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Report on Input Data for Decommissioning Planning Information Models

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Summary

The main objective of WP4 was to collect and analyze data on the information needs and preferences of the stakeholders involved in the decommissioning planning of nuclear facilities. The aim was to identify the gaps and challenges in the current practices and to evaluate the potential benefits of the PLEIADES platform as a digital solution for decommissioning planning. These evaluation results are presented in two deliverables: D4.1 Report on Input Data for Decommissioning Planning Information Models (this report); and D4.2 Report on Strengths, Weaknesses and Optimization of Decommissioning Planning Information Models. The evaluation focused on the relevance, completeness, accuracy, usability and added value of the information models and the PLEIADES platform for the users. The data for carrying out the evaluation were collected using a mixed-methods approach that combined a questionnaire, semi-structured interviews and workshops with end-users and developers among internal project partners. The questionnaire was designed to assess the current situation and the expectations of the respondents regarding the information management and communication in decommissioning planning. The interviews and workshops were used to explore the details and validate the findings of the questionnaire. The information needs and preferences of the stakeholders vary depending on their roles, responsibilities, and contexts in decommissioning planning. There is a need for a common understanding and a standardized approach for the information management and communication in decommissioning planning. The strengths of the PLEIADES platform are its user-friendly interface, its interoperability with other systems and tools, its customizability to different user needs and preferences, and its scalability to different project sizes and complexities. The PLEIADES platform is a useful and innovative tool that can facilitate and improve the information management and communication in decommissioning planning. It can integrate and visualize the information from different sources and formats. It can also support the collaboration and coordination among the stakeholders. It can enhance the transparency, traceability, and quality of the information. The information models developed in the PLEIADES project are relevant and comprehensive for the decommissioning planning process. They cover the key information elements and flows that are needed by the stakeholders. They also provide a flexible an...

Approval

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PLEIADES project

WP4: Modelling and results evaluation

D4.1: Report on input data for decommissioning planning information models

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Abbreviations and acronyms

Acronym	Description
API	Application Programming Interface
BCOT	Base Chaude Opérationnelle du Tricastin
BIM	Building Information Model
D&D	Decommissioning and Dismantling
HRR	Halden Research Reactor
SMG	Santa María de Garoña Nuclear Power Plant
WP	Work Package

Executive Summary

The main objective of WP4 was to collect and analyze data on the information needs and preferences of the stakeholders involved in the decommissioning planning of nuclear facilities. The aim was to identify the gaps and challenges in the current practices and to evaluate the potential benefits of the PLEIADES platform as a digital solution for decommissioning planning. These evaluation results are presented in two deliverables: D4.1 Report on Input Data for Decommissioning Planning Information Models (this report); and D4.2 Report on Strengths, Weaknesses and Optimization of Decommissioning Planning Information Models.

The evaluation focused on the relevance, completeness, accuracy, usability and added value of the information models and the PLEIADES platform for the users. The data for carrying out the evaluation were collected using a mixed-methods approach that combined a questionnaire, semi-structured interviews and workshops with end-users and developers among internal project partners. The questionnaire was designed to assess the current situation and the expectations of the respondents regarding the information management and communication in decommissioning planning. The interviews and workshops were used to explore the details and validate the findings of the questionnaire.

The information needs and preferences of the stakeholders vary depending on their roles, responsibilities, and contexts in decommissioning planning. There is a need for a common understanding and a standardized approach for the information management and communication in decommissioning planning.

The strengths of the PLEIADES platform are its user-friendly interface, its interoperability with other systems and tools, its customizability to different user needs and preferences, and its scalability to

different project sizes and complexities. The PLEIADES platform is a useful and innovative tool that can facilitate and improve the information management and communication in decommissioning planning. It can integrate and visualize the information from different sources and formats. It can also support the collaboration and coordination among the stakeholders. It can enhance the transparency, traceability, and quality of the information. The information models developed in the PLEIADES project are relevant and comprehensive for the decommissioning planning process. They cover the key information elements and flows that are needed by the stakeholders. They also provide a flexible and modular framework that can be adapted and extended to different situations and needs.

The weaknesses of the PLEIADES platform are its dependency on the availability and reliability of the data sources, its limited functionality for some advanced features, such as simulation, optimization and risk analysis, and its lack of validation and verification for some critical information.

Recommendations for the future work are to further develop and improve the PLEIADES platform by adding and enhancing the functionalities and features that are requested or suggested by the stakeholders, such as data import/export, data analysis, data editing, data security, data quality control, user feedback, user guidance, user training, etc. Another recommendation is to conduct more tests and pilots with the PLEIADES platform in real-life scenarios and with larger and more diverse stakeholder groups, in order to evaluate and demonstrate its effectiveness and impact in decommissioning planning.

Keywords

Nuclear, Decommissioning, Platform, Digital Tools, Data Collection, Modelling, Evaluation

1. Introduction

As part of Modelling and results evaluation in WP4, which main objective is to analyze and evaluate the results of WPs 1, 2 and 3, the deliverable 4.1 addresses the PLEIADES evaluation process, and describes the process and efforts involved in collecting the input data needed to perform the modelling and calculations presented in WP3. The deliverable is therefore two-fold with a focus first on the evaluation process and the methodologies underlying the PLEIADES evaluation involved in WP4, which after the deliverable proceeds to an evaluation of the input data collection process and the effort involved.

With the aim to provide a coherent presentation on deliverable 4.1 of WP4, the purposes of the work packages preceding WP4 are briefly recapitulated. As outlined in the previous deliverables, the purpose of WP1 was to define the requirements and the necessary ontology for the management of Decommissioning and Dismantling (D&D) activities of nuclear facilities. WP2 implemented the PLEIADES platform and established a Common Data Environment, browser interface and API connection through which the different software tools of the partners can exchange data. For WP3, the PLEIADES platform was tested by analyzing representative user stories from D&D projects. Data of three real nuclear facilities could be used for this purpose (HRR, SMG, BCOT; data collection and 3D and BIM modelling were performed through tasks 3.1, 3.2 and 3.3).

Thus, in line with deliverable 4.1, as a follow-up the evaluation process and the methodologies underlying the PLEIADES evaluation involved in WP4 are presented. The evaluation process of PLEIADES, which was formulated to gain an overview of PLEIADES by gathering timely data regarding its present status and the factors determining it, was executed with the implementation of two distinct research methodologies. This deliverable will delve into the two research methods, as in the PLEIADES evaluation questionnaire, which applied a mixed methodology as a research method, and interviews, which adopted a qualitative methodology as a research method. This deliverable will be discussing in particular their mutual relationship, the rationale for their selection, and their implementation in practice. The aim is to address the subject concerned in a manner that would allow a straightforward interpretation of the results of the research methods in deliverable 4.2.

Following the evaluation process, this deliverable examines the data collection process and the effort needed to collect the required data for performing the analyses in WP3 with PLEIADES platform. In this deliverable, each data type is reviewed in terms of the data collection process and the effort involved in order to be consistent with the structure of tasks 3.1 and 3.2. Thus, the types of data to be included are 3D models of the facilities, data related to ambient radiation in the premises, radiological characterization data, data related to waste management, cost-related data, and other data. In addition, to support the former, the data collection process in general, the challenges associated with the process and the occurrence of challenges at different phases of the data collection process are examined.

Deliverable 4.1 is structured as follows. After the introduction, this deliverable continues by presenting the evaluation process of PLEIADES platform in a holistic manner by first giving an overview of the background and purpose for the evaluation process, following with a chapter of the PLEIADES evaluation questionnaire presented in more detail. This chapter includes sections on the

implementation of the questionnaire, the mixed research methodology, as well as the framework of the questionnaire. After the PLEIADES evaluation questionnaire chapter, this deliverable continues to chapter concerning the PLEIADES evaluation interviews, which includes section on the implementation of interviews, the end-user interview framework and the developer interview framework. In a coherent way, this deliverable proceeds to the chapter regarding the evaluation of input data collection. This chapter includes sections entitled “Background and purpose”, “Data collection process”, and “Evaluation of effort”. Of these, the middle section includes sub-sections according to the above-mentioned data types presenting the data collection process and the effort involved by data type. The final two chapters of deliverable 4.1 are the conclusions and references.

2. PLEIADES evaluation process

2.1. Background and purpose

The evaluation process of PLEIADES was designed to provide a comprehensive understanding of the current state of the PLEIADES user experience. In the process of supporting the former, the aim was to obtain a better understanding of the weaknesses and strengths of PLEIADES, as well as to strengthen the overall understanding of the views of partners on the future state of PLEIADES. Thus, by exploring the user experience of PLEIADES from multiple perspectives, it was identified as a way to create a holistic view of the evaluation.

The research method for the evaluation process of PLEIADES was decided to be a mix of quantitative and qualitative research methods, namely a mixed research method. The quantitative research method was perceived as being a valuable part of the evaluation process for its ability to gather measurable and hence comparable results (Creswell, 2003). However, as the evaluation aimed to explore individuals' experiences and perceptions of PLEIADES, it was identified as necessary to use qualitative research methods in order to achieve the intended purpose of the evaluation. Unlike quantitative research, qualitative research focuses on gathering data through open-ended and conversational communication to gain a deeper understanding of the topic under examination (Creswell, 2003). Hence, two evaluation methods were used, a questionnaire, which was a mix of quantitative and qualitative research methods, and interviews, which was a qualitative research method. By using different research methods, the aim was to obtain comprehensive results of the evaluation.

The implementation of the evaluation was gradual. The PLEIADES evaluation questionnaire and interviews were conducted in a sequential order, with the questionnaire first and the interviews following, based on the rationale of using the questionnaire results to generate the interview questions. Thus, the interviews served as a complementary research method for the questionnaire filling in particular the gaps in information that were not clear from the responses to the questionnaire. Thus, to conclude, the questionnaire sought to obtain an overall view of the evaluation, after which the interviews sought to gain a deeper understanding of the underlying determinants of the responses.

Both evaluation methods were carried out internally, meaning that both the participants in the questionnaire and the interviews were partners in the project. Participants included both end-users and developers of PLEIADES, as this was identified as contributing to the gain of a holistic understanding of the user experience and the factors that influence it. Thus, for both methods, it was assumed that the participant had some degree of prior knowledge of PLEIADES, its use or development, or both. This had an impact, among other things, on the type of questions that were addressed in the methods.

Next, we present in more detail the methods used for the evaluation, the PLEIADES evaluation questionnaire and interviews.

2.2. PLEIADES evaluation questionnaire

2.2.1. Questionnaire implementation

The PLEIADES evaluation questionnaire, as a first step in the evaluation of the user experience of PLEIADES, was carried out by collecting responses electronically from six internal project partners. The purpose of the PLEIADES evaluation questionnaire was to establish a comprehensive overview of the use of PLEIADES, and therefore the questionnaire contained a set of questions covering the main aspects of the use of PLEIADES.

The PLEIADES evaluation questionnaire was distributed online with the aim to offer the respondents a freely chosen place and time to complete the questionnaire. This was to contribute to higher quality results by supporting the ability of respondents to answer questions with the necessary care. Hence, the objective was to avoid situations where the respondent would have to answer in a time pressure or in an unsuitable environment, among other things. Regarding the PLEIADES evaluation questionnaire timetable, the evaluation questionnaire was scheduled for the summer of 2023, so that the responses from respondents were received during July and August. Respondents' time to respond ranged from ten minutes to twenty minutes.

The PLEIADES evaluation questionnaire was completed anonymous. As stated earlier, the respondents to the questionnaire were internal partners of the project who were expected to have prior knowledge and experience of using PLEIADES. It was also known in advance that the respondents to the questionnaire had different levels of experience in using PLEIADES as well as other similar tools. The respondents also represented different sectors and included both end-users and developers of PLEIADES. These background factors had an impact on the formulation of the questions in the PLEIADES evaluation questionnaire, which will be discussed in more detail in the next section.

2.2.2. Mixed research method

The PLEIADES evaluation questionnaire was implemented as a mixed research method, exploiting the strengths of both qualitative and quantitative research (Creswell, 2003). By implementing a mixed method questionnaire, the purpose of the qualitative research approach was to gain a better understanding of the topic under study by presenting questions that required the respondents to open up their own perspectives and its contextual factors on the topic. The quantitative research approach, on the other hand, was intended to recognize measurable similarities between the respondents. In this way, exploiting both qualitative and quantitative approaches, the aim was to obtain a holistic picture of the topic.

The questionnaire contained a total of 53 questions, which represented, in mixed order, both quantitative and qualitative approaches in terms of question format. Most questions, however, were quantitative and thus were formulated as 5-point Likert scale questions asking respondents to indicate how much they agree or disagree with a specific statement. The response options included "Strongly disagree", "Disagree", "Agree", "Strongly agree" and " I don't know". In addition to the 5-point Likert scale questions, the first section of the questionnaire contained quantitative questions with two or more pre-defined response options but which, unlike the 5-point Likert scale questions, did not measure agreement with a particular statement but offered response options that did not correlate with each other.

Alongside the quantitative questions, the questionnaire also included the qualitative questions. All qualitative questions, except for the questions regarding the first and the last sections, were open-ended questions, which were presented as a follow-up to the quantitative question, asking the respondent to justify verbally their response to the previous quantitative question. The first and the last sections contained open-ended questions that were not linked to quantitative questions but were rather independent questions.

2.2.3. Questionnaire framework

The PLEIADES evaluation questionnaire framework was designed to support the stated purpose of the evaluation. Thus, the questionnaire framework comprehensively covered the different aspects of using PLEIADES by consisting of six sections including background, data-, engineering- and work process, strengths and weaknesses, as well as feedback questions. These six sections were designed to proceed in a logical sequence, with the preceding section supporting the next.

The first section, which was titled as "Your profile", contained questions about the respondent's background and experience. The purpose of the first section was to create an understanding of the respondents' perspective on the topic and thus to understand the background factors that would influence the responses to the questions in the following sections of the questionnaire. First section included among others a question on the respondent's perspective on which of their present methods PLEIADES could replace, as well as a question on the respondent's role as the main user on PLEIADES.

The next section, entitled "Data Process", included questions regarding the respondent's perspectives on the data processes of the PLEIADES platform, such as data acquisition, cleaning, formatting, storage, and validation. A large part of the questions sought to clarify how helpful and suitable the above-described aspects of the data processes are for the respondent in their work when using the PLEIADES platform. The questions in the second section of the questionnaire included, among others, the statement questions "The PLEIADES platform is helpful in determining which radiological characterization data needs to be collected" and "The data collecting process in PLEIADES is well-suited for waste management.". There was a total of 20 questions on the data process in the questionnaire.

The third section of the questionnaire, the "Engineering process", contained questions regarding engineering process activities like iterative planning in order to stay "real-time", steering the work process, utilizing data, and utilizing modules. This section contained a total of five questions, including questions in the form of a statement such as "Using PLEAIDES for radiological characterization is problematic because of issues related to 3D modelling" and "In waste management, the PLEIADES platform is helpful in determining the different potential routes for waste delivery and choosing between them".

The following section, which was entitled as “Work process”, focused on questions concerning the implementation of the engineering process. The purpose of this section was to create an understanding of the respondents’ views on work process activities, such as planning, workflow and collaboration, and standardization. The “Work process” section included 10 questions in which was covered questions for example concerning the usefulness of PLEIADES platform as a workflow tool and collaborating platform with respect to radiological characterization, as well as concerning the

helpfulness of PLEIADES platform in standardizing methods across projects with respect to waste management.

The fifth section, as in the "Strengths and weaknesses", of the questionnaire exploited the level of agreement of respondents concerning a list of strengths and weaknesses of PLEIADES. Accordingly, this section was divided into two parts, the strengths and the weaknesses. The first part included five questions, which were formed to cover the strengths of PLEIADES by asking statement type of questions, such as "The PLEIADES platform helps to improve accuracy" and "The PLEIADES platform helps to improve flexibility", in which the respondents were supposed to give an answer on their level of agreement. The second part of the "Strengths and weaknesses" section focused on the weaknesses of PLEIADES by asking statement type of questions, such as "The PLEIADES platform has these negative effects: needs added special expertise" and "The PLEIADES platform has these negative effects: lacks accuracy if key inputs are not available".

The final section of the questionnaire requested for feedback on the questionnaire from the respondents. This section was two-fold with the first part focusing on feedback on the questionnaire while the other part focused on feedback for the upcoming interviews. In more detail, the latter requested for the views of respondents on the topics that should be covered in the upcoming interviews that was not asked yet on the questionnaire or which was not covered in enough depth.

2.3. PLEIADES evaluation interviews

2.3.1. Interviews implementation

As a second step in the evaluation of the PLEIADES user experience, PLEIADES evaluation interviews were conducted. As stated previously, the interviews were aimed at complementing the previously conducted questionnaire, in order to fulfil the parts of the questionnaire that were not holistic in terms of established results. Thus, the formation of the interviews was based on the results of the questionnaire for its purpose to conduct a holistic overview as well as a deeper understanding of the status of the PLEIADES user experience.

The PLEIADES evaluation interviews were carried out through interviews with ten internal project partners which included both end users and developers of the PLEIADES platform. The interviews lasted from 45 minutes to one hour. For the interviews, each interviewee made an appointment from the two week-long time slot calendar at a time that suited them. Accordingly, each interviewee received the interview questions two days in advance. The aim of booking an appointment and preparing the interviewee for the interview questions in advance was to create the conditions for the interviewee to participate in the interview that would contribute ideally to the conduct of the conversation and its resulting findings.

In contrast to the PLEIADES evaluation questionnaire, ten project partners participated in the interviews. This was an outcome for the sequential order of contemplating the two research methods enabling a reinforced understanding that the number of participants has a key impact on increasing the holistic understanding of the results produced. As with the PLEIADES evaluation questionnaire, also the interviews were conducted anonymously ensuring that the results obtained through the

interviews did not reveal the source of the results. The interviews were recorded and transcribed in order to support the analysis of the results.

2.3.2. Qualitative research method

The PLEIADES evaluation interviews were conducted as semi-structured individual interviews, as previously mentioned, following a qualitative research methodology. The semi-structured individual interviews contained preplanned open-ended questions, in addition to which there were other questions that emerged from the dialogue between the interviewer and the interviewee. Since in the semi-structured interviews an open dialogue and, more precisely, the willingness of the interviewee to open up the subject in depth from the perspectives that are perceived as central, are essential for the formation of comprehensive results, the efforts mentioned in the previous section on scheduling and setting up optimal interview conditions were essential for semi-structured interviews in this context.

Supporting the purpose of the PLEIADES evaluation, the individual semi-structured interviews allowed to understand each individual's personal view on the topic and the factors that determine it. The individual semi-structured interview enabled a flexible interviewing style whereby, depending on the individual and their views, the emphasis of each interview could be tailored. This was identified as a viable interview style for PLEIADES evaluation interviews as the different backgrounds of the interviewees, such as the different industry which the interviewees represented and various levels of experience in using PLEIADES, were identified as having an impact on the diversity of responses offered by the interviewees.

2.3.3. Interview framework

The PLEIADES evaluation interview framework was designed to support the purpose of the evaluation in that it sought to create a deeper understanding of the PLEIADES user experience by complementing those points where comprehensive results were not yet obtained from the questionnaire. Because the PLEIADES evaluation interviews were conducted with both PLEIADES platform end-users and developers, separate interview frameworks were constructed for PLEIADES end-users and developers. This differed from the PLEIADES evaluation questionnaire, which had only one framework for all. The purpose of the two frameworks was to explore the PLEIADES user experience more broadly, delving deeper into the individual's own experience.

Therefore, the PLEIADES evaluation interview frameworks for PLEIADES end-users and developers were distinct in the sense that they included different sections of interview questions that were linked to their roles and to the purpose of the PLEIADES evaluation, as in to gain a deeper understanding of the PLEIADES user experience. The PLEIADES end-user interview framework consisted of six sections, which were background-, user experience-, D&D data management-, D&D work process-, exploitation-, and feedback sections, whereas the PLEIADES developer interview framework was slightly shorter consisting of only four sections including background-, development and maintenance of the connector and platform-, exploitation-, and feedback sections. The rationale for the PLEIADES developers' interview framework having fewer sections was that the purpose of conducting the

interviews and thus the evaluation was to strengthen the understanding of the PLEIADES user experience, which is why the PLEIADES end-users were identified as having more to contribute on this topic and thus the interview frameworks were formulated accordingly.

As next, a more detailed presentation of both interview frameworks is given, describing the purposes of the sections within both frameworks and giving examples of the questions.

2.3.3.1. End-user interview framework

The first section, entitled as “Background” section, included questions about end-user’s background and experience. Although this section was similar to the first section in PLEIADES evaluation questionnaire and thereby the relevant background information of the participants was already available, this section was identified as essential to maintain also as part of the interview framework for two reasons. Firstly, it was identified as valuable to retain this section in the interviews in order to gain a more profound understanding of the interviewee's background and thus the perspective it brings to the questions in the following sections. Another central reason for keeping the "Background" section was that there were more participants in the interviews than there were participants in the questionnaire, and thus for some of the participants no background information was available beforehand. Thus, the first section aimed to provide a good basis for interpreting the answers to the questions in the following sections.

The next section, which was entitled "User experience", addressed the end-users' experience of using the PLEIADES platform. The purpose of this section was to understand in more depth what was currently excellent about the PLEIADES user experience and where there was room for improvement. This section included questions about the functionality of the PLEIADES browser interface to the databases, the MinIO repository functionalities interface to the databases, and also questions about what it was like to learn to use the PLEIADES platform.

The third section, the "D&D data management" section, consisted of questions on experiencing the D&D ontology, data classes, and related functions. The purpose of this section was to understand the strengths and weaknesses of the D&D ontology and data classes, and thus the features that would be appreciated in the future. This section included questions such as "What is your opinion on the D&D ontology and data classes implemented within the platform?" and "What additional guidelines or framework would you set to ensure unambiguous use of information exchanged between users through the PLEIADES platform?".

The following section, entitled as “D&D work processes” section, included questions on the experience of PLEIADES end-users in areas such as data collection, data validation and task optimization. The purpose of this section was to build a deeper understanding of how end-users perceived the PLEIADES platform to contribute to the above-described tasks, whether the PLEIADES platform could contribute even more and where the platform would need to improve to contribute more to the tasks. This section included questions such as "Could you comment on the way the Pleiades platform and connected tools helped in collecting the data necessary for your task?" and "Could you comment on the use of the Pleiades platform and connected tools to assess the costs of the D&D activities?".

The fifth section, which addressed the exploitation of the PLEIADES platform, was entitled "Bonus question" as it did not directly address the perceived user experience of PLEIADES. However, this was identified as a key area to address in the PLEIADES evaluation interviews, as it was intended to explore

the PLEIADES end-users' views on the future of the PLEIADES platform and the associated commercialization of the platform. This section was essentially linked to the end-users' views on whether the PLEIADES platform should be further developed, what further development would require and whether the end-users interviewed would be willing to participate in the further development of the PLEIADES platform.

The final section of the end-user framework for PLEIADES evaluation interviews addressed the feedback. The purpose of this section was to gather feedback from end-users on the PLEIADES evaluation interviews and to give the interviewed end-users the final opportunity to elaborate on a topic if they felt that it was not sufficiently or not at all covered.

2.3.3.2. Developer interview framework

The first section of the PLEIADES developer interview framework, entitled "Background" contained questions regarding the interviewee's experience of PLEIADES in relation to the present methodology used. The purpose of this section was to understand, from the perspective of the PLEIADES developer, how PLEIADES differs from the perceived present method. Therefore, this section included questions on the strengths and weaknesses of the methods and their differences.

The second section, entitled "Connector development and maintenance questions", focused on the developer perspective on connector development for tools which were to be connected to the PLEIADES platform. Thus, the purpose of this section was to understand in depth the developer's experience of connector development and the factors impacting on it. This section included questions that sought to explore the developer's experience of how implementing software connectors could be improved, what was good about the PLEIADES API and what should be improved in terms of connector development and maintenance. In addition, this section included more specific questions on platforms access speed to data, scaling with database size, ensuring security of data, as well as future updates in the API and class definitions.

The third and fourth developer interview framework sections were similar to the sections of the end-user interview framework. As with the end-user interview framework, also with the developer interview framework, the third section, focusing on the PLEIADES exploitation, aimed to find out the interviewee's perspective on the future state of PLEIADES, whether the interviewee expressed an interest in participating in the further development of PLEIADES, and whether the interviewee saw an opportunity for business development in PLEIADES. The fourth section, which covered the feedback from the interviews, also in this framework included the purpose to explore the feedback and give the interviewee the final opportunity to elaborate on a topic if they felt that it was not sufficiently or not at all covered.

3. Evaluation of input data collection

3.1. Background and purpose

This chapter examines the data collection process and the effort involved in data collection. Therefore, the purpose of this chapter is to create a stronger understanding of the data collection process, the factors that determine it and the level of effort that the data collection process requires.

For the purpose of this chapter, the following section, entitled “Data collection process”, presents the evaluation of the data collection process in a sequential order according to data types. Thus, the types of data to be included are 3D models of the facilities, data related to ambient radiation in the premises, radiological characterization data, data related to waste management, cost-related data, and other data. Yet, before presenting the data collection process according to the data types, this section examines the data collection process in general, briefly both the challenges associated with the process and the occurrence of challenges at different phases of the data collection process.

After the data collection section, this chapter proceeds to the evaluation of effort section, which presents analysis based on the PLEIADES evaluation interviews and questionnaire on the effort used for input data collection. The difference between the evaluation of effort section and the data collection process section above is that the latter delves into the data collection process according to data types, going through the data collection activities, challenges, strengths and effort for each data type, while the evaluation of effort section delves into the input data collection effort more broadly, relying on the results of the PLEIADES evaluation interviews and questionnaire.

3.2. Data collection process

As described in WP3 deliverable 3.1 on Input data, data collection was a three-phase process which followed the designation first, second, and third data collection campaign. As discussed in deliverable 3.1, the first data collection campaign was the opportunity to launch technical exchanges between Cyclife-DS (T3.1 leader) and the contacts of the 3 use cases, whereas the second data collection campaign had necessary data much more precisely defined since the start of the second campaign was when the structure of the database was already well defined. The final data collection campaign, as described in deliverable 3.1, was divided in two phases, integration of data collected during the two previous campaigns into the databases of the three use cases in the PLEIADES platform, and identification of missing data regarding the finalized structure of the database and entry of this data directly into the structure of the database. A more detailed description of the data collected can be found in deliverable 3.1.

In the context of the PLEIADES data collection process, it was identified as a challenge to retrieve specific technical data for the installations. This was due to two potential reasons, either because the format was not the one expected by the PLEIADES database, in which case conversions were necessary, or because the data was not available, in which case it had to be retrieved from experts or produced on the basis of assumptions. The challenge of data collection varied depending on the phase of the data collection process. In particular, the data retrieval work was found to be complex at the beginning of Task 3.1, which was based on the first use of the database. During the tests at the end

of WP2, data retrieval was only lightly tested. In this context, mainly hypothetical data were used. However, the work was considered much simpler with a few dozen hours' experience, knowing what kind of data was needed, such as the expected formalism, the best order to make the declarations and the different solutions for making these declarations in the database.

Therefore, it can be concluded that a key aspect concerning the PLEIADES data collection process is whether the PLEIADES platform and its connected tools facilitate data collection for the management of D&D activities. Perspectives on this topic argue both for and against this. Some transversal data, such as standard cost items, are readily available through connected tools, and in this sense working with the PLEIADES platform helps to make this data quickly available. However, for facility-specific data, the tools do not really simplify data collection. In the future, an aim could be to develop tools that simplify the transfer of data between the collection phase and the uploading to the database for further use.

In the following sections, the data collection process will be presented in more detail according to data types.

3.2.1. 3D models of the facilities

This section addresses the data collection process for 3D models of the facilities. The purpose of this section is to examine the data collection process and the factors that determine the process when dealing with 3D facility models.

Regarding 3D models of facilities, it was identified that 3D models are often not available for the nuclear facilities that are being decommissioned. This can be a result of many factors, such as the sensitivity of the facilities and the consequent security constraints on performing 3D scans. However, current methods have been identified as making it easier to perform 3D scans of facilities and, given the current methods, it can be argued that scanning is relatively easy nowadays. Also, as demonstrated in user story #5, point cloud can meet certain verification and visualization needs.

As for the 3D scanning, it is found to be a valuable part of building 3D models and reviewing existing models. 3D scanning has been identified as being able to perform certain studies, such as collision detection or to identify the working environment for learning and risk identification. For PLEIADES, the tools attached to the platform have demonstrated that scanning can be used to perform these studies. Indeed, many specialized software programs allow to build a 3D model from a point cloud. Hence, it is possible to model only what is relevant to the decommissioning site, such as the structure and access routes, safety-relevant equipment and elements that will be dismantled during operations.

A downside of 3D scanning is that it has been considered insufficient for waste assessment studies. This is due to the fact that there is little or no physical data associated with the scan. Moving to a real BIM model of an installation, with equipment correctly represented in 3D and categorized, and for which links have been made with an existing database, it is identified as a large-scale task, even with the current means.

The strengths of the PLEIADES platform in the context of 3D models of the facilities are the standardization of the required data and the exclusive use of the IFC format. As shown in the figure below, the use of "IFC GUID" references in the 3D model can be used to predict the definition of buildings, floors and rooms associated with activities, and can therefore be linked to other data in the

database. For example, information that a particular operation will be performed in that room, or the dose rate of a room.

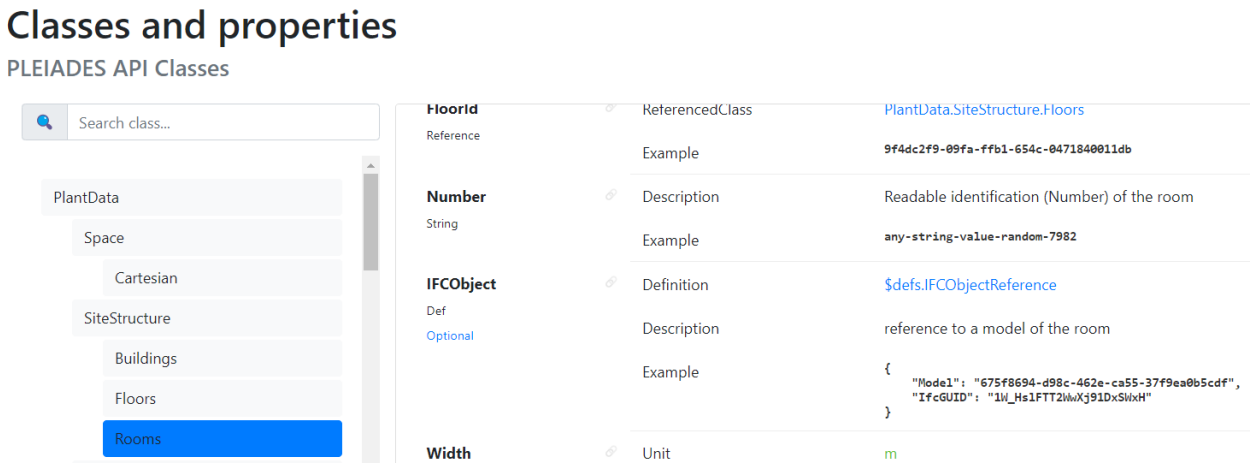

Figure 1: PLEIADES API Classes and properties, zoom on 3D data.

Despite the positive aspects, negative aspects have also been identified with the use of the IFC format. Non-IFC 3D models have been identified as challenging to convert to IFC. Indeed, face inversions that had a negative impact on visual rendering were encountered, which is illustrated in the figure below on vision through certain 3D objects depending on the point of view. Furthermore, in the case of PLEIADES, the tools connected to the platform did not use the IFC format and thus certain tools connected to the platform did not read the properties of the IFC file. For example, in DEMplus, the IFC format was accepted for geometries and certain data, such as surfaces and masses of objects, but other data was deleted.

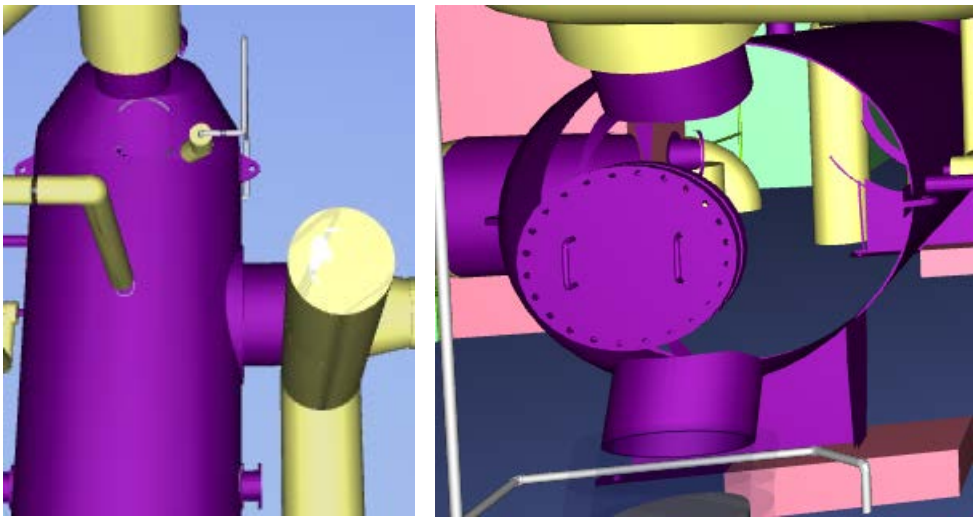

Figure 2: Inverting faces of a 3D object after converting the 3D file to IFC format

3.2.2. Data related to ambient radiation in premises

This section addresses the data collection process for data related to ambient radiation in premises. The purpose of this section is to examine the data collection process and the factors that determine the process when dealing with data on ambient radiation in premises.

Ambient radiation data is perceived to be easily collected with existing measurement techniques. In nuclear installations, radiation protection monitoring has to be carried out, and thus for each room at least a dose rate level has to be available, but usually also information on the hot spots of the room. One finding showed that such measurement is considered even easier than 3D scanning since it does not require the same level of spatial resolution.

Regarding the PLEIADES project, it was found that the connected tools of PLEIADES made it possible to convert measurements into mapping for the purposes of dose estimates. Presumably this whole process was not automated from on-site measurement to uploading a dose map to a database, but this was identified as something that could be achieved with further development of the tools based on current knowledge. However, to have access to data from the most irradiating rooms of the facilities was considered as possibly more complicated.

The PLEIADES platform linked a dose rate to a workstation, which was determined using 3 properties, “Exposure Type” comprising either “Constant”, or “Percentage”, and the "ExposurePercentage" in percentage or "ExposureConstant" in µSv/h. Furthermore, the workstation was linked to a room in the 3D model which had its own ifcGUID. It can be determined to have an advantage as it can locate the workstation precisely.

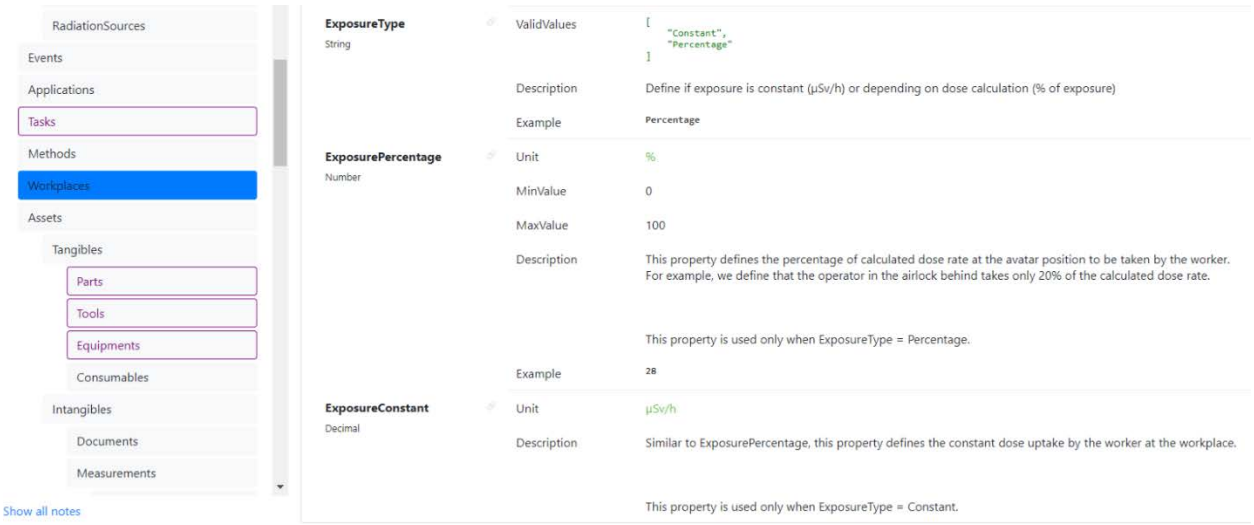

Figure 3: PLEIADES API Classes and properties, zoom workplace ambient dose rate

3.2.3. Radiological characterization data

This section addresses the data collection process for radiological characterization data. The purpose of this section is to examine the data collection process and the factors that determine the process when dealing with radiological characterization data.

Obtaining accurate information on the radiological characterization of the facilities to be dismantled is recognized as the biggest challenge of most of the dismantling projects. Converting the radiation measurement into an isotopic vector has been identified as a challenge, as it is not uniformly distributed in matter. This is the information that is usually needed in dismantling projects to correctly estimate the amount of waste generated during dismantling. In the current situation, merging data from in-situ radiation, laboratory characterization of samples and further generalization using physical models may be necessary.

In this context, it was recognized during the PLEIADES project that it is difficult to obtain radiological characterization data, due either to the unavailability of the data or because they are too sensitive to be disseminated externally. Nevertheless, the few classes provided for declaring, for example, a hot spot and surface contamination, enabled the radiological data required for simulations and for estimating the absorbed dose to operators to be made visually comprehensive. These included the measurement spectrum, namely the "NuclideVector" in the PLEIADES database, and the properties of "Assets.Intangibles.Measurements" class, as in measurement type and unit, description, date, location and measurement value.

For the PLEIADES project, it was also identified that to some extent it is possible to work with assumptions to make preliminary estimates. In PLEIADES, some simulations used fictitious data to illustrate the concept. This showed, also for the PLEIADES project, that obtaining radiological

characterization data is difficult and hence, at this stage, it not how the PLEIADES approach could make the process of gathering radiological characterization data easier.

Besides the practical difficulties related to the acquisition of these radiological characterization data by the building operator and the person in charge of the dismantling operations, one difficulty encountered during the parameterization of the SMG use case database and user story #2 was related to the relevance of the measurements in relation to the scenario to be simulated. Although many measurements were available for this use case, such as local dose rates and surface contamination, not all of these data were equally relevant and useful for simulating the planned operations.

To conclude, as shown in the figure 4 below, several radiological data were reported that were not relevant for the simulations and were therefore not used by the software connected to the platform.

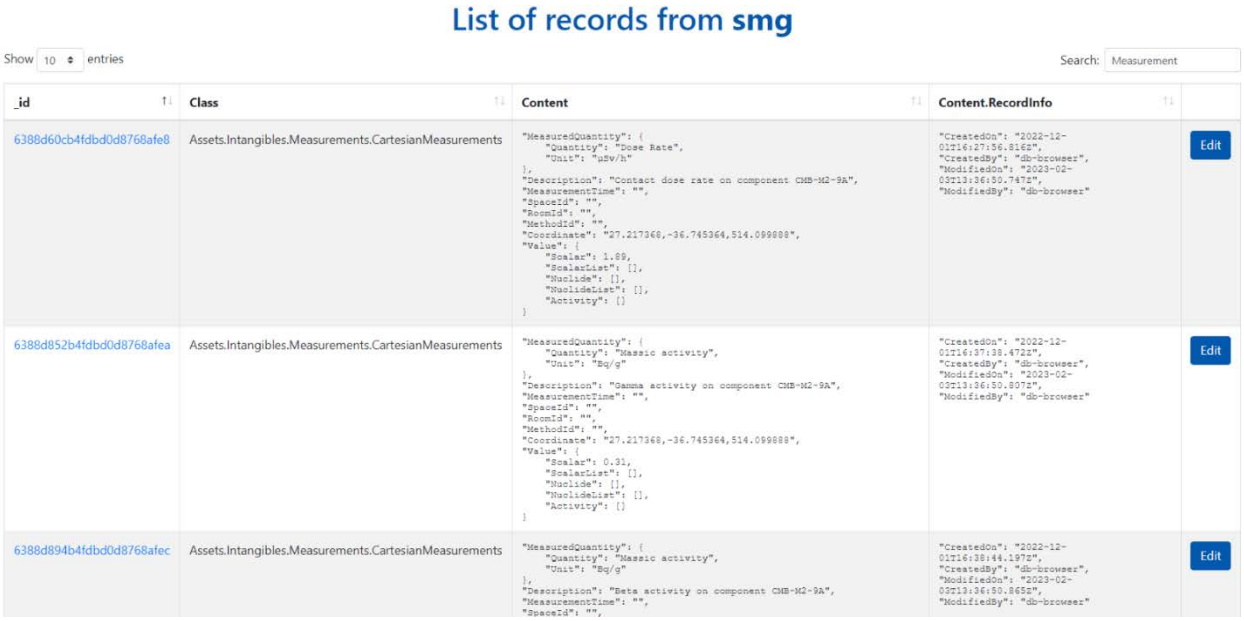

Figure 4: SMG PLEIADES database, focus on CartesianMeasurements

In the PLEIADES project, the above, that is shown in figure 4, was found to occur also in user story #3. A large number of surface contamination measurements existed per surface of the rooms to be renovated, more specifically 4 walls, 1 floor and 1 ceiling per room. Results were obtained for alpha and beta gamma contamination and two related spectra. However, given that the scenario to be simulated planned to remediate each surface in a single operation, a single contamination value per face was sufficient. Therefore, a data pre-processing phase was necessary. This consisted in establishing an average contamination per face, one alpha and one beta-gamma, calculating an average radiological spectrum, and weighting these two averages using the spectrum to produce a single average contamination per face of the rooms to be remediated. The average values obtained were then declared in the use case database and associated with the 3D objects concerned.

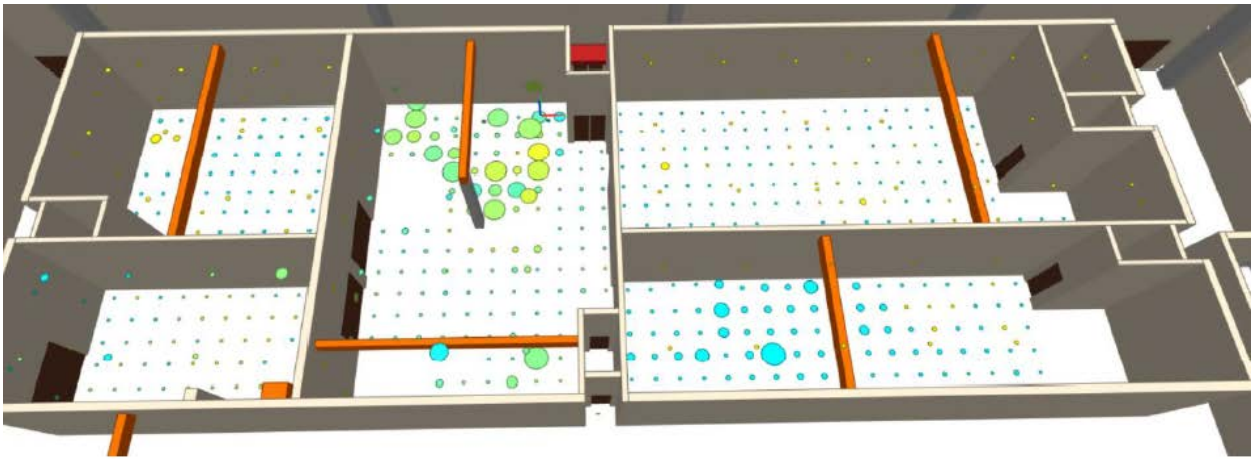

Figure 5: Part of the 3D model of EDF BCOT use case

Figure 5 shows the various discs that represent radiological contamination results, more specifically various colors for alpha contamination and beta gamma contamination. Regarding figure 5, one of the IFC properties of these objects, namely the coloured discs, was used to store the contamination values. In the PLEIADES project, it was considered as an option to allow the PLEIADS platform to read this data, but it was found that the method used by EDF's subcontractor to make the model was not considered as good practise. This conclusion was also supported by the finding that there were too many measurements for what was needed in the PLEIADES project. It was therefore decided to pre-process the data, in order to define an average contamination per surface to be remediated, as well as an average spectrum. Eventually, only this data was inserted into the PLEIADES platform in the "bcot" database. Therefore, an average spectrum and a contamination per "Part" were to be remediated in this scenario.

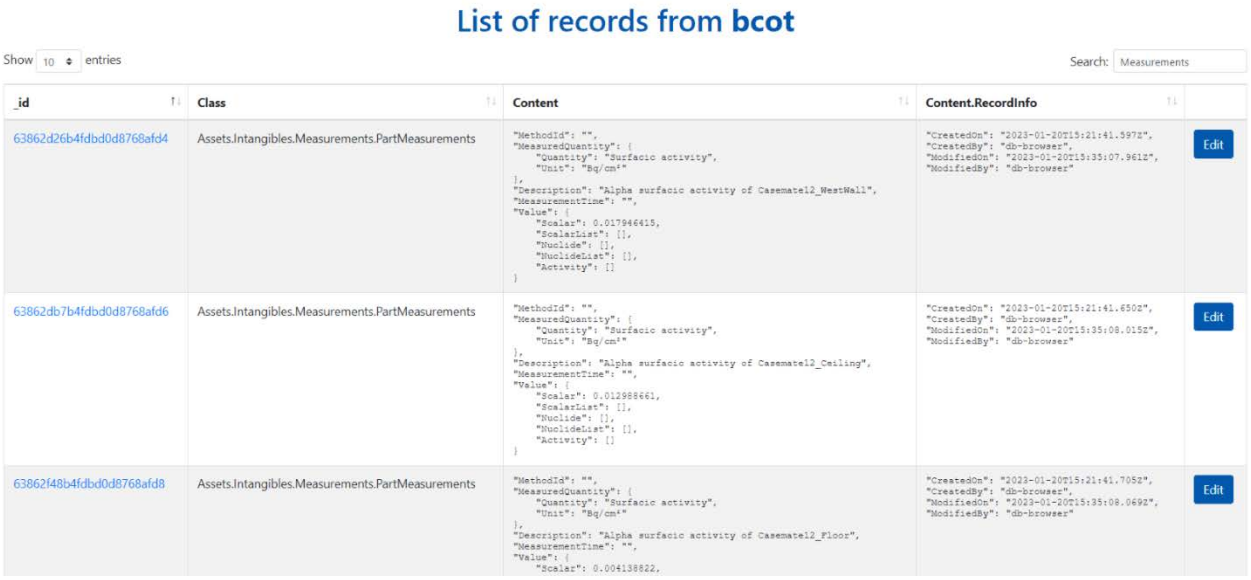

Figure 6: BCOT PLEIADES database, focus on CartesianMeasurements

From the many initial values to the average contaminations declared in the database. Thus, in summary, for radiological characterization data, there is an acknowledged need to cooperate with the end-user in order to retrieve only those measurements that are relevant to the radiological analysis that is to be performed.

3.2.4. Waste management data

This section addresses the data collection process for data related to waste management. The purpose of this section is to examine the data collection process and the factors that determine the process when dealing with waste management data.

In the context of waste management data, the input data are known to include, among other things, the criteria to be met at the level of the different waste types. In this respect, the challenge is that each country has its own specific characteristics. For instance, in Belgium, the criteria are not fully defined, as is the case for some packaging methods that have not yet been certified. Furthermore, as is recognized, it is necessary to be able to quantify the volume and mass of the material to be unloaded in order to make assessments. For this purpose, the existence of a 3D model can provide help, for instance by measuring the surfaces to be restored from the model. However, it is not necessarily sufficient to rely on the external 3D geometry of the external surfaces of the components and it is not easy to collect data from these geometries. In this case, we have to perform a non-automated inventory based on all available information, such as plans and specifications.

The feasibility and quality of the estimates of the waste produced depend on the correct declaration of the physical inventory of the 3D model, at least of the 3D objects that are dismantled. The second set of important data corresponds to the classification of the radiological waste produced and the definition of the packages to be used. In this respect as well, the PLEIADES platform provides a degree of standardization and clarification of the data required for this type of study. A finite number of classes and properties provide the data needed to estimate the waste produced. This holds for the following; the tasks that define the dismantled 3D objects, as in the "Tasks" class, the waste categories to be associated with each dismantled 3D object, as in Safety.Regulatory.WasteCategories, package types and their usage data, namely the "Wastes.PackageTypes", the radiological criteria to be met by the final package, namely the "Wastes.WasteAcceptanceCriterias", and the specific operations involved in producing a full waste package, as in the "Wastes.ManagementProcesses".

To conclude, European countries have specific rules governing the production, transport and storage of nuclear waste packages. It is therefore a real challenge to have a single platform for declaring the data required for nuclear waste studies in these different countries. However, due to the flexibility of the PLEIADES platform's waste-related data classes, this challenge has largely been met with PLEIADES. Nevertheless, it should be noted that studies carried out in other countries may indicate a possible lack of data or an inappropriate methodology, but in such a case data classes could be added or modified if necessary.

3.2.5. Cost-related data

This section addresses the data collection process for cost-related data. The purpose of this section is to examine the data collection process and the factors that determine the process when dealing with cost-related data.

Regarding cost-related data, it can be considered transversal within a project and possibly also between projects. They should be relatively easily reusable between different activities within the same project, such as human labor costs, resource costs and waste costs. However, costs can vary widely from country to country, both in terms of human costs and waste-related costs, given the different regulations in each country.

The cost data used for demonstrating the use of the PLEIADES platform were provided by the client of the project, which provided data of the labor costs, and through the connected tools that provided this functionality, such as DemPlus and AquilaCosting. However, it appeared that cost data was difficult to obtain for PLEIADES. The background for this was the sensitivity of the data. Cost data has been identified as being almost as sensitive as radiological data, if not more, for some decommissioning project managers.

Once the cost data had been obtained or produced in a hypothetical way to enable to execute the various user stories for the PLEIADES project, it was realized that some of the data were redundant. This was not necessarily a negative point, as it was possible to calculate the cost of use for certain specific items of equipment, such as electromechanical tools, in several different ways. Yet, the risk to be avoided was to double-count the cost of using this tool.

In addition, with regard to costs, it was recognized during the execution of user stories that it was difficult to define the limit for estimating the costs associated with the simulated operations, as shown in Figure 7 below. In fact, it can be concluded that it is not always clear whether the cost of decommissioning waste packages should be taken into account. Similarly, this applies to the operations carried out on the packages produced, such as concreting, transport, storage or incineration. One central aspect is the question of the cost for managing secondary or technological waste. Some of the tools connected to the PLEIADES platform calculated these costs natively for each operation simulated, while for others it may be necessary to add specific operations at the end of the phase to include the management of this waste, both for estimating the quantity of waste generated and for the overall cost of the operations.

Finally, it can be considered as worthwhile addressing the "duration of simulated operations" aspect when taking into account the costs. A misunderstanding can easily arise between productive hours, payable hours, the total duration of the project in working days, calendar days, among others. Feedback from the user stories in WP3 raised the question of clarifying the use of ratios, and in particular cost ratios, in order to provide a better framework for their use in the estimates made by the various tools connected to the platform. This requires future cooperation between stakeholders to enable further development.

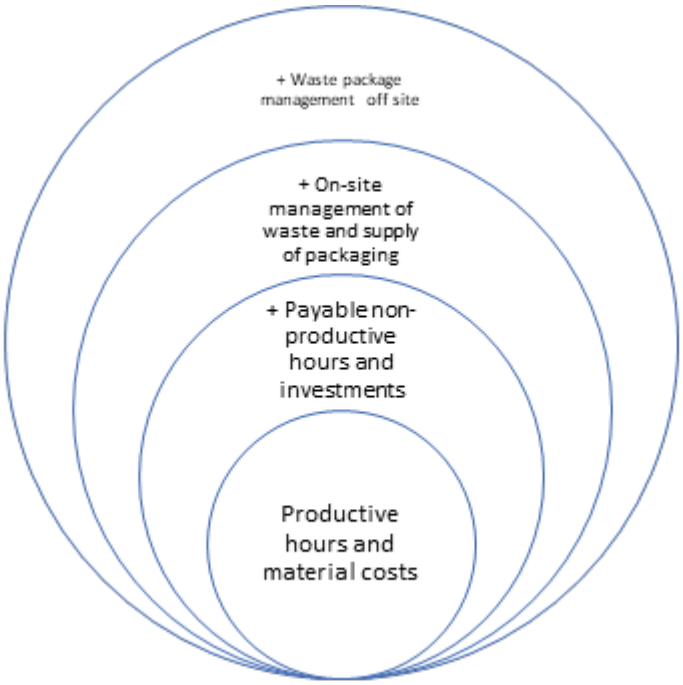

Figure 7: Illustration of the different possible perimeters for costing dismantling operations

3.2.6. Other data

This section addresses the data collection process for other data. The purpose of this section is to examine the data collection process and the factors that determine the process when dealing with other data. In this context, these other data types which are recognized are miscellaneous risks, project management data, human related data, and documentation.

Concerning the data collection process of the miscellaneous risks, they have been recognized as requiring hand encoding for identifying risks. This process has been identified to be able to make easier with the help of photos, scans, and 3D models gathered in the PLEIADES database that are complementary to on-site visits. Regarding the project management data, although it was not completely demonstrated withing PLEIADES, it has been recognized that synchronizing data between mainstream project manager application, such as Primavera and Microsoft Project, and tasks, schedules, resources in the PLEIADES database could be done. The data collection process of human related data followed the objective of collecting generic data on workers for the use cases and thus, very detailed data collection of workload management for all workers was not considered necessary. The documentation, which includes all the documentation that is referenced along the D&D activities, was identified as a very important data collection process, so that the availability of this documentation would be very important for assurance quality and independent review of the D&D processes. In the framework of the WP3 simulations, this aspect was slightly discussed through user story #5, yet as the simulations in WP3 concern mainly preparatory work, it did not need to go as far as collecting all the required documentation for review.

3.3. Evaluation of effort

This section presents an evaluation of the effort used to collect input data according to the PLEIADES evaluation interviews and questionnaire. The purpose of this section is to complement the previous data collection process section by reviewing the effort regarding input data collection in a broader context. Thus, the aim of this section is to create a holistic picture of the data collection process in conjunction with the previous section on data collection process.

Regarding the input data collection effort, the results obtained from the interviews and the questionnaire indicate that the PLEIADES data collection process involved effort, yet that the PLEIADES platform, compared to other similar tools, involved less manual data collection, simplified the management of various tools and data structures, and thus the effort involved was also lower. This has been justified, among other things, by the ease of use of the PLEIADES platform, the need for less preparation and assessment, and it being a more database centric method compared to other similar tools. Also, the MinIO repository was found to be a useful part of the data collection process in facilitating the storage and download phases of the data collection process, indicating that it reduced the effort involved in the data collection process.

In general, when evaluating the data collection process effort of the PLEIADES platform, the ability of PLEIADES to streamline communication between different applications and ensure that data adhered to predefined formats, making data exchange easier, has to be taken into account. The PLEIADES platform was able to provide data for its connected tools, but also to receive data from these tools, which demonstrates its multidimensional nature in the data collection process.

However, according to the results, the PLEIADES data collection process was not considered as unambiguous in terms of effort. Based on the results of the interviews and the questionnaire, the data collection challenge may be that not all data is structured in the way that is necessary for PLEIADES. It was recognized that effort is required for data validation, standardization, and ensuring data consistency. Also, it was identified that improvements are needed in certain areas, particularly in areas like data access policy, additional API classes, and functionality for risk management. Moreover, the present PLEIADES-comparable method would not be easily entirely replaced by PLEIADES, as there are doubts about the success of the data transfer from the present method to PLEIADES.

In the context of evaluating the effort used to collect input data according to the PLEIADES evaluation interviews and questionnaire, it can be concluded that the PLEIADES platform is considered as including less effort when comparing it to other similar tools. However, the results also indicate that PLEIADES data collection activities still require a lot of effort in terms of several aspects and in that improvements would be needed to reduce the effort.

4. Conclusions

This report on input data for decommissioning planning information models, as a two-fold deliverable, addresses the PLEIADES evaluation process, and describes the process and efforts involved in collecting the input data needed to perform the modelling and calculations presented in WP3. As part of WP4 purpose, which was to analyze and evaluate the results of WPs 1, 2 and 3, the purpose of deliverable 4.1 was to formalize the results of the evaluation. As intended, the deliverable 4.1 was the first part of the formalization of the evaluation outcome, which is followed by deliverable 4.2, a report on strengths, weaknesses and optimization of decommissioning planning information models, which formalizes the feedback on the approach proposed in PLEIADES.

The evaluation process of PLEAIDES, which was carried out through two research methods, a questionnaire, which followed a mixed research method combining quantitative and qualitative research methods, and interviews, which was a qualitative research method, were conducted in sequential order with the aim that the research methods would complement one another in order to achieve holistic results of the current state of the PLEIADES user experience. The research methods were addressed to the internal participants of the project, namely the project partners, which were both end-users and developers of the PLEIADES platform. The purpose of this was to build a holistic understanding of the current state of the PLEIADES user experience.

The evaluation of input data collection addressed the data collection process both at a general level by examining the PLEIADES data collection challenges at different phases, as well as according to data types, as in 3D models of the facilities, data related to ambient radiation in the premises, radiological characterization data, data related to waste management, cost-related data, and other data. In general, the results showed that the data collection process involved challenges. More specifically, the results indicate that it can be challenging to retrieve specific technical data for the installations. This was identified as being due to two possible reasons; either because the data were not in the format required by the PLEIADES database, in which case they had to be converted, or because the data were not available, in which case they had to be obtained from experts or produced on the basis of assumptions.

The evaluation of the data collection process by data type showed that there are differences in the data collection process and the effort required to collect data according to different data types. More specifically in terms of data types, it was identified that for the 3D models of the facilities data, even though 3D models are often not available for the nuclear facilities that are being decommissioned, it is nonetheless relatively easy to make 3D models today with current methods. It was also found that it is easy to collect data related to ambient radiation in premises, as, among other things, the connected tools of PLEIADES made it possible to convert measurements into mapping for the purposes of dose estimates, but there was still room for improvement in the collection of this data, as the process was not very automated. In turn, radiological characterization data was identified as very challenging to collect. Regarding waste management data collection, it was identified as a challenge that European countries have their own specific rules governing the production, transport and storage of nuclear waste packages, which was recognized to bring a certain amount of effort into the data collection process for this type of data. Cost-related data and other data were also not straightforward in terms of the data collection process. Especially for the former, the data collection process was challenged by the sensitivity of the data.

The evaluation of effort section addressed the effort of collecting input data according to the PLEIADES evaluation interviews and questionnaire. Thus, the aim was to complement the previous data collection process section by reviewing the effort regarding input data collection in a broader context. This section also showed that the PLEIADES data collection process involved effort, yet that the PLEIADES platform, compared to other similar tools, involved less manual data collection, simplified the management of various tools and data structures, and thus the effort involved was also lower. Based on the results of the interviews and the questionnaire, it was also central to recognize in this context that PLEIADES was perceived as a more data-centric method and that it enabled communication between different applications and ensured that data adhered to predefined formats, making data exchange easier.

In general, regarding PLEIADES input data collection and the effort involved, it can be defined that PLEIADES has taken, based on the results, one step closer to a lower effort. This is based on the results that PLEIADES has been identified as containing less effort compared to other similar tools, but still has been identified as having room for improvement in multiple aspects. As mentioned previously, for PLEIADES, an option has been identified to improve the data collection process and reduce the effort involved, by developing the tools connected to PLEIADES. In terms of the data collection process and the effort involved, the connected tools could be improved by increasing automation and by developing a new functionality that would allow the data to be transformed into a suitable format for the PLEIADES platform, among other things. This would require future cooperation between stakeholders to enable further development and improvement of PLEIADES input data collection.

5. References

Creswell, J. W. (2003). RESEARCH DESIGN.