

Constructing a Knowledge Management System for Traditional Craftsmen through Digitalization

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Abstract

Since the enactment of the Cultural Heritage Preservation Act in 1982, Taiwan has witnessed a gradually increase in the number of designated and registered cultural heritage sites, and among them, architectural heritage is now facing a periodic restoration required approximately every 20 to 30 years. In response to the need, the number of officially certified traditional craftsmen, who are specialists legally qualified to perform heritage restorations, has increased from 572 in 2013 to 984 in recent years. However, this quantitative growth belies a more pressing concern: the dual challenges of an aging restoration workforce and the imminent loss of traditional techniques. Despite the critical role traditional craftsmen play in the maintenance and transmission of traditional techniques, there remains a conspicuous lack of systematic integration of their experiential knowledge. To address this deficiency, this study aims to establish a people-centered, data-driven knowledge management system specifically designed for traditional craftsmen engaged in the field of cultural heritage restoration. The methodology integrates document analysis, field surveys, semi-structured interviews, and relational database design with MySQL.

The system records and organizes a wide array of information of traditional craftsmen, including their biographies, lineage of their techniques, techniques they have specialized in, projects they have participated in, and their learning trajectories. It establishes a searchable and expandable database that not only facilitates knowledge preservation but also promotes accessibility and traceability. This research incorporates the DIKW (Data–Information–Knowledge–Wisdom) framework, emphasizing that data is not merely a record-keeping instrument, but a critical substrate through which expert knowledge is translated, synthesized, and mobilized.

1. Introduction

1.1 Research Background and Objectives

Situated at the convergence of major tectonic plates in East Asia, Taiwan possesses a unique geographical location and a rich confluence of diverse ethnic and cultural influences. This has given rise to an exceptionally varied and complex architectural landscape. In Taiwan, the term “traditional craftsman” refers specifically to skilled professionals engaged in the restoration of tangible cultural heritage. Different from practitioners of traditional handicrafts, traditional craftsmen adhere to precise methodologies grounded in meticulous investigation and historical research. Their practice is defined by the application of time-honored traditional techniques, executed in accordance with traditional principles and blueprints, with the primary objective of preserving the material authenticity and cultural integrity of heritage sites.

As such, traditional craftsmen play a pivotal role in the conservation of cultural heritage. Their techniques embody not only accumulated hands-on experience, but also a broader narrative shaped by social transformations, economic transitions, and generational transmission through master-apprentice systems. The buildings and structures they have restored or constructed, while inevitably subject to the passage of time, bear traces of the past and stand as irreplaceable vessels of collective memory and cultural identity. These architectural works are not merely physical artifacts, but living proofs that Taiwan’s evolving cultural heritage has been shaped and sustained through the hands of these master craftsmen.

According to the most recent official data, a total of 984 individuals in Taiwan have been certified as “traditional craftsmen”, and are thereby qualified for the restoration of cultural heritage. Notably, 492 of them are already beyond 65

years old, and the gradual aging and declining of this cohort of skilled craftsmen are inevitable. Despite their extensive hands-on experience, there exists a critical gap in the systematic documentation and transmission of their valuable knowledge and techniques, much of which remains dispersed across personal memories, handwritten notes, and fragmented visual recordings. The lack of structural integration and a coherent repository severely hinders the effective preservation and intergenerational transmission of traditional craftsmanship.

This pressing situation necessitates a re-evaluation of how technology can be leveraged to construct a sustainable digital knowledge base for traditional techniques. As early as 1998, the Committee on Cultural Heritage Education underscored the importance of education in this domain, emphasizing that understanding the past is pivotal in shaping a meaningful future (Ott and Pozzi, 2008). Craftsmanship is fundamentally sustained by experiential learning and reflective practice, yet the advancement and elevation of traditional techniques also rely on the incorporation of scientific knowledge (Liu, 2016).

In response, this study aims to digitize the tacit and explicit knowledge of traditional craftsmen and develop a structured, scalable knowledge management framework. Utilizing MySQL as the system’s backbone, the framework encompasses five key dimensions: collection, organization, storage, sharing, and application. This system facilitates the systematic preservation of traditional techniques, contributes to the promotion of cultural heritage education and boosts the long-term digital sustainability of knowledge on intangible cultural heritage.

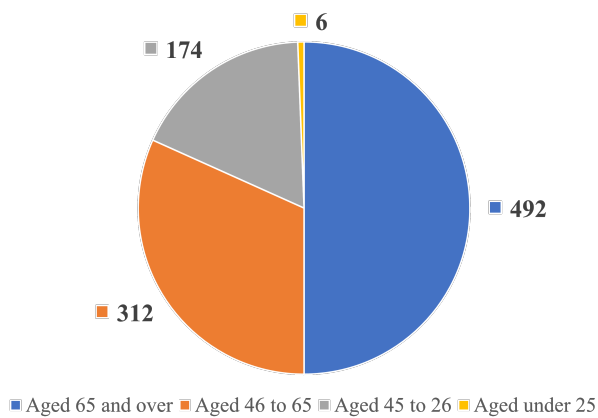


Figure 1. Age Statistics of Taiwan's Traditional Craftsmen

2. Research Methodology

This study adopts MySQL as the primary platform for constructing a knowledge management system specifically tailored to traditional craftsmen engaged in cultural heritage restoration. Emphasis is placed on the systematic collection, synthesis, and analysis of preliminary data, with the objective of reconstructing a coherent knowledge framework grounded in the lived experience and technical practices of traditional craftsmen. By critically reviewing relevant literature and extracting insights through targeted fieldwork, the research seeks to bridge the gap between dispersed experiential knowledge and formalized digital records. The methodology employed encompasses three core qualitative approaches: document analysis, field surveys, and semi-structured interviews. Through this triangulated methodology, the study establishes a robust empirical foundation for the design and implementation of a sustainable, scalable, and context-sensitive knowledge management system.

2.1 Document Analysis

This method refers to the systematic collection, critical evaluation, and organization of documentary sources that help understand facts and contexts. In the present study, document analysis focuses on materials relevant to traditional craftsmen, including archival records, project reports, academic theses, and monographs. Particular emphasis is placed on historical documents, fieldwork notes, interview transcripts, and survey records derived from previous research initiatives on traditional craftsmanship. Furthermore, the study incorporates technical reports related to the restoration of architectural heritage, including monuments, historic buildings, commemorative structures, and vernacular settlements paying close attention to sections that document the participation of craftsmen, their traditional techniques and methodologies, and the workflow processes within restoration projects.

2.2 Field Survey

This method involves the direct observation, interviewing, photographic documentation, and systematic recording of empirical data essential to the research. In this study, field surveys were conducted in conjunction with semi-structured interviews, targeting five representative traditional craftsmen selected based on their expertise and significance within the field of cultural heritage restoration. The information obtained through these on-site investigations was then cross-referenced with documentary sources to enhance the reliability and depth

of the findings. Through this comparative analysis, the study proposes a foundational framework for constructing a knowledge base tailored to the practices and transmission patterns of traditional craftsmen.

2.3 Semi-Structured Interview Method

Also referred to as "guided interviews," the semi-structured interview method is employed to obtain comprehensive and context-rich information from participants. In this study, interviews were conducted with selected traditional craftsmen, beginning with the collection of essential biographical information, including year of birth, alternative names, and contact details. The interviews then focused on core aspects of their professional history and technical expertise, such as master-apprentice lineage (including year of formal qualification and relationships with fellow apprentices), training of successors, specialization in traditional techniques or distinguishing technical features, composition of their construction teams, and their representative works. In addition, particular attention was paid to the accurate documentation of technical terminology and process details. All responses were systematically organized and recorded using structured data forms to ensure consistency and traceability.

Moreover, to evaluate the usability and functional robustness of the system, five academic experts in information systems were invited to conduct interface testing. Their feedback was used to assess the user-friendliness of the platform, the internal logic of the database structure, and the potential for future expansion and integration with other digital systems.

3. Knowledge Transformation Analysis

3.1 Knowledge Construction

The term "knowledge" encompasses both cultivated understanding and scholarly learning, as well as the experiential insight acquired through processes of study and practice. Distinct from data and information, knowledge is characterized as a systematized and structured integration of intuition, experience, and factual content (Edvinsson and Malone, 1997; Stewart, 1997). As noted by Davenport and Prusak (1998), knowledge is not a static entity but a dynamic and contextualized amalgam comprising frameworks derived from experience, embedded values, contextual information, and professional insight. These components together construct a cognitive framework through which individuals interpret, assess, and internalize new experiences and information. In this regard, knowledge is distinguished from data and information by its reliance on human interpretation, judgment, and application. Unlike raw data, which is unprocessed, or information, which is organized but lacks depth, knowledge derives its significance from the human capacity to synthesize and apply it meaningfully within specific contexts.

1. Data: Unprocessed numerical values or records.
2. Information: Structured and organized data endowed with meaning.
3. Knowledge: Information embedded in personal experience, making it systematic and actionable.

The conceptualization of knowledge was notably advanced by the British philosopher Michael Polanyi (1891–1976) in 1966, who famously asserted that "we know more than we can tell." Based on this insight, Polanyi distinguished knowledge into two fundamental categories: explicit knowledge and tacit knowledge.

Explicit knowledge refers to information that can be codified, documented, and communicated through formal means such as language, texts, symbols, and diagrams. In contrast, tacit knowledge encompasses the intuitive, experiential, technical, and value-laden understandings internalized by individuals through prolonged practice and observation, rendering it difficult to articulate or transfer verbally.

The effective classification and management of knowledge—commonly termed Knowledge Management—has long been subject to scholarly debate. Mockler (1992) described Knowledge-Based Systems (KBS) as comprising two core components: the Knowledge Base and the Inference Engine. The Knowledge Base functions as a repository for storing knowledge, while the Inference Engine facilitates problem-solving and decision-making by applying logical reasoning to the stored knowledge. More recently, Tiwari (2022) emphasized that the essential elements of knowledge management include the utilization of both data and information.

Synthesizing these perspectives, knowledge management can be understood as the systematic acquisition and integration of data, combined with the timely and accurate dissemination of appropriate knowledge to the right individuals, thereby enabling the cyclical regeneration and effective utilization of knowledge.

3.2 DIKW Model

The conceptual framework of the DIKW hierarchy: Data, Information, Knowledge, Wisdom, originates from the literary reflections of the British poet T.S. Eliot (1888–1965), who in his poem *The Rock* poignantly questioned:

*"Where is the wisdom we have lost in knowledge?
 Where is the knowledge we have lost in information?"*

Building upon this philosophical foundation, American management scientist Russell Ackoff (1919–2009) further articulated the concept in 1989, defining wisdom as "the ability to increase effectiveness, which creates value and requires a capacity known as judgment." In other words, wisdom is not merely the aggregation of knowledge; rather, it fundamentally involves the exercise of judgment to navigate complexity and uncertainty, thereby minimizing errors and effectively applying knowledge to resolve challenges.

Synthesizing the foregoing arguments, this study takes the traditional timber framing techniques as a case study to conduct an analysis of the composition of knowledge:

- 1.Data: The various databases possessed by individuals, encompassing construction drawings, tools, measurement records (such as dimension logs), and observational notes.
- 2.Information: Practical skills distilled from data—e.g., blueprint interpretation, tool-handling techniques, timber identification, dimensional layout for vertical and horizontal components, and carving practices.
- 3.Knowledge: The ability to integrate and apply these techniques—such as independently executing a project, precisely scaling component proportions, and assembling or disassembling complex joinery.
- 4.Wisdom: The expert judgment exercised on-site, adapting methods to emergent conditions. For example, upon dismantling a deteriorated timber frame infested by termites, a craftsman must:

1. Determine and sequence the disassembly order (beginning with the ridge beam).

2. Employ non-destructive dismantling techniques (e.g., inserting protective blocks before striking to avoid secondary damage and to preserve painted surfaces).
3. Assess the extent and etiology of timber damage.
4. Estimate requirements for materials, labor time, and costs; prepare new components; and plan for their finishing.
5. Accurately template and carve replacement members, then conduct dry-assembly trials before final reassembly.

This DIKW-based analysis illuminates how raw construction data evolve into on-site craftsmanship wisdom, guiding both the preservation of building authenticity and the intergenerational transmission of traditional carpentry knowledge.

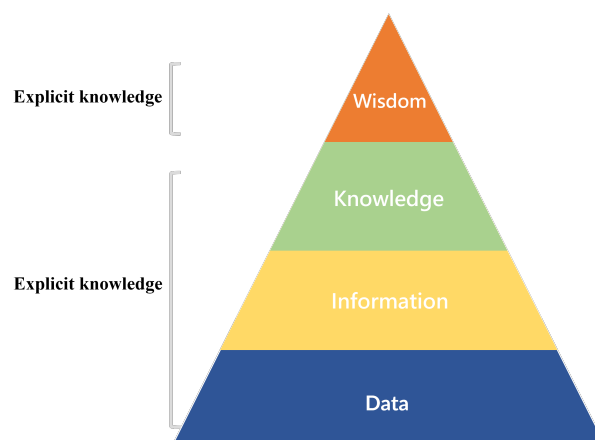


Figure 2. Knowledge Composition Model of Traditional Craftsmen

4. Research Framework and Content

Beginning with the collection of documentary materials and the structuring of system data tables, this study stores core knowledge, such as traditional craftsman profiles, technical competencies, specialized techniques, traditional tools, and other relevant information, within a MySQL database, thereby enabling effective knowledge sharing and application.

4.1 Database Design Principles

This study employs MySQL as the database management system to develop a dedicated database supporting a website for the management of traditional craftsman information. The database, named "tb_craftsman," comprises multiple relational tables designed to store diverse data types, including textual entries, dates, timestamps, and symbolic data. The primary objective is to enable efficient management and retrieval of traditional craftsman information, thereby facilitating seamless data access and interaction for website users. Leveraging MySQL's robust functionalities for data storage and querying significantly enhances the performance and reliability of the craftsman information repository, ultimately contributing to the effective consolidation and integration of pertinent traditional craftsman data.

To safeguard sensitive personal and heritage data, the system environment and security protocols fully comply with Taiwan's Cybersecurity Management Act and Personal Data Protection Act. Measures include regular vulnerability scanning and the deployment of SSL/TLS certificates, guaranteeing data confidentiality, integrity, and secure user interactions.

2.1 Targets Summary

The number of potential vulnerabilities found for each target by severity.



Figure 3. Passed Security Testing

4.2 Database Fields

Based on our literature review and semi-structured interviews, we first identified the core tables and their principal fields, including: Account ID、Name、Personal Profile、Professional Experience、Years of Service、Apprenticeship Records.

These primary fields were then decomposed into related sub-fields and linked via relational tables, allowing us to unify each craftsman’s technical competencies, specialized skills, and master–apprentice affiliations within a coherent schema. The following sections detail the design of each database domain.

4.2.1 Personal Profile: Includes craftsman's date of birth, government-issued identification details, contact telephone number, mailing address, highest level of educational attainment, certified qualifications as a traditional craftsman, and current professional status. The latter encompasses various categories, including full-time employment, part-time employment, non-engagement in related work, retirement, and inability to work due to medical reasons.

tb_craftsman	
cm_id	int(11) NN
cm_account	varchar(50)
cm_pwd	varchar(100)
cm_pwd1	varchar(100)
cm_type	varchar(20)
cm_name	varchar(100) NN
cm_doc_num	text
cm_technical	varchar(200)
cm_hr_zipcode	varchar(10)
cm_hr_city	varchar(20)
cm_hr_area	varchar(20)
cm_hr_addr	varchar(200)
cm_sex	tinyint(4) NN
cm_bh_year	int(11)
cm_bh_month	int(11)
cm_bh_day	int(11)
cm_bh_city	varchar(20)
cm_idcard	varchar(20)
cm_idcardfile	varchar(200)
cm_idcardfile2	varchar(200)
cm_headfile	varchar(200)

Figure 4. Basic Information Fields (Excerpt)



Figure 5. Homepage of the Traditional Craftsmen Knowledge Management Database System (Excerpt)

4.2.2 Professional Experience: Encompasses vocational-technician licenses, professional certificates, records of award-winning projects, and documented training history.

tb_craftsman_certificate	
cc_id	int(11) NN
cm_id	int(11) NN
cc_sort	int(11) NN
cc_title	varchar(200) NN
cc_category	varchar(100) NN
cc_no	varchar(200) NN
cc_startdate	date
cc_enddate	date
cc_file	varchar(255) NN
cc_updatetime	datetime NN
is_approved	int(11) NN

Figure 6. Certificate Fields



Figure 7. Traditional Craftsmen Knowledge Management Database System – Certificate

4.2.3 Years of Service: This domain captures documented project achievements, including : Project Location、Project Title、Project Type、Execution Period、Scope of Work、Names of Co-practicing Craftsmen.

tb_craftsman_work_performance	
cwp_id	int(11) NN
cm_id	int(11) NN
cwp_title	varchar(200) NN
cwp_place	varchar(50) NN
cwp_startdate	date
cwp_enddate	date
cwp_kind	varchar(100) NN
cwp_types	varchar(30) NN
cwp_category	varchar(50) NN
cwp_category_other	varchar(200)
cwp_full_name	varchar(200) NN
cwp_zipcode	varchar(10) NN
cwp_addr	varchar(200) NN
cwp_work_item	varchar(200) NN
cwp_company_name	varchar(200) NN
cwp_hosted_craftsman	varchar(200) NN
cwp_range	text NN
cwp_other_craftsman	text NN
cwp_sort	int(11) NN
cwp_updatetime	datetime NN
cwp_lock	tinyint(4) NN

Figure 8. Work Achievement Fields



Figure 9. Traditional Craftsmen Knowledge Management Database System – Work Achievement

4.2.4 Apprenticeship Records: Documents the following of each craftsman's training:

1. Disciplines Trained: Specific technical work items mastered during apprenticeship
2. Age at Apprenticeship Commencement
3. Age at Mastery Certification
4. Mentor: Apprentice Relationship
5. Apprenticeship Narrative: Chronological account of training progression
6. Acquired Traditional Techniques: Codified craft methods learned
7. Traditional Tools Employed: Inventory of hand tools and equipment used throughout training

tb_craftsman_relationship	
cm_id	int(11) NN
cmrs_seq	tinyint(3) NN
cmrs_type	tinyint(4) NN
cmrs_ranking	varchar(20)
cmrs_name	varchar(100) NN
cmrs_sort	int(11) NN
cmrs_updatetime	datetime NN

Figure 10. Apprenticeship Record Field



Figure 11. Traditional Craftsmen Knowledge Management Database System – Apprenticeship Records (Excerpt)

5. Research Results

Based on the aforementioned database schema and expert consultation, this study developed and implemented a knowledge management system centered on MySQL, specifically tailored for traditional craftsmen engaged in the restoration of cultural heritage. Through practical application and system testing, the feasibility and internal logic of the system were validated. Additionally, the personal profiles of 984 craftsmen currently certified under Taiwan's official

traditional craftsman registry were integrated into the database. This initiative addresses the long-standing issue of fragmented and paper-based records that are prone to loss, while significantly enhancing the coherence, accessibility, and manageability of traditional craftsmanship data.

From an interface design perspective, the system supports filtering by gender and identity type, and utilizes color-coded categorization to facilitate intuitive navigation and rapid data retrieval. Practically, the database allows users to trace craftsmen's historical involvement in restoration projects, offering valuable reference points for future planning and for selecting appropriate construction methods based on proven expertise.

From an academic standpoint, the establishment of a structured repository of traditional techniques provides a foundational resource for interdisciplinary research across the fields of architectural history, anthropology, and cultural studies. Furthermore, by mapping apprenticeship relationships and analyzing cumulative work experiences, the system elucidates the division of labor among craftsmen and reveals the tacit networks of collaboration and knowledge transmission. This, in turn, enables more nuanced investigations into the genealogy and developmental logic of Taiwan's traditional building systems and craft ecologies.

6. Conclusion

In response to the critical challenges of an aging workforce and the gradual loss of traditional restoration knowledge in Taiwan's cultural heritage sector, this study proposes a novel framework that integrates digital technologies with human-centered knowledge preservation. By reconceptualizing traditional craftsmen not merely as laborers but as knowledge bearers, this research explores the potential of information technologies to construct a comprehensive, scalable knowledge management system that addresses the longstanding fragmentation of craftsman data previously scattered across handwritten notes, architectural drawings, oral histories, and field practices.

Drawing on the DIKW (Data Information Knowledge Wisdom) hierarchical framework, the study utilizes a MySQL relational database to translate and organize experiential knowledge into structured digital content. Through expert consultations and system validation, the platform has demonstrated a high degree of data integration capacity and operational functionality. It captures critical information such as biographical data, technical expertise, project participation, and apprenticeship history, enabling precise multi-parameter queries based on geographic location, craft specialization, and years of experience. More than a static archive, the system constitutes a dynamic and extensible cultural network that maps relationships among masters, techniques, and apprentices thereby supporting in-depth analyses of the genealogical and socio-technical dimensions of traditional techniques systems.

To ensure long-term sustainability, the platform also incorporates data encryption, periodic vulnerability assessments, and backup protocols in compliance with information security best practices. As such, this research does not merely offer a functional database, but presents a pioneering model for interdisciplinary convergence between architectural heritage conservation, digital knowledge management, and cultural informatics. It exemplifies how contemporary information

systems can serve as vital infrastructure for safeguarding intangible cultural assets in the digital age.

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