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Digitizing Cultural Legacy: Standardization and Preservation of Historical Heritage in Finland

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Tiivistelmä

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Tämä opinnäytetyö tarkastelee kulttuuriperinnön digitointia Suomessa, keskittyen standardointiin ja säilyttämisen haasteisiin. Tutkimus hyödyntää tapaustutkimusta yhteistyössä Tietoa Oy:n ja Museoviraston kanssa.

Tutkimus syventyy kulttuuriperinnön digitoinnin ohjaaviin periaatteisiin, korostaen esinevalintaa, säilyttämisen näkökohtia ja teknologian kehityksen vaikutusta. Analyyttinen tarkastelu digitointiprojekteista, erityisesti taiteilija koti Ainola-projektista, paljastaa laitteiden, teknologian ja menetelmien kehityksen vaikutukset digitaalisten mallien laatuun.

Osana jatkuvaa keskustelua tämä opinnäytetyö pyrkii tarjoamaan hienovaraisen näkemyksen standardoinnin haasteisiin kulttuuriperinnön digitalisoinnissa, tarjoten näkökulman, joka mukautuu alati muuttuviin vaatimuksiin alalla.

Avainsanat: Digitizing, 3D digitizing, cultural heritage, preservation,
                        standardization, laser scanning, photogrammetry, point
                        cloud, archiving.

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Abstract

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This thesis navigates the complex landscape of cultural heritage digitization in Finland, focusing on standardization and preservation challenges. Examining technological advancements and industry collaborations, the research adopts a case study approach, partnering with Tietoa Oy and the Finnish Heritage Agency.

The study explores the guiding principles for cultural heritage digitization, emphasizing the importance of site selection, preservation considerations, and the impact of technology development. An analysis of digitization projects, particularly the Ainola Artist Homes, reveals the evolving influence of equipment, technology, and techniques on digital model fidelity.

As a contribution to the ongoing discourse, this thesis aims to provide nuanced insights into the challenges of standardization in cultural heritage digitization, offering a perspective that aligns with the ever-changing demands of the field.

Keywords:	Digitizing, 3D digitizing, cultural heritage, preservation, standardization, laser scanning, photogrammetry, point cloud, archiving.

Acknowledgement

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1 Introduction

In the dynamic realm of cultural heritage digitization, the intersection of technological advancements, standardized methodologies, and collaborative initiatives forms a dynamic overall picture. This thesis delves into the intricacies of digitizing cultural legacy, with a specific focus on the architectural heritage of Finland. With a commitment to standardization and preservation, the research navigates the multifaceted challenges and opportunities embedded in the digital preservation of historical artifacts.

Framed within the context of the digitization of Ainola Artist Homes, this study conducts a comparative analysis of digital models and point cloud data produced in 2013 and 2023. The examination revolves around the impact of evolving equipment, technology, and techniques on the fidelity and quality of digital representations.

Collaborative efforts with industry stakeholders, particularly Tietoa Oy and The Finnish Heritage Agency, underscore the practical application of theoretical frameworks. Expert interviews, including perspectives from Jaakko Hauru of Tietoa Finland Oy and Specialist Designer Tuuli Ahlholm from The Finnish Heritage Agency, contribute invaluable insights into the current state and future trajectories of cultural heritage digitization in Finland.

As the digital preservation landscape in Finland undergoes continuous transformation, this thesis aims to unravel key principles and guiding recommendations for effective digitization, setting a foundation for future endeavors in preserving the rich cultural tapestry of the nationwide digitally.

2 Literature Overview

In this section, the topic explores the concept of digital preservation within the context of cultural heritage and drawing from prominent EU-based research journals and articles, while examining the evolving methodologies and best practices in digitizing cultural heritage materials. While acknowledging the scarcity of Finnish-specific literature on the topic, some EU frameworks can provide invaluable insight into a comprehensive understanding of the critical challenges and advancements in the field.

2.1 Digital Preservation and Cultural Heritage

According to UNESCO (2009), heritage encompasses the legacy from our past, our present reality, and what we transmit to future generations. It represents something of value that is intended to be passed down through the ages.

Cultural heritage pertains to sites, objects, and intangible aspects that hold cultural, historical, aesthetic, archaeological, scientific, ethnological, or anthropological significance for both communities and individuals. Similarly, the concept of natural heritage relates to physical, biological, and geological characteristics, including the habitats of plant and animal species, and areas of scientific or aesthetic importance, as well as those crucial for conservation purposes.

The interpretation of heritage must consider its context. UNESCO (2009), for instance, defines world heritage as encompassing sites of exceptional cultural and natural significance that merit preservation. Similarly, numerous national and state bodies establish their own definitions of heritage at various levels. However, the value of heritage can also be rooted in its significance to specific groups or communities. In practice, heritage materials often extend beyond the boundaries set by national laws or global agreements. Anything deemed

important enough to be passed down to future generations holds some form of heritage value (UNESCO, 2009).

Preserving cultural heritage entails safeguarding artifacts and traditions from factors that seek to alter or wear them down. Typical endeavors include the restoration of historical structures, the continuation of time-honored crafts, and the documentation of customary narratives. Digital heritage transcends temporal, geographical, cultural, and format boundaries, making it culture-specific while potentially available to individuals worldwide (UNESCO 2009). This allows minority voices to communicate with majorities and individuals to engage with a global audience.

It is imperative to preserve and provide accessibility to the digital heritage of all regions, nations, and communities, ensuring the representation of diverse peoples, cultures, and languages over time (UNESCO 2003).

Digital preservation within the context of architectural and structural heritage involves the systematic and strategic application of techniques and processes to safeguard and maintain digital representations of architectural and structural artifacts for future generations. This preservation practice aims to ensure the longevity, accessibility, and integrity of digital resources related to architectural and structural heritage. By employing digital preservation methods, institutions and organizations can mitigate the risks of data loss, technological obsolescence, and deterioration associated with digital materials, thereby guaranteeing the continued accessibility and usability of these resources for scholarly research, educational purposes, and public engagement (Discover Digital Libraries, 2016).

Academically, digital preservation in the domain of architectural heritage encompasses a multidisciplinary approach that integrates principles from archival science, information technology, conservation, and cultural heritage management. It involves the implementation of standardized protocols for the creation, management, and storage of digital assets, including architectural

designs, blueprints, construction plans, photographs, and historical documentation. Moreover, this practice necessitates the use of advanced digital technologies, metadata standards, and archival strategies to ensure the authenticity, reliability, and long-term sustainability of digital representations of architectural and structural heritage.

The initial stage of the comprehensive documentation process for objects and monuments within cultural heritage involves 3D digitization. This process encompasses various procedures and demonstrates variations depending on specific application requirements. Given the intricate digitization needs inherent to the diverse array of objects, an array of methods and technologies has been developed. Each technique aims to effectively capture a particular type of object or category of monuments, meeting the specific demands of digital recording projects, such as comprehensive archiving or presentation purposes. The availability of numerous 3D digitization systems can be attributed to three primary factors influencing the suitability and adaptability of a method: the complexity in size and shape, the morphological intricacy (level of detail), and the diversity of raw materials. Consequently, specialized techniques cater to microscopic, small, medium, and large objects, as well as monuments and structures. Furthermore, distinct techniques are available for handling ceramic, metallic, and glass objects. It is imperative to acknowledge that certain techniques yield satisfactory outcomes for specific object categories. (Methods for 3D digitization of Cultural Heritage 2007).

2.2 Standardization Efforts in Cultural Heritage Digitization

Emphasizing the critical nature of standardized protocols, best practices, and metadata schemas, this chapter sheds light on their profound impact on the preservation, accessibility, and scholarly exploration of the varied cultural heritage resources across Europe. Moreover, it aspires to distill valuable insights from these commendable initiatives, seeking their practical application within the specific context of digitizing the cultural heritage of Finland.

In the realm of contemporary preservation practices, the digitization of cultural heritage emerges as a pivotal aspect, demanding the precise application of standardized methodologies and frameworks. This ensures the effective conservation and accessibility of a myriad of cultural artifacts and historical materials. A notable exemplar in this pursuit is Europeana, a leading digital platform that exemplifies a scholarly commitment to standardization, primarily through the adoption of the Europeana Data Model (EDM) (Europeana Pro, 2023). Through the seamless integration of this standardized metadata framework, Europeana has facilitated the aggregation, retrieval, and cross-referencing of data (photo 1). This, in turn, empowers comprehensive exploration and analysis of cultural heritage collections spanning the European landscape.

A noteworthy contributor to the field is the 3D-ICONS Project, generously funded by the European Commission. This project has made significant strides by concentrating on the formulation of best practices specifically tailored for the three-dimensional (3D) digitization of cultural heritage objects and sites. The establishment of standardized protocols for the entire process, from capturing to processing and disseminating 3D cultural heritage data, has resulted in a unified framework. This framework ensures the preservation and accessibility of 3D heritage artifacts, fostering innovative research and educational experiences for a global audience (Europeana Pro, 2023).
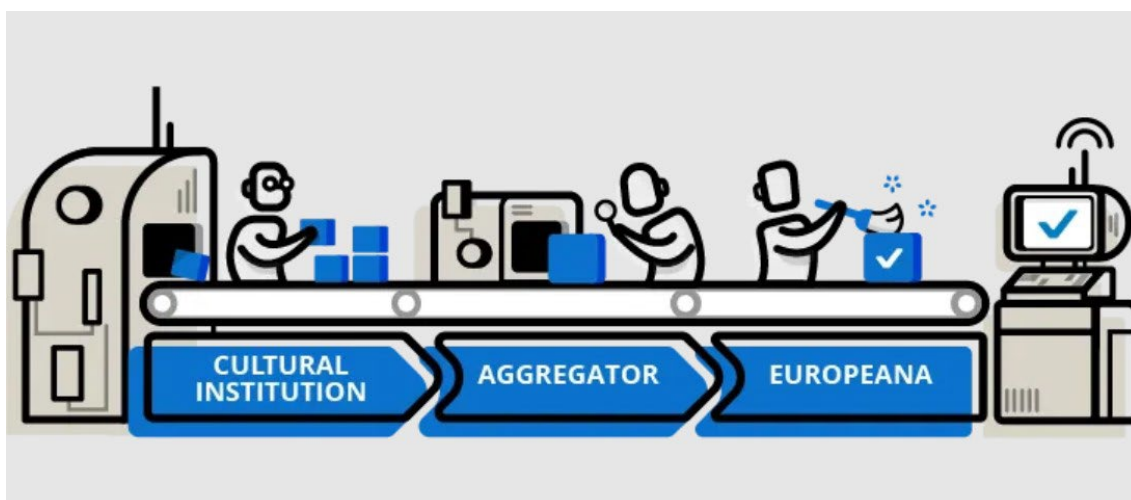
Photo 1. Aggregation process by Europeana

Similarly, the Cultural Heritage Cloud project, backed by the European Union, underscores the importance of standardized digitization practices for diverse cultural heritage materials (European Commission, 2022). Advocating for the adoption of standardized workflows and metadata schemas, the project has played a crucial role in facilitating the systematic documentation and archival of cultural heritage resources. This, in turn, promotes comprehensive scholarly analysis and enhances public engagement with the rich cultural legacy of Europe.

2.3 Digital Preservation Landscape in Finland

The digital preservation terrain in Finland intricately weaves together technological strides, regulatory structures, and institutional endeavors. This chapter endeavors to present a comprehensive panorama, drawing insights from pivotal sources, primarily the digital preservation portal curated by the National Digital Library of Finland (National Digital Library, 2023) and the comprehensive documentation on Finland from the Council of Europe's HEREIN project (Council of Europe, 2023).

Within the Finnish architectural realm, showcasing historical structures ranging from traditional wooden vernacular buildings to modernist masterpieces. Each structure holds profound cultural and historical significance. The digital preservation landscape in Finland mirrors the collective efforts of cultural institutions, governmental bodies, and heritage organizations. These collaborations aim to construct robust frameworks for systematically documenting and preserving architectural heritage through digital channels. Here, cutting-edge digitization technologies, standardized preservation protocols, and collaborative initiatives converge to ensure the endurance and accessibility of Finland's diverse architectural legacy.

Examining Finland's digital preservation landscape, as unveiled by the National Digital Library and the HEREIN project, reveals a comprehensive and forward-thinking approach. The intricate interplay between institutional initiatives, legislative frameworks, technological advancements, and international collaborations positions Finland as a pivotal player in the global endeavor to safeguard cultural heritage in the digital domain (National Digital Library, 2023; Council of Europe, 2023).

2.3.1 Technological Innovations: Advancements in Digital Preservation

The digital preservation landscape in Finland is marked by continuous technological innovations, as evidenced by the initiatives highlighted in the National Digital Library's portal (National Digital Library, 2023). The incorporation of cutting-edge technologies, such as advanced metadata standards, secure storage solutions, and evolving digitization methods, reflects Finland's organizations and institutes commitment to staying at the forefront of digital preservation practices. These innovations not only address the current challenges but also position Finland as a proactive contributor to the global discourse on digital heritage preservation.

2.3.2 Collaboration and International Engagement

The collaborative spirit of Finland in the realm of digital preservation is underscored by its active participation in international projects, as documented by the HEREIN project (Council of Europe, 2023). Collaborative endeavors with European partners and engagement in transnational initiatives highlight Finland's commitment to sharing expertise, resources, and methodologies. This collaborative ethos positions Finland within a broader context of international cooperation, fostering a collective approach to addressing the challenges of preserving digital cultural heritage.

2.3.3 Development of technology

The technological landscape of digitizing cultural heritage in Finland has witnessed significant strides, primarily influenced by the dynamism of the construction industry. In Finland, the construction industry emerges as a prominent catalyst of the advancements scanning technology has seen in recent years. This influence has notably impacted the accessibility, affordability, and speed of scanning technology.

The construction industry's demand for efficient and rapid data acquisition has driven the development of scanning equipment and software. This push has opened access to scanning technology, making it more widely available across sectors, including cultural heritage preservation. The increased affordability and accessibility have expedited the digitization process, aligning with the construction industry's need for swift and reliable data capture.

However, this symbiotic relationship between the construction industry and digitization technology has introduced a trade-off. The emphasis on speed and efficiency has sometimes come at the expense of scan quality. The rapid evolution of scanning equipment, while enhancing accessibility, has posed challenges in maintaining the highest standards of fidelity and detail in the final scans. This compromise prompts a nuanced consideration of the balance

between speed, accessibility, and the preservation of high-quality cultural heritage data.

2.3.4 Methods of Digitization of technology

The methods employed for 3D digitization are inherently diverse, primarily contingent upon the size of the objects subjected to the process. A crucial distinction arises between the digitization of individual objects and that of monumental structures, necessitated by technical limitations and specific application requirements.

Monumental digitization often relies on methodologies rooted in traditional topographic techniques, a choice driven by the sheer scale of these structures. This approach proves particularly effective in capturing the intricate details and dimensions of large-scale monuments and structures, ensuring a comprehensive representation in the digital realm.

Conversely, the digitization of smaller objects constitutes a dynamic domain marked by ongoing research and development. This facet of digitization operates within the confines of specific digitization plans, presenting a spectrum of possibilities. Various scanning techniques play a pivotal role in capturing the nuances of smaller artifacts, each method tailored to specific requirements.

Laser scanning stands out as a prominent technique in capturing high-resolution, precise 3D models of objects. This method employs lasers to measure distances to objects, producing point cloud data that can be transformed into detailed digital models. Photogrammetry, an increasingly utilized approach, involves the use of photographs to create 3D models through the analysis of visual data.

Structured Light Scanning employs a patterned light source to project a known pattern onto the object, capturing distortions to generate a 3D model. Additionally, Computed Tomography (CT) scanning, traditionally associated with medical imaging, has found application in cultural heritage, providing internal views of objects with complex structures.

These diverse scanning techniques collectively contribute to the multifaceted landscape of cultural heritage digitization, offering tailored solutions for capturing and preserving objects of varying scales and complexities.

3 Methodology

This chapter delves into a comprehensive examination of the digital models and point cloud data capturing of Ainola, the artist home of profound cultural significance. Executed by Tietoa Finland Oy, these digital representations span period from 2013 to 2023. The primary focus is on scrutinizing the impact of evolving equipment, technology, and techniques on the fidelity and quality of the digital models.

To conduct this analysis encompassing a systematic comparison of the 2013 and 2023 digital models and associated point cloud data. The examination includes an in-depth assessment of the technological nuances, equipment enhancements, and methodological shifts implemented during the intervening years. By understanding how technological evolution has shaped the digital representations of Ainola, insights emerge for refining methodologies in capturing and preserving cultural heritage digitally.

3.1 Comparative analysis of Ainola's digitization from 2013 and 2023

The comparative analysis of Ainola Artist Homes' digitization projects in 2013 and 2023 reveals notable advancements in equipment, technology, and techniques, influencing the fidelity and quality of the digital models. Despite achieving essentially, the same high-quality and detailed results in both projects, distinctions emerge in the methodologies and outcomes. The intended result of the projects could be clearly noted.

The purpose of the 2013 production appeared more inclined towards documentation purpose. The files could be used by conservators, aiding in repairs or to function as a support for documentation to portray the condition of the building during that time.

The scans produced of the indoor spaces of Ainola were done in sections and processed into their own files. The scans, though of excellent quality, were time-intensive, and focusing exclusively on the main building. With the technology at the time, the time required for the equipment to complete their scanning was extensive, Jaakko Hauru mentioned during the interview. Each floor was scanned in pieces (table 1), the first floor alone consists of 32 separate parts, that would require separate process to connect. The cloud data itself is highly dense (table 1), which allows the creation of high-quality 3D models and holds the potential for repurposing. The 2013 project data primarily presented colorless, rendering everything in grayscale. Coloring is a separate post-process.

Table 1. Basic data of the cloud data produced 2013.

Location	Version	Cloud Points	File size
1st Floor	1/32	16,117,255	442 614 kt
2nd Floor	1/24	12,432,326	341 419 kt
Cellar	1/17	26,513,213	728 106 kt
Attic	1/13	13,175,405	361 825 kt
Facade	1/25	6,836,708	187 753 kt

In contrast, the 2023 project demonstrated enhanced clarity in both the methodology and outcomes. The production involved the utilization of point cloud data generated through drone scanning employing photogrammetry (photo 4). This scanning method allows the integration of color into the point cloud data, a feature not achievable with alternative methods like LiDAR. A direct comparison between the resulting file and its optimized version (table 2) reveals noticeable distinctions. While the optimized file is well-adapted for presentation purposes, the compression process has resulted in the loss of intricate details present in the original file (photo 3). It fulfills a purpose that the original file, due to its sheer file size, cannot achieve.

Table 2. Simple comparison between original and optimized photogrammetry scans.

File	Cloud Point	File Size
Original	1,183,086,516	17 405 364 kt
Optimized	3,091,910	45 491 kt

The processing approach for the data is noteworthy. Unlike the segmented method employed in 2013 (photo 2), the cloud data in the recent project was consolidated into a single file, eliminating the necessity for distinct processes. Notably, the point cloud data indoors has been directly transformed into 3D models. These models underwent cleaning and compilation processes before integration into the Unreal engine. This marks a distinctive departure from the 2013 production methodology.
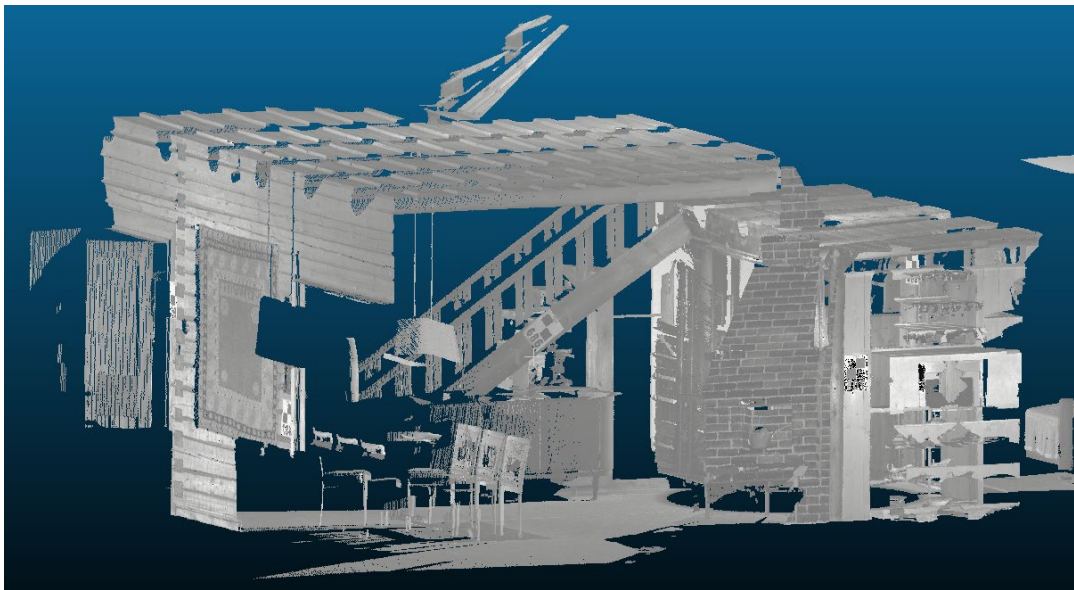

Photo 2. Portion of scanned area from Ainola, done in 2013.

Photo 3. Comparison between original and optimized photogrammetry scans on scale 1:3500.
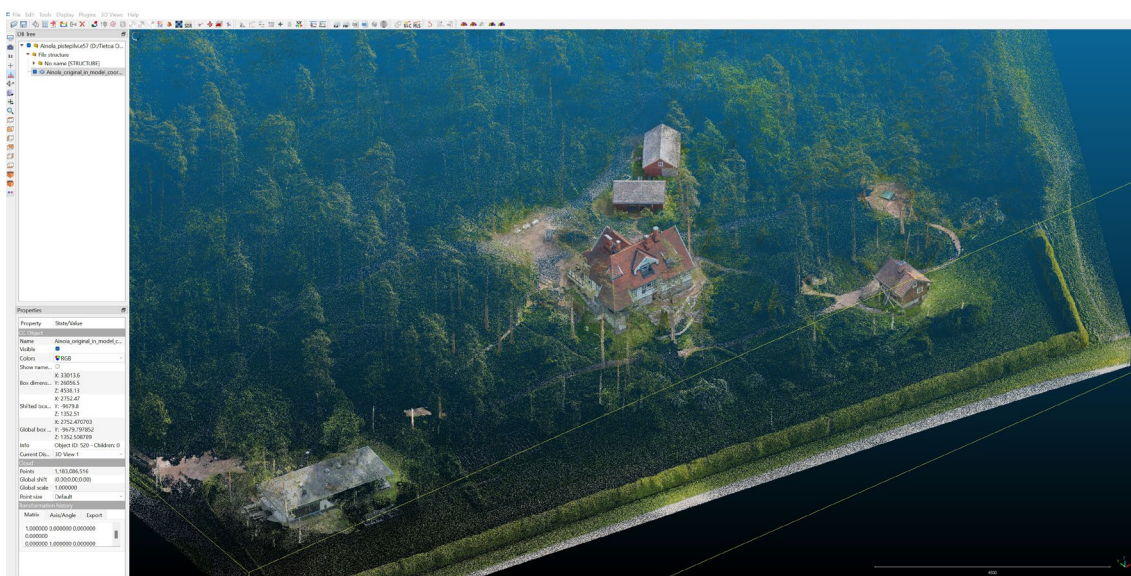

Photo 4. Point cloud model produced with photogrammetry.

This analysis underscores the significant impact of evolving technology and methodologies on the scope and depth of digitization projects, portraying a trajectory of enhancement and diversification over the decade between the two endeavors.

3.2 Expert Interviews

The foundation of this research is grounded in insights garnered from the notable professionals in the field. Jaakko Hauru, the Head of Unit at Tietoa Finland Oy, and Tuuli Ahlholm, a Specialist Designer at The Finnish Heritage Agency, serve as voices contributing valuable perspectives to the discourse. Through their interviews, this thesis endeavors to distill comprehensive insights, unraveling the challenges, opportunities, and nuances that define the digitization of cultural heritage.

As specialists of contemporary approaches to digitization, Hauru and Ahlholm bring forth a wealth of experience and knowledge. Their roles, situated at the intersection of technology and cultural preservation, provide a unique vantage point to discern the intricacies inherent in the digitization process. By hearing their perspectives, this research aims to contribute to the ongoing dialogue on cultural heritage, offering a pragmatic understanding of the challenges faced and the potential avenues for advancement.

3.2.1 Technological Potential: Governmental Progress and Commercial Considerations

During the interview Jaakko Hauru sheds light on the evolving potential of digitization technology, noting a gradual increase in governmental engagement. The trajectory of technological advancement within the sector is mirrored by Finland's prominent status as a hub for innovation, with the tech industry reigning as a major source of income.

However, Jaakko underscores a prevalent challenge with the technology development. As speedier scanning methods and more affordable equipment emerge, a trade-off with quality becomes apparent. This raises questions about the delicate balance between efficiency and the preservation of high-quality digitized artifacts.

3.2.2 Financial Constraints and Varied Production Requirements

An overarching challenge surfaces financial limitations addition to the limited understanding of the technological potential within the cultural sector. Tuuli Ahlholm, representing The Finnish Heritage Agency, emphasizes the struggle with funding shortages and a lag in comprehending the myriad possibilities offered by digitization.

Moreover, the nuances in production requirements further complicate matters. While the cultural sector demands meticulous detail, other industries, like construction, prioritize rapid yet reliable outcomes. Bridging this gap requires adaptable digitization processes that can cater to varied expectations, ensuring the technology's applicability across sectors.

3.2.3 Long-term Storage Dilemmas: Physical vs. Digital

The conundrum of long-term storage emerges as a critical consideration. Physical storage solutions require ongoing maintenance, mirroring the upkeep demanded by their digital counterparts. Presently, cloud storage stands out as a frontrunner due to its flexibility and accessibility.

Both commercial and cultural sectors face the challenge of determining preservation priorities. For commercial entities, ease of preservation takes precedence, while the cultural sector, in collaboration with CSC, leans toward achieving the longest possible shelf life and the highest quality for preservation, even exploring long-term bunker storage solutions.

3.2.4 Industry Dynamics and Documentation Challenges

The cultural sector's lag in harnessing the full potential of digitization technology becomes apparent, with other industries, particularly construction, leading the way. This discrepancy highlights a crucial area for improvement and collaboration within the cultural sector.

A noteworthy opportunity lies in documentation, especially in the context of rescue documentation for restoration or renovation projects. The digital copies serve as a crucial resource for preserving the original essence and details of cultural artifacts during transformative processes.

3.2.5 Version Management and Compatibility Challenges

The complexity of version management and compatibility adds another layer of challenge to the digitization process. Both Jaakko Hauru and Tuuli Ahlholm emphasize the necessity for streamlined documentation and version control mechanisms to ensure the continued accessibility and relevance of digitized content.

The potential utilization of artificial intelligence in management was a topic of discussion; however, both parties expressed skepticism about witnessing practical implementation in the immediate future. The circumstances may change in the future, perhaps in the coming years, but as of now, the technology isn't yet up to the task.

In conclusion, the expert perspectives provided by Jaakko Hauru and Tuuli Ahlholm offer a comprehensive understanding of the challenges and potential avenues for improvement in the realm of cultural heritage digitization. The intersection of technological advancement, financial considerations, and industry dynamics shapes a landscape that demands careful navigation and collaborative solutions. As Finland endeavors to preserve its rich cultural legacy

in the digital age, the insights from these experts serve as valuable guideposts in shaping effective and sustainable digitization strategies.

4 Standardization and Recommendations

4.1 Guiding Principles for Cultural Heritage Digitization

In cultural heritage digitization, the efficacy of the process hinges on the meticulous adherence to guiding principles. Derived from extensive research and insights gleaned from industry experts, this chapter elucidates a comprehensive set of principles that form the bedrock of successful digitization endeavors. These principles encapsulate the essence of informed decision-making, strategic planning, and a profound understanding of the intricate facets inherent in the digitization process.

1. Consider the Need and possible Value for 3D Digitization.
The foremost principle underscores the imperative of evaluating the intrinsic value and necessity of 3D digitization. Architectural heritage varies in significance, and a discerning assessment aids in prioritizing what architectural object warrants digitization, aligning with overarching preservation goals. Important to note, 3D digitization does not prevent risks to cultural heritage, nor does it function as a replacement for physical preservation.

2. Select What to Digitize and for What Purpose.
Central to the success of any digitization initiative is the strategic selection and a clear delineation of the intended purpose. This principal advocates for a judicious approach, ensuring that the chosen heritage site align with the overarching objectives of preservation, accessibility, and scholarly research. This also aids in the initial steps of planning, for different use cases require different approaches and equipment to achieve the required quality result.

3. Decide Whether to Digitize In-House or Outsource the Production.

The decision to undertake digitization in-house or outsource is pivotal. Careful consideration is given to the expertise, resources, and timelines required, with the goal of ensuring a seamless and efficient digitization process.

4. Determine the Minimum Quality Needed but Aim for the Best Available.

Quality considerations are paramount in digitization. While defining a minimum quality threshold is essential, the principle encourages aiming for the highest quality achievable. This approach safeguards against potential degradation over time and ensures fidelity in representing cultural heritage sites. This principle encourages the examination to the best price to quality ratio in terms of accuracy and resolution to cost and equipment, software, and skill requirements.

5. Identify Different Versions and Formats for Various Use Cases.

The versatility of digitized cultural heritage demands an understanding of diverse use cases. This principal advocates for the identification of different versions and formats tailored to specific applications, ensuring optimal accessibility and usability.

6. Planning for Long-Term Preservation of Acquired Data.

Acknowledging the impermanence of digital formats, the principle of long-term preservation underscores the need for strategic planning. This involves the meticulous curation and storage of acquired data to withstand the test of time and technological evolution.

7. Using the Right Equipment, Methods, and Workflows.

Execution is as crucial as planning. This principle emphasizes the selection of appropriate equipment, methodologies, and workflows tailored to the unique requirements of each digitization project. This principle emphasizes the careful evaluation of equipment outputs. What may be suited for movable tangible assets may not be sufficient for immovable cultural heritage.

8. Having Knowledge of 3D Technologies, Processes, and Content.
A foundational principal advocate for a profound understanding of 3D technologies, processes, and the content being digitized. Expertise or basic understanding alone in these domains ensures informed decision-making and fosters innovation in cultural heritage digitization.

9. Clarification of copyright aspects.
This principle addresses the critical need to untangle copyright complexities before embarking on digitization initiatives. The emphasizes is in the necessity of navigating legal nuances surrounding architectural structures. Simultaneously, the principle advocates for a proactive strategy in fostering open and extensive access to digitized architectural heritage. Recognizing the societal importance of democratizing cultural knowledge, experts affirm the crucial role of accessibility in enabling public engagement, scholarly research, and educational initiatives centered around architectural legacy.

4.2   Recommendations for Future Projects in Finland

Adherence to a set of comprehensive recommendations and guidelines are imperative, as defined by various organizations such as UNESCO. These recommendations, rooted in best practices and established principles (UNESCO 2009), serve as guiding parameters for the seamless execution of digitization initiatives. The entire projects success heavily depends on the initial planning. Some things to consider (table 3) in the planning process is how the digitization would be produced and by whom.

The decision between in-house digitization and outsourcing production merits careful consideration. Factors such as expertise, technological capabilities, and project scope should guide this decision-making process (table 3). Establishing a systematic workflow, utilizing appropriate equipment and methods, and

adhering to standardized protocols ensure consistency and efficiency in the digitization process.

Emphasizing the need for the highest achievable quality in digitization, while acknowledging the practical limitations of technology, is paramount. Striking a balance between optimal quality and available resources ensures that the digitized sites meet scholarly and preservation standards (table 3).

No	Criterion
1	Cost
2	Material of digitization subject
3	Size of digitization subject
4	Portability of equipment
5	Accuracy of the system
6	Texture acquisition
7	Skill requirements

Table 3. The Seven-Criteria-Table for planning an appropriate approach for digitization project.

The strategic selection of objects for digitization, aligning with the purpose of preservation and accessibility, is another critical recommendation. This involves a judicious evaluation of the cultural significance and historical value of artifacts, ensuring that the chosen items contribute meaningfully to the broader narrative of Finland's cultural heritage. Four processes can be identified in digital recording. Digital recording comprises four identifiable processes, elucidated graphically in Picture 5. Each of these processes imposes specific demands for sophisticated algorithms, innovative hardware, and refined software implementations.

Planning for the long-term preservation of acquired data is a foundational recommendation. Given the dynamic nature of technology, ensuring the adaptability and sustainability of digitized content over time requires a proactive approach to data storage and management. Cloud storage solutions, in line with current best practices, offer a viable option for long-term preservation.
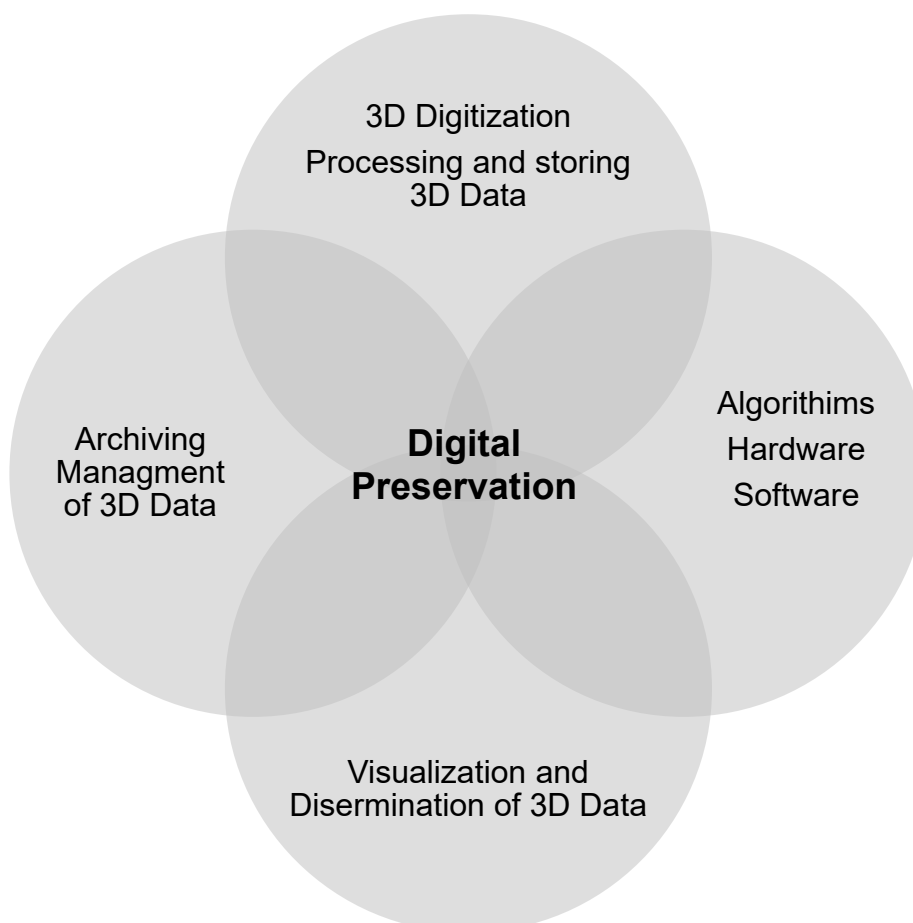
Picture 5. The recording of cultural heritage and it's requirements.

In conclusion, these recommendations collectively form a strategic framework for cultural heritage digitization projects in Finland. By adhering to these guidelines, digitization initiatives can navigate the nuanced challenges of the field, ensuring the preservation, accessibility, and scholarly investigation of Finland's diverse cultural heritage resources.

5   Results & Discussion

5.1   Digital Preservation

The Finnish architectural milieu is marked by a rich tapestry of historical structures, ranging from traditional wooden vernacular buildings to modernist masterpieces, each bearing profound cultural and historical significance. The digital preservation landscape in Finland reflects combining the coordinated efforts by cultural institutions, governmental bodies, and heritage organizations to develop robust frameworks for the systematic documentation and preservation of architectural heritage through digital means.

The approach Finnish institutes are implementing is referred as Archiving. This practice involves creating and managing archives, which are structured repositories holding digital assets with enduring value. This process is characterized by the implementation of state-of-the-art digitization technologies, standardized preservation protocols, and collaborative initiatives aimed at ensuring the longevity and accessibility of Finland's diverse architectural legacy.

The digital archiving in Finland encompasses a multifaceted approach to safeguarding the nation's rich architectural heritage in the digital realm. With a strong emphasis on technological innovation, interdisciplinary collaborations, and standardized preservation methodologies, Finland is emerging as one of the pioneers in the integration of digital preservation practices within the architectural conservation domain. Digital archiving is crucial for preserving cultural heritage, institutional knowledge, and valuable information in a format that transcends physical constraints.

The Archiving process in Finland thrives on a robust framework of interdisciplinary collaborations and strategic partnerships between governmental institutions, cultural heritage organizations, academic research institutions, and technology-driven enterprises. Collaborative initiatives, such as the Finnish Heritage Agency's and Senate Properties digital documentation projects in collaboration with leading architectural conservation experts and technology firms, exemplify the synergistic approach to digital preservation. These partnerships have facilitated the development of comprehensive preservation strategies, standardized documentation protocols, and capacity-building programs, fostering a culture of knowledge exchange, skill enhancement, and the spread of the best practices within the Finnish architectural preservation ecosystem.

Looking ahead, the digital Archiving landscape in Finland is poised to confront an array of challenges and opportunities inherent to the dynamic nature of technological advancements and evolving conservation model. Anticipated challenges include the management of vast digital datasets, the preservation of intangible cultural heritage elements, the integration of artificial intelligence and machine learning in preservation workflows, and the sustainable long-term storage of digital architectural replicas. Addressing these challenges demands a concerted effort to develop adaptive preservation frameworks, foster cross-disciplinary collaborations, and prioritize the integration of ethical and sustainable preservation practices, thereby ensuring the enduring protection and accessibility of Finland's architectural heritage for future generations.

5.2 Expert Insight

This chapter distills key insights drawn from enlightening interviews with industry experts, providing a nuanced perspective on the ever-evolving landscape of architectural heritage digitization. The dynamic interplay between expert perspectives and research findings deepens our comprehension of the challenges and opportunities inherent in the field.

A significant observation validated through expert dialogues is the symbiotic relationship between equipment development and influences from diverse industries, notably the construction sector. This affirmation emphasizes the dynamic nature of technological progress, seamlessly integrating into practices within architectural heritage digitization.

A compelling revelation surfaces concerning collaborative initiatives initiated by The Finnish Heritage Agency alongside CSC, commencing in the autumn of 2023, and gaining momentum in early 2024. This collaboration strategically leverages digitalization tools and expertise, exemplifying Finland's commitment to technological advancements in cultural heritage preservation.

A noteworthy alignment in viewpoints emerges, particularly concerning guiding principles for cultural heritage digitization, as articulated by Tuuli Ahlholm. This convergence underscores a universal acknowledgment of the complexities inherent in standardization efforts. The consensus on the challenging nature of this task, amidst swift industry, technological, and methodological evolution, reaffirms the crucial role of establishing guidelines for effective collaboration and industry-wide coherence.

The interviews collectively underscore the intricate challenge posed by standardization in architectural heritage digitization. The rapid evolution of industry practices, technological landscapes, and methodological approaches

highlights the need for adaptable yet robust guidelines. Expert insights shed light on the delicate balance required to navigate standardization in a field characterized by swift transformations.

A unanimous sentiment among experts emphasizes the necessity of guidelines, particularly in the context of collaboration between industries or commercial entities. The dynamic nature of the digitization landscape necessitates adaptable frameworks that can facilitate collaborative endeavors, ensuring coherence amid industry diversifications.

In conclusion, expert insights gleaned from interviews enrich our understanding of architectural heritage digitization dynamics. Confirmed observations, collaborative initiatives, and shared perspectives on standardization collectively contribute to the evolving narrative of technological progress within the field. As the industry continues to evolve, these insights serve as valuable signposts, guiding future endeavors in the nuanced realm of architectural heritage digitization.

6 Conclusion

This thesis has illuminated the formidable challenges that decision-makers and organizations face, particularly in the realm of standardization. The fast-paced evolution of technology, a relentless force since the turn of the millennium, poses a constant hurdle in establishing concrete operational guidelines. The pace at which technology becomes obsolete adds a layer of complexity, requiring dedicated investments to keep abreast of developments.

The paradox arises in the quest for standards: stringent guidelines drawn up today risk obsolescence in a rapidly changing technological landscape within a few short years. This challenge underscores the necessity for standards with enduring relevance, a task that magnifies the complexity of an already intricate process.

Consequently, a deliberate choice was made in this thesis to adopt a neutral stance, pivoting away from overly technical facets. Instead, the focus shifted toward a thought model and values that could stand the test of time. Drawing on personal experience, research findings, and professional insights, the thesis advocates for a more flexible and adaptive approach in the digitalization process.

In conclusion, the thesis recognizes the evolving nature of cultural heritage digitization and the need for a paradigm that accommodates the relentless dynamism of technology. By emphasizing adaptable values and thought models, the thesis aims to contribute to the ongoing discourse on the standardization challenges, fostering a nuanced perspective that aligns with the evolving demands of the digitization landscape.

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Other Sources

- Picture 1: Aggregation process (2023) Europeana Foundation
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- Picture 2: Portion of scanned area from Ainola, done in 2013. Table by Author (2023)

- Picture 3: Comparison between original and optimized photogrammetry scans on scale 1:3500. Table by Author (2023)

- Picture 4: Point cloud model produced with photogrammetry. Table by Author (2023)

- Picture 5: The recording of cultural heritage and it's requirements. Table by Author (2023)

- Table 1: Table by Author (2023)

- Table 2 Table by Author (2023)

- Table 3 Table by Author (2023)