Digitalizing Malay Medical Manuscripts: A Database-Driven Approach to Preservation, Knowledge Management, and Intellectual Property

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Abstract

This study explores the digitalization and structured knowledge management of 18th to mid-19th century Malay medical manuscripts, integrating digital humanities and intellectual property considerations. The primary objective is to ensure the preservation, accessibility, and systematic organization of traditional Malay medical knowledge through the development of a structured digital database. To achieve this, the study is structured around three core objectives. First, extraction of Malay medical knowledge focuses on identifying and digitizing traditional medicinal treatments, herbal remedies, and compound formulations recorded in selected Malay medical manuscripts. Second, categorization and ontology development aim to systematically classify the extracted data based on herbal taxonomy, medicinal compounds, and therapeutic applications, using an ontology-based approach to enhance data searchability and knowledge representation. Third, database design and development involve creating an interactive and accessible digital repository using Protégé (ontology editor tool) and XAMPP. The findings indicate that the ontology-based classification has significantly improved the organization and retrieval of information from the manuscripts, offering a new avenue for research in traditional medicine and historical pharmacology. By preserving and structuring this knowledge digitally, the study enhances accessibility for researchers, medical historians, and practitioners, bridging the gap between traditional healing practices and modern medical research. Furthermore, by addressing legal and ethical considerations, this research contributes to the ongoing discussions on intellectual property protection and responsible knowledge sharing in the digital era. This study highlights the critical role of digitalization in safeguarding cultural heritage and ensuring the continued relevance of traditional Malay medical knowledge. By developing a structured digital repository, this research provides a sustainable framework for integrating historical medical wisdom into contemporary knowledge systems, ensuring its long-term preservation and accessibility.

Keywords: Digital preservation, intellectual property, digitalization, prototype, Malay medical manuscript

Introduction

The Malay medical manuscripts from the 18th to 19th centuries demonstrate the advanced healing practices of the Malay world by providing essential knowledge about a complete medical system which existed before Western colonial domination. The handwritten manuscripts contain a distinctive combination of physical and spiritual healing methods together with botanical understanding and cultural beliefs which established traditional Malay medical practices.[1]

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[1] Mulaika Hijjas, "Marsden's Malay Manuscripts: Reassessing a Colonial Collection," *Philological Encounters* 8, no. 1-2 (2023): 38–72. See also Roziah Sidik @ Mat Sidek and Azizan Baharuddin, "Traditional Healing in Malay Culture: The Case of A Malay Manuscript of the 19th Century," (Faculty of Islamic Studies, National University of Malaysia and Centre for Civilizational Dialogue, University of Malaya), accessed April 22, 2025.

The medical tradition centers on intellectual contributions from scholars including Sheikh Shafiyuddin al-'Abbasi who demonstrated the advanced understanding of local medical knowledge through his works.[2] The manuscripts together create an essential knowledge base which guides modern medical practices and promotes cultural heritage appreciation in contemporary healthcare systems.[3] The Book of Tib maintains its importance as a vital connection between ancient medical traditions and changing cultural environments through MSS 2515 which continues to help understand medical practices of the region after its initial creation.[4] These manuscripts collectively form an irreplaceable repository of knowledge that continues to inform contemporary medical practices while fostering greater appreciation for cultural heritage within modern healthcare systems.[5]

The preservation of these invaluable documents faces numerous challenges that threaten their survival. Physical deterioration poses an immediate threat, with many manuscripts suffering from material degradation over time, including fragile paper and fading inks.[6] The preservation challenges become worse because of biological factors that include mold growth and insect damage[7]. The preservation of these texts is hindered by accessibility issues because collections are spread across multiple institutions worldwide and many texts contain archaic terminology and incomplete documentation.[8]

The current state of digital preservation presents additional concerns. The current state of technology does not provide a complete digital repository which properly organizes and provides access to the extensive knowledge found in these manuscripts.[9] MSS 2515 stands among many other important texts which have not received sufficient digital representation while digital collections fail to achieve proper organization for research purposes.[10] The process of merging traditional medical knowledge with contemporary research faces major barriers. The specialized language found in manuscripts creates difficulties when trying to understand them within present-day medical practices.[11] The scientific validation of numerous traditional treatments found in the texts[12], remains pending while colonial-era biases persist in the way traditional knowledge systems are perceived.[13] Research becomes more difficult because of the need to match historical disease concepts with modern medical classification systems.[14]

The Malay medical manuscripts face various obstacles but they hold significant potential to benefit various academic and practical fields. Digital humanities can use these manuscripts to create advanced ontologies which would establish connections between herbs and diseases and their corresponding treatments.[15] Medical historians can use these manuscripts to study knowledge exchange between Malay, Islamic and Ayurvedic traditions while documenting the advanced medical systems of pre-colonial times. The

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[2] G. L. Koster and H. M. J. Maier, "A Medicine of Sweetmeats: On the Power of Malay Narrative," *Bijdragen tot de Taal-, Land- en Volkenkunde* 141, no. 4 (1985): 441–461.

[3] Izzuddin Ahmad Nadzirin, "Analysis of Malay Medical Manuscript MSS 3136 and Remedies for Eye-Related Diseases," *International Journal of Allied Health Sciences* 5, no. 5 (2021): 2407-15.

[4] Nadirah Norruddin, "Magic or Medicine? Malay Healing Practices," *BiblioAsia*, October–December 2018, accessed April 23, 2025, https://biblioasia.nlb.gov.sg/vol-14/issue-3/oct-dec-2018/magic-or-med-m-heal/.

[5] Adat Aceh: Royal Malay Statecraft in the 17th Century," *Asian and African Studies Blog*, British Library, November 13, 2017, accessed April 23, 2025, https://blogs.bl.uk/asian-and-african/malay/page/4/. See also Muhammad Hakim Kamal et al., "Malay Medical Manuscript of The Book of Tib Mss2515: An Analysis of Skin Diseases Treatment," *International Journal of Religion* 5, no. 11 (2024): 294-307.

[6] Khairullah Anuar et al, "Materials in Traditional Malay Medicine: A Study of Manuscript Mss 1653," *International Journal of Chemical and Biochemical Sciences* 24, no. 5 (2023): 255–261.

[7] Sermons in the Malay World," *Asian and African Studies Blog*, British Library, April 14, 2014, accessed April 23, 2025, https://blogs.bl.uk/asian-and-african/2014/04/sermons-in-the-malay-world.html.

[8] Rosemary Wall and Anne Marie Rafferty, "Trouble with 'Status': Competing Models of British and North American Public Health Nursing Education and Practice in British Malaya," in *Translating the Body: Medical Education in Southeast Asia*, accessed April 23, 2025, https://www.ncbi.nlm.nih.gov/books/NBK465035/.

[9] Ahmad Nadzirin, et al., "Analysis of Malay Medical Manuscript MSS 3136," 2407-15.

[10] Kamal et al., "Malay Medical Manuscript of The Book of Tib Mss2515," 294-307.

[11] Kim, Yun Jin. "The Current Studies of Education for a Traditional and Complementary Medicine in Malaysia." *Journal of Evidence-Based Complementary & Alternative Medicine* 22, no. 4 (2017): 531–537.

[12] Oman Fathurahman, "Medical Manuscript and Islam in the Malay World (Nusantara): Aceh and Mindanao," in *Malay Medical Manuscripts: Heritage from the Garden of Healing*, ed. Mohd Affendi Mohd Shafri and Intan Azura Shahdan, (Cambridge: The Islamic Manuscript Association, 2017), 19–34.

[13] Anuar et al., "Materials in Traditional Malay Medicine," 255-261.

[14] Jin Kim, "The Current Studies of Education," 531–537.

[15] Chee Heng Leng, "Health Status and the Development of Health Services in a Colonial State: The Case of British Malaya," *International Journal of Health Services* 12, no. 3 (1982): 397–417.

manuscripts create essential intellectual property management issues because they need protection from biopiracy and unauthorized patenting of traditional remedies. The ethical management of traditional medical knowledge requires frameworks to address its proper use and sharing practices.[16]

A solution to these challenges needs multiple strategies. The digitization process needs to use high-resolution scanning technology that supports Jawi script analysis while developing ontology-based databases to properly organize and access the manuscripts' contents. The project needs international collaboration to coordinate with global collections that hold Malay manuscripts and to establish standardized digital preservation protocols. Academic institutions should integrate the study of these manuscripts into their programs through Jawi literacy initiatives and interdisciplinary research projects that combine historians with medical researchers and traditional medicine practitioners. Traditional healers and local communities must participate meaningfully in preservation efforts because their knowledge and perspectives should guide the process.

Literature Review

Traditional Malay medical knowledge exists as a complex fabric which combines ancient cultural customs with indigenous knowledge and communal healing traditions spanning multiple centuries. The Malay medical tradition uses holistic practices which unite herbal treatments with spiritual healing and community-based care to treat physical and mental health problems. Traditional healers known as dukun or bomoh have traditionally served dual roles in healthcare and social governance while demonstrating the interconnectedness of health leadership in Malay communities.[17] Traditional healers in Malay villages served as the main medical practitioners while simultaneously fulfilling important governance responsibilities in their communities. The bomoh titles of Maharaja Lela in Selangor and Sultan Muda in Perak granted them complete access to royal compounds because of their high social standing.[18] These healers performed sacred ceremonies and rituals to bless the village which demonstrated their ability to combine spiritual and practical health practices.[19]

Traditional Malay medicine underwent substantial development throughout history because colonial rule introduced Western medical approaches which resulted in regulatory measures for traditional healing practices. The transformation affected traditional healers' standing and reshaped maternal healthcare delivery through colonial oversight of midwives (bidans).[20] Traditional Malay medicine continues to be vital in healthcare systems because local authorities and international organizations including the World Health Organization acknowledge its effectiveness and cultural importance.[21] The tib books serve as manuscripts that preserve medicinal knowledge which contains treatment methodologies and healing philosophies from the 15th century onwards. The medical texts demonstrate the advanced understanding of Malay civilizations before Western influence while showing how health involves physical, spiritual and environmental elements. The texts function as essential references for practitioners by containing treatment approaches alongside disease explanations and prevention methods which showcase the knowledge base of Malay healing practices.[22]

Digital Humanities in Manuscript Preservation

The digital preservation of manuscripts has evolved through time because of sustained efforts to protect historical documents as the world transitions to digital technology. The initial focus of digitization projects

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[16] Wen Tien Tan et al., "Traditional Chinese Medicine in Malaysia: A Brief Historical Overview of the Interactions between China and Malay Peninsula," *Chinese Medicine and Culture* 1, no. 2 (2018): 60–63.

[17] Mohd Affendi Mohd Shafri and Intan Azura Shahdan, *Malay Medical Manuscripts: Heritage from the Garden of Healing* (Kuala Lumpur: Akademi Jawi Malaysia and The Islamic Manuscript Association, 2017).

[18] Anuar et al., "Materials in Traditional Malay Medicine," 255-261.

[19] Anuar et al., "Materials in Traditional Malay Medicine," 255-261.

[20] Raznah Ramya et al., "The Ethnobotanical Elements in Traditional Malay Medical Knowledge: A Review," *International Journal of Research and Innovation in Social Science* 8, no. 11 (2024): 2903-2918.

[21] Ji-Eun Park et al., "Twenty Years of Traditional and Complementary Medicine Regulation and Its Impact in Malaysia: Achievements and Policy Lessons," *BMC Health Services Research* 22, no. 102 (2022), 2-3.

[22] Ji-Eun Park et al., "Twenty Years of Traditional and Complementary Medicine," 3.

involved data encoding for systematic analysis which led to present-day initiatives that reproduced unique archival materials to improve historical text accessibility.[23] The digitization of manuscripts supports modern preservation approaches which focus on providing both present-time accessibility and enduring sustainability. Digitization projects need proper initial planning to succeed because they must address funding sources and technical support requirements and digital image preservation strategies.[24] The method provides both immediate accessibility to valuable content and solutions for maintaining digital collection integrity throughout time.[25] The method provides both immediate accessibility to valuable content and solutions for maintaining digital collection integrity throughout time. Digital humanities (DH) as a field includes multiple methodologies and practices which aim to improve cultural heritage preservation and understanding. Researchers performed qualitative case study analyses across different global perspectives to investigate the relationship between DH and manuscript preservation initiatives.[26] The research examines seven U.S. academic libraries through their unique practices to demonstrate how these institutions operate their DH programs and thematic research collection support.

The Dutch and Flemish libraries visited as part of this project maintain their Medieval manuscripts through in-house digitalization. The economic value of the codices and transportation and insurance costs that result from sending them out of the library remain the primary reasons for this practice. The institutions operate their activities through two main equipment types. The Zeutschel brand stands out as a very popular choice among book scanners. The scanning process using a book scanner proves faster than photography because codices can achieve 180° opening for per-opening reproduction. A book scanner supports its books through the use of adjustable book wedges which consist of two boards. A well-supported position of the book exists because the boards adjust their height independently from each other. The book rests within a space created by the boards which holds the book spine. The book receives spine support through a piece of cloth that attaches to both boards. The glass plate serves as an undesirable element during the scanning process. The manuscript suffers potential damage from excessive book joint pressure because the plate fails to adjust its pressure properly. Raising the glass plate also risks drawing folios which could result in damage to either paper or parchment. The glass plate should never be used with powdered inks as well as fragile pigments or raised gold leaf applied on gesso bases. The second type of device is a high-resolution digital camera. A book cradle provides support to manuscripts throughout the camera-based reproduction process. The Conservation Copy Stand (CCS) or Grazer Kamertisch serves as a widely popular model for reproduction work in both Netherlands and Belgium. The Conservation Copy Stand exists in a transportable version which enables photographers to work at different locations. The Traveller's Conservation Copy Stand (also called the Grazer Traveller. The system includes a specialized protective case for convenient transportation. The device comes with a customization feature for book binding and edge photography through the combination of foam with a mirror. The Traveller's Conservation Copy Stand served at the St. Catharina Church crypt in Maaseik during December 2015 to digitize the Codex Eyckensis which represents the eighth-century Gospel and the oldest illuminated book from Belgium, the Netherlands and Luxembourg.[27]

The Library of Congress National Digital Information Infrastructure and Preservation Program (NDIIPP) and the National Archives and Records Administration's Electronic Records Archive (ERA) represent two of the major initiatives. These projects seek to create extensive digital collections that will preserve and make available vital historical materials and objects.[28] The Yemeni Manuscript Digitization Initiative serves as a successful cultural preservation project that academic institutions organized to show how collaborative efforts can work in the digitization landscape.

[23] Brian Ogilvie, "Scientific Archives in the Age of Digitization," *Isis* 107, no. 1 (2016): 102–108.
[24] Missouri University of Science and Technology, "Digitization Services: Digitization Best Practices," accessed April 23, 2025, https://libguides.mst.edu/c.php?g=335435&p=2256780.
[25] Jonathan L. Zecher, "Digital Technologies Have Made the Wonders of Ancient Manuscripts More Accessible than Ever, but There Are Risks and Losses Too," *The Conversation*, February 8, 2024, accessed April 23, 2025, https://theconversation.com/digital-technologies-have-made-the-wonders-of-ancient-manuscripts-more-accessible-than-ever-but-there-are-risks-and-losses-too-221869.
[26] Raha Rafii, "Digitizing Manuscripts from Southwest Asia: Access, Ethics, and Sustainability," *The Ancient Near East Today* 11, no. 7, July 2023, accessed April 23, 2025, https://www.asor.org/anettoday/2023/07/digitizing-manuscripts-southwest-asia.
[27] Ilse Korthagen et al., "Checklist for the Digitisation of Manuscripts," in *Digitisation of Manuscripts* (University of Amsterdam, KU Leuven Libraries, 2019), 5-42.
[28] Thomas Rieger et al., eds., *Technical Guidelines for Digitizing Cultural Heritage Materials: Third Edition* (Washington, D.C.: Library of Congress, U.S. National Archives and Records Administration, and Image Science Associates, 2023), pp. iii- iv.

Scope and Methodology

The research study presents a multi-stage methodology for building a semantic database from 10 Malay medical manuscripts spanning the 18th to 19th centuries which included [*Kitab Macam-macam Khasiat, MS 33 for 4 vol, MSS 1754, MSS 1653, MSS 2366, OR1714 and MSS 2999*]. The project implements ontology engineering with Protégé support while using philological analysis and interdisciplinary focus group discussions (FGDs) to create a digital knowledge framework for traditional Malay-Islamic medicine. The method combines Islamic epistemology with Malay heritage alongside contemporary knowledge representation tools to protect and enable searching of extensive textual data from classical Jawi manuscripts. The project launched a transliteration and semantic mapping initiative based on Protégé ontology modeling to address this need. The research aimed to convert essential concepts from these manuscripts into a digital knowledge base which could be searched through religious and medical frameworks. The initial phase concentrated on gathering a strategic collection of ten historical Malay medical manuscripts. The selection process relied on four criteria: the manuscripts needed to be legible and have complete themes with Islamic content and good preservation status. The manuscripts originated from three reliable institutions which included Perpustakaan Negara Malaysia (PNM), Perpustakaan Uni.Malaya and National Library Board, Singapore. The team recorded metadata for each manuscript which included title information alongside estimated century of origin and regional source and page numbers and script characteristics. The collected corpus served as the base for extracting linguistic elements and thematic content and epistemological information. The second phase required manual Jawi text translation into Romanized Malay. The interpretation process needed attention to traditional script elements and orthographic inconsistencies as well as context-based spelling rules. The transliteration followed Dewan Bahasa dan Pustaka guidelines and MS ISO 233 Arabic transliteration standards while verifying results through classical Arabic dictionaries and Malay commentary works from the past. The transliterated texts received structured document file treatment which maintained original page references for future semantic linking purposes.

The third step focused on extracting semantic data from the corpus. This process involved a hybrid approach:
  i.   Manual reading and thematic tagging of terms related to diseases, symptoms, treatments, rituals, and religious invocations.
  ii. Software-assisted coding using NVivo, where terms were grouped under initial nodes such as *Penyakit, Bahan Herba, Rawatan, Adab Etika, Simptom, and Preskripsi.*

The stage resulted in a first-stage keyword taxonomy containing more than 150 terms which were linked to manuscript title and context of appearance and frequency. A structured FGDs were conducted to guarantee conceptual validity and cultural accuracy, and each session included a multidisciplinary panel:
  i.   Two Islamic manuscript scholars
  ii. One expert in Malay ethnomedicine
  iii. One Tibb Nabawi specialist

The sessions analyzed how to define and organize and connect essential terms. The term "*angin jahat*" received analysis in both religious and physical aspects. The group created subcategories which included Amalan Spiritualitas, Pantang Larang and Diagnosa Tradisional. The FGD results underwent transcription and summarization before the classification model received updates to include detailed local and Islamic interpretations. The fifth stage began after validating terms by using Protégé 5.x to construct the semantic ontology model. The ontology used OWL (Web Ontology Language) and consisted of:

  i.   Core classes: Penyakit, Rawatan, BahanHerba, Amalan, Simptom, Doa, RujukanTeks
  ii.   Object properties: merawat, menyebabkan, disebutDalamManuskrip, berkaitDenganHerba
  iii. Individuals: Extracted terms (e.g., barah, kunyit, mandi wap) assigned to appropriate classes

Each term received annotations that included manuscript source information along with page references and contextual notes and cross-referenced synonyms. For example:

Individual: demam
 Class: Penyakit
 hasSymptom: badan panas
 dirawatDengan: air rebusan daun gelenggang
 disebutDalamManuskrip: Kitab Tib Melayu ms. 21

In the final phase, the ontology was tested for logical consistency and usability. Sample SPARQL queries were run to evaluate information retrieval:
 i.   "Cari semua rawatan untuk bisa ular"
  ii.   "Senaraikan herba yang berkaitan dengan panas dalam"

The experts who participated in previous FGDs reviewed and validated the outputs and suggested refinements such as clearer disambiguation for terms with multiple meanings (e.g. kunyit as ffood vs.medicine).

Result and Discussion

The project started by establishing the ontology framework through WebProtégé which operates as an open-source ontology editor accessible online. Through this platform users could develop ontologies while managing them and sharing them with authorized contributors. The interface (Figure 1) displayed the Malay Medical Manuscripts project together with other domain-specific ontologies. The examination of texts along with their classification system revealed important information about medical practices and knowledge contained in the manuscripts. The ontology editor tools enabled complete classification of treatments together with medicinal plants and medical procedures. The ontology model received real-time updates from team members and experts and developers through its online accessibility during the keyword classification and FGD validation phases.

Figure 1: WebProtégé Interface Displaying Ontology Project Listing for Malay Medical Manuscripts
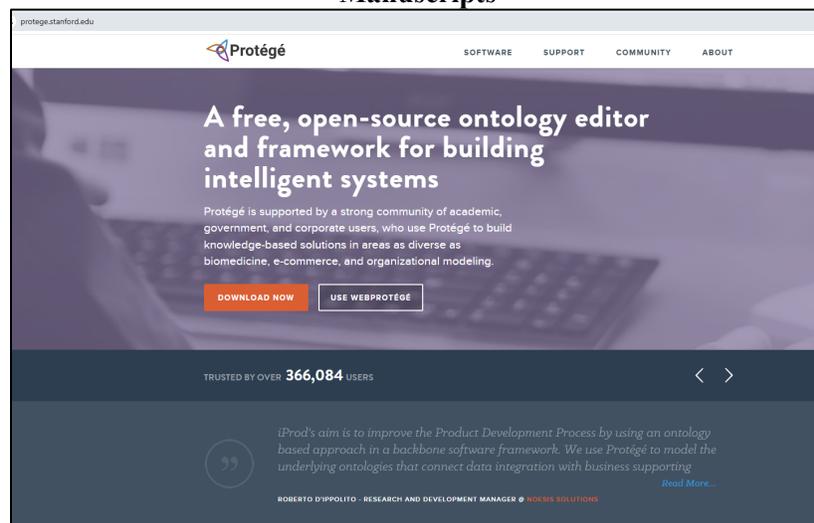
The transliteration process for each manuscript ended at Figure 2 before subclasses were established under Kitab_Tib. The ontology development followed a top-down method which starts with defining broad concepts (classes) before adding progressively more detailed subclasses and instances. The approach matches the structure of manuscript domain knowledge which starts with broad categories (Kitab Tib, Khasiat, Perubatan) before moving to specific details (herbs, diseases, prescriptions, rituals). The field of knowledge representation provided semantic hierarchy principles for implementation. The ontology

structure included classes and subclasses which both represented manuscript thematic divisions and established logical inheritance relationships to enable reasoning (e.g., X as a subclass of Materia Medica requires it to be a medicinal substance).

The domain of all included Malay medical knowledge received its highest classification as Kitab_Tib. The root class Kitab_Tib functions as the container for all medical and ethical and therapeutic and ritual information extracted from the full collection of traditional texts under analysis. The major and minor subclasses of Kitab_Tib maintain a hierarchical structure which creates a consistent model structure and enables unified querying across the complete manuscript collection.

The manuscripts received their archive codes (e.g. Kitab Macam-macam Khasiat, MSS2502) before being organized into standardized thematic categories for semantic classification of the content. Six major classes were identified and constructed, each representing a key conceptual dimension of traditional Malay medical knowledge. Their construction was based on two main sources: (1) content extracted from transliterated manuscripts, and (2) validation through Focus Group Discussions (FGD) involving Islamic scholars, traditional healers, and ontology experts.

MACAM_MACAM_KHASIAT (Various Benefits and Properties)
The class unites therapeutic properties and health benefits which herbs and treatments provide. The class needed its own definition to separate the substances used from their therapeutic applications. The antiseptic property of turmeric results in its appearance in the ontology under both Materia_Medica_MMK and MACAM_MACAM_KHASIAT.

Adab_dan_Etika_Makanan_MMK (Ethics and Etiquette of Food)
The course examines ethical food intake principles presented in manuscripts. The majority of texts included spiritual and religious guidance about food choices which depended on health and akhlak (character). The class includes dietary restrictions together with food recommendations and nutritional guidance presented through religious perspectives.

Kondisi_Pesakit_MMK (Patient Conditions)
The state of the patient can be evaluated through this essential category which separates between the diseases themselves (Penyakit_MMK) and patient-specific contextual description chronic vs. acute, weak vs. energetic, spiritual disturbance vs. biological symptoms.

Materia_Medica_MMK (Medicinal Substances)
This is one of the most content-rich classes. It includes all ingredients—herbal, mineral, and animal-based—used in treatments. The decision to isolate this class allows for precise indexing of substances and their sources. For example, halia, madu, and serai wangi are categorized here, often with references to their corresponding therapeutic roles.

Penyakit_MMK (Diseases)
The class contains explicit labels for illnesses which appear in the texts. The class enables thematic medical subclassification into penyakit kulit (skin conditions), masalah penghadaman (digestive issues), or sawan (seizures). The separation allows for disease-based querying and mapping against treatments.

Sukatan_dan_Timbangan_MMK (Measurements and Dosage)
Traditional medicine includes specific instructions about the precise amount of medication needed. The class contains information about measurement units (*kati, cupak, tahil*) and dosage forms (*powder, decoction, paste*). The documentation includes information about preparation duration and application timing as well as application methods.

This structuring ensured data consistency across all manuscripts while maintaining their individuality in the hierarchy.

Figure 2: Creation of Subclasses for Each Malay Medical Manuscript in Protégé
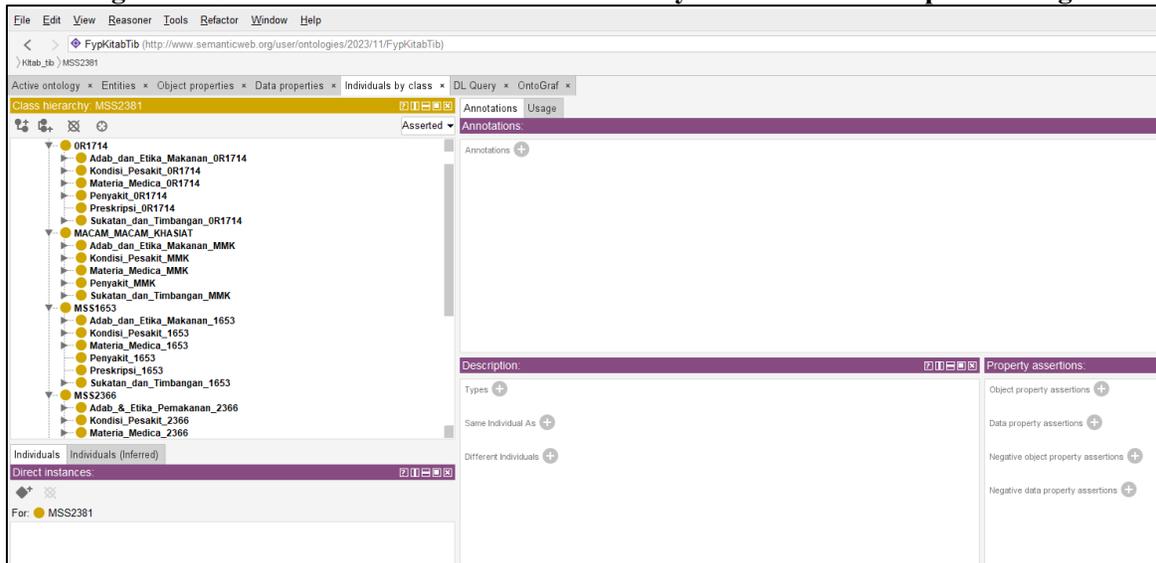
The ontology class hierarchy in Figure 3 shows a detailed structure under MACAM_MACAM_KHASIAT. The class contains particular instances such as Kondisi_Pesakit_1653, Materia_Medica_1653 and Penyakit_1653. Each instance corresponds to real data entries from the manuscript MSS1653, which shows that ontology development was closely tied to textual extraction and transliteration outcomes. This mapping reflects not only the manuscript's structure but also the knowledge system embedded in its content, preserving both textual and semantic value.

Figure 3: Individuals by Class View Representing Instances of Data Extracted from Manuscripts
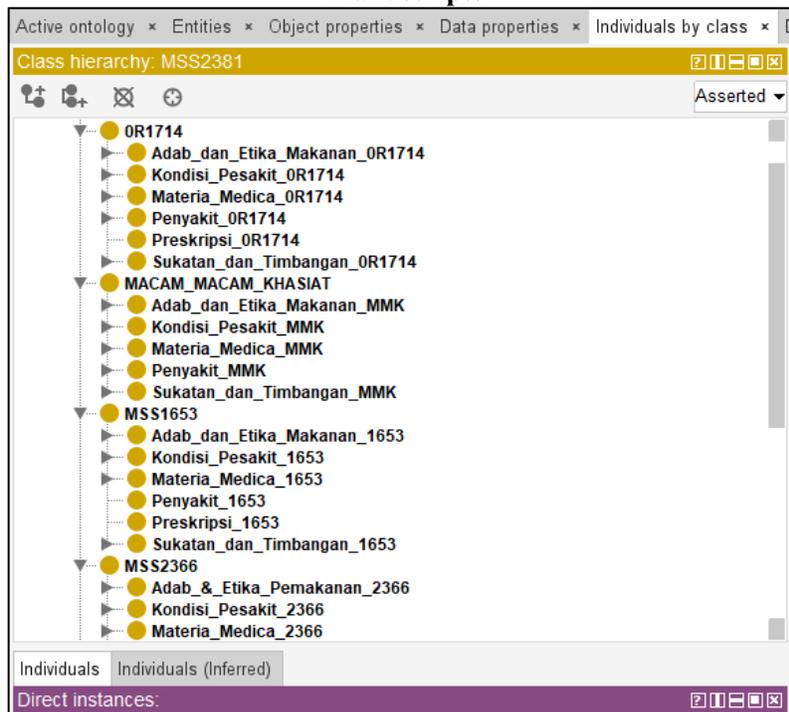
Each major class was expanded into subclasses based on recurring categories observed across the manuscripts. For example:

- Penyakit_MMK was subclassed into:
    - Penyakit_Kulit
    - Penyakit_Paru
    - Gangguan_Akal
- Materia_Medica_MMK was subclassed into:
    - Tumbuhan (Plants)
    - Mineral
    - Produk_Haiwan (Animal-derived)
- MACAM_MACAM_KHASIAT included:
    - Anti-radang (Anti-inflammatory)
    - Pelancar_darah (Blood circulation)
   - Penguat_tenaga (Vitality enhancer)
    -

The subclasses contained actual instances of people who were identified through the extraction of terms from the manuscripts (e.g. *kunyit, madu, penyakit kuning, angin dalam badan*). The individuals were connected to the manuscript and the context. The OntoGraf plugin (Figure 4) enables users to view the ontology as a network of classes and individuals that are connected to each other. In this figure, the central node OR1714 has its branches that show the relationships with Herba, Adab, Kondisi, and Preskripsi.

This graphical model:
- Aids in understanding the hierarchical structure and object properties
- Allows researchers to trace knowledge flows, e.g., from disease → treatment → herb
- Provides visual validation that individuals are correctly linked within major classes

The layout is semantically meaningful, illustrating a robust categorization that is machine-readable and researcher-friendly.

Figure 4: OntoGraf Visualization of Class and Instance Relationships for Sukatan_dan_Timbangan_OR1714
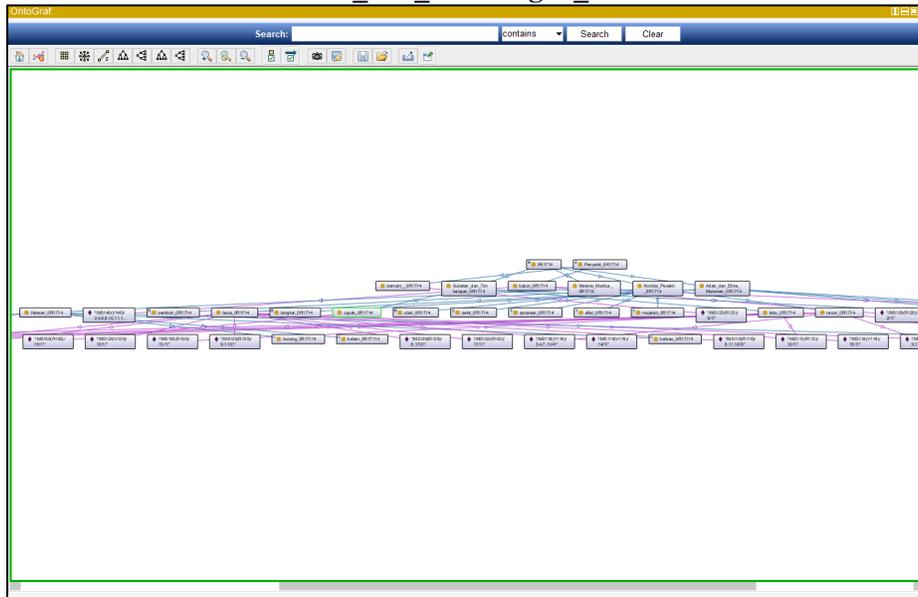
The figure presents a semantic network which was derived from the Malay medical manuscript OR1714. It illustrates the relationships between the main concepts, treatments, substances, diseases and traditional measurement units that are recorded in this manuscript. The visualization has OR1714 at its center which represents the particular Malay medical manuscript that is being analyzed and semantically encoded. The

various classes and instances are linked to this root node through logical object properties to form a well-structured ontology. Several high-level categories are directly linked to OR1714 which correspond to the major semantic classes previously constructed:

**Table 1: Core Ontology Classes and Their Functions in
the Malay Traditional Medical Knowledge Base**

Class Node	Function
Penyakit_OR1714	Represents diseases (e.g., *demam, batuk*)
Sukatan_dan_Timbangan_OR1714	Includes traditional measurement units (*cupak, biji*)
Materia_Medica_OR1714	Lists medicinal ingredients and materials (*labu, akar*)
Kondisi_Pesakit_OR1714	Documents patient conditions or symptoms (*sakit, sembuh*)
Preskripsi_OR1714	Treatments and formulations (*ubat_OR1714*)
Adab_dan_Etika_Makanan_OR1714	Ethical/ritual practices in food and healing (*mantera, azimat, tangkal*)

The development of this Ontology improves traditional medical knowledge accessibility through digital repositories that are structured and searchable and logically organized. Researchers use Protégé ontology engineering tools to transform Malay medical manuscript core concepts into a knowledge base which aligns with religious and medical frameworks. The structured approach enables the development of connections between different elements including diseases and symptoms and treatments and herbal remedies. The ontology contains fundamental classes including '*Penyakit*' (diseases), '*Rawatan*' (treatments) and '*BahanHerba*' (herbal ingredients) which are linked through established relationships. Users can follow knowledge paths starting from diseases and continuing to treatments and herbs to gain a complete understanding of traditional medical practices.

Conclusion

The research achieved successful translation of historical manuscript content into a modern structured ontology through Protégé by following transliteration and semantic tagging and expert validation procedures. The research revitalizes ancient Malay medical manuscripts through their precise digital preservation process. The combination of Jawi text transliteration with remedy semantic tagging and traditional healer validation through Protégé resulted in an active digital repository. The OntoGraf interactive tool converts historical medical knowledge into visual maps which show the relationships between medicinal plants and their therapeutic applications and disease treatments. This work protects cultural heritage through its technological achievement while making it useful for current needs. The digital archive protects manuscripts from decay while breaking down language barriers that previously restricted access to this wisdom. Researchers can track how fever remedies have developed across time periods and discover medicinal plants that have been lost through simple computer interactions. The project maintains respect for traditional knowledge through ethical frameworks which both protect against exploitation and promote responsible knowledge sharing. The system benefits healers who maintain ancestral practices as well as scientists who study herbal compounds and communities who want to reconnect with their heritage.

Acknowledgement

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Chee Heng Leng, "Health Status and the Development of Health Services in a Colonial State: The Case of British Malaya," *International Journal of Health Services* 12, no. 3 (1982): 397–417.

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