, terminology, and procedures of microscopic evacuation simulations and thus makes it available to a broad user community.

B. Causal Condition

According to German law, physical structures must be erected, altered and maintained in such a way that public security and order are not endangered. Particularly for buildings which are intended to be used by many people, evacuation calculations are recommended. The utilization of computer-based methods issues new challenges to the authorities. Especially for assumed scenarios and for parameters of evacuation calculations, standardized criteria are essential.

C. Initiation of the project

The standardization project was initiated in March 2011. Besides the initiator (a CEO of an SME and a participant of a project within the German security research program) three industry experts (two SME, one university) asserted their willingness to participate in an upcoming working group.

The initiator had gained positive experience with the development of similar standards and guidelines. A previously developed standard promoted the acceptance of his software tools, similar to a certification. All participants knew each other from various former projects. Consequently, a common contextual understanding had already been established, allowing for an efficient workflow.

The project started in May 2011. During the kick-off meeting, the business plan was prepared, the project initiator was elected chairman, and further steps were initiated. Fire safety offices, event technicians, fire departments, software developers, public authorities, as well as members of the working group itself have been identified to be the target group of a respective DIN SPEC.

The project flow was planned as follows:

- conference call in the 2nd month
- finalization of first internal draft of the DIN SPEC at the end of the 2nd month
- presentation of the concept at an industry association in the 4th month
- another conference call in the 4th month
- finalization of the DIN SPEC in the 5th month
- final meeting in the 6th month.

Several existing standards and guidelines within the context of the project were identified, all of which do not interfere with the intended scope of the current efforts. These include, for example, a policy of an industry association, which then constituted the basis for the current project.

Right from the beginning, the working group used various electronic means for its work like dropbox and a wiki. Conference calls served as discussion forums, while personal meetings provided a forum for decision-making.

Communication with external partners was particularly facilitated by well-established contacts to the industry association. Shortly after the kick-off meeting, the project was presented at the association's general meeting. Moreover, it was announced that the draft version of the DIN SPEC would be presented during the next workshop in autumn 2011 and that the association's feedback would be incorporated into the final version. The participants came to the agreement that the DIN SPEC and a guideline of the industry association may not contradict each other. Accordingly, the association expressed the willingness to make editorial modifications to its own technical guideline and to subsequently develop a revised version, once the DIN SPEC was approved.

In conclusion, the working group realized that the DIN SPEC should not be too detailed, as some production methods might be excluded otherwise.

D. Creation of the first internal draft

For developing the first internal draft, the chairman prepared a preliminary version which was sent out to the participants, who were given the time to comment electronically on the document. Careful considerations were made regarding parameters and values suitable for specification. Subsequent decisions resulted in appropriate measures to avoid use of the DIN SPEC other than for its intended purpose.

During the following conference call, the document was further refined and comments were resolved. Simultaneously, wikis were used. Affirmatively, the decision was made that the current version would be presented during a workshop of the industry association in September 2011.

As the result of this phase, a first draft had been developed which was intended to be presented at a workshop of the industry association. In the course of the workshop, open issues concerning specific values and definitions should be reconciled.

E. Creation of the second internal draft

In order to inform interested parties, the draft of the DIN SPEC was sent to all members of the industry association (about 100 persons) as well as approximately 450 members of a XING group via e-mail at the end of summer 2011.

Twenty-seven participants attended the workshop of the industry association in September 2011. The previously developed draft version gained broad acceptance. The workshop itself led to new ideas, contacts and further impetus to the issue at hand.

The results of the first workshop served as the basis for the second internal draft. Thus, during the conference call in October 2011, information on possible inclusions was actively exchanged.

It became increasingly evident that the working group was pioneering the relevant domain and that no comparable set of regulations was existent worldwide. The finalization of the second internal draft not only led to great satisfaction within the working group, but also ensured that benefits for the target group became obvious. The association's workshop, on the other hand, raised awareness. Overall, the DIN SPEC takes on a global pioneering role and does not exclude any players.

F. Approval and publication

Following the conference call in October 2011, a new version of the DIN SPEC was published online, including the recommendations that arose from the industry workshop.

Through the association's website, approximately 50 people were informed of the document. In the aftermath of the diffusion within the XING discussion group, a small engineering company sent out comments concerning building law, which proved to be helpful.

At the end of November 2011, the working group's final meeting for the time being took place. First, the second draft was revised based on the external commenting. Afterwards, the updated manuscript was put up for discussion by sending it to the working group members through the chairman. All participants agreed on the approval of the currently revised version. The adopted version was subsequently released for publication.

Members of the working group who also belonged to the target group have planned first implementations. Furthermore, it was anticipated that 30 additional players who are going to develop evacuation reports will refer to the DIN SPEC.

G. Preview of the further Development of the Specification

Like the presentation of the DIN SPEC at an international conference that took place in July 2012 the next meeting of the industry association will be used to support the diffusion of the DIN SPEC. In addition, responses to the DIN SPEC are monitored for about one year order in order to decide on further action, such as developing an international formal standard or a European specification.

VII. Success Factors of the Standardization Project

As shown in Table 1, the standardization project was characterized by several success factors.

Prior experience of the chairman in standardization issues supported the execution of the project. Work without conflict was possible since the members of the working group knew each other from several previous activities. Consequently, they were familiar with the technical views of the partners and already had had positive experience in former collaboration efforts. The development of the DIN SPEC is based on an industry association guideline. Consideration of this directive constitutes an important foundation for the future application of the DIN SPEC.

The working group is integrated into a dense network with the target group. They communicated and interacted actively with a broad group of interested parties, which further enhanced the diffusion of the standard.

It was possible to structure the project into sub-processes, which in combination with the utilization of electronic media allowed for an efficient workflow.

Not only the present project, but also previous experiences of the chairman highlight the importance of building on existing standards and guidelines if carrying out projects which aim at standardizing.

When initiating the project, the working group found it beneficial that several university libraries provided access to databases for conducting research on standards.

Table 1 shows all success factors and the potential problems they helped overcome. So far, no specific success factors related to Intellectual Property Rights occurred. According to Table 2, the success factors were classified by four groups: basic conditions, organization of work, characteristics of the DIN SPEC and the preparation of further steps.

VIII. Challenges and Solutions

The biggest challenge from the chairman's point of view was the completion of the project within an appropriate timeframe. The aforementioned success factors – particularly the utilization of electronic media, appropriate structuring of the project, as well as constructive interactions with the target group – however, helped overcome this issue successfully.

For the chairman, the most important lesson learned was the observation that projects aiming at developing DIN SPECs require the willingness of the chairman to take on a large amount of effort himself or herself. Since the participation within the working group as well as all relevant activities took place on a voluntary basis, only a small portion of the workload could be assigned to the members of the working group. Without the chairman's efforts to actively prepare each project meeting, projects of that kind seem to not be feasible.

IX. Conclusions and Final Remarks

The investigated project gave an example of linking research and standardization appropriately and unveiled a list of factors which facilitated the successful development of a specification in the civil security research field. They refer to basic conditions, the organization of work, characteristics of the specification and the preparation of further steps. In addition to the current state of research the findings include both security-related and general success factors.

An important basis for success is to maintain a close relationship to all major parties within the context of the project.

The findings also show the importance and nature of appropriate marketing measures to promote further steps in the lifecycle of the specification.

The working group could work efficiently as a small group without competition, allowing for work without conflict. Therefore, assumptions about the size of the standardization group and its efficiency given by [29] were confirmed. To avoid problems regarding the acceptance of a new standard or specification mentioned by [29] the working group interacted actively with the target group of the DIN SPEC.

Appropriate strategies to avoid use of the specification other than for its intended purposes can be regarded as key success factors related to the specific security-related aspects of the project.

Several results of the case study seem to be quite specific and therefore difficult to generalize but there are also results of common interest. The following advice was derived:

- Establish appropriate relationships with the target group, relevant industry consortia and networks
- Use modern communication methods instead of meeting personally whenever possible (see also [37])
- Structure the project into sub-processes
- Define the specification level appropriately
- Focus on avoiding inconsistencies with existing standards and guidelines and initiate solution-oriented negotiations with the relevant parties, if necessary
- Use platforms and social networks like XING to raise awareness of a new standardization project, to communicate with the target group and to support the diffusion of a new standard or specification

Additionally, regarding security research projects, appropriate strategies are needed to avoid the use of a security-related specification or standard other than for its intended purposes.

The acceptance of the established standard in the case study as well as the future benefits for the researchers involved in its establishment are to be analyzed in coming research steps. It will be of high scientific value to analyze the adoption of the standard as well as its further direction.

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Potential problems in standardization processes	Success factors in the project to overcome such problems
Resources	• Efficiency through conference calls and utilization of shared, web-based document exchange • Utilization of preliminary work • Appropriate structuring of the project into sub-processes
Time required	• Experience of chairman in standardization issues • Appropriate structuring of the project into sub-processes
Consensus-building/ conflicts within working group	• Positive common collaboration experiences by the members of the working group
Acceptance and usability	• Well-defined added value of the DIN SPEC • Aiming at an international standardization gap • Availability of established networks • Appropriate communication with the target group
Specific problems related to security-standards	• Appropriate strategies to avoid use of the specification other than for its intended purpose
Further development of the specification	• Monitoring responses to the DIN SPEC for about one year in order to decide on further actions
IPR	• Not relevant

Table 1: Success factors within the standardization process

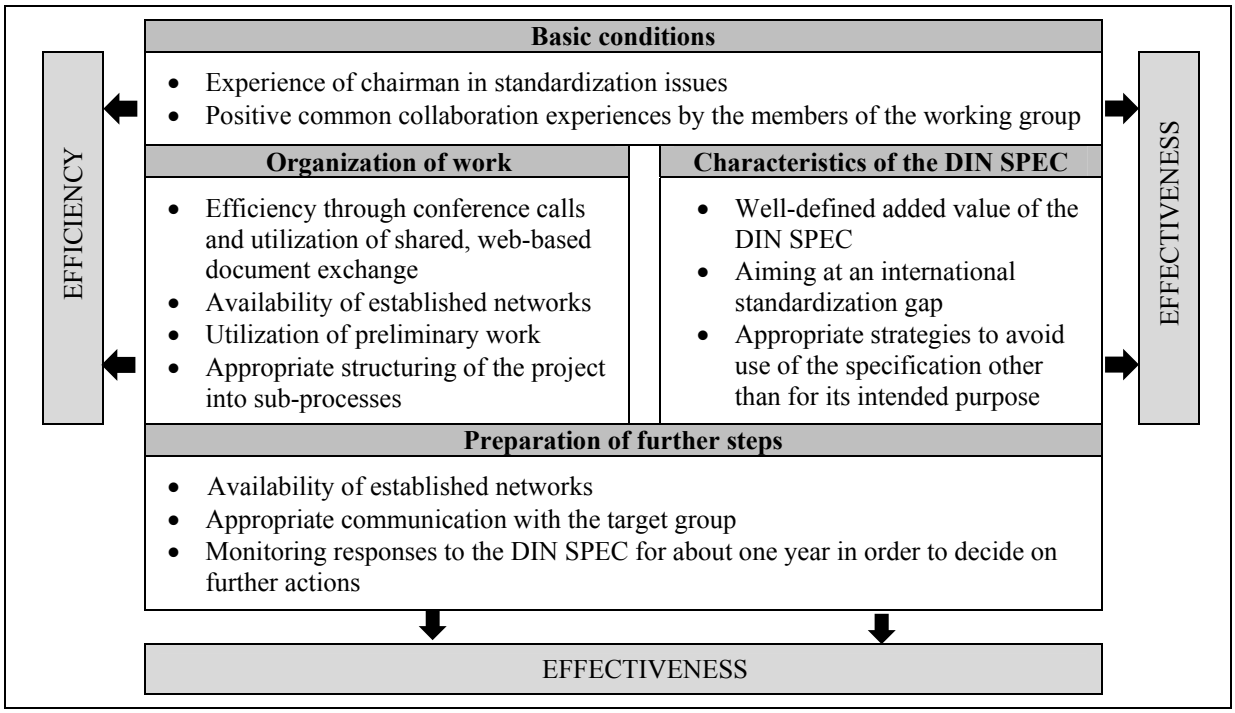

Table 2: Clustered success factors of the standardization project and their effects

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