X-tendo

GUIDELINES HOW TO ENSURE KEY CROSS CUTTING CRITERIA OF QUALITY/RELIABILITY, USER FRIENDLINESS, ECONOMIC FEASIBILITY AND CONSISTENCY WITH INTERNATIONAL STANDARDS FOR THE 10 FEATURES

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EXECUTIVE SUMMARY

This report presents the "Guidelines how to ensure key cross-cutting-criteria of quality and reliability, user friendliness, economic feasibility and consistency with internal standards for 10 features". The framework was developed and tested during the H2020 X-tendo project, and the presented guidelines are a result from the experience gained during the project.

In the context of the project, the four cross-cutting-criteria "quality and reliability, user friendliness, economic feasibility and consistency with internal standards" were assessed and evaluated for all 10 features during the phases of development and testing. Therefore, the work described in the present report englobes results from both project phases.

This report starts with a chapter 1 "Introduction". Then, chapter 2 presents the "General framework for cross-cutting-criteria". Chapter 3 "Cross-cutting-criteria feature development" presents the conditions set by the feature developers before starting with the development. Chapter 4 "Cross-cutting-criteria feature evaluation" presents the results from the testing activities in the project. Finally, Chapter 5 "Conclusions" presents the main conclusions and proposes a final workflow for supporting feature's development by a cross-cutting-criteria approach.

The insights derived from the check of the cross-cutting criteria are incorporated as far as possible in the final project phase and the final update of methodologies and tools.

1 INTRODUCTION

This report has the objectives of presenting the workflow followed in the X-tendo project to apply cross-cutting criteria in the development of the 10 features. The intention of using cross-criteria was to support the developers during the development process. At the same time, creating indicators to assess the developed methodologies during the testing phase. As this is an innovative approach, this report presents the followed workflow, delivering final guidelines based on the X-tendo experience for future works for future replicability.

During the X-tendo project, the cross-cutting-criteria workflow was applied in different phases, as summarized in the Framework Figure 1 . In the beginning, the feature developers played a stronger role, by setting up the relevant indicators (for each feature) and assessing if the indicators had been met, after the finalization of the methodology. In a second phase, the partners responsible for testing the methodology (implementing partners) also assessed the methodology against the cross-cutting criteria. It enabled that the results from both phases were then compared.

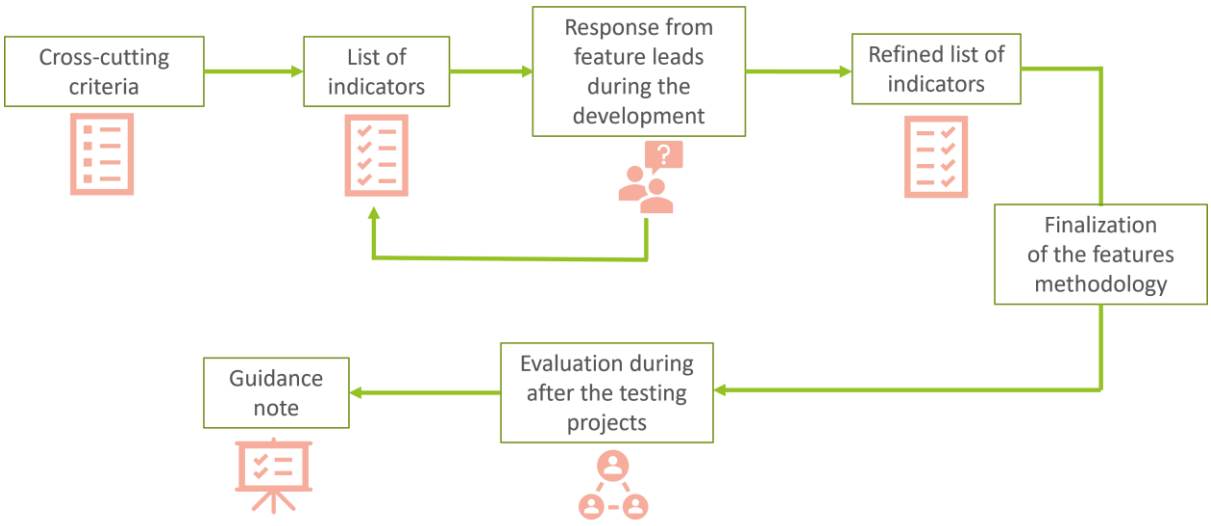


Figure 1: X-tendo framework for cross-cutting-criteria

The four are cross cutting criteria: (1) quality and reliability, (2) user-friendliness, (3) economic feasibility and (4) consistency with international standards.

2 FRAMEWORK OF THE CROSS-CUTTING CRITERIA

The framework of cross-cutting criteria consists of a set of indicators that are used to develop and assess the performance of various EPC features, during development and testing. Therefore, X-tendo cross-cutting criteria are conceived as a set of external reference points to guide the development of all innovative EPC features. The four criteria are:

1. Quality and reliability: It is the foundation of the EPC framework and its features. They influence the impact of EPC frameworks, as well as the potential new and innovative features. They are the foundation to ensure user trust and data consistency and allow policymakers to develop policies based on EPC data. Furthermore, quality control and reliability ensure that the EU-wide and national goals for the building stock can be monitored and can help achieve them.
2. User-friendliness: It emphasises that the EPC and its features must be easy to use and understand for various users. The end-user (often a building owner or resident) or target audience (e.g. public authorities) often has limited knowledge of the new features and technical aspects of buildings. Clear information is needed with easily understandable explanations and visuals. The degree of user-friendliness can be assessed regularly through feedback and checks. It is important to make sure that there is a balance between user-friendliness and accurate data and information that give a full and reliable picture. The level of user-friendliness needed for the feature (presentation/ documentation/explanation) can be obtained through user-testing.
3. Economic feasibility: In the context of EPCs, it refers to how cost-benefit ratios are calculated when implementing specific features. Economic feasibility study is crucial during the early development of the indicators and forms a vital component in the feature development process. During the decision-making process, these cross-cutting criteria weigh much higher compared to others. It is important to include an analysis of the market, economic and technological conditions of a Member State before implementing the new features.
4. Consistency with international standards: It provides a basis for mutual understanding among individuals, businesses, public authorities and other kinds of organisations. Since features being developed are foreseen to be adopted and adapted by different Member States, this cross-cutting criterion will ensure that they are compatible and comparable across the EU by maintaining consistency with international standards such as CEN/ISO.

A list of indicators was identified under each cross-cutting criterion that has been defined in consultation and feedback with the involved project partners. Feature leads and implementing partners assessed the new features during their development using the cross-cutting criteria and their several indicators that were used to enable this process as shown in Figure 2. However, since their scope and strength of application differed based on

the individual feature requirements, they were not binding on all features equally. The indicators were refined through discussions with the consortium partners and were updated for each feature based on their relevance and suitability. A recommendation of proposed application was provided for all the indicators in the description of each cross-cutting criterion.

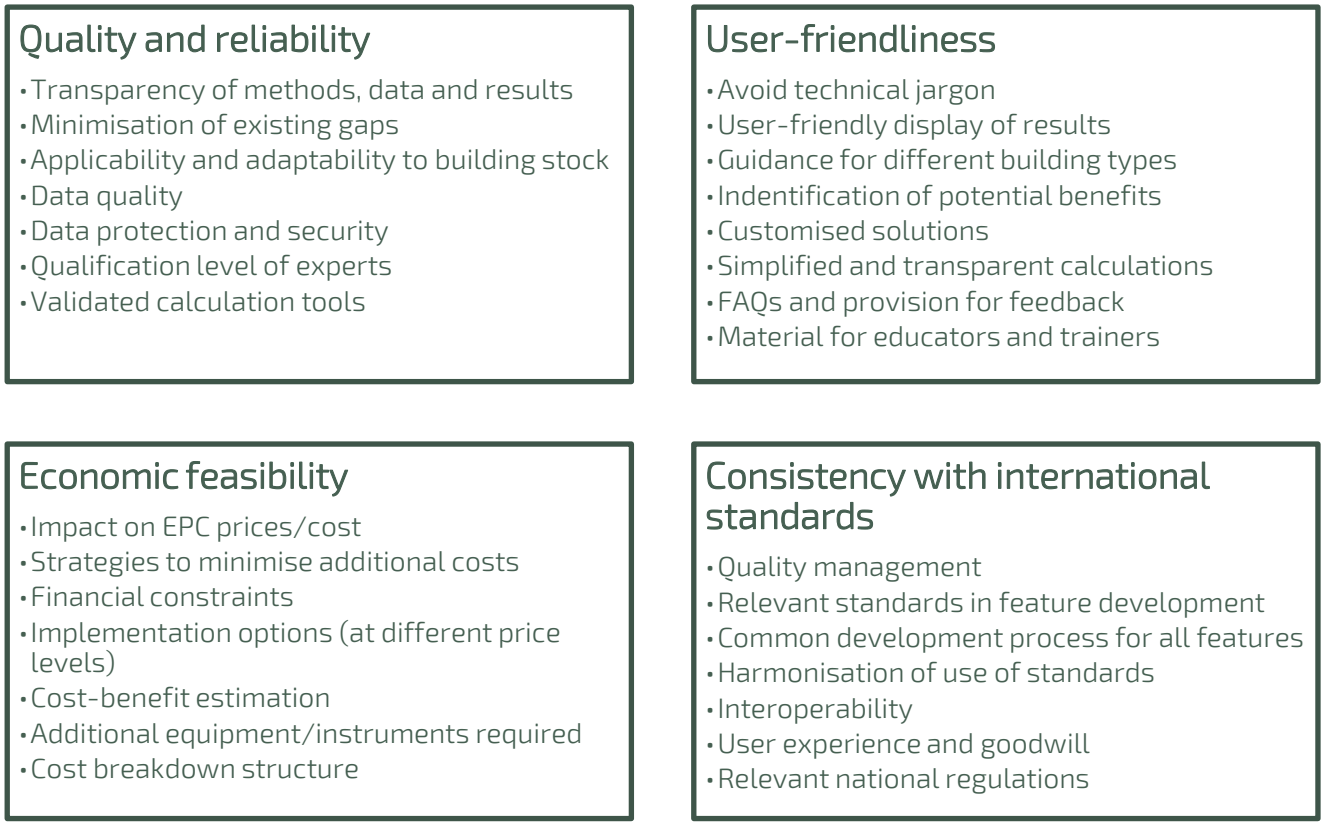


Figure 2: Summary of indicators for four cross-cutting criteria

Each feature was assessed, evaluated and validated against the indicators to ensure compliance with the cross-cutting criteria in all the stages of the project with the support of the implementing partners. A guidance roadmap was prepared for the application of the framework which was divided into three steps for the project.

1. Step 1 focused on the initial phase of the project, from months 1-10. In this period, an initial assessment (i.e. "gauging mandatory indicators") was conducted for each of the features against the applicable indicators of each cross-cutting criteria. The identification and definition of the specific indicators under each cross-cutting criterion were finalised by BPIE, TU WIEN and NAPE.
2. Step 2 took place in the following period from months 11-17, during which the feature leads evaluated the criteria in detail (i.e. "degree of application required"), and outlined the measures taken to address the applicable indicators of each cross-cutting criterion. The evaluation allowed the feature leads to advance the integration of the framework in their features.

3. Step 3 was the validation (i.e. "check and confirm during the testing of the feature") of cross-cutting criteria, in months 18-33 of the project. The finalised indicators were reported and included in the X-tendo toolbox.

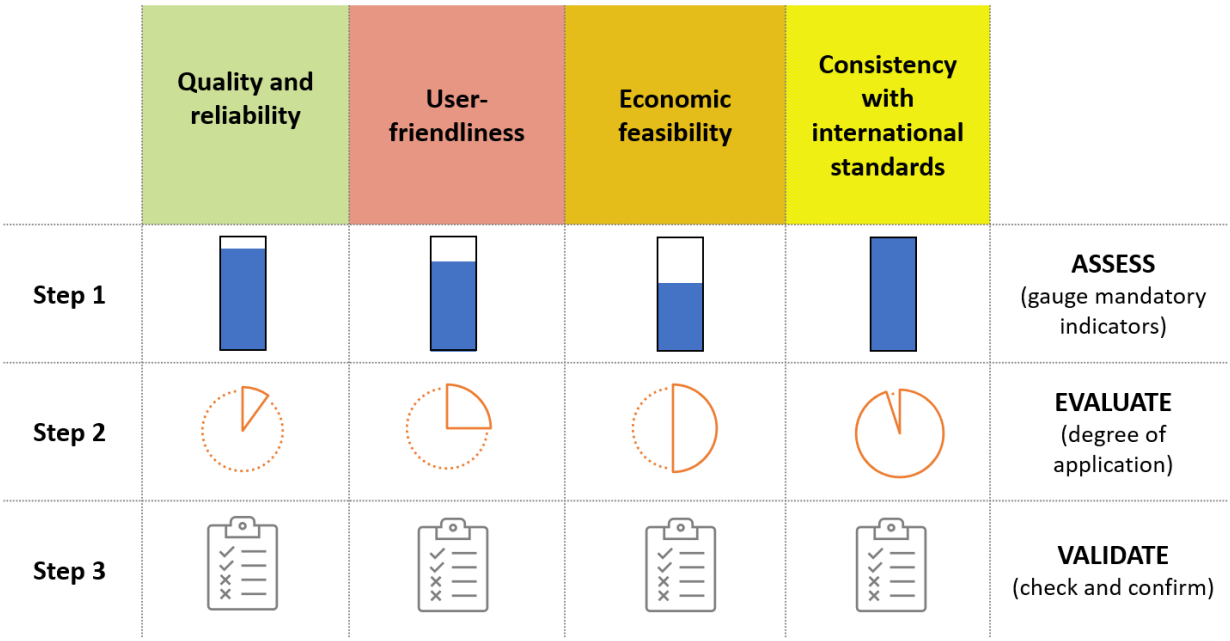


Figure 3: Guidance roadmap for the application of the framework

The final feature development considered the context-specific needs from the Member States testing the feature. Moreover, the guidance roadmap provided a stepwise plan that enabled overcoming the barriers of implementation and making the features more meaningful for the EPC systems in the Member States.

3 CROSS CUTTING CRITERIA: FEATURES DEVELOPMENT

The cross-cutting criteria had the main objective to support X-tendo feature developers to develop their methodologies. For each criterion, four indicators were listed. Then, the first step was to indicate the most relevant indicators (maximum two per criterion). This served as orientation during the development of the methodology. And, the main target was to meet, at the end of the feature development, at least the criterion crossed as most relevant. The tables below show the selected indicators per criterion and feature. The "not" selection does not necessarily mean that the indicator is not relevant. It may mean that is it "less" relevant than others. Furthermore, this exercise is a qualitative indication and may change according to the person selecting the indicator or in the national context of implementation.

The tables below show, for each criterion, a list of indicators including their main goal. The selected indicators are crossed with "X" by the feature developers.

Table 1 shows the relevant indicators by feature for the criterion "Quality and Reliability". Almost all feature developers informed that "Transparency of methods, data and results" is the most important indicator, besides F1 (Smart readiness) and F10 (One-stop-shops). The second most selected indicator was "Minimise gaps (knowledge, skills and awareness)".

Table 1: Relevant indicators by feature, criterion "Quality and Reliability"

CRITERION 1	**Quality and Reliability**		***Which indicators are most relevant for your feature? Please mark maximum 2 indicators.***									
No.	***Indicators***	***Main goal***	**F1**	**F2**	**F3**	**F4**	**F5**	**F6**	**F7**	**F8**	**F9**	**F10**
1	Transparency of methods, data and results	The main goal of this indicators is to clearly outline which input data is used, which methods are used and what calculations are conducted and how results have been processed.		X	X	X	X	X	X	X	X	
2	Minimise gaps (knowledge, skills, awareness)	The feature should minimise existing gaps during the development for better uptake of the feature by public authorities and end-users.			X		X			X	X	X
3	Data quality	The main purpose of this indicator is to ensure that there is a data quality assurance process implemented during testing of the feature.	X	X					X			
4	Qualified experts	The main goal of this indicator is to ensure that clear requirements of training and qualification of experts/assessors should be outlined for the assessments. This information would assist in integrating the features with existing EPC	X					X				X

Table 1 shows the relevant indicators by feature for the criterion "User-friendliness". The indicator selected as most relevant was "User-friendly display of results". And, the second most selected was "Simplified and transparent calculations/processes". In general, we can say that for this feature the answers from the feature developers were very diversified and feature specific.

Table 2: Relevant indicators by feature, criterion "User-friendliness"

CRITERION 2	User-friendliness		Which indicators are most relevant for your feature? Please mark maximum 2 indicators.									
No.	Indicators	Main goal	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
1	Avoid technical jargon	The main purpose of this indicator is to ensure that simple and clear language is used for the description of the features.		X			X					
2	User-friendly display of results	This indicators emphasizes that feature displays are not overburdedned with unecessary information. It also focuses on the use of clear descriptors and use of graphics and figures.	X	X	X				X	X	X	X
3	Identification of potential benefits	The main purpose of this indicator is to outline the multiple-benefits for different stakeholders. These must be clearly outlined, emphasised and considered in economic terms.	X						X		X	X
4	Simplified and transparent calculations/processes	The main purpose of this indicator is to ensure provision of guidelines on the calculations/process. The stepwise guidelines should also be provided for the tools used (if any).			X	X	X	X		X		

Table 3 shows the relevant indicators by feature for the criterion "Economic feasibility". Almost all feature developers informed that "Impact on EPC prices/costs" is the most relevant indicator, besides for F6 (EPC Databases). The methodology of the feature "EPC Databases" focuses on EPCs in the database (and that have already been issued). Because of that, the methodology for F6 does not have a direct impact of EPC costs. Financial constraints for setting up an IT infrastructure (capable server, digital database, etc) were considered the most relevant indicator for this feature. For the F2 (Comfort) feature, also costs for additional equipment/instruments were considered relevant. For the F10 (One-stop-shops), the stepwise implementation is also a relevant indicator.

Table 3: Relevant indicators by feature, criterion "Economic feasibility"

CRITERION 3	Economic feasibility		Which indicators are most relevant for your feature? Please mark maximum 2 indicators.									
No.	Indicators	Main goal	F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
1	Impact on EPC prices/costs	The main goal of this indicator is to assess how the X-tendo methodology impacts the actual EPC costs. Economically feasible methodologies are the ones which should not generate many additional work-load or data gathering, in order to avoid significantly increase on the EPC price	X	X	X		X		X	X	X	X
2	Financial constraints	The main goal of this indicator is to assess the financial constraints involved to implement the feature and its required infrastructure						X			X	
3	Implementation options (at different price levels)	The main goal of this indicator is to assess if the economically implementation of the feature can be divided into differents steps										X
4	Additional equipment/instruments required	The main goal of this indicator is to assess if the use of additional equipments and instruments is required and how affordable and market available are them.		X								

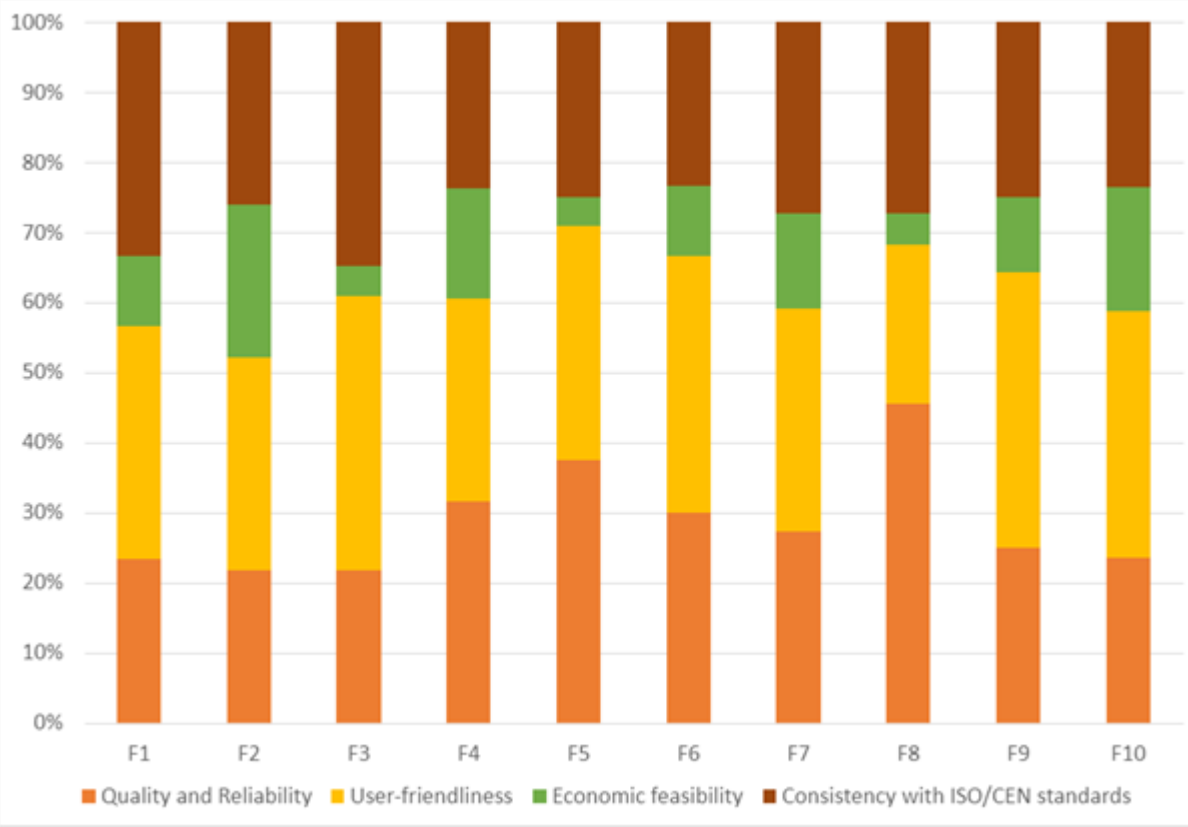
Table 4 shows the relevant indicators by feature for the criterion "Consistency with ISO/CEN standards". Almost all feature developers informed that "Interoperability" is the most relevant indicator, besides F10 (One-stop-shops). For this feature the consistency with ISO/CEN standards were considered not applicable. The indicator "Relevant standards in feature development" was the second most voted indicator.

Table 4: Relevant indicators by feature, criterion "Consistency with ISO/CEN standards"

CRITERION 4	Consistency with ISO/CEN standards		Which indicators are most relevant for your feature? Please mark maximum 2 indicators.									
			F1	F2	F3	F4	F5	F6	F7	F8	F9	F10
No.	*Indicators*	*Main goal*										
1	Quality management	The main purpose of this indicator is to ensure that adequate quality control methods are provided in the feature development process.					X				X	
2	Relevant standards in feature development Relevant national	The main purpose of this indicator is to ensure that the feature methodology is based on ISO / CEN standards or national regulation, where applicable.		X	X	x		X		X		
3	Common development process for all features	The main purpose of this indicator is to ensure that the each feature clearly outline the steps/stages of the development process.										
4	Interoperability	The main purpose of this indicator is to ensure that each feature is designed to be adapted to the national EPC system.	X	X	X		X	X	X	X	X	

After the feature methodologies were finalized, the feature developers assessed the cross-criteria again. This time, they had to assign whether the indicator has being "met" by the methodology (or not). Graph 1 shows the "met" indicators per criterion. The graph also shows that in all features the most met criteria were "Quality and Reliability" and "User-friendliness" – together they result in a share of about 51-71%. Then, "Consistency with ISO/CEN Standards" was the third most met indicator. And the last one, "Economic feasibility" which was also very feature specific varying between 5%-15%.

Graph 1: Features developers assessing if the developed methodology met the indicators



4 CROSS CUTTING CRITERIA: FEATURES EVALUATION

Feature 1: Smart Readiness

The Smart Readiness Indicator (SRI) is intended to raise awareness about the benefits of smart buildings, including energy efficiency, optimised mix of various energy sources, user occupancy experience and grid flexibility.

One methodology was tested – method B, that relies on an on-site inspection and includes more detailed information about the building smartness components. Its specificity makes it suitable for assessing large private (residential, offices) and public (schools, hospitals, etc.) buildings. Both are implemented in spreadsheets.

The Smart readiness feature was tested in Austria (EASt), Estonia (TREA), Greece (CRES) and Romania (AAECR).

Quality and reliability

All implementing partners (Austria, Estonia and Greece) reported that the methodology is clearly described with requirements of input data. They found the results are clear and transparently presented in the calculation sheet, which is very useful for the assessor. Additional verification was also conducted by the assessor on the data that were collected for their completeness and correctness. Pre-knowledge of the topic was an advantage; however, additional training might be required for the assessment of the feature.

User-friendliness

During the development of the methodology, the provision of glossary and stepwise description was very useful in testing. The results are presented graphically which makes it easy to understand, however, Greece identified that the benefits to the owner could be better presented to estimate the cost savings. All four countries reported that the method is flexible for all building types.

Economic feasibility

According to the evaluation performed by the implementing countries the most relevant indicator for this criterion is the "Impact on EPC prices/costs". All four countries Austria, Estonia and Greece reported that the feature methodology would impact the national EPC costs, in Estonia even remarkably. Any of these countries need an additional on-site visit or measurements will however additional data than in the EPC will be required – which main lead to an additional time effort longer than one hour.

International standards

All implementing partners (Austria, Estonia, Greece and Romania) reported that there is no need to adapt the feature methodology to national regulation. This indicates that the methodology can be used in all EU countries as it is in line with ISO/CEN standards. It was

also reported that part of the data for the methodology is already covered by the current EPC.

Feature 2: Comfort

The Comfort is intended to raise awareness about the perceived indoor thermal comfort of building users. The developed X-tendo methodology assesses the indoor comfort level of a building. The idea is that integrating the procedure into the EPC assessment is fairly straightforward. The method can be applied to both new and existing buildings. If the building is in use and occupied, an operational rating is available (CORP), while for new or unoccupied buildings, a provisional asset rating is available (CARP).

The comfort feature (both CORP and CARP) was tested in Austria (EASt), Greece (CRES), Portugal (ADENE) and Romania (AAECR).

Quality and reliability

All implementing partners (Greece, Austria and Portugal) reported that the calculation methods used are clearly described and well established. They found some inputs challenging as they did not cover all scenarios/situations. All indicated that the results and calculations are very transparent with clear flow of input and information.

User-friendliness

The development of the feature was done in a straightforward language and the partners reported it as very useful. However, they emphasised the need to have a glossary with important terms. The partners reported that the results are presented in a user-friendly format that makes it usable by owners. Since the assessment method was developed for all building types, the partners confirmed and validated its application to other building types during testing.

Economic feasibility

According to the evaluation performed by the implementing countries, the most relevant indicator for this criterion is the "Impact on EPC prices/costs". Especially for this feature, the indicator related to the "additional costs for equipment and instruments are also relevant ". Three countries (Romania, Greece and Portugal) reported that the methodology would impact the EPC costs. In Austria, the impact was considered partial, as many input data can be gathered during the on-site visit. Although equipment for this methodology is required, in Romania, Greece and Austria this equipment is readily available on the market. Especially in Austria, the equipment can be purchased buy less than 150 Euros (according to the information provided by the project partner).

International standards

The three of the implementing partners (except Portugal) reported that there is no need to adapt the feature methodology to national regulation. Portugal indicates that the current

EPC methodology is already being revised to include the calculation of the thermal comfort indicator. It was also reported that part of the data for the methodology is already covered by the current EPC, however, some issues were raised, for example: the lack of measurements in the current EPC or detailed information on technical systems.

Feature 3: Outdoor air pollution

Buildings affect both the quality of the outside air (pollutant emission) and the purity of the indoor air (air filtration). The X-tendo methodology for this feature developed two indicators for measuring air pollution: 1) The Local Air Pollution Contributor Index (LAPCI), and 2) the Indoor Air Purity Index (IAPI). Both have the main aim of increasing building owners' and users' awareness of their buildings' impact on smog development and air- filtration efficiency.

This feature was tested in Poland. The X-tendo partner NAPE was responsible for undertaking in-building tests on multiple buildings and survey of energy auditors (as user test).

Quality and reliability

The testing reported clarity in the input and outputs required in the calculation (for LAPCI and IAPI), however, certain segments such as formulas are not accessible to the user. The user is provided with fundamental technical knowledge to understand the details of the feature. The information provided by the tool has been found to be reliable for building renovation measures.

User-friendliness

The implementing partner reported that the tool is graphically designed for user-friendliness and the results are presented in a simple format. It was also reported that the application requirements were not fully clear in the case of IAPI.

Economic feasibility

According to the evaluation performed by the implementing partner, the methodology would impact the EPC prices/costs, due to the need to collect additional data. It was estimated additionally 20 Euros for the-end-user.

International standards

It was stated by the implementing partner that both for LAPCI and IAPI some additional data in comparison to the current EPC is needed. It was reported that the national regulation does not have to be used in the methodology, however, default national values should be applied.

Feature 4: Real energy consumption

The gap between real energy performance and EPC-calculated performance can be significant and is a source of confusion for EPC users. Therefore, the X-tendo methodology

developed an indicator for a measured energy performance that reflects the actual energy performance of the building at standard conditions of climate and use.

This feature was tested in Austria (EASt), Estonia (TREA), Italy (ENEA) and Romania (AAECR).

Quality and reliability

Based on the test reports, a major issue that was identified by Romania and Austria is the transparency of results, however, the inputs are clearly asked with partly well described calculation method. All testing countries also outlined that the specific requirements to carry out the assessment are not well presented, which posed some difficulties to the assessors. This feature requires the assessors to have some additional training, but they are expected to have some familiarity with the concepts.

User-friendliness

Testing reported that the language used in the feature description is not straightforward, and Romania and Austria specifically faced some challenges. On the other hand, all countries reported that the references and stepwise descriptions are well presented and eased the testing. They found the calculation description in the guidelines very helpful during feature testing, but the frequent reference to standards was an issue.

Economic feasibility

According to the evaluation performed by the implementing partners from Austria, Italy and Romania, the methodology would impact the EPC prices/costs. Due to the fact that many input data required in the methodology are not part of the EPC scheme, the EPC costs can be highly impacted (as reported by partners). Exceptionally for Estonia, the methodology would not affect the EPC costs, because it is similar to a standard procedure already implemented in the current EPC practices in the country.

International standards

Romania and Estonia reported that in the methodology the national regulation on degree-days has been used. The default value has been used by implementing partner from Austria. For Italy, the national standard for weather data was used.

Feature 5: District energy

District heating and cooling networks are an important pillar for low-carbon heating (and cooling) in the future. At the same time, the technical and economic feasibility of district heating and cooling supply depends on buildings properties such as heating / cooling demand or supply temperatures.

The X-tendo methodology tested a set of parameters related to the two temperatures, supply and return flow temperatures, that are related to building's heat distribution system. The testing was performed in three implementing countries: Italy (ENEA), Poland (NAPE) and Romania (AAECR).

Quality and reliability

Poland and Italy reported that the calculation method is well described but Romania reported that the default values used in the method are presented without reference and hence impact the reliability. All the countries found the results transparent and access to calculations useful in assessing the feature. Poland and Romania found that the outputs are less reliable to take any decision regarding renovation and are more useful for the utility supplier. All reported that fundamental technical knowledge is needed to assess this feature.

User-friendliness

All the testing countries (Poland, Romania, Italy) overall reported that the feature is very user-friendly with regard to the language used, supported with a good presentation of a glossary of technical terms. However, there is not a single glossary but it is distributed in each calculation sheet. They also reported that the stepwise description for feature assessment is well presented with a clear description of the calculation in the guidelines.

Economic feasibility

The most relevant indicator for "Economic feasibility" of District energy is the "Impact on EPC prices/costs" and, according to the evaluation performed by the implementing partners from Italy, Poland and Romania, the methodology would impact the EPC prices/costs. Poland, however, did not consider the impact to be very high. And, Italy informed that additional data selection during the on-site visit would be needed.

International standards

Poland and Romania reported that due to the need for radiator type information there is a need in changing the methodology during the implementation into the national EPC system. They reported that the data used for the feature is not covered by the current EPC, while Italy stated that some of the information is currently being collected.

Feature 6: EPC Database

Energy performance certificate (EPC) databases store EPCs and underlying data. Because they are an important tool for public authorities to source building stock information, quality assurance can go a long way towards improving trust in EPCs. Therefore, the X-tendo methodology for this feature focused on implementing quality assurance routines.

The feature was tested in the countries Denmark (DEA), Greece (CRES) and Italy (ENEA).

Quality and reliability

The programming code (method) provided was well described and a clear readme file was given which was very useful for the testing countries (Greece, Italy, Denmark). Thresholds and percentile values to be checked in EPC database were clearly defined and the code was editable. It was also reported that the results are transparent by Greece, however Italy found

the results written in tables were difficult to read. All the countries reported that no additional training is needed for this feature.

User-friendliness

This feature was based on system testing (programming code) and not an application interface. Partners reported that clear instructions were provided but the description of the calculation process was lacking. Italy reported that, however, no guidelines were written for this feature they could have been useful in its application and testing.

Economic feasibility

The most relevant indicator for "Economic feasibility" of EPC databases is the "Financial constraints". In any of the implementing countries Denmark, Greece and Italy, additional IT infrastructure would have to be implemented. Therefore, the financial constraints were not considered relevant. However, high skilled professionals with programming expertise are required to handle the database and run the programming code. In the X-tendo project, the high-skilled professionals were already part of the EPC Database manager's stuff.

International standards

All of the implementing partners (Denmark, Greece and Italy) stated that the data used for the feature is already covered by the current EPC. However, it was noticed that any of the national regulations have not been used in the methodology of this feature.

Feature 7: Logbook

Building logbooks are repositories for detailed building information, including energy performance data but can also include administrative data, material inventory, smart building aspects, history of maintenance and renovations etc. For this feature, the current state of each implementing country was a relevant starting point, which led to different needs. Being the common goal to each part to take steps towards the full-fledged logbook concept. On the hand, it resulted in three different test scenarios.

The feature was tested in the countries Estonia (EST), Greece (CRES) and Portugal (ADENE).

Quality and reliability

This feature was tested at system and user level. All the countries that tested the feature reported that the input and outputs were clear, and all the results are transparent. Some aspects of the feature do not clearly indicate the aspect of completeness with limited data input options. The feature does not contain measures to improve data quality, however, data format is found to be interoperable with other platforms.

User-friendliness

Based on the reporting by Portugal, Greece and Estonia, the building logbook feature is developed in a straightforward language and is very user-friendly in general. The feature

results are partially presented in a graphical way and enhance the user understanding. The evaluation of feature is not yet fully flexible for all building types; however, the different functionalities can be adapted to other building types in the future.

Economic feasibility

According to the evaluation performed, the impact on the EPC prices/costs is the most relevant indicator. As this feature collects EPC data, the partners from Estonia, Greece and Portugal did not encounter any additional EPC costs for the feature.

International standards

As there aren't any standards regarding the logbooks, the implementing partners only refers to the presence in the current EPC of the data needed for this feature. It was reported by all partners (including user and system test) that the data used for the feature is only partly covered in the current EPC.

Feature 8: Enhanced recommendations

EPC recommendations in many EU countries are not sufficiently informative to meet renovation rate goals. Therefore, the methodology developed by the X-tendo project aimed to demonstrate how to automatically provide enhanced recommendations in energy performance certificates (EPCs), mainly for building transactions (sell/ buy/ renovate) where indicative measures and their costs are required.

The feature was tested in the countries Denmark (DEA), Poland (NAPE) and Scotland (EST).

Quality and reliability

All the testing countries reported that the calculation software is not very transparent, and some input fields would be better supported with explanation/descriptions. Most of the countries had difficulty with input data as the exact information was missing at the Member State level. All countries found the calculation software intuitive, however, they mentioned that the feature would require some training to understand it clearly.

User-friendliness

Since there was no interface developed under the scope of this tool, the user-friendliness was reported regarding the expectations for the enhanced recommendations. They reported that it would be helpful to illustrate the breakdown of costs, number of benefits etc. Countries also reported that the feature was not developed considering different building types, but this would be very useful for different users. The stepwise description provided for testing was insufficient and made the assessment challenging for Denmark and Poland.

Economic feasibility

The most relevant indicator for "Economic feasibility" of "Logbook" is the "Impact on EPC prices/costs". The project partners from Denmark, assessed that the feature would not affect EPC costs, while Poland and Scotland assessed that it would affect them partly.

International standards

It was reported by the partners that the data used for the feature is covered (Denmark, Scotland) or partly covered (Poland) in the current EPC. Poland stated that the information on the scope and the costs of modernization are not included now in EPC.

Feature 9: Financing schemes

Integrating information on financial support in the Energy Performance Certificate (EPC) and its specific recommendations can help to persuade building owners to undertake an energy renovation and steer investments towards deep renovations. The X-tendo methodology for this feature explores how the integration of financing options can boost the perceived usefulness of the EPC, increase its impact on renovation decisions, and help public authorities to develop more effective financial support schemes.

The feature was tested in the countries Denmark (DEA), Portugal (ADENE) and Romania (AAECR).

Quality and reliability

The testing countries reported that the feature is clear, and results are transparent. They reported that they had access to the tool and its evaluation method. All the countries pointed that financing options have the potential to provide users reliable information to take decision on renovation measures.

User-friendliness

The testing reported that the feature results are graphical and easy to understand. The feature does not need further development for different building types. Some benefits considering the use of the feature for end-users are presented with the possibilities of investments.

Economic feasibility

The most relevant indicator for "Economic feasibility" of Financing schemes is the "Impact on EPC prices/costs". The partners from Romania, Portugal and Denmark assessed that the feature would not (or would partially) generate additional EPC costs.

International standards

Denmark reported that issues regarding international standards do not apply to this feature. Romania stated that the data used for the feature are not covered by the current EPC.

Feature 10: One-stop-shops

One stop shops (OSS) are transparent and integrated advisory tools / venues, which will accelerate energy renovations by informing, motivating, and assisting building owners throughout the renovation journey, from the beginning until the end. As the countries had different stages of implemented OSS, the X-tendo methodology focused on country specific solutions.

The feature was tested in Denmark (DEA), Portugal (ADENE), Scotland (EST) and Romania (AAECR).

Quality and reliability

Most of the countries conducted user testing and it was reported that the feature has functionality for the assessor to access reliable information for decision making. The assessor is also provided with fundamental technical knowledge necessary to understand the feature. All the countries reported that some additional training is required to use this feature by assessors.

User-friendliness

Regarding user-friendliness of the feature, all the countries reported that the feature and its results are graphical and has further potential for improvement. The multiple benefits in terms of energy and costs savings are partly presented in the feature, but other aspects can also be included. The feature provides holistic information regarding renovation measures but not explicitly for different building types.

Economic feasibility

The most relevant indicators for "Economic feasibility" of One-stop-shops are the "Impact on EPC prices/costs" and "Different stage of implementation". All project partners declared that the methodology would have no impact on EPCs costs, on the contrary, it improves the EPC services. Regarding the stepwise implementation, they informed that the feature can be implemented in different stages and has the advantage that it can be implemented in a modular approach.

International standards

The feature developers decided that the criterion "Consistency with ISO/CEN standards" does not apply to this feature. Therefore, no questions were asked to the implementing partners on this cross-cutting criterion.

5 CONCLUSIONS

General conclusions for each criterion and respective most relevant indicators are presented next and also summarised in a table at the end of this chapter.

Quality and reliability

The most relevant indicator was "**Transparency of methods, data and results"** for most of the features. According to the testing report, "Yes" was indicated by most of the features which meant that the input data is clearly asked; the calculation methods are clearly described, and the results are shown transparently. Most of the features managed to meet the expectations in this regard such as SRI, Comfort, Building logbooks. However, it was observed in some of the feature's such as Real energy consumption, District heating and Enhanced recommendations that inputs, results, underlying calculations and technical descriptions were not very clear which presented some challenges for the testing countries.

Exceptionally, for the feature F10 (One-stop-shops) the most relevant indicator was "**Minimise gaps (knowledge, skills and awareness)"**. Wherefore, the response for testing partners "Yes" in testing report indicated that the feature minimizes existing gaps during the development for better uptake of the feature by public authorities and end-users. Also, for SRI the most relevant indicator was "**Data Quality**" where their response "Yes" indicated that measures are in place to collect and verify the data for its quality.

Overall, quality and reliability cross-cutting criteria was met by all the features in good capacity and was also considered very essential during the development and testing of all the features being one of the key factors for next-generation EPCs.

User-friendliness

The most relevant indicator was "**User-friendly display of results"** According to the testing activities "Yes" was indicated by most of the features which meant that the results are presented in a graphical way and the impact of graphical results on the user was considered. Since the features have to be used by the assessors for assessment, evaluation and provide results, this indicator was one of the most crucial during the development of the feature and testing specially for SRI, Comfort, Outdoor air pollution, Building logbook and OSS.

Exceptionally for the features F4 (Real energy consumption), F5 (District energy) and F6 (EPC Database) the most relevant indicator was "**Simplified and transparent calculations/processes**". Wherefore, in the testing report their response "Yes" indicated that the stepwise description for feature assessment and the calculation/process description is provided in guidelines. Since these features are prone to higher scrutiny by assessors, they tend to be more inclined on the aspects of their methodology and provide a more user-friendly assessment process.

'User-friendliness' is regarded as one of the most important cross-cutting criteria after 'quality and reliability' based on the findings of this report. It is understood crucial from the

point of view of the assessor and also from the point of view of the end-user. The duality increases its importance and makes it highly valuable for the successful implementation of the features.

Economic feasibility

The most relevant indicator was "**Impact on EPC prices/costs"**. The testing activities assessed: "Yes" (when the feature implementation would affect the EPC costs) and "No" (when the feature implementation would not affect the EPC costs).

Exceptionally for the feature F6 (EPC Database) the most relevant indicator was "**Financial constraint**". Wherefore, the "No" indicates that the methodology does not generate any additional financial costs to be implemented.

The economic feasibility is together with user-friendliness, one of the most important criteria. It provides a first indication about the chances that the feature has to be really implemented in the national EPCs. Meaning that, features' methodology which are assessed as "with high impact of the EPC prices/costs", will probably have lower chances to be in the best interest of public authorities. In general, all the features "innovative indicators" were assessed as affecting EPC prices while the feature "innovative data handling" would not affect them. However, the country specific singularities have to be taken into account to understand the dimension of the impact – high, partly or low (as described in the previous section).

Consistency with international standards

The most relevant indicator was "**Interoperability**". This indicator was assessed according to two aspects: data covered by the current EPC and restriction in changing (or adapting) the feature's methodology. The testing activities assessed: "Yes" (there is a restriction for changing the methodology during feature implementation or the data used for the feature is already covered by the current EPC) and "No" (there is no restriction for change of methodology during feature implementation or the data used for the feature is not already covered by the current EPC).

Exceptionally for the feature F4 (Real energy consumption) the feature lead decided to check the "Relevant standards in feature development / Relevant national regulations" indicator, that after "Interoperability" was the second indicator chosen for this cross cutting criteria. The testing activities assessed: "Yes" (the national regulations have been used in the methodology of this feature) and "No" (the national regulations have not been used in the methodology of this feature).

The features were developed in order to be implemented by different countries, therefore in most cases (i.e. comfort, outdoor air pollution) the local regulation or requirements can be included in the methodology. The developed features are for the next generation EPCs, therefore the data used for the feature is only partly covered by the current EPC. It was stated that this criterion does not apply to the feature F10 (One-stop-shops).

Summary table

In the table below presents the most relevant indicator for each criterion and the relative majority response for each feature.

	Quality and reliability	User-friendliness	Economic feasibility	International standards
MOST RELEVANT INDICATOR	Transparency of methods, data and results	User-friendly display of results	Impact EPC prices/costs	Interoperability
Smart Readiness	Yes	Yes	Yes	Partly
Comfort	Yes	Yes	Yes	No/Partly
Outdoor air pollution	Yes	Yes	Yes	No/Partly
Real energy consumption	Yes	Yes[1]	Yes	Yes/Partly[2]
District energy	Yes	Yes[3]	Yes	Yes
EPC Database	Yes	No[4]	No[5]	Yes
Logbook	Yes	Yes	No	Partly
Enhanced recommendations	Partly	No	No	Yes
Financing schemes	Yes	Yes/Partly	No	Partly
One-stop-shops	Yes[6]	Yes	No	NA

[1] For this feature, the indicator „Simplified and transparent calculations/processesError! Reference source not found." was considered the most relevant

[2] For this feature, the indicator „ Relevant standards in feature development Relevant national regulations" was considered the most relevant.

[3] For this feature, the indicator „Simplified and transparent calculations/processesError! Reference source not found." was considered the most relevant

[4] For this feature, the indicator „Simplified and transparent calculations/processesError! Reference source not found." was considered the most relevant

[5] For this feature, the indicator „Financial constraints" was considered the most relevant.

[6] For this feature, the indicator „Minimise gaps (knowledge, skills and awareness)" was considered the most relevant.

6 FINAL GUIDELINES AND RECOMMENDATIONS

The general conclusions from the presented framework, on how to integrate cross-cutting-criteria assessment into the development of feature's methodology, are:

- The framework guided the feature developers to develop the methodology according to the initially set criteria;
- Self-reflective/continuously evaluations were important during the whole development process, and helped features leads to make a step outside the methods and evaluate the methodology from other perspectives;
- The four criteria had different relevance for each feature. The initial intention was to have the same indicators for all features with the final aim to compare them. However, the comparison between features turned to be less important. The most important aspect is that each developer achieves the relevant indicators set for the feature;
- "Quality and reliability" and "user-friendliness" turned to be the most important criterion for developers in all ten features;
- From end-user's perspective, "user-friendliness" is a very important criterion which emphasizes its importance;
- "Economic feasibility" may be the first relevant criterion regarding the replicability and implementation in the national EPC schemes. Having the features with low/partly impact on the EPC costs, higher chances to be on interest of public authorities;
- "Consistency with international standards" criteria indicated the link between the developed methodology, the national standards and the current EPC schemes.

Below, a general 6-steps workflow for including cross-cutting-criteria routines during the development of innovative features is presented:

1. Definition of relevant indicators (per feature)
2. Continous assessement if cross-cutting-criteria indicators are being met in the methodology (under development) (by feature developers)
3. After the finalization of methodology, assess how/if indicators were met (by feature developers) and do possibly adjustments
4. Evaluation during the testing phase (by feature testers)
5. Comparison between assessments from feature developers and testers
6. Improvement of the methodology according to the testing evaluation

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