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Standardization process for urban resilience

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Abstract: The adaption and implementation of resilience related approaches at urban level via standardization is the key aspect that this paper is addressing. Reframing of resilience practices through standardization will enhance the sharing of knowledge and experiences among especially urban areas. This paper is showing a path for transferring results of research and innovation projects into the market via standardization of the projects' outcomes. In order to assess the proposed methodology a survey with organizations involved in the standardization activities of a resilience related research project was conducted.

Keywords: standardization; resilience; urban resilience; standardization process; lessons learned.

1. Introduction

Only a few studies exists that have assessed the role and impact of standardization for research and innovation projects (Technopolis Group 2013). However, especially in the field of security there is a high demand for new standards. This was for example identified throughout the work resulted from the mandate M/487 (European Commission 2011) established by the European Union to analyze the current security standards landscape in Europe. There, standardization potentials have been identified for all security areas mentioned in the mandate. It was summarized from the mandate work that to achieve the proposed standardization work it is necessary to have a common understanding of security, research and innovation and to integrate standardization in all the phases (Poustourli 2016).

In general, several publications highlighted that standardization is beneficial for the research and innovation activities; i.e. standardization as a tool for transferring the developed technology or project results into the market, and existing standards as enablers and facilitators for research and innovation

(Blind 2013). Hereby the differentiation between standardization, as a process for developing new standards or for giving input to existing standards, and standards, as consideration of existing standards for the implementation of research and innovation activities, has to be taken into account.

Besides standardization, which is currently rarely used in research and innovation, several other tools and methods exist to transfer the research results into practice. However, most related actions led to the development of scientific publications rather than to be transferred into practice (Blessing and Seering 2016). At the same time, funding programs like Horizon 2020 or Horizon Europe from the European Union have an increased focus on the impact and transfer of research results, since a couple of years also by proposing standardization as a tool in research and innovation projects to support the exploitation and dissemination (European Union 2013; European Commission 2018).

This paper describes a methodology for using standardization practically within security and resilience related research and innovation projects, i.e. the process of developing standards out of project results as well as potential criteria for selecting specific results for standardization activities. For this purpose two exemplary European research and innovation projects belonging to the field of disaster resilience are presented within this paper that have integrated standardization in their scopes and used (partly) the methodology mentioned below. The questions that derive from these practical examples of integrating standardization in research and innovation projects are:

- How to decide which of the results of a research and innovation project are appropriate to transfer into a standard?
- What can be a process of transferring a research result into a standard; and which other aspects need to be considered?

Both questions are addressed in the upcoming chapters and a methodology for integrating standardization in research and innovation projects is presented and initially analyzed by the means of a survey within one of the above mentioned research projects.

2. Methodology to include standardization in research and innovation projects

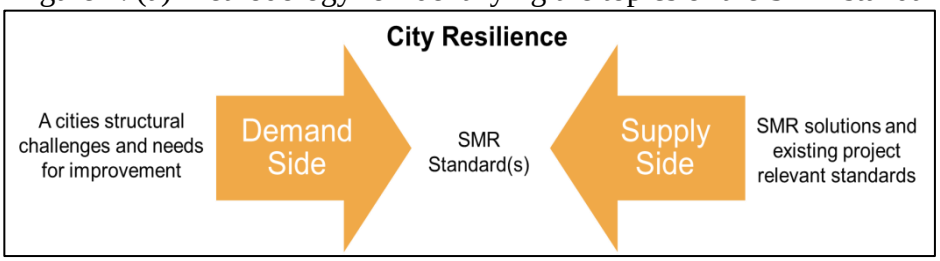
The integration of standardization in research and innovation is supported on European level by several national standardization bodies (NSB), who among other related activities are participating in research and innovation projects. This is also key to fulfill the demand by the European funding authorities in several of their calls in which references related to standardization are explicitly mentioned. As the respective funded research and innovation projects have put different priorities for standardization, the way it is being addressed differs from project to project. However, when a NSB is involved in the project a set of different activities is usually conducted (CEN-CENELEC 2018a), such as:

- Screening and analyzing existing standards and ongoing standardization activities,
- Analyzing the standardization potential of research results,
- Advising on the standardization strategy of the project,
- Supporting the establishment of a liaison with Technical Committees (TC) relevant for the project,
- Developing a roadmap for future standards and standardization activities,
- Assisting the standardization process for developing new standards or for giving input to ongoing standardization work.

Within the two European research and innovation projects SMR (Smart Mature Resilience) and DRIVER+ (Driving Innovation in Crisis Management for European Resilience), which this paper is looking at and which have been included standardization, an NSB was integrated for being responsible for the standardization activities; mainly to support the impact and dissemination of the findings of the projects. Like other projects these two have also used different means for the dissemination and exploitation of their project results, and among them standardization was one element to support this. As first activity, an analysis of existing standards and ongoing standardization activities was conducted in both projects (DRIVER 2018a; SMR 2016). This supported the awareness on existing standards in general, but also the implementation of the different work packages.

The analysis of existing standards together with the assessment of the project results built the basis for identifying the standardization potential in the projects. For the case of the SMR project the standardization potential of the project results (i.e. SMR tools to enhance city resilience) was identified by using a dedicated methodology considering a supply and demand side. The supply side consisted of the research results (i.e. five solutions and an overarching guideline) that were developed during the SMR project as well as standards that already exist on the topic of city resilience. And the demand side included the specific needs of the city partners concerning their resilience goals and the optimization of city resilience. For the latter a survey with project partners was conducted as well as different interactive sessions during project workshops were held. Finally, by using individual assessment criteria the standardization potential of the project solutions were analyzed, considering also the results of the assessment of the supply and demand side.

Figure 1. (a) Methodology for identifying the topics of the SMR standards



(b) SMR project D6.2 Summary of Standardization Potentials (SMR 2018b)

Figure 1 shows the relation between the demand and supply side that resulted in the identification of new possible standardization activities. In summary, two of the five developed solutions of the SMR project were transferred into a standard and additionally the overarching guidance document that refers to all five solutions.

The approach used within the SMR project is also the basis for the general methodology for integrating standardization in research and innovation projects presented in this paper. The methodology includes the following six items:

1. Initial analysis of existing standards and standardization activities of relevance for the project, and promoting it among the project partners,
2. Assessment of the resulting standards list with support of the project partners,
3. Raising awareness among the project partners on the possibility standardization is offering for the project, and agree on a standardization strategy,
4. Identify the standardization potential of the project results driven by a demand side - the needs of the end-users / project partners and a supply side - the existing standards and individual project results, with the means of a dedicated project workshop,

5. Assess the identified standardization potential by using individual assessment criteria, and agree with project partners on the envisaged standards creation,
6. Conduct the development of the standards within the timeframe of the project, and potentially liaise with relevant standardization committees.

In order to identify lessons learned of the integration of standardization activities a survey was conducted within the SMR project by the end of the project with project partners and external partners involved in the project related standardization activities, i.e. the development of the standards. The main purpose of the survey was to reflect on the conducted standardization activities and to support future research and innovation projects with providing respective recommendations.

The survey was divided into four different blocks of questions. Mainly closed questions with multiple choice answers were provided in an online-survey in order to receive a good response rate. In question block A general questions on the background of the respondent, the previous knowledge on standardization (e. g. on the standardization process) and usage of standards, the working experiences with the respective NSB, as well as the reasons for participating in the standardization activities were asked. The question block B was only targeted to the project partners and was set up to get feedback on the individual project tasks related to standardization, i.e. the provision and usage of a list of relevant standards, the methodology and criteria to identify the standardization potential. In question block C the experiences of taking part in the development of SMR standards were asked, including questions on the way of working, on the integration and exchange between organizations and city representatives as well as on individual lessons learned. The last block D summarized the feedback of the respondents related to their participation in the standardization activities, consisting of questions on the knowledge on standardization after the project, the willingness for exploiting the standardization results and for future participation in standardization, as well as strategic questions like having standardization as integral part in research and innovation projects.

The survey was targeted to all 12 other partner organizations of the project as well as 12 additional organizations having participated in the standards development as project externals. In total 21 answers were collected. Considering that the survey was less than two weeks online and available for the potential respondents, it can be acknowledged that all project partners and three project external organizations have answered the survey. This was giving a good basis for the evidence of the survey outcomes.

3. Case study descriptions

SMR project

The first project of this paper is the SMR project (SMR 2018a), a Horizon 2020 project conducted between June 2015 and June 2018 with focusing on the development of various tools and a guideline to enhance city resilience. Because of its significant outcomes, SMR was marked as a success story by the REA, the Research Executive Agency of the European Commission. One of the reasons for achieving this level of success was the effective and fruitful integration of standardization activities within the project lifetime, resulting in a series of standards called 'City Resilience Development'.

The aim of the SMR project was to deliver a Resilience Management Guideline that supports city decision-makers in developing and implementing resilience measures in their cities. In the project there have been several theories and methods identified that support resilience development. As

outcome of the project in total five resilience building tools were developed, which all have been included in the Resilience Management Guideline.

The five tools developed within the project are: 1) a Resilience Maturity Model, 2) a Risk Systemicity Questionnaire, 3) a Resilience Information and Communication Portal, 4) a City Resilience Dynamics Model and 5) a Resilience Building Policies tool.

1) The Resilience Maturity Model (RMM) helps cities to assess their resilience status and to identify the ideal path for the evolution of the resilience building process from an initial stage to a more advanced stage, going through a number of intermediate stages.
2) The Risk Systemicity Questionnaire (RSQ) has been developed to address the risk assessment aspect of increasing the resilience level of cities, considering risk scenarios as causal chains and vicious cycles.
3) The Resilience Information and Communication Portal (RP) allows for different levels of users to allow for city managers, critical infrastructure providers, citizens or other stakeholders to be able to contribute information as applies to a given city context.
4) The City Resilience Dynamics Tool (CRD) aims to help city disaster managers diagnose, explore and learn about the resilience building process. They can use the tool to make decisions and be able to take the correct actions in the resilience building process. The model allows the user to try different policy options, identifying the implications of each of them in the resilience improvement process.
5) The Resilience Building Policies (RBP) tool is an extension of the online version of the RMM. It combines custom ways to view policies contained in the RMM with detailed information and examples from case studies detailing policy implementation in partner cities, references of sources to case studies from other cities around the world, and links to risk mitigation actions that support the policies.

As different cities were involved in the project a practical use for cities or urban areas was needed that was achieved by a more end-user oriented development of supporting documents such as standards. In this regard the SMR has integrated standardization as one of the instruments to transfer the project outcomes and tools into the market, and thus to their potential end-users the cities. Within the framework of the standardization activities, a European Workshop has been organized that integrated all the other projects funded under the same research call as well as other cities and relevant stakeholders. By conducting this kind of event it was possible to engage with stakeholders having similar research objectives and to identify potential partners for the standards development arising from the SMR project.

The project had therefore dedicated one work package to address all standardization related aspects, i.e. the analysis of project relevant existing standards and standardization activities, the identification of standardization potential of project results and based on these the initiation of new standardization activities. The standardization work package implemented the methodology presented above and used the following five assessment criteria to assess the standardization potential of the SMR solutions: necessity (Cities' need for having the solution implemented or up taken), transferability (solution has high potential to be transferred into a standard, i.e. the envisaged standard should consist of approx. minimum 90% requirements and maximum 10% recommendations), feasibility (current status of the solution – not ready vs. finalized, for deciding if possible to develop within project lifetime), complementation of existing standardization landscape (gap in existing standardization), and further input (integration of project externals for enhancing the quality and uptake of the solution) (SMR 2018b).

The assessment with the use of the above mentioned selection criteria resulted that two of the five solutions as well as the overarching Resilience Management Guideline have been analyzed as appropriate to transfer into standards. This outcome was the basis to initiate the development of three standards, i.e. the CWA (CEN Workshop Agreement) 17300 series on 'City Resilience Development' (CEN-CENELEC 2018b), consisting of:

- CWA 17300 City Resilience Development – Operational Guidance (as overarching document),
- CWA 17301 City Resilience Development – Maturity Model, and
- CWA 17302 City Resilience Development – Information Portal.

Therefore a series of open workshops was conducted to which project external organizations and cities have been invited to participate.

DRIVER+ project

The second project of this paper is DRIVER+, a currently ongoing project funded under the 7th Framework Programme of the European Commission, whose main aim is "to cope with current and future challenges due to increasingly severe consequences of natural disasters and terrorist threats, by the development and uptake of innovative solutions that are addressing the operational needs of practitioners dealing with Crisis Management" (DRIVER 2018b).

Within the DRIVER+ project the first phase of screening relevant existing standards have been accomplished (DRIVER 2018a). As the project terminates only by April 2020 and as the identification of the standardization potential of the project activities is still ongoing only a first initial overview of the status regarding standardization of project results can be shared within this paper. The goal of the DRIVER+ standardization activities is to uptake (partly) the successful established methodology implemented within the SMR project. For example both projects have initiated a liaison with the respective technical standardization committee with the goal to ensure fast uptake of the standards developed within the project. On the other hand, by implementing the methodology another time additional components are identified, tested and will be integrated in the next version of the methodology for integrating standardization in research and innovation projects.

Besides the specific solutions for supporting European crisis management and disaster resilience that have and will be analyzed and tested in several trials, also the procedures to facilitate these demonstrations are considered for potential standardization. These procedures are for example related to the test bed for testing the relevant crisis management solutions within DRIVER+, as well as activities related to support an enhanced shared understanding of crisis management among Europe.

4. Results of the survey

The outcomes of the survey on the experiences and lessons learned of the project partners in SMR and the external organizations involved in the standards series development resulted in several quantitative and qualitative responses (SMR 2018c). For instance, within the development of the above mentioned CWA standards series on 'City Resilience Development' it was through the open standardization process possible to involve other cities and research projects easily. This answered the identified need of the participating cities to have an exchange of experiences with other cities on their resilience challenges and resilience building activities. In the end of this process the city representatives and researchers acknowledged and committed to the standards series as they have been an essential part of its creation.

The survey results in block A illustrated that in the beginning of the project and the development of the standards the knowledge on standardization was in general quite low among the involved organizations. This is not really uncommon as the integration of standardization in research and innovation projects is just increasing the last years and therefore continuous awareness raising on the envisaged standardization activities and its related processes was needed during the project lifetime. The result of a specific study question in block D, which is related to the respondents' experiences after the standardization activities, has shown that the amount of knowledge on standardization has been significantly increased from 5% to almost 50% after having finished the project[1].

One success factor of the standards development in SMR was the involvement of all project partners as well as several external partners. The survey asked the involved persons on their reasons for participating in the CWA development and it resulted that most of them have seen the importance (e. g. of the dissemination and exploitation possibilities) of the tools described in the standards, were general interested in the topic of city resilience or wanted to be part in the standards development on this topic.

The project team had seen the essential benefits of having an analysis of relevant existing standards and ongoing standardization activities already in the beginning of the project, mainly to get an increased awareness of the diversity of existing standards and to support the implementation of the project tasks and work packages. But also they identified standards of interest for their own work within their city or research, which was important for future engagement of the consortia in standardization.

While assessing the standardization potential of project results, the criteria of 'filling the gap' on existing standardization, the need of getting 'further input' to the project results' and the 'transferability' of the solution into a standard have been seen as most appropriate ones. The standardization methodology of the project was rated in general as suitable for the needs of the project. Especially the conduction of the European Workshop with other similar projects was seen as a success for sharing project results with externals and for identifying possible project external contributors for the development of the standards.

During the development of the three standards the co-creation method and the mix of different kind of meetings have been highlighted from more than 75% of the respondents as most appropriate. Especially the splitting into small groups has been rated from more than 90% respondents as useful or very useful. This type of working mainly supported a common understanding on the respective topic of the standard. In the same time and due to the different sessions held during the standards development, most of the Workshop members have not seen a real difficulty working in a bigger group of experts and to find consensus on the content. Since the CWAs are targeted to mainly cities, it was of great benefit to have several project external cities and stakeholders within the standards development involved. Thus it was possible to have a deep exchange on sharing others' experiences and good practices as well as to get to know other resilience approaches and to widen the own network.

After participating in the standardization activities of SMR the respondents of the survey summarized in the question block D that more than

- 75% of the respondents have a high willingness for future involvement in standards development,

[1] Survey resulted that in the beginning of the project only 5% of the involved persons had good knowledge on standardization, in the end of the project 48% have rated their knowledge either very good or good.

- 70% of the respondents want to promote the standards in their own network ,
- 40% of the respondents want to use the standards in their own city,
- 80% of the respondents consider standards more in future research and innovation activities,
- 45% of the respondents want to be more active in standardization with closer relationship to their standardization organization,
- 65% of the respondents wish to have standardization as essential part in research and innovation, and
- 80% of the respondents see standardization as an appropriate tool to transfer research results into the market.

5. Discussion

After having accomplished the SMR project and parts of the DRIVER+ project several lessons learned could be identified. With regard to the SMR project the following qualitative lessons learned from the organizations having participated in the standards development could be derived (SMR 2018c).

Considering standardization work as early as possible in the project supports the establishment of basic objectives and gives the opportunity to influence upcoming research and innovation activities as well as ongoing and forthcoming standardization activities adequately. Especially the overview and understanding of existing standards related to the project work and objectives builds a proper basis for implementing the different work packages and tasks of the project. In the same time the availability of well defined standards could be a possible scientific basis for e.g. a robust definition of resilience policies.

The development of standards such as CEN Workshop Agreements as part of a research project could increase the information sharing about and uptake of project results, intensifies the view on specific project results among project partners by having the possibility to include externals as well as could support the application and transfer of achieved research and innovation results. Also when starting from city-centric research and innovation activities as well as with an intensive engagement of the project consortia in the standardization processes, the (technical) quality of standards and their reliability as well as their practical applicability in and by cities can be enhanced.

The participating standardization organization such as a national standardization body should have a role as a guide and capacity developer. This key feature can only be ensured when the standardization organization has a technical understanding of the topic, an overview of relevant ongoing standardization activities and the accessibility and know-how to effectively link project activities into standardization. The communication and dissemination of the standardization deliverables such as CWAs to other European cities is needed to support the uptake of these standards. Therefore the European Commission should promote actively the developed standards. In general, they should foster the integration of standardization within R&I projects to support exploitation and prepare transferring research and innovation results to market effectively.

Additionally further specific lessons learned and recommendations were captured which are directly targeted to standardization organizations involved in the research projects (SMR 2018c).

The standardization body should ensure that project partners have sufficient resources (i.e. travels and time) for their participation in the standardization activities of the project but also for related activities at international level, (ISO, IEC, ITU), European level (CEN, CENELEC, ETSI) and national

level. And these resources should be checked frequently. It is crucial that the standardization organization ensures visibility and active involvement during the whole duration of the project, e.g. by spreading information and maintaining awareness on ongoing standardization activities in the consortium and by having dedicated standardization sessions at the different project meetings to link the identified standards directly with the project work. Therefore an early involvement in content-developing WPs of the project is essential.

Additionally it is important to present the advantages of the chosen standardization option (e.g. CWA) to the project partner, i.e. possibility for engaging with externals in project specific standards development, the support of the dissemination and exploitation of project results, and the mentioning of project partners and external organization involved in standard in the standard itself. Key for the standards development is that project partners become or see themselves as "owners" of the standards. This can be achieved by for example having transparency among all project partners when developing a project plan for a CEN Workshop Agreement and by asking them for direct contributions.

Also enough time for the standards development need to be considered; in specific an early but appropriate start of the standards development allows to have the scope of the envisaged standard clearly defined. The results of the research project chosen for a standard should be ready and relevant outputs of the project (e. g. innovative methods and instruments such as systems and tools, product or service specifications).

When being in the process of developing the standards a continuously exchange with the involved project partners but also with the ones less involved is needed to remain them always in the development group and have them contributed when needed. Especially the involvement of city representatives play a key role to ensure the integration of a variety of stakeholders important for urban resilience.

The above mentioned review of the standardization activities conducted in the project as well as the specific lessons learned from the participants in these activities and especially within the standards development are of high value for future integration of standardization in research and innovation projects.

6. Conclusions

The methodology on the integration of standardization in research and innovation projects as described in this paper has been acknowledged within the SMR project. The approach seems to be appropriate for the purpose of transferring research results into the market. The used criteria to identify the standardization potential of the project outcomes were also suitable. However, this might differ from project to project and surely other criteria will be identified for future exploitation. Therefore further insights and experiences from for example the DRIVER+ project can be beneficial to provide an evidence based list of criteria.

With regard of the chosen standardization deliverable and especially within the field of security and resilience in which a need for more end-user driven standards is given, the tool of a CEN Workshop Agreement can be the right one to easily integrate the relevant stakeholders in a consensus building process and thus to transfer research results into a standard. Especially the diverse and complex topic of security and resilience in which a variety if stakeholders is affected, standards such as CWAs could support the fast uptake of the urgent needed research and innovation activities.

The current status of the standardization activities within the DRIVER+ project show that the methodology is also transferable to other security related research and innovation projects. However, as this project is still ongoing a final summary can not yet made.

In the future, standardization will become a regularly used element for research and innovation projects to disseminate and exploit their results. Practical examples of projects in which the integration of standardization have been done successfully – like SMR and DRIVER+ – are key to raise awareness and to support this approach of linking effectively standardization with research and innovation.

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Conflict of Interest

The authors declare no conflict of interest.

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