From Metadata to Meaning: Applying AI in the National Library of Estonia

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Abstract The National Library of Estonia (NLE) plays, defined by its legal framework, a dual role on the one side as a National and on the other side as a Parliamentary Library, uniquely integrating these functions to preserve Estonia's cultural and digital heritage. NLE was founded in 1918 and supports the development of all Estonian libraries. Furthermore, it leads research in the humanities and social sciences and is a hub for library and information science innovation. With 250 staff members and a budget of EUR 33.39 million, the NLE advances nationwide e-services and professional training for librarians. In 2019, the NLE launched two AI-driven projects, "Automatic Indexing" and "Ask Us". As automated and AI-driven services becoming more and more important, the idea was to address challenges in manual processes and improve user services. The Automatic Indexing project develops machine learning and AI to streamline publication tagging, enhancing accuracy, consistency, and efficiency while reducing costs. Ask Us, part of Estonia's "Bürokratt" initiative, integrates generic building blocks and chatbot technology to improve accessibility to library services. Both projects concluded in 2023, delivering prototypes and reusable technical components. During the project phase, NLE faced several challenges, including staff scepticism towards AI and adapting IT governance. Staff engagement through regular updates, workshops, and collaborative testing built the basis for acceptance and trust. All initiatives emphasise the commitment to implementing technology for library modernisation and, at the same time, preserving Estonia's linguistic and cultural identity.

Keywords Estonia · National Library · Artificial Intelligence · AI · Chatbot · Automated Indexing · Eesti Rahvusraamatukogu · Digital Transformation · e-Government · Sustainability

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1 Introduction

The Estonian National Library (Estonian: Eesti Rahvusraamatukogu) is a national public institution in Estonia that operates according to the National Library of Estonia Act. The National Library of Estonia (NLE) was initially established on December 21, 1918, as the Parliamentary Library of Estonia. The NLE employs about 250 staff members and operates with a total budget of € 33.39 million, which includes allocations for its e-library (€ 232,000), e-rental solutions (€ 115,000), and ICT costs (€ 1.01 million) [1].

Today, it continues serving as a parliamentary library and national cultural hub. The NLE plays a vital role in preserving the nation's digital heritage, overseeing the Estonian Web Archive to collect and store Web pages significant to Estonia's society and cultural history.

As a centre of excellence, it supports the development of libraries nationwide by offering centralised e-services, collecting library statistics, coordinating field-specific terminology, and providing professional training for librarians. Its research focus lies in the humanities and social sciences, and it leads library and information science development through standardisation and terminology efforts. One of the interviewees said: "*I think libraries are in a really good position for AI because we have been working for many years with structured, high-quality data. But cataloguing is extremely labour-intensive. AI can help by automating metadata tagging for books, newspapers, and other publications.*"

In 2019, NLE initiated two artificial intelligence-driven projects: Automatic Indexing and the Chatbot service *Ask Us*. Both projects resulted 2023 in prototypes and provided reusable (technical) components. The Automatic Indexing system has achieved significant milestones, with plans to implement the service soon. Meanwhile, the Ask Us service will be enhanced with a chat function and a virtual assistant to streamline user interactions. Within the two projects, a prototype and reusable technical components were developed. The maturity levels are major milestones accomplished (*Automatic Indexing*). In the coming months, the complete version is planned to be implemented. The full version will consist of a chat function and a robot for the NLE (*Ask Us*).

2 Description of the Project

The Estonian government has developed a predominant strategy for using AI as a service or solution for the different departments. The so-called AI "Kratt" strategy, adopted by the government in July 2019, seeks to boost the take-up of AI in both the private and public sectors [1]. The implementation of AI and the initiation of the project are integral parts of the government's general approach. It is foreseen, if possible, to use AI for all aspects of public services. One interviewee said: "*I think a big driver is actually the like Estonian government; General, kind of progressive thinking in this area.*"

The NLE became part of the national AI initiative, which was also caused by the substantial amount of data that is building a sound basis for the development and training of AI. An interviewee explained: "*I think libraries are in a really good position for AI because we have been working for many years with structured, high-quality data. But cataloguing is extremely labour-intensive. AI can help by automating metadata tagging for books, newspapers, and other publications.*"

The NLE uses two parts of the project: the Chatbot and the automated indexing project.

The "Ask Us" Chatbot Project

The "Ask Us" project is part of the Estonian government's overarching "Bürokratt" project [2]. The central approach is to create a solution that will serve as a central Chatbot model for all government institutions. Bürokratt is an interoperable network of Chatbots on the Web sites of public authorities that allows people to obtain automated information from these authorities through a chat window [3]. This approach aims to prevent redundant developments and allows easy customisation to meet the various needs of the different departments and agencies, e.g. the NLE. To enhance the value, Bürokratt provides a single point of access to information for individuals and officials. The extensibility and future expansion of the Bürokratt network to other organisations is paramount. An interviewee explained: "The Chatbot is part of a broader national AI strategy. It can handle general inquiries and even redirect users to different government agencies. This ensures users get accurate information 24/7 without needing human intervention."

Bürokratt is a horizontal project that does not focus on only one organisation; it uses a distributed design, where the different Chatbots used by the agencies are independently developed but interconnected, based on generic technical building blocks provided to various government organisations. An interviewee said: "We are developing a network of Chatbots across public institutions in Estonia. The idea is that a user can ask one Chatbot a question, and if it is not library-related, it will redirect to another relevant Chatbot within the system." The information provided by the Chatbot is generated via the Automatic Indexing project and staff members of the NLE. The case illustration will focus mainly on the Automatic Indexing project.

Automatic Indexing Project

One of the main tasks of the National Library is the collection, long-term preservation, and accessibility of all publications published in Estonia and their registration in the database of the Estonian National Bibliography (ERB). The database ERB registers data about national publications. National publications include all publications published in Estonia in all languages and publications published abroad in Estonia, including works by Estonian authors and their translations, regardless of their physical format (paper, electronic). The principles for compiling ERB are defined in the document "Principles of National Bibliography Compilation".

The publications in the NLE collections are described and tagged manually. To achieve this, experts inside NLE review each publication and allocate tags to the content. The allocation is based on the beliefs of the staff members and what they

think accurately reflects its content. This process does not utilise artificial intelligence or algorithms. Consequently, there are several concerns:

1. Tags created by the employees may not always be the most suitable or logical from the user's perspective.
2. This methodology may not consistently produce the most objective and accurate results.
3. Tagging in this manner is highly resource-intensive for the library (i.e. the state).
4. Ensuring consistent tagging for all publications on the same topic is challenging.

2.1 Need(s) Behind the Implementation

Tagging items is a labour-intensive and time-consuming task that demands significant personnel resources not only in the National Library of Estonia (NLE). The whole process heavily depends on the knowledge and judgments of the individual librarians or information specialists responsible for selecting tags, which can result in inconsistencies in the tags assigned to other editions of the same publication. Because tagging has so far been a predominantly manual job, the potential for human error and subjective interpretation is high, leading to variability in the quality and accuracy of the tags. The lack of standardisation can create challenges for users of NLE who rely on tags created by the librarians to find information, as inconsistent tagging can make it difficult to retrieve specific information.

Besides that, the manual nature of the tagging process can be time-consuming and costly. Organisations like NLE must invest in training personnel to continuously ensure they have the expertise to tag items accurately. Even with training, the subjective nature of tagging means that discrepancies are almost inevitable. To address these challenges, NLE decided to explore automated tagging systems that utilise AI and machine learning. The NLE has a solid starting point for AI projects. It preserves a considerable amount of data. An interviewee explained: "*The National Library has a legal deposit obligation, meaning we collect all published books and documents in Estonia. This makes us a natural hub for AI-driven language processing and indexing.*" The different components that are under construction can analyse the content of regular books or handwritten text. They can generate text based on the analysed content. This is leading to greater consistency and increased efficiency. However, even if the results of the automated indexing reach, in general, a higher quality, human experts' supervision is necessary to ensure consistency and, at all times, the same level of quality.

The project aimed to develop a prototype that applies machine learning and AI to automate publication content analysis and tagging. During the project, it was recognised that it is relevant if the subject to be tagged is a book or, e.g. a newspaper article. An interviewee explained: "*We developed two AI prototypes: one for automated subject indexing of books and another for newspaper articles. Books worked well because they contain rich content, but short articles were more challenging due to the different methodologies used by librarians versus AI.*"

NLE has developed a multi-modal AI that includes components of subject indexing with meta-tagging and content indexing, plus OCR and meta-tagging. Essential aspects of the project were the support of the Estonian language by reusable technologies independent from large tech companies, the reduction of costs, the enhancement of processes, and ensuring the consistency of metatags. One expert stated, "*This is not one specific solution, but it's composed of about a dozen different modules. We want to make these components publicly accessible as open-source software.*"

Furthermore, by implementing machine learning and AI, the prototype will be able to analyse publications' content automatically [4] and generate relevant tags simultaneously. This will significantly reduce the required (manual) effort, lowering the tagging process's expenses. Besides that, the automation of processes will expedite the tagging, allowing faster management and increased availability of tagged publications. One interviewee said: "*The AI tool analyses books and other publications, extracts metadata, and suggests subject tags. Librarians then validate and refine them. This hybrid approach ensures accuracy while reducing workload.*"

One interviewee emphasised that automated systems can apply standardised criteria uniformly, reducing the variability and subjectivity inherent in manual tagging. This consistency will ensure that all publications on similar topics are tagged coherently and allow for better searchability and organisation.

Furthermore, the project had the additional goal to contribute to developing technologies supporting the Estonian language. By creating sophisticated AI tools customised explicitly to the Estonian language, another task was to promote the growth and refinement of linguistic resources and technologies specific to Estonia. This will benefit the library and support broader applications in other fields requiring advanced language processing capabilities.

The project aims to conduct a comprehensive analysis and develop a prototype and solution capable of analysing and automatically tagging the content of a publication when the full text is available.

The project is separated into two main phases:

1. **Detailed Analysis Report**: The first phase starts with an in-depth analysis of the methods and tools used to analyse the content and tagging. The assessment will highlight the strengths and limitations of the existing system, on the one hand, and, on the other hand, it is foreseen to identify the requirements and the prerequisites for augmentation. Furthermore, the technical specifications for the prototype will be outlined. The report also includes an evaluation of the potential impact of automated meta-tagging on the different workflows, efficiency, resource allocation, and accuracy. Additionally, it will explore the integration of Estonian language technologies to ensure the prototype is tailored to the linguistic nuances of Estonian publications.
2. **Prototype Development**: This second phase will be built on the results of the first phase and the detailed analysis, and it will focus on creating a functional prototype. The prototype will include machine learning systems and AI algorithms for an automated analysis and meta-tagging. It handles various publication types and ensures tags are accurate and consistent. The development process

included iterative testing and refinement to address any challenges identified during initial trials. The ultimate goal is to produce a robust and scalable solution seamlessly integrated into the library's digital infrastructure.

2.2 Actors Involved

Numerous individuals are involved in the AI projects at the National Library NLE. These include the head of development at the NLE, who also oversees other public libraries in Estonia, and internal and external project managers for the two AI projects. Additionally, internal and external experts with experience in artificial intelligence, data management personnel, development team members, and the individuals currently performing the tasks that are slated for automation all play crucial roles in these projects. The following description of co-creation types indicates the level of collaboration and involvement from various stakeholders in each phase based on the phases described by Mergel et al. [5] (Table 1).

2.2.1 Organisational Level

The National Government sets the general AI strategy and provides funding and policy direction for AI adoption in public institutions, including libraries. Within the National Library of Estonia (NLE), the Head of Library Services Development is responsible for implementing AI-related components within the institution. It also has the task to oversee the AI-related developments and ensure the reusability in other public libraries in Estonia, and the alignment with national strategies. The Data Science and Digital Humanities Team, led by the library's sole data scientist, plays a key role in the technical implementation of AI. These people are responsible for the machine learning models, data structuring, and metadata extraction, collaborating with external IT developers to refine AI tools. Librarians and cataloguers are actively involved in training, validating, and improving AI-generated metadata. Their involvement shall ensure that the AI-based indexing will be aligned with traditional cataloguing methodologies and provide real-world feedback to developers. The IT and Infrastructure Team supports AI integration into the library's digital infrastructure, ensuring data security, storage, and system scalability. Finally, Library Leadership and Policy Makers must see beyond the borders and ensure the long-term AI strategy, securing funding, managing ethical concerns, and ensuring AI aligns with the library's mission of preserving and providing access to Estonian cultural heritage.

2.2.2 External Actors

In the different AI projects, two private companies, TEXTA OÜ and Net Group OÜ, are involved as external vendors. These companies are responsible for developing AI prototypes and reusable technical components to automate subject indexing,

Table 1 Co-production process in the Automatic Indexing project at the NLE

Phase	Co-production type	Description
Co-initiation	Prospective co-production phase	The National Library of Estonia identified the need for AI in cataloguing and subject indexing. The initiative was internally proposed by the library's leadership, data scientists, and librarians, and supported by the Estonian government and funding bodies. External IT firms and universities were approached to explore AI feasibility
Co-design	Concurrent co-production phase	A prototype was developed, integrating machine learning models for subject indexing. Collaboration included library staff, data scientists, IT companies, and academic researchers. External AI developers provided expertise in OCR, NLP, and metadata extraction, while librarians trained AI models with existing catalogue data
Co-implementation	Concurrent co-production phase	The AI system was deployed in a pilot phase, tested by librarians and IT teams. External AI developers worked on fine-tuning models, while cataloguers validated the AI-generated metadata. Continuous testing occurred with feedback loops between users, developers, and researchers to improve accuracy
Co-use/production moment	Concurrent co-production phase	AI tools are now used for metadata extraction, subject indexing, and cataloguing. Librarians oversee AI results, correct errors, and refine models. The system is accessible to multiple Estonian libraries, enabling broader adoption. Open-source modules support external researchers
Co-evaluation	Retrospective co-production phase	AI tools are evaluated based on librarian feedback, user acceptance, and indexing accuracy. Formal assessments involve research institutions, government agencies, and external experts. Continuous improvements focus on reducing biases, increasing training data, and enhancing AI-human collaboration

metadata extraction, and cataloguing. Aside from these IT vendors, the National Library of Estonia (NLE) collaborates with academic institutions, such as the University of Tartu and Tallinn University. These institutions contribute linguistic expertise and research in natural language processing (NLP) to enhance AI's ability to process Estonian-language texts. Other Estonian public and academic libraries, including the University of Tartu Library and the Estonian Literary Museum, participate in testing and implementing AI solutions. They help refine models to ensure AI-driven cataloguing works effectively across different institutions. At the European level, NLE engages with Nordic national libraries, particularly Finland and Norway, to exchange best practices, open-source AI tools (e.g., Annif), and research on AI-driven library solutions. Finally, the Estonian government and funding bodies support AI projects by providing financial resources and ensuring alignment with the national AI strategy. They promote the adoption of AI in public institutions while addressing ethical, legal, and data security concerns.

2.3 Challenges

IT regulation was a significant challenge in AI implementation, especially in 2019. Since 2018, the National Library of Estonia (NLE) has outsourced IT services and project development to the Information Technology Centre for the Ministry of Finance. However, after assessing service needs, it was decided that the library should regain control over IT development while the IT Centre continued workplace maintenance. This led to the re-establishment of NLE's IT Department to provide greater flexibility, also in the AI projects.

Besides that, librarians of NLE are described as people who often worry that implementing new technologies will render their jobs obsolete. There's a concern about what their future roles will be. One interviewee said: "*Many librarians are set in their ways and not very open-minded about change.*" It takes time to bring in new, younger, and more flexible people who understand the value of these innovations. Initially, it can be challenging to create a shared understanding of what AI is doing in the library and what the librarian's role will be, especially with things like automatic cataloguing or coding examples. This also has an impact on the development of AI solutions, as AI cannot self-learn new subject terms and needs continuous librarian input.

However, the users and patrons of the NLE are described as very open-minded. They are eager to use the new technologies. For example, university students and other customers are thrilled to have API access to NLE data or scientific books. They are very supportive and provide valuable feedback about improving and moving forward with projects. Therefore, the support of staff members is essential. An interviewee explained: "*AI can index already known words using existing ontologies. But it cannot recognise or add completely new subject terms, that still requires human input.*"

Further challenges are data quality issues and AI accuracy caused by limited Estonian-language datasets. They hinder OCR and metadata extraction and require constant human validation. Additionally, ethical and legal concerns limit AI's scope, which is mainly based on data privacy and copyright restrictions.

In general, AI development requires high investment and specialised personnel, which NLE fights to attract. Because of the lack of internal IT specialists, AI tools depend on external developers, which creates a risk to long-term sustainability.

Addressing these challenges requires investment, collaboration, and training to ensure AI supports, rather than replaces, human expertise.

3 Results

The implementation and prototyping of the solution have created different kinds of impact. The results influence various levels inside the NLE. It also widens the role of the NLE from an organisation that stores information and provides data. One interviewee explained: "*Libraries are transitioning from just being book*

repositories to becoming data providers. AI helps us systematise and structure this data for wider reuse."

3.1 Organisational Level

The National Library of Estonia (NLE) aims to increase efficiency and accuracy through AI-driven metadata extraction, subject indexing, and cataloguing [6]. AI automates labour-intensive tasks, reducing the cataloguing time from manual efforts to near-instant processing. As a result, this will not only lower the costs, it will also expand accessibility by enabling the cataloguing of previously unprocessed materials such as Web archives, PDFs, and news articles. By leveraging machine learning models and OCR, AI improves metadata consistency, though human oversight remains essential to correct errors and refine outputs. Additionally, AI makes large-scale data processing feasible and will support researchers by providing structured linguistic and cultural analysis datasets.

To stay updated on AI advancements and best practices, NLE relies on internal knowledge sharing and participation in conferences and collaborations. Employees attend AI and library technology conferences, after which insights are disseminated through internal newsletters, workshops, and briefings. Digital humanists and data scientists share findings in short presentations or written reports in the library's internal weekly updates. The collaboration with especially the Nordic but also the European libraries provides valuable knowledge on AI tools and methodologies, e.g. Finland's Annif [7] for automated subject indexing. This ensures that NLE remains aligned with global AI trends in library science while fostering internal capacity-building.

To overcome scepticism, it is vital to keep the people who are not working on a day-to-day basis in the project informed and involved. In the NLE case, the project's responsible people ensure regular communication and updates. NLE publishes an in-house newsletter highlighting the week's news and developments every Friday. This helps keep all staff members informed about what's happening in the IT field.

3.2 Value Created and Co-created

The implementation of the AI solution created different kinds of values and results. First, it has reduced the time to catalogue per item from 30 to 45 min to a nearly instantaneous metadata generation. In parallel, it has changed and enriched the work of the staff members. They became responsible for reviewing the outcomes of the AI work and ensuring quality while enabling scalability. An interviewee explained, "*We're not trying to fully automate cataloguing. The goal is to widen the bottleneck—librarians use AI-generated suggestions and then validate or correct them.*" Furthermore, the automation of tagging improves discoverability and standardisation across publications. It also created the necessary resources for

processing materials like Web archives, PDFs, and historical newspapers that were previously unindexed due to resource constraints. One interviewee said, "*AI improves accessibility by making previously unindexed documents searchable. This helps both researchers and the general public find relevant materials more efficiently.*"

The development and piloting process was accompanied by various internal and external stakeholders, e.g. librarians, IT vendors, researchers, and users. They collaborate across the different phases, from prototype to implementation. University students and researchers' feedback helps to refine the results.

3.3 Lesson Learned

It was reported that the employees of the NLE have a low level of trust in AI solutions. Therefore, keeping them informed about ongoing developments is crucial to build confidence and transparency. NLE also conducts workshops, and whenever someone attends a conference, whether in-house or external, they share their insights with the team upon their return. This might be through a brief 15-min talk or by writing a short article for the NLE newsletter. One interviewee explained: "*In our case, if we are doing something, then we have every Friday going out, it's like in-house newspaper when we are saying out what is this week's news. We are communicating to all librarians what's happening in this field. Of course, we have this, as I already mentioned, we have three digital humanists working in library. They are sharing their knowledge, making some workshops here. Also, when some conference will be enhanced in-house or outside, they are coming back and then they are sharing their knowledge. If somebody wants to know something about it, they are making very, very quick let's say ten or fifteen minutes speak [of] what they heard and sometimes even small article to our everyday newspaper.*" This way, NLE keeps everyone updated, involved, and informed about the latest developments and advancements. The development of AI solutions should be carried out meticulously to ensure success and trust.

First, the process should start with a thorough analysis of the state of play of the methods and tools used for the services and by the staff in the library. This analysis will help to identify different areas for improvement and help to create a solid foundation for AI implementation.

Second, the focus should shift to the prototype. A functional prototype will serve as a proof of concept. It demonstrates the potential benefits and allows addressing possible employee concerns. The case of the NLE has highlighted the importance of involving the staff during this phase. The gathering of feedback is the basis for necessary adjustments and the alignment of the solution with needs and expectations. Another aspect is the preservation of the Estonian language. One interviewee explained: "*If we don't have AI tools that understand Estonian, we risk our language becoming less relevant in the digital world. The National Library plays a key role in preserving digital Estonian heritage.*"

Once the prototype has been refined and thoroughly tested, the final step is to move it into production. This phase should only proceed when the AI solution works reliably and effectively. Continuous monitoring and support will be necessary to ensure smooth integration and address any issues that may arise.

4 Conclusions

The National Library of Estonia (NLE) has demonstrated a forward-thinking approach by integrating modern AI technologies into its operations, focusing on enhancing efficiency and supporting digital transformation.

Projects such as "Ask Us" and especially "Automatic Indexing" are on the one hand contributing to the commitment to modernising the services of the NLE while addressing challenges in manual processes, resource allocation, and technological adoption. On the other hand, these initiatives allow to streamline the library's internal workflows and also deliver the opportunity to position NLE as one of the leading National Libraries in leveraging AI within the public sector. Moreover, by contributing to developing Estonian language technologies, NLE is pivotal in advancing linguistic resources and tools for broader applications and ensuring independence from global software companies, especially for minor languages.

Implementing these projects underscores the importance of balancing innovation with stakeholder engagement, e.g. via co-creation activities. In parallel to the implementation, challenges, e.g. the need to involve further (technical) experts and the scepticism of the employee on the integration of AI into traditional workflows, have emerged. NLE's focus on transparent communication and continuous training has fostered trust and collaboration among its staff. The employment of additional staff, the involvement of external experts, and the cooperation with companies have on the one side strengthened the library's technical capabilities and on the other side ensuring the development of robust, scalable, and re-usable solutions.

Looking ahead, the successful implementation of these AI-driven projects has the potential to provide a sound foundation for NLE to expand its technological ambitions. The full deployment and integration of the AI-based solutions in the services of the NLE will increase user accessibility, reduce operational costs, and improve service quality. Additionally, these advancements pave the way for NLE to explore further AI applications, such as personalised recommendations and advanced data analytics, to meet evolving user expectations and establish the National Library as a data provider.

Digital transformation is continuously reshaping the role of libraries globally, and NLE is well-positioned to lead by example. To summarise, prioritising innovation, fostering collaboration, and addressing the human aspect of technological change in a National Library can ensure the relevance of the library as a cultural and technological cornerstone in the national digital infrastructure.

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Appendix

See Table 2.

Table 2 Overview of the AI projects at the NLE

Case and project name			
Automatic Indexing and enquiry answering service Ask Us			
Country	**Number of employees**	**Type of AI solution**	**Year and maturity level**
Estonia	250	Multi-modal AI including components of subject indexing with meta-tagging and content indexing + OCR and meta-tagging	2023/ Prototype and major milestones accomplished
Project description			
The goal is to develop a prototype utilising machine learning and AI to automate publication content analysis and tagging			
Need(s) behind implementation	**Actors involved**	**Challenges**	
Tagging items is a labour-intensive task that demands significant resources. This process relies heavily on the knowledge and judgments of individual taggers. Additionally, the manual nature of tagging can be time-consuming and costly	Head of development at the NLE, internal and external project managers, experts with experience in AI, data management personnel, development team members, customers, and vendors	It is vital to keep the people who are not working on a day-to-day basis in the project informed and involved	
Results			
Organisational level	**Value created and co-created**	**Lesson learned**	
The project is coordinated by the Head of Library Services Center and his team. It is supported by the Estonian government and part of the overarching AI strategy	• The users and patrons are described as very open-minded. They are eager to use the new technologies. They are very supportive and provide valuable feedback on improving and moving forward • It can be challenging to grasp what AI is doing in the library and what the librarian's role will be, especially with things like automatic cataloguing or coding examples	It was reported that the employees of the NLE have a low level of trust in AI solutions. Therefore, keeping them informed about ongoing developments is crucial to build confidence and transparency in the process. Furthermore, it is important to do it step by step: • Detailed analysis • Prototyping • Production (this phase should only proceed when the AI solution works reliably and effectively)	

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