A Data-Driven Approach to Evaluate the Smart Readiness Indicator for the Functionality “Respond to Users’ Needs”

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Abstract. The Smart Readiness Indicator (SRI) is a European rating scheme introduced in 2018 by the Energy Performance of Building Directive (EPBD). The SRI is conceived as Key Performance Indicator (KPI) to better understand to what extent the entire building stock is ready to adopt new smart solutions. The SRI should be able to cope with the occupants' needs and the energy grid requirements, enhancing the integration of smart technologies to improve energy efficiency as well as flexibility of buildings in energy demand. This paper presents a new approach to enhance the existing evaluation process for SRI. The proposed methodology makes use of building operational data for the evaluation of the SRI. It combines the application of a Multi-Criteria Decision-Making method with the assessment of Indoor Environmental Quality, particularly addressing comfort and well-being aspects in building interior spaces. By introducing a data-driven approach, this work represents a reference use case that changes the current static evaluation of SRI into a dynamic one.

Keywords: Smart Readiness Indicator (SRI), Data-driven approach, Indoor Environmental Quality.

1 Introduction

Building automation and control systems (BACS) are increasingly being used across Europe to improve energy efficiency during operation and indoor environmental quality. To help achieve the 2050 CO_2 neutrality goal, the EPBD introduced the Smart Readiness Indicator (SRI) in 2018, which assesses the ability of buildings to use Information and Communication Technologies (ICTs) to adapt their operation to the needs of occupants and the energy grid, improving the building performance [1]. The latest EPBD amendments establish the mandatory application of the SRI for specific buildings by 31 December 2024 [2]. Considering the upcoming implementation of SRI, this work focuses on the development perspective of a new SRI's assessment method that is able to use monitored data during the building operation phase (defined in the Final Report as method C [3]). The paper is structured into four sections. Firstly a comprehensive introduction to the fundamental concept of SRI is provided. In the second section, the use of the data-driven approach for evaluating SRI is discussed. Following that, a case study is presented, and eventually, the overall conclusions of the study are provided.

1.1 The Smart Readiness Indicator

The Final Report released by the European Commission [3] introduced the SRI methodology, which is based on:

- Three "key functionalities", stated by the EPBD: Energy performance & operation, Respond to users' needs, Respond to the needs of the grid;
- Seven "impacts criteria", distributed under the key functionalities. They are Energy efficiency, Maintenance & fault prediction, Comfort, Convenience, Health & well-being, Information to occupants and Energy flexibility. The first two criteria belong to the functionality "Energy performance and operation", Energy flexibility belongs to "Respond to the needs of the grid", and the remaining are part of the functionality "Respond to users' needs";
- Nine technical "domains", distributed under each impact criterion. They are heating, cooling, domestic hot water, controlled ventilation, lighting, electricity, dynamic envelope, electric vehicle charging and monitoring & control;
- List of "smart-ready services", defined for each domain. They are characterized by different functionality levels, i.e., automation degrees. A higher functionality level reflects a smarter implementation of the service.

The SRI assessment procedure involves an inventory of services in a building and the evaluation of their functionality levels. The Final Report [3] proposes three methods for evaluating SRI: the "Simplified method" (A) and the "Detailed method" (B), which use a checklist approach but vary in the number of services covered in each catalog. The third method is the "In-use method" (C), which focuses on utilizing building monitored data directly for SRI assessment. However, a methodology for evaluating SRI using this approach has not yet been established. Starting from the assessment of the functionality levels associated to each service implemented in the building, the SRI score is defined as a percentage of the theoretical maximum score achievable. The multi-criteria approach used for its calculation methodology can be synthesized in three steps [3]:

- Triage process. It consists in evaluating the functionality level of each implemented service in the building and its related pre-calculated set of scores associated to impact criteria. The scores achieved within each domain are summed up to obtain a single value for each impact criterion, forming a matrix called the "real score matrix". The same procedure is applied using the maximum achievable score, which represents the highest functionality level for all the assessed services, resulting in a matrix containing the maximum score values (i.e., maximum score matrix).
- Vertical aggregation. All the scores located in the aforementioned matrices are multiplied by specific domain weighting factors. These weights can be

fixed, equal or obtained from energy balance calculations. The weighted values obtained, both for real and maximum score matrix, are then summed up to obtain an overall score per impact criterion;
- Horizontal aggregation and SRI score. The real and maximum scores obtained from vertical aggregation are multiplied by weighting factors associated to impact criteria. These weighted scores are summed to calculate the overall weighted real and maximum scores. The final SRI value is determined by dividing the real score by the maximum score, expressed as a percentage.

Additional information about the SRI assessment can be found in the Final Report [3]. According to the presented procedure, the next section outlines the methodology for SRI assessment following a data-driven approach (method C).

2 Methodology

The present work focuses on the key functionality "Respond to users' need" of the SRI. In particular, a data-driven approach is proposed at the "triage process" level, combining information from regulations and the reference literature. The poposed approach relies on the assessment of Key Performance Indicators (KPIs) associated to Indoor Environmental Quality (IEQ) to evaluate services' impacts on "Comfort" and "Health & Well-being" criteria. The criteria "Information to occupants" and "Convenience" are not included in the proposed methodology since the functionality levels are able to fully express impacts on them. The proposed approach aims to be a first step for the development of an "in-use" method C for the SRI evaluation. Moreover, the so-called "equal" weighting factors currently used for the vertical and horizontal aggregation under the key functionality "respond to users' needs" are revised, analysing the responses of a survey through the Analytic Hierarchy Process (AHP) [10]. The AHP application resulted in new weights that could better reflect the real importance of criteria and domains for specific climatic conditions and building final use.

2.1 Data-driven approach for the Smart Readiness Indicator

The procedure adopted by the SRI for the triage process can lead to overestimation of the real indoor conditions, because domains' scores only depend on the automation degree of implemented services. A new scoring methodology is then proposed to assess impacts on "Comfort" and "Health & Well-being", combining the functionality levels with KPIs, which reflect the actual indoor environmental conditions during operation. Values assumed by different KPIs are firstly rated using classes proposed by Standards and then scaled within a range from 0 to 3. For services in which more than one KPI is defined, the overall score is obtained as arithmetic mean between all the KPI's scores. Secondly, the final service score is obtained through Equation 1, in which the previous KPI score is normalized between 0 and the maximum score achievable with the implemented functionality level of that service, as reported in [3].

$$score_{norm} = \frac{(KPIscore - KPIscore_{min}) \cdot (Score_{FLmax} - 0)}{(KPIscore_{max} - KPIscore_{min})} \quad (1)$$

In Equation 1, $KPIscore$ is the score derived from the IEQ assessment, $KPIscore_{min}$ and $KPIscore_{max}$ are the minimum and maximum scores that the index can reach respectively according to Standards, and $Score_{FL,max}$ is the achievable score with a certain functionality level according to pre-calculated tables proposed in [3]. The employed scoring system leads to the development of two new assessment methods related to the evaluation of the SRI: i) Short-term assessment, that uses short-term KPIs, ii) Long-term assessment, that uses long-term KPIs. These approaches result in a dynamic SRI score that can vary over time depending on the sampling time-step (e.g., every hour, season), according to the indoor conditions during the considered period.

Short-term assessment with short-term KPIs The Short-term assessment has been studied and proposed with the aim to evaluate the Smart Readiness Indicator instantaneously, at pre-defined time-step (e.g., every hour) obtaining a dynamic SRI score able to report the performance over time. This procedure considers the actual indoor conditions through the use of the proposed short-term KPIs for all the services that have impact on "Comfort" and "Health & Well-Being". The Fanger's KPIs Predicted Mean Vote (PMV) and Predicted Percentage of Dissatisfied (PPD) are defined to evaluate impacts on "Comfort" for services belonging to Heating and Cooling domains. The Operative temperature is chosen to assess impacts on "Health & Well-being". The value ranges are defined using tables and thresholds given by the Standards EN 16798-1:2019 [4] and ISO 7730:2005 [5] and then have been converted into a score according to Table 1. For services defined under the Ventilation domain, the impacts' assessment on "Comfort" was carried out using the Air speed index. Air speed's ranges were differentiated considering heating or cooling period, as showed in Table 1. For "Health & Well-being" impacts were evaluated using the indoor CO_2 concentration. For services defined under the Lighting domain, impacts on "Comfort" were evaluated using three indices: the Unified Glare Rating (UGR), the Visual Comfort Probability (VCP) and the Color Rendering Index (CRI). Standards do not define classes and ranges for the lighting domain, but instead provide acceptability thresholds. Consequently, lighting domain ranges reported in Table 1 were defined scaling the corresponding KPI values from 0 to 3. Table 2 reports the maximum and minimum limit values for the aforementioned KPIs. For "Health & Well-being" the lighting domain was expected to have no impacts. To evaluate the impacts on "Comfort" for services under the Dynamic Envelope domain the Daylight Factor (DF) was selected. Impacts related to "Health & Well-being" were assessed using the Daylight Glare Probability (DGP) and the Daylight Glare Index (DGI). For DGI, limit values are reported in Table 2.

Long-term KPIs The Long-term assessment has been proposed with the aim of evaluating the SRI at the end of a reporting period (e.g., season, month) using collected historical data. In this case, the SRI assumes values depending on the average performance level maintained during the considered assessment period. Impacts on "Comfort" were evaluated using the Severity of Dis-compliance (SD) for each of the short-term KPIs defined above. According to Ref. [9], the SD score

Table 1: Scoring table for short-term KPIs based on ranges from Standards. Data are from [4,5,6,7]

Heating & Cooling				
Comfort		Health & Well-being		Score
PMV range	PPD range	Op (winter)	Op (summer)	
-0.2 < PMV < +0.2	PPD < 6 %	22 ± 1 °C	24.5 ± 1 °C	3
-0.5 < PMV < +0.5	6 % < PPD < 10 %	22 ± 2 °C	24.5 ± 1.5 °C	2
-0.7 < PMV < +0.7	10 % < PPD < 15 %	22 ± 3 °C	24.5 ± 2.5 °C	1
-1.0 < PMV < +1.0	PPD > 15 %	> 22 ± 3 °C	> 24.5 ± 2.5 °C	0

Controlled ventilation			
Comfort		Health & Well-being	Score
Air speed (winter)	Air speed (summer)	CO_2 range	
< 0.10 m/s	< 0.12 m/s	< 550 ppm	3
0.10 m/s < v < 0.16 m/s	0.12 m/s < v < 0.19 m/s	550 ppm < CO_2 < 800 ppm	2
0.16 m/s < v < 0.21 m/s	0.19 m/s < v < 0.24 m/s	800 ppm < CO_2 < 1350 ppm	1
> 21 m/s	> 24 m/s	> 1350 ppm	0

Lighting			
Comfort			Score
UGR range	VCP range	CRI range	
5 < UGR < 7	95 < VCP < 100	< 97 CRI < 100	3
7 < UGR < 12	80 < VCP < 95	< 90 CRI < 97	2
12 < UGR < 16	67 < VCP < 80	< 87 CRI < 90	1
> 16	< 67	< 87	0

Dynamic envelope			
Comfort	Health & Well-being		Score
DF range	DGI range	DGP range	
DF > 4 %	< 3	< 0.35	3
2.6 % < DF < 4 %	3 < DGI < 11	0.35 < DGP < 0.40	2
1.6 % < DF < 2.6 %	11 < DGI < 18	0.40 < DGP < 0.45	1
DF < 1.6 %	> 18	> 0.45	0

Table 2: Threshold values for KPIs under lighting and dynamic envelope domains. Data are from [6,8].

KPI	$val_{limit,min}$	$val_{limit,max}$
Unified Glare Rating (UGR)	19	5
Visual Comfort Probability (VCP)	60	100
Color Rendering Index (CRI)	80	100
Daylight Glare Index (DGI)	22	0

was computed for each short-term KPI as the average of the hourly-score of that KPI during the considered period. The aforementioned hourly-score was assessed using Table 3, obtaining an SD value for each KPI under the same domain. The overall domain score is evaluated from the average between the SD values related to KPIs under the same domain. For impacts related to "Health & Well-being" the long-term KPI chosen is the Percentage Outside Range (POR) for all the aforementioned short-term KPIs. It evaluates the percentage of time outside pre-defined range defined in Table 1 or limit value reported in Table 2.

Table 3: Scoring table for Long-term KPIs. Data are from [9,4].

Heating & Cooling			
Comfort			
PMV range	PPD range	SD	Score
$-0.2 \leq \text{PMV} \leq 0.2$	$< 6\,\%$	0	3
$-0.5 \leq \text{PMV} \leq 0.5$	$< 10\,\%$	1	2
$-0.7 \leq \text{PMV} \leq 0.7$	$< 15\,\%$	2	1
$> 0.7 \wedge \text{PMV} < -0.7$	$> 15\,\%$	3	0
Health & Well-being			
Op limits: $22 \pm 3\,^{\circ}$C (winter), $24.5 \pm 2.5\,^{\circ}$C (summer)			
Weekly POR	Monthly POR	Yearly POR	Score
$0\,\%$	$0\,\%$	$0\,\%$	3
$< 20\,\%$	$< 12\,\%$	$< 3\,\%$	2
$20\,\% < \text{POR} < 50\,\%$	$12\,\% < \text{POR} < 25\,\%$	$3\,\% < \text{POR} < 6\,\%$	1
$> 50\,\%$	$> 25\,\%$	$> 6\,\%$	0
Controlled ventilation			
Comfort			
Heating season	Cooling season	SD	Score
Air speed range	Air speed range		
$< 0.10\,$m/s	$< 0.12\,$m/s	0	3
$0.10\,\text{m/s} < v < 0.16\,\text{m/s}$	$0.12\,\text{m/s} < v < 0.19\,\text{m/s}$	1	2
$0.16\,\text{m/s} < v < 0.21\,\text{m/s}$	$0.19\,\text{m/s} < v < 0.24\,\text{m/s}$	2	1
$> 0.21\,$m/s	$> 0.24\,$m/s	3	0
Health & Well-being			
$CO_2 > 1350\,$ppm			
Weekly POR	Monthly POR	Yearly POR	Score
$0\,\%$	$0\,\%$	$0\,\%$	3
$< 20\,\%$	$< 12\,\%$	$< 3\,\%$	2
$20\,\% < \text{POR } 50\,\%$	$12\,\% < \text{POR} < 25\,\%$	$3\,\% < \text{POR} < 6\,\%$	1
$> 50\,\%$	$> 25\,\%$	$> 6\,\%$	0
Lighting			
Comfort			
UGR range	VCP range	SD	Score
$5 < \text{UGR} < 7$	$95 < \text{VCP} < 100$	0	3
$7 < \text{UGR} < 12$	$80 < \text{VCP} < 95$	1	2
$12 < \text{UGR} < 16$	$67 < \text{VCP} < 80$	2	1
> 16	< 67	3	0
Dynamic envelope			
Comfort			
$\text{DF} > 1.6\,\%$ time ranges			Score
$100\,\%$			3
$< 50\,\%$			0
Health & Well-being			
DGI> 22			
Weekly POR	Monthly POR	Yearly POR	Score
$0\,\%$	$0\,\%$	$0\,\%$	3
$< 20\,\%$	$< 12\,\%$	$< 3\,\%$	2
$20\,\% < \text{POR } 50\,\%$	$12\,\% < \text{POR} < 25\,\%$	$3\,\% < \text{POR} < 6\,\%$	1
$> 50\,\%$	$> 25\,\%$	$> 6\,\%$	0

2.2 Determination of SRI weighting factors using the Analytic Hierarchy Process

The current SRI methodological framework is structured to give the same importance to impact criteria and domains belonging to the key functionality "Respond to users' needs". The use of a Multi-Criteria Decision-Making method was developed to compute new weighting factors for the SRI to assess the importance of domains and impact criteria for specific European locations and building types. The methodology is introduced to overcome the problem related to the lack of information about priorities between domains and criteria under the key functionality "Respond to users' needs". The proposed procedure was tested in this paper for a non-residential building located in Italy (i.e., office), in order to give an effective contribution for future developments of the SRI. The AHP method requires data collection from questionnaire, in which the experts involved can express their priorities with respect to a set of specific questions. The proposed questionnaire was organized in two parts: the first one was intended to obtain a comparison matrix for the impact criteria under the key functionality "Respond to users' need", while the second aimed to compute the comparisons between the domains. Therefore, in the first part the four impact criteria are compared one to each other, while in the second part is asked to experts to rank each pair of domains with respect to one of the four impact criteria. The questionnaire was delivered to a group of ten academic experts in the field of energy and buildings with a background in Architecture and Engineering. All the judgment matrices were synthesized using geometric mean to obtain a single matrix related to impact criteria (first part) and four matrices related to domains, one for each of the aforementioned impact criteria (second part). The resulting weighting factors were computed using the principal eigenvalue method (EM) [10]. Starting from the impact criteria matrix (first part), the eigenvector associated to the maximum eigenvalue of that matrix was calculated, after checking that the consistency index was less than 0.10 [10]. Therefore, the computed eigenvector provided the set of priorities, i.e., weighting factors, associated to the Impact Criteria "Comfort", "Health and Well-being", "Convenience" and "Information to occupants". At the domains level the same procedure was carried out for the four matrices (second part), obtaining the weights vectors applicable to domains. Finally, a comparison between the weighting factors currently used by the SRI methodology and the new ones resulting from this work is showed in Table 4. Impact criteria weights are defined in order to reach a maximum of 33,3% when summed (i.e., 1/3 per Key functionality [3]). Domain weights were computed to reach a maximum of 100% when summed up. A total of 80% was reached by domains in which fixed weights were defined by the Final Report. Due to restrinction on paper lenght, further information on fixed weights distribution among domains can be found in the Final Report [3].

3 Case Study

The case study consists of an office building located in Turin, with a rectangular layout and a floor area of about 33 m^2. The building is equipped with a chiller

Table 4: Comparison between the default SRI "equal" weighting factors and the new ones resulting from the AHP.

Impact Criteria - Horizontal aggregation				
	Comfort	Convenience	H&WB	Information to occupants
Default weights	8.33 %	8.33 %	8.33 %	8.33 %
New weights	11 %	3 %	15 %	4 %

Domains - Vertical aggregation				
Default weights				
	Comfort	Convenience	H&WB	Information to occupants
Heating	16 %	10 %	20 %	11.4 %
Cooling	16 %	10 %	20 %	11.4 %
Ventilation	16 %	10 %	20 %	11.4 %
DHW	-	10 %	-	11.4 %
Lighting	16 %	10 %	-	-
Electricity	-	10 %	-	11.4 %
Dynamic Envelope	16 %	10 %	20 %	11.4 %
EV charging	-	10 %	-	11.4 %
New weights				
	Comfort	Convenience	H&WB	Information to occupants
Heating	27 %	11 %	28 %	13 %
Cooling	21 %	10 %	14 %	15 %
Ventilation	16 %	12 %	31 %	8 %
DHW	-	8 %	-	6 %
Lighting	10 %	8 %	-	-
Electricity	-	18 %	-	25 %
Dynamic Envelope	6 %	5 %	7 %	5 %
EV charging	-	8 %	-	8 %

system. It operates in a on/off mode for cooling the interior spaces or to charge a thermal storage. The chiller operates either at constant supply temperature or constant flow, considering the interior space requirements. The considered indoor setpoint temperature during the considered season is set at 26°C. The shading system is not present and the lighting system is controlled with a scheduled on/off depending on occupancy patterns. The building is occupied from 9.00 a.m. to 6.00 p.m. by a maximum of ten people during weekdays, while during Saturdays and Sundays it is closed. The deployment of the new methodology proposed requires as first step the collection of monitoring data to evaluate all the KPIs above introduced. In this paper data have been synthetically generated by a simulation model in EnergyPlus™. The simulation was performed during the cooling season, in June, with an hourly time-step.

3.1 Results

The SRI scores have been computed using both the new weighting factors and the scoring methodology proposed in the present work and the default one stated by the Final Report [3], to explore the main differences between the approaches. The short-term analysis was carried out on June 21st, where for each working hour of the day the KPIs were evaluated to compute an hourly-SRI score. Figure 1 shows the SRI calculated with both the default triage process method and the one proposed in this paper, considering the default weights and the new weights resulting from the AHP methodology. As can be seen, the SRI score does not change over time when is implemented the default triage procedure, while with the proposed methodology, dynamic values of SRI can be obtained. The Long-term analysis was carried out considering all the working hours in June, i.e., from 9.00 a.m. to 6.00 p.m., from Monday to Friday. Figure 2 shows the SRI score computed at the end of the reporting period (i.e., June) considering both the standard triage process and the proposed one with the two set of weights (standard and those resulting from the AHP methodology). Even in this case, the Long-term assessment configurations lead to a not negligible variations of SRI when compared to with default methodology.

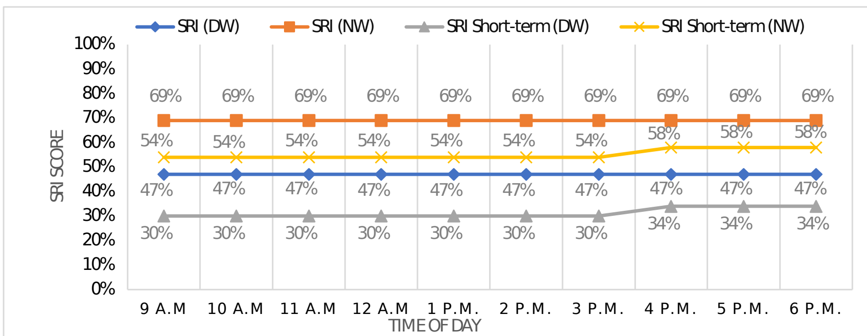

Fig. 1. Four SRI scores in short-term analysis: SRI default methodology (SRI DW), SRI default methodology with new weights (SRI NW), SRI Short-term using default weights (SRI Short-term DW) and SRI Short-term using new weights (SRI Short-term NW).

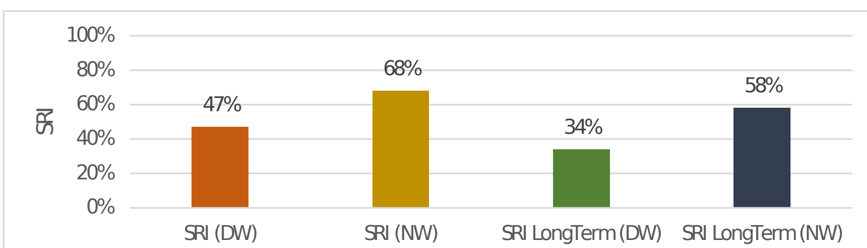

Fig. 2. Four SRI scores in long-term analysis: SRI default methodology (SRI DW), SRI default methodology with new weights (SRI NW), SRI Long-term using default weights (SRI Long-term DW) and SRI Long-term using new weights (SRI Long-term NW).

4 Conclusions and discussion

The aim of this paper is the definition of a novel data-driven methodology to assess the SRI. The European SRI methodology overlooks the potential of combining functionality levels with the actual indoor environmental quality (IEQ) of a building, which may results in an overestimation of the real indoor quality conditions. As evidence of this, the case study confirmed significant differences in SRI final scores computed using the EU calculation procedure and the novel one defined in this paper. These differences reflect the discrepancy between the expected IEQ conditions due to implemented functionality level (evaluated using Methods A and B) and the real operating conditions, increasing the need of a data-driven assessment method for the SRI calculation procedure of in-use buildings. Moreover, the proposed weights resulted from the survey affect the SRI evaluation, better reflecting real priorities expressed by experts with reference to the use case analyzed. Future works will be devoted to the in-depth investigation of SRI's comparison problems among Europe, emerging when SRI scores are calculated using new weights different from those proposed by the European Commission. Subsequently, possible new weighting factors can be computed for different building types involving more experts in the process, leading to consistent results for the SRI evaluation in the Italian context. Further steps can focus on expanding the data-driven approach to all SRI criteria and domains, coupled with the definition of minimum smartness levels required in buildings to allow data acquisition for the deployment of the proposed approach.

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Response to reviewers

Dear reviewers,

We would like to thank you for taking the time to assess our manuscript. We are very grateful to the reviewers for their careful comments and suggestions, which allowed us to improve the scientific quality and robustness of the paper. All the review comments have been addressed and the manuscript has been revised accordingly. The detailed responses are shown as below.

Point-to-Point responses to the Reviewer 1

Reviewer's remark	**Response by the authors**
Improve and expand the conclusions. Giving more description. The current conclusions are poorly discussed and presented.	Thank you for the comment. We have revised the entire conclusion section to address your concerns. In the revised version of the paper the conclusions are more clear and discussed. The revised conclusions contain the pivotal aim of the research work and better explain the beformentioned problems emerging from the case study with their justification. Moreover, the part related to future works includes more suggestions for the improvement of the research work. In particular, concepts related to comparison problems between SRIs among Europe have been added, coupled with the idea of defining minimum smartness levels in buildings to implement the data-driven approach, which can be investigated better in the future. These revisions can be found at page 10 of the manuscript, in "Conclusions and discussion" section.

Point-to-Point responses to the Reviewer 2

Reviewer's remark	**Response by the authors**
Further to 3(no) reviews to understand the paper - requires further proof-reading?	Thank you for the suggestion. We have revised and rewritten some parts in the manuscript to address this concern in order to be clearer when explaining specific/technical concepts. In particular, we revised the "Introduction" section, especially the "Smart Readiness Indicator" part, explaining better how the SRI is structured and how it is calculated. Moreover, further information regarding the analysed case study, are reported in the "Case study" section.Eventually, the "Conclusions and discussion" section has been extended for better highlighting the intent of the research work, the results obtained and providing additional suggestions for improvements and future developments of the work carried out.
To edit grammar and structure to provide clarity to some complex statements. (shorter sentences?)	Thank you for the comment. We have reviewed the entire paper to make sentences shorter and to better explain complex statements. We rewrite parts of the "Introduction" section and the entire subsection titled "Smart Readiness Indicator" under the "Introduction" section. The latter modification consists in a more schematic description of the SRI structure and methodology, which was difficult to understand in the previous version of the manuscript.
Also unclear as to the level of knowledge the paper's target audience? For example needed to research what Method C was - (Self reporting based on BACS long-term data) to understand approach? think this should have been defined?	Thanks for the suggestion. To address this concern, we have introduced the definition of Method C in the initial part of the article, at in the "Introduction" section. In particular, in the reference document of the SRI (i.e., the Final Report[3]), the method C is intended as a development perspective of the current SRI assessment procedure, based on data measured/monitored in building during the operation phase and able to assess the real performance/smartness of buildings and not only the expected one (evaluated using the current checklist approaches A and B).

Point-to-Point responses to the Reviewer 2

Reviewer's remark	**Response by the authors**
Paper reports modelled short-term data? pertinent as a preliminary study to establish the new approach feasibility.	Thank you for this comment. To address this concern, additional information was added in the "Case study" section to better explain how the test building was characterized by a technical point of view. In particular, in the "Case study" section, we described the cooling, storage, lighting and shading systems and their main control logics. The entire case study consists of a simulation conducted using EnergyPlus. The simulated environment allows a preliminary application of the novel methodology to be conducted while minimizing the difficulties related to the evaluation of SRI. Indeed, the SRI assessment procedure requires the knowledge of a large amount of data and technical information (i.e., how a specific technical system works, with which level of automation is implemented within the building), especially when conducting the "Triage process" step (further information about this step can be found in the Final Report[3]). This type of information is often difficult to find and obtain for existing buildings. Therefore, the assumptions that are made during the "Triage process" of the SRI, can greatly influence the final SRI score because of subjective choices due to a lack of information about the building and its systems. For these reasons, we decided to use a simulated building with its systems, for which every technical part and the related set of automation degrees are known a-priori and defined. This condition minimizes the risk of obtaining results affected by errors due to lack of building knowledge and subjective choices in defining degrees of automation of services implemented within the building. Indeed, the selected case study allowed to reduce the subjective component that affects the triage process, making the test case an effective demonstrator for the preliminary application of the proposed data-driven approach for the SRI evaluation.