

# Expert evaluation of the traditional Malay Medicine Kitab Tib Melayu database

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## ABSTRACT

*The Traditional Malay Medicine Kitab Tib Melayu Database (TMM-KTMDB) was developed to digitally preserve, organise, and systematise Traditional Malay Medicine (TMM) knowledge from historical manuscripts. For a digital resource to be credible and usable across research, education, and policy contexts, its usability, reliability, and data accuracy must be evaluated. Expert feedback testing was conducted using two instruments: a task assignment and a feedback questionnaire. Quantitative responses were analysed using section scores and an overall score to assess usability across system components. Qualitative feedback was examined through thematic interpretation, focusing on polarity and themes including usability, system functionality, content quality, and information accuracy. Task-based testing demonstrated excellent usability across the search engine, guest accessibility, system functionality, and repository application, with overall scores ranging from 86% to 100%. Thematic analysis identified content and information quality (92.6%) and system functionality (50%) as major strengths. Weaknesses centred on search functionality (64.3%) and glossary clarity (21.4%). Opportunities were noted for content expansion (71.4%) and support features. The findings affirm TMM-KTMDB as a functional and content-rich digital knowledge system while highlighting areas for improvement in information retrieval, glossary development, and interface design. From a library and information science (LIS) perspective, structured expert evaluation supports validation of organisation, accessibility, and trustworthiness. The evaluation indicates that TMM-KTMDB aligns with expectations for a reliable digital resource for Traditional Malay Medicine. Continued refinement will further strengthen usability, accuracy, and relevance for research, education, clinical practice, and policy within the medical and health sciences domain.*

**Keywords:** Traditional Malay medicine; Database; Expert feedback.

## **INTRODUCTION**

The preservation and management of traditional medicine knowledge present a longstanding challenge (Kalbande & Suradkar, 2021; Reyes-García et al., 2021), particularly in information organisation, digital preservation, and database evaluation. Traditional medical knowledge is often dispersed across manuscripts, oral traditions, practitioner memories, and heterogeneous textual sources, resulting in inconsistent structure, limited discoverability, and a high risk of information loss (Fredriksson, 2023; Jiashuo et al., 2022).

Within this broader context, this study evaluates the Traditional Malay Medicine Kitab Tib Melayu Database (TMM-KTMDB), a digital platform developed to gather and consolidate dispersed Traditional Malay Medicine (TMM) information that is inconsistently documented and at risk of loss. The purpose of this study is to assess the TMM-KTMDB through structured expert feedback, focusing on its usability, search engine performance, guest access, system functionality, repository interaction, and information quality. The study aims to determine whether the database functions effectively as a digital resource for TMM knowledge and to identify its strengths, weaknesses, and opportunities for improvement. Through this assessment, the study examines how well the system supports user needs and where refinement is required to enhance its value for research use.

The significance of this study lies in its contribution to the evaluation of a digital repository for traditional medicine, rather than in the documentation of TMM itself. The study addresses a gap in the usability evaluation of digital repositories that organise complex, culturally grounded medical knowledge by conducting a structured, expert-based assessment of the TMM-KTMDB. Beyond system-level evaluation, the research contributes to LIS theory and methods by extending usability evaluation into the domain of knowledge organisation and digital repositories for traditional knowledge, where expert mediation and provenance-sensitive representation are central. By combining task-based interaction with structured expert feedback, the study demonstrates how SUS-informed usability assessment can be methodologically adapted to evaluate not only interface usability but also the organisation, accessibility, and interpretability of networked traditional knowledge systems. The findings offer methodological guidance for the evaluation of similar repositories and support the development of sustainable, user-centred digital resources for research, education, and policy contexts.

## **LITERATURE REVIEW**

### **Traditional medicine database**

Traditional medicine includes indigenous health practices, herbal remedies, and holistic healing systems passed down through generations. Examples include Ayurveda, Traditional Chinese Medicine (TCM), Traditional Malay Medicine (TMM), and other indigenous practices. Although rooted in culture, these practices have significant potential in modern healthcare, particularly for disease prevention and natural therapies. However, much of this knowledge remains scattered across manuscripts, oral traditions, and fragmented texts, putting it at risk of being lost (Pandur, 2023). Digitising traditional medicine and creating centralised databases are essential to preserve it, improve accessibility, and support scientific validation. These efforts protect cultural heritage and help connect traditional practices with modern evidence-based healthcare.

In TCM, several notable databases have been developed to digitise and modernise traditional knowledge using network pharmacology approaches. The LTM-TCM database is a comprehensive network pharmacology platform that bridges traditional and modern medical approaches by providing detailed molecular and phenotypic analyses (Li et al., 2022). Through the LTM framework, classical Chinese medical knowledge is systematically extracted, digitised, and restructured within a modern biomedical database. Similarly, DCABM-TCM demonstrates how traditional knowledge can be transformed into a specialised digital resource, focusing on the complex network of blood constituents in TCM prescriptions (Liu et al., 2023). Other notable TCM databases have also applied network pharmacology approaches: IGTCM emphasises genome annotation of TCM-related herbs (Ye et al., 2023), while BATMAN-TCM explores herb–protein interactions (Kong et al., 2023). These initiatives, summarised in Table 1, collectively illustrate the progress in digitising traditional medicine knowledge into structured, research-ready repositories. The Traditional Knowledge Digital Library (TKDL) is a national initiative developed by the Government of India to document and protect traditional medical knowledge such as Ayurveda, Unani, Siddha, and Yoga. It organises knowledge from classical texts into a structured, standardised database and links traditional concepts to modern systems such as the International Patent Classification to prevent misappropriation and patenting of traditional knowledge.

Table 1: Traditional medicine databases and their status

Traditional Medicine	Status	Databases
<b>Chinese</b>	It features extensive, well-regarded databases encompassing a wide range of fields and reflecting modern medical perspectives, offering a comprehensive resource.	<ul style="list-style-type: none"> <li>• LTM-TCM (Li et al., 2022),</li> <li>• DCABM-TCM (Liu et al., 2023),</li> <li>• IGTCM (Ye et al., 2023),</li> <li>• BATMAN-TCM (Kong et al., 2023)</li> </ul>
<b>India (Ayurveda)</b>	It safeguards India’s extensive traditional medical knowledge, a rich tapestry of practices and remedies, from exploitation through patents and misappropriation (Fredriksson, 2023).	TKDL (Fredriksson, 2023)

For the time being, there is no dedicated integrated database for Malay medicine. Thus, TMM-KTMDDB is conceptualised and designed to connect distributed knowledge sources, curate, structure, visualise, and preserve Traditional Malay Medicine (TMM) knowledge through structured data models, standardised terminology, controlled dictionaries, and explicit source attribution linked to authoritative manuscripts and related studies. At its current stage, TMM-KTMDDB contains 433 formulations and 336 medicinal ingredients derived from 10 published Malay medical manuscripts, also termed *kitab tib*. These are handwritten codices composed in the Malay language using Jawi script and at least one hundred years of age. Their provenance spans regions including Aceh, Pontianak, the Malay Peninsula, Riau, and Pattani, collectively reflecting the shared medical knowledge and cultural heritage of the Malay civilisation. In this study, manuscript data related to four COVID-19 cardinal symptoms were used as a focused use case for system assessment.

As with any knowledge-based information system, particularly those managing culturally sensitive and health-related content, the effectiveness of a digital repository depends not only on the accuracy of its content but also on system usability, clarity of information presentation, and accessibility for intended users (Li et al., 2021; Feng et al., 2024; Ye et al., 2023). Within usability and user-centred design research, expert validation and structured feedback provide a rigorous means of evaluating complex repositories where specialised knowledge is mediated through digital interfaces (van Haasteren et al., 2019). Accordingly, the expert feedback testing for TMM-KTMDB constitutes a critical stage in assessing the repository's usability, structural data, and user interaction, ensuring that the system effectively supports information access, navigation, comprehension, and task completion.

### **Expert feedback**

In the case of TMM, developing TMM-KTMDB requires not only careful curation of textual, codified knowledge but also validation through expert feedback. Beyond technical validation, expert feedback strengthens user trust by demonstrating that the application is grounded in credible knowledge and professional oversight. To systematically capture these insights, conducting a usability study supported by standardised scales is essential (Hahn et al., 2024). Usability studies provide a structured way to evaluate how effectively and efficiently users interact with the system, while scales offer quantifiable measures of user satisfaction, clarity, efficiency, and accessibility (Wang et al., 2022). When combined with qualitative feedback, these evaluations translate professional insights into actionable improvements, ensuring that health-related apps are not only scientifically accurate but also intuitive and user-friendly.

Expert feedback, usability testing, and standardised scales are not merely technical validation, but a collaborative process that invites informed critique and constructive evaluation. This ensures that the TMM-KTMDB database does not simply digitise knowledge, but does so in a way that is respectful, reliable, and meaningful to the communities it represents and the users it intends to serve, prioritising accurate, scientifically backed data and trustworthiness.

## **METHODS**

This study adopts an integrative methodological approach to evaluate the TMM-KTMDB as a digital knowledge-based system. Expert feedback evaluation methods adapted from mHealth usability research are employed (van Haasteren et al., 2019), given the functional parallels between mHealth platforms and TMM-KTMDB as digital medical tools. Additionally, usability principles from established TCM databases serve as comparative reference points for traditional knowledge system assessment, while ethnobotanical concepts inform relational mapping between formulations, ingredients, and preparation methods. For focused system evaluation, the dataset analysed was limited to four COVID-19-related cardinal symptoms: cough, phlegm, shortness of breath, and fever. The study does not assess medical efficacy but evaluates how TMM knowledge is digitally stored, accessed, structured, and presented, aligning with core LIS concerns regarding knowledge organisation and information access. The assessment is structured around two primary dimensions: content quality and system usability. Content evaluation considers clarity, consistency, terminology, search functions, and network representations. Usability evaluation examines navigation intuitiveness, search and retrieval efficiency, and interface design clarity.

To ensure a comprehensive evaluation, the study incorporated expert feedback from multiple disciplines, including modern healthcare, traditional medicine research, medical regulation, academia, drug patenting, and digital standards. Expert feedback was collected through structured usability walkthroughs and questionnaires and applied iteratively, with findings from each phase informing subsequent refinements to the system. This iterative process supported continuous improvement of the TMM-KTMDB.

A mixed-methods data collection approach was adopted, combining quantitative analysis of structured feedback with qualitative insights from open-ended expert responses. This method is widely used in the evaluation of digital health systems and knowledge-based repositories, where expert judgement is essential for assessing usability and structural adequacy. To support systematic implementation, the Expert Feedback Testing Technique (EFTT) was organised into eight phases (Figure 1): expert selection, preliminary engagement, evaluation design, pilot testing, feedback collection, data analysis, validation of findings, and a follow-up phase. Based on the results, necessary adjustments and improvements were made, followed by a follow-up phase to monitor progress and maintain continuity.

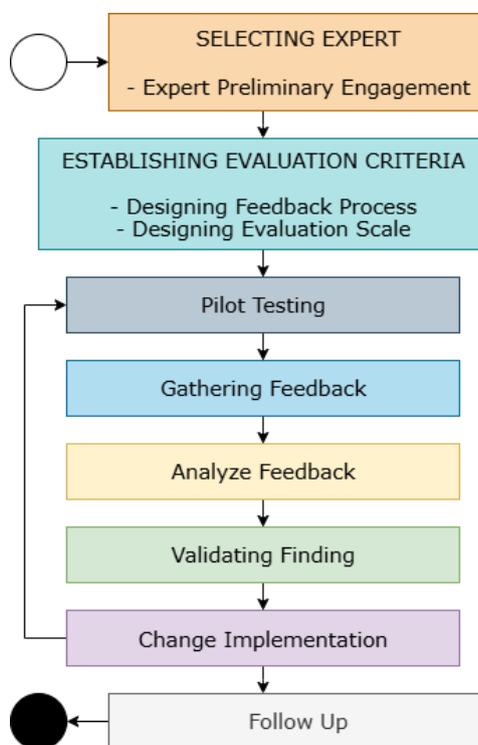


Figure 1: Eight phases of expert feedback trust testing method

### **Expert selection**

A purposive sampling approach was used to select experts with specialised knowledge relevant to TMM, ensuring that participants had appropriate professional experience, academic background, or practitioner-level expertise. Experts were identified through selected organisations known for their relevant expertise. Eligibility criteria included professional experience in at least one of the following areas: modern healthcare, traditional medicine, medical regulation, or medicine and drug patenting. For this study, nine experts from various organisations and five academic researchers from three Kulliyah (faculties) at IIUM were successfully recruited. Their diverse backgrounds provided valuable insights. Table 2 presents a detailed list of experts in the field. Before conducting the EFTT sessions, a

preliminary expert engagement was carried out with selected organisations to gather early input on the proposed framework. This stage involved introductory meetings, framework presentations, and initial feedback discussions aimed at assessing relevance, clarity, and practical applicability. Expert feedback testing serves a dual purpose: (1) to familiarise experts with the TMM-KTMDB database through structured task-based interactions, and (2) to collect detailed feedback based on their observations, experience, and organisational requirements.

Table 2: List of experts for EFTT

Focus group	Expert
Non-academic researcher	3
Patent agent	2
Policy maker	2
Pharmaceutical regulator	3
Academic researcher	5
Total	15

**Establishing evaluation criteria**

**First set: task assignment (refer to Appendix 1)**

This section comprises guided task assignments requiring experts to interact directly with the TMM-KTMDB platform. The tasks simulate real-world usage and provide hands-on experience with system functionality, data organisation, and usability, enabling informed and contextual feedback. The task-based evaluation approach is adapted from usability and expert assessment studies in medical and health information systems by van Haasteren et al. (2020). Tasks were organised into four evaluation areas: UI/UX, guest accessibility, database features, and knowledge application. The first three areas used closed-ended yes/no questions to capture measurable system performance, while the knowledge application section used open-ended questions to assess how well experts could apply database information in practical contexts. This structure enabled evaluation of both usability and functional capability, as well as support for meaningful knowledge use.

**Second set: expert feedback (refer to Appendix 2)**

Following the task-based interaction, experts provided their evaluations using a structured feedback form designed to capture both quantitative ratings and qualitative insights. This stage collected expert opinions based on professional background and domain knowledge to assess system usability, relevance, data credibility, and potential areas for improvement and application. The feedback form consisted of seven sections covering UI/UX, system functionality, overall usability, perceived usefulness, potential application areas, and an evaluation of strengths and weaknesses. All sections except the final one used a five-point Likert scale (1 = Strongly Agree to 5 = Strongly Disagree) to capture structured expert perceptions. The final section included open-ended questions to allow detailed qualitative feedback on weaknesses, strengths, and opportunities for improvement. These two tasks provided both a structured technical assessment and a holistic expert-driven evaluation, ensuring that the database was reviewed from multiple perspectives. The detailed breakdown of both tasks and their respective sections is presented in Table 3.

Table 3: Task assignment and expert feedback evaluation criteria

Task	Objective	Focus	Question type	Total task
<b>Task assignment</b>	To expose experts to the practical aspects of TMM-KTMDB and help them understand its scope, data organization, usability, and core functionalities.	UI/UX Effectiveness (Search Engine)	Closed (Yes/No)	7
		Guest Accessibility	Closed (Yes/No)	3
		User interface and experience (UI/UX) (functional)	Closed (Yes/No)	8
		Repository application	Open-ended	6
<b>Expert feedback</b>	To gather critical feedback based on the expert's professional background, domain knowledge, and organizational context, with the aim of identifying areas for improvement, validation of data credibility, and potential use cases.	General user interface and experience (UI/UX)	Closed (Likert Scale)	8
		Objective, functionality and accessibility	Closed (Likert Scale)	3
		Usability and usefulness	Closed (Likert Scale)	13
		Uses of the database	Closed (Likert Scale)	6
		Database strengths	Open-ended	1
		Database weaknesses	Open-ended	1
Database opportunity	Open-ended	1		

**Evaluation scale**

Usability of the Expert Feedback Task/Test (EFTT) was evaluated using the Expert Feedback Usability Scale (EFUS), adapted from the System Usability Scale (SUS) (Adilla et al., 2022) and refined with selected elements from the expert trust model proposed by You et al. (You et al., 2024). The scale retained the core SUS structure, with items rephrased to suit the EFTT context and alternating positive and negative statements to reduce response bias. Task assignments used a true/false scale, while expert feedback used a five-point Likert scale. Responses were classified as positive, neutral, or negative and scored as 1, 0.5, and 0 points, respectively. Scores were aggregated and normalised to produce a Section Score (Section-Score), expressed as a percentage to enable comparison across participants and tasks. The calculation is presented in Equation 1 below (adapted from Adilla et al., 2022):

$$Section\_Score = \frac{\sum(P_i + N_i)}{T} * 100$$

Where:

- $i$  = section number
- $P_i$  = score assigned to positive responses
- $N_i$  = score assigned to neutral responses
- $T$  = total number of participants/experts
- Negative responses = **0 mark** (not included in the sum)

Equation 1: Section\_Score for TMM-KTMDB usability grading

Finally, section scores were aggregated to compute the Overall Score (Overall-Score) for both the task assignment and expert feedback questionnaires. The Overall Score was calculated by averaging the Section\_Scores across tasks and converting the result into a percentage to enable comparability, as shown in Equation 2 (adapted from Adilla et al., 2022):

$$Overall\_Score = \frac{\sum Section\_Score_i}{S * 100} * 100$$

Where:

- *Section\_Score<sub>i</sub>* = the Section-Score for section *i*
- *S* = total number of tasks in the section

Equation 2: Overall score for TMM-KTMDB usability grading

For interpretation, percentage scores were classified into usability levels according to the models proposed by Adilla et al. (2022) and Permana et al. (2024), with higher scores indicating stronger expert consensus on usability and applicability, and lower scores highlighting areas for improvement. This aggregation and classification process produced the usability scale, which translates task performance and expert feedback into clear, quantifiable usability measures, as shown in Table 4.

Table 4: The usability scale adopted from Adilla et al. (2022)

Percentage	Grade of usability	Remark
86–100%	Excellent	Optimal usability
76–85%	Good	Adequate usability
56–75%	Fair	Requires improvement
Below 55%	Poor	Unsatisfactory usability

**Thematic analysis**

As the evaluation included both closed-ended and open-ended questions, additional analysis was conducted for qualitative responses using two complementary approaches. For the Task Assignment questionnaire, open-ended responses were classified as positive or negative based on whether they met the expected outcomes. Following the polarity-based thematic approach described by Olagunju et al., (2020), responses aligned with the intended answers were coded as positive, while others were coded as negative. These classifications were then quantified using the Section Score to ensure consistency with the Overall Score calculation.

For the Expert Feedback questionnaire, three open-ended questions were analysed qualitatively to capture the depth of expert perspectives. A thematic analysis approach was applied (Iren et al., 2023; Meduri et al., 2025), involving systematic coding and categorisation of responses. Feedback was first coded into broad dimensions such as usability, functionality, content quality, and applicability, after which recurring patterns were grouped into higher-level themes. This process enabled structured interpretation of expert insights and informed system improvement and future development strategies.

## RESULTS AND DISCUSSION

A total of 15 experts participated in the feedback process. They were selected based on relevant professional expertise, institutional affiliation, educational background, and familiarity with Traditional Malay Medicine and health informatics. A summary of the expert participants is provided in Table 5.

Table 5: Summary of experts

Expert ID	Position of expert	Field of expertise	Task assignment	Expert feedback
E1	Patent Examiner	Biotechnology	Submitted	Submitted
E2	Regulatory	Pharmacy	Submitted	Submitted
E3	Regulatory	Pharmacy	Submitted	Submitted
E4	Regulatory	Pharmacy	Submitted	Submitted
E5	Policymaker	Medicine	Submitted	Submitted
E6	Policymaker	Medicine	Submitted	Submitted
E7	Non-Academic Researcher	Pharmacy	Submitted	Submitted
E8	Non-Academic Researcher	Medicine	Submitted	Submitted
E9	Non-Academic Researcher	Botany	Submitted	Submitted
E10	Academic Researcher	Pharmaceutical Chemistry	Submitted	Submitted
E11	Academic Researcher	Pharmacy	Submitted	Submitted
E12	Academic Researcher	Microbiology	Submitted	Submitted
E13	Academic Researcher	Parasitology	Submitted	Submitted
E14	Academic Researcher	Biomedicine	Submitted	Submitted
E15	Patent Examiner	Biotechnology	Submitted	Not Submitted

One expert affiliated as a Patent Examiner (E15) did not complete the second questionnaire, which constituted the expert feedback component of the study. As the methodology required complete feedback across all stages to ensure consistency and comparability, this expert's data was excluded from subsequent analysis. This exclusion was procedural and intended to maintain the integrity and reliability of the findings, rather than reflecting on the expert's qualifications or expertise.

### **Task assignment: UI/UX effectiveness (search engine)**

The evaluation of the search engine UI/UX in TMM-KTMDB showed excellent Section-Scores across all tasks. For example, accessibility, search by symptom, ingredient, dosage form, route of delivery, and multiple filters each achieved a Section-Score of 100%. Only the search by method of preparation task recorded a slightly lower score, with 92.9% positive and 7.1% negative responses. When combined, the Overall-Score for this section was 99.0%, placing it in the "Excellent" category according to the usability grading criteria presented in Table 4. The summarised calculations are presented in Table 6.

Based on the Overall Score of 99% and its corresponding usability grade in Table 4, the results indicate that the TMM-KTMDB search engine demonstrates optimal usability and high effectiveness. The perfect Section Scores for most tasks suggest that the system supports

intuitive navigation and efficient information retrieval. Similar findings have been reported in evaluations of Spanish mHealth platforms (Hahn et al., 2024), where alignment between system structure and domain experts’ cognitive models supports intuitive navigation, search, and efficient retrieval. The slightly lower score for method of preparation searches points to a minor issue with terminology or categorisation, which may have caused small usability challenges. From an LIS perspective, this finding underscores the importance of controlled vocabularies, semantic standardisation, and transparent categorisation in reinforcing systems, especially in search engine optimisation (Stephen, 2020). Overall, the high Overall Score (99.0%) confirms that the search engine is an excellent usability feature, with only minor improvements needed for specialised queries, thereby supporting the system’s role as a credible digital infrastructure for traditional medical knowledge.

Table 6: UI/UX effectiveness on the TMM-KTMDB search engines

Elements	All		Section score (%)
	True	False	Score
TMM-KTMDB accessibility	14	0	100
TMM-KTMDB formulary search based on symptom	14	0	100
TMM-KTMDB formulary search based on ingredient	14	0	100
TMM-KTMDB formulary search based on method of preparation	13	1	92.9
TMM-KTMDB formulary search based on dosage form	14	0	100
TMM-KTMDB formulary search on route of delivery	14	0	100
TMM-KTMDB formulary search based on multiple filters	14	0	100
Calculation (Sum of section-score / (total number of questions * 100) *100)			(692.9/700) *100
Overall-score			99%
Grade of usability			Excellent

**Task assignment: guest accessibility**

The assessment of guest accessibility in TMM-KTMDB yielded consistently high results across all evaluated tasks. For example, the formulation information page, formulation information exploration, and material information limitation for guest users each achieved a Section Score of 100%, with all 14 evaluators confirming successful task completion. As all tasks received perfect scores, the Overall Score for this section was also 100%, placing it in the “Excellent” category according to the usability grading criteria in Table 4. The summarised calculations are shown in Table 7.

Based on the Overall Score of 100% and its corresponding usability grade in Table 4, the results indicate that TMM-KTMDB guest and formulation accessibility demonstrate optimal usability and high effectiveness. This outcome aligns with previous LIS, digital library, and health information system studies, including evaluations of large-scale traditional medicine repositories such as India’s Ayurveda Digital Library (Narayanan et al., 2025) and the Traditional Knowledge Digital Library (Fredriksson, 2023), which also employ tiered access and selective disclosure to protect sensitive knowledge while supporting public and scholarly use. From a UI/UX perspective, the formulation information pages are clear and accessible, while the material limitation function ensures that guest users cannot access restricted details. The Overall Score of 100% confirms the robustness of this feature, showing that experts considered guest accessibility to be both well-designed and user-friendly. This

indicates that TMM-KTMDB successfully supports general access without compromising data security.

Table 7: TMM-KTMDB guest accessibility

Elements	All		Section-score (%)
	True	False	Score
TMM-KTMDB formulation information page	14	0	100
TMM-KTMDB formulation info exploration	14	0	100
Material information limitation for Guest user	14	0	100
Calculation (Sum of Section-Score / (total number of questions * 100) *100)			(300/300) *100
Overall-Score			100%
Grade of Usability			Excellent

**Task assignment: UI/UX effectiveness (functional)**

The evaluation of functional UI/UX tasks in TMM-KTMDB revealed a combination of excellent and moderate performance. Five tasks – member access, ingredient botanical network, active compound network, protein network, and active compound network with protein – achieved very high Section-Scores, ranging from 92.8% to 100%, indicating strong usability in these areas. However, two tasks exposed usability gaps. The ingredient botanical arc network recorded a notably low Section-Score of 28.6%, with the majority of evaluators (71.4%) rating it negatively. Similarly, the active compound repository section achieved only 78.6%, which falls into the “Good” category according to the usability grading criteria in Table 4. When aggregated, the Overall-Score for this section was 86.6%, placing it within the “Excellent” category based on the usability grading criteria in Table 4, but with clear evidence of variability across tasks. The summarised calculations are presented in Table 8.

Table 8: UI/UX effectiveness on the TMM-KTMDB functionality

Elements	All		Section-score (%)
	True	False	Score
TMM-KTMDB Member Access	14	0	100
TMM-KTMDB Ingredient Botanical Network	14	0	100
TMM-KTMDB Ingredient Botanical Arc Network	4	10	28.6
TMM-KTMDB Active Compound Network	14	0	100
TMM-KTMDB Active Compound Network with Protein	13	1	92.8
TMM-KTMDB Active Compound Repository Section	11	3	78.6
TMM-KTMDB Protein Network	14	0	100
TMM-KTMDB Protein Repository Section	13	1	92.9
Calculation (Sum of Section-Score / (total number of questions * 100) *100)			(692.9/800) *100
Overall-Score			86.6%
Grade of Usability			Excellent

Based on the Overall-Score of 100% and its corresponding usability grade in Table 4, the evaluation indicates that TMM-KTMDB member access and several network-based features demonstrate optimal usability, reliability, intuitiveness, and strong alignment with expert expectations. This outcome is consistent with findings from other traditional medicine knowledge platforms such as LTM-TCM (Li et al., 2022) and TCM Bank (Lv et al., 2023), where

standardised entity relationships and clearly defined network structures enable intuitive interaction and reliable knowledge exploration. In contrast, the low performance of the ingredient botanical arc network highlights a well-documented challenge in network visualisation research, as overly complex or densely connected visual representations can hinder interpretability and user navigation if not carefully designed. Similar usability issues have been reported in compound–target and herb–compound networks within TCM databases (Kong et al., 2023; X. Li et al., 2023; Zheng et al., 2025), where insufficient visual hierarchy, unclear labelling, or limited interaction cues reduce user comprehension. For example, BATMAN 2.0 by Kong et al. (2023) avoids presenting all compound–target–herb relationships within a single network visualisation; instead, it separates the data into gene-centric, herb-centric, and ingredient-centric views to improve clarity and interpretability.

The overall score of 86.6% reflects a robust functional UI/UX foundation for TMM-KTMDB, but the variation across tasks demonstrates that usability is uneven. While most features operate at an “Excellent” level, the weaker-performing components highlight the need for targeted interface redesign and clearer visualisation strategies. To address this, future iterations of TMM-KTMDB will adopt a modular network visualisation approach similar to that used in BATMAN 2.0 (Kong et al., 2023), in which complex relationships are separated into formulation-centric, ingredient-centric, and target-centric views rather than being presented within a single network. This strategy is expected to reduce visual complexity, enhance interpretability, and support more effective exploration of botanical and biomedical relationships within the system.

#### Task assignment: repository application

The evaluation of repository application tasks, designed as open-ended questions, provided insights into how experts used TMM-KTMDB’s advanced features for problem-solving. Responses were coded through thematic analysis into positive and negative categories, forming the basis for the TPF-Score calculation. Three tasks – frequency of Halia Bara as a treatment for phlegm, best formulation for COVID-19, and formulation analysis – recorded Section-Scores of 85.7%, indicating generally strong but not complete effectiveness, as some evaluators (14.2%) gave incorrect or incomplete responses. In contrast, the remaining two tasks, COVID-19 receptor binding for Piperine and formulation analysis using multi-repositories, both achieved 100% Section-Scores, demonstrating that evaluators could consistently apply TMM-KTMDB’s repository features to generate correct responses. The Overall-Score for this section was 89.2%, placing repository application within the “Excellent usability” category according to the usability grading criteria in Table 4. The summarised calculations are presented in Table 9.

Table 9: TMM-KTMDB repository application

Elements	All		Section-score (%)
	True	False	Score
What is the frequency of Halia Bara as a treatment for phlegm?	12	2	85.7
What do you think is the best formulation for COVID-19 based on TMM-KTMDB data? (key in formulation number e.g. MSS2515.F.xx. xx)	12	2	85.7
What COVID-19 receptor can Piperine bind to?	14	0	100
Analyse these formulations using TMM-KTMDB. Discuss your analysis (e.g. Use fN-Index, iN-Index, protein & receptor repositories, etc.).	14	0	85.7
Calculation (Sum of Section-Score /			(357.1/400) *100

(total number of questions * 100) *100)	Overall-Score	89.2 %
	Grade of Usability	Excellent

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The findings show that TMM-KTMDB’s repository application is highly effective in supporting knowledge retrieval and applied analysis. The maximum Section-Scores (100%) for direct retrieval tasks, such as identifying receptor binding or formulation indices, highlight clear system logic, intuitive menu pathways, and reliable presentation of repository data. This performance suggests strong alignment between the database architecture, indexing model, and expert search behaviour, a trend also observed in established TCM (Chen et al., 2024; Huang et al., 2024) and Ayurveda digital repositories (Fredriksson, 2023; Narayanan et al., 2025), where entity-based indices and structured schemas support efficient use.

By contrast, lower scores for more interpretive or integrative tasks reflect a broader challenge common in traditional medicine systems (A. Wang et al., 2024), where users must synthesise information rather than simply retrieve it. From an LIS perspective, this shift represents a movement from retrieval-oriented usability to sense-making usability, which depends on stronger cross-linking, explanatory metadata, and visual aids to support interpretation (Mishra, 2023). Based on the Overall Score of 95.2% and its corresponding usability grade in Table 4, TMM-KTMDB performs at an optimal level, though improvements in guided support and visual tools would enhance performance on complex tasks.

**Expert feedback: general user interface and experience (UI/UX)**

Experts reported very positive feedback on several aspects of TMM-KTMDB. The ability to register and log in, and the system’s responsiveness, both achieved 100%, indicating no usability issues. Design consistency was also highly rated at 96.5%, while navigation between features, the intuitiveness of the user interface, and the overall visual appeal each scored 85.7%. Search functionality received 78.6%, and the lowest score was recorded for clarity of data presentation (60.7%). The Overall Score for this section was 86.6%, reflecting an excellent level of usability based on the grading criteria presented in Table 4. The detailed calculations are shown in Table 10.

Table 10: Expert feedback on general user interface and experience

Elements	SA	A	N	Section-Score (%)
I can register and log in to TMM-KTMDB.	14	0	0	100
I can search for specific data in TMM-KTMDB.	5	4	2	78.57
I can easily navigate from one feature to another in TMM-KTMDB.	1	10	1	85.71
The user interface of TMM-KTMDB is intuitive and user-friendly.	2	8	2	85.71
The TMM-KTMDB user interface is visually appealing.	1	10	1	85.71
I can easily understand the data given in TMM-KTMDB.		6	2.5	60.71
The TMM-KTMDB design is consistent across the application (e.g., fonts, colours, layouts).	6	7	0.5	96.52
TMM-KTMDB responds (loading/display) within acceptable time limits.	11	3	0	100
Calculation (Sum of Section-Score / (total number of questions * 100)*100)				(692.93/800) *100
				Overall-Score
				Grade of Usability
				86.6 %
				Excellent

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The results show that TMM-KTMDB performs well in technical usability, demonstrating high stability, responsiveness, and consistent interface behaviour. Experts found the interface intuitive and visually acceptable, as indicated by the 85.7% scores for navigation, user-friendliness, and visual appeal. This is consistent with evaluations of traditional medicine platforms such as LTM-TCM and DCABM-TCM, where strong technical performance is considered essential for sustained system use (Li et al., 2022; Liu et al., 2023). However, lower scores in search functionality and clarity of data presentation indicate significant usability gaps. Although visually coherent, experts had difficulty locating information and interpreting complex data. This highlights challenges in cognitive and interpretive usability, commonly reported in LIS and digital library research (Kayode & Oguntayo, 2024), where interface aesthetics alone do not ensure effective sense-making (He et al., 2024; Trivedi et al., 2023). Based on the overall score of 86.6% and its corresponding usability grade in Table 4, the database demonstrates a strong overall user experience, but targeted improvements in search, data clarity, and guided interpretation would better support expert use.

**Expert feedback: objective, functionality and accessibility**

Experts fully agreed on the purpose of TMM-KTMDB, with a section score of 100%. Most also confirmed that buttons and navigation worked correctly, giving a section score of 89.21%. However, completing key workflows was more difficult, with a lower section score of 67.85%. The overall score was 85.7%, indicating a good level of usability based on the usability grading criteria in Table 4. The detailed calculations are presented in Table 11. The findings indicate that experts clearly understood the aims of TMM-KTMDB and that core technical functions, such as navigation controls and interactive elements, were reliable. This demonstrates strong clarity of purpose and functional stability, consistent with LIS and health information system studies, where clear system intent and stable interface mechanics are essential for establishing user confidence (Eichenauer et al., 2024; Huang et al., 2024; Narayanan et al., 2025; Trivedi et al., 2023).

Table 11: Expert feedback on objective, function and accessibility

Elements	SA	A	N	Section-score (%)
I can complete all the key workflows successfully	1	7	1.5	67.85
All buttons, links, and navigational elements are functioning correctly	4	8	0.5	89.21
I think I understand the aims of TMM-KTMDB	6	8	0	100
	Calculation (Sum of Section-Score / (total number of questions * 100) *100)			(257.06/300) *100
	Overall-Score			85.69%
	Grade of Usability			Excellent

However, lower scores for completing key workflows highlight areas where usability can be improved. Experts encountered challenges when performing multi-step processes, which may be due to interface complexity, limited guidance, or inconsistencies between features. Similar patterns in Spanish medical system evaluations show that fragmented task sequences can hinder effective use, even when individual features function well (Hahn et al., 2024; Trivedi et al., 2023; van Haasteren et al., 2020). To address this, TMM-KTMDB would benefit from simplifying workflows and providing clearer instructional support through step-by-step guidance or tooltips. Although the Overall Score categorises this section as “Excellent,” improvements in workflow integration would further enhance end-to-end usability.

**Expert feedback: usability and usefulness**

Experts generally gave positive feedback on the usability and usefulness of TMM-KTMDB. Future use intention scored 89.21%, relevance to agencies reached 100%, and overall perceived benefit was 96.43%. Tool-specific usefulness was also strong, with the networks (formulation, botanical, active compound, protein) scoring 96.43%, the arc function 92.86%, and repositories 96.43%. Lower ratings were found for readiness for use at 53.57% and accuracy of data display at 82.14%. The item on supporting discovery of formulations for COVID-19-like symptoms scored 85.71%. The overall score for this section was 88.1%, classified as a good usability level based on the usability grading criteria in Table 4. The detailed calculations are presented in Table 12.

Table 12: Expert feedback on usability and usefulness

Elements	SA	A	N	Section-score (%)
I think TMM-KTMDB is ready to use.	0	4	3.5	53.57
I will utilise TMM-KTMDB in the future.	4	9	0.5	89.21
I think TMM-KTMDB is relevant to my agency.	5	9	0	100
I consider TMM-KTMDB is beneficial to all.	6	7	0.5	96.43
I find Formulation / Botanical / Active Compound / Protein Network is useful.	3	10	0.5	96.43
I find Formulation / Botanical / Active Compound / Protein Arc is useful.	3	10	0	92.86
I find the Botanical / Active Compound / Protein Repository is useful.	4	9	0.5	96.43
I find the data display in TMM-KTMDB is accurate.	1	8	2.5	82.14
I think TMM-KTMDB can be used to find a prospective formulation for disease with COVID-19-like symptoms.	5	7	0	85.71
Calculation (Sum of Section-Score / (total number of questions * 100) *100)				(792.78/900) *100
Overall-Score				88.07%
Grade of Usability				Excellent

The findings confirm that experts view TMM-KTMDB as relevant, beneficial, and generally useful across its main features. Strong section scores for future use and agency relevance indicate alignment with real-world expert workflows. Positive feedback on network, arc, and repository functions shows that the system supports knowledge exploration and integration, consistent with evaluations of traditional medicine and health digital platforms, where perceived relevance is a key predictor of system adoption (Hensher et al., 2021; Patwardhan et al., 2023).

Two important gaps were also identified. Lower scores for system readiness suggest that further refinement is required before full operational deployment. Concerns about data accuracy highlight the need for more transparent validation mechanisms to ensure user confidence, a challenge also noted in similar digital system evaluations (Kamath et al., 2021; Zheng et al., 2025). Although the Overall Score for this section falls within the “Excellent” range, improvements in readiness, accuracy assurance, and reliability indicators would help position TMM-KTMDB for broader use.

**Expert feedback: uses of the database**

Experts rated the usefulness of TMM-KTMDB across different domains. For Section-Score calculation, responses were categorised as follows: EU and VU = positive, U = partially

positive, and NVU and NVA = negative. The highest Section-Score was observed for Botanical Research (92.86%), followed closely by Drug Development (89.29%) and Medical Research (89.29%), indicating strong perceived usefulness in research-related tasks. Patent Application and Historical Research both received 75.00%, indicating moderate usefulness. The lowest score was for policy making (57.14%), reflecting more mixed expert opinions. Aggregating these results, the Overall Score for this section was 79.76%, placing it within the good usability level based on the usability grading criteria presented in Table 4. The detailed calculations are presented in Table 13.

Table 13: Expert feedback on what TMM-KTMDB can be used for

Elements	EU	VU	U	Section-score (%)
Patent Application	4	5	1.5	75
Drug Development	6	5	1.5	89.29
Policy Making	2	4	2	57.14
Botanical Research	3	9	1	92.86
Medical Research	3	8	1.5	89.29
Historical Research	2	6	2.5	75
Calculation (Sum of Section-Score / (total number of questions * 100) *100)				(478.58/600) *100
Overall-Score				79.76%
Grade of Usability				Excellent

The results show that TMM-KTMDB is perceived as particularly strong in supporting research-related domains. High scores in botanical research, drug development, and medical research suggest that experts regard the system as a valuable tool for exploring natural products, validating compounds, and generating biomedical insights. Moderate usefulness in patent applications and historical research indicates that further refinement may be required for greater applicability in these areas. This pattern mirrors findings from evaluations of traditional medicine knowledge systems, such as TCM, Austrian, and Ayurveda digital platforms, which tend to demonstrate higher value in research and scientific exploration than in governance or policy contexts (Eichenauer et al., 2024; Fredriksson, 2023; Jiashuo et al., 2022; Zhang et al., 2023). The lowest score in policy making highlights a gap in connecting research outputs to decision-related use. This indicates a need for features such as policy-oriented summaries or indicators to improve relevance for non-research stakeholders. The overall score category of “Excellent” reflects strong research usefulness, while also signalling opportunities to improve applied domains such as policymaking, intellectual property, and historical use.

**Expert feedback: TMM-KTMDB strengths**

The analysis revealed that Content and Information was the most frequently cited strength, mentioned by 13 participants (92.6%). This was followed by Functionality (System Capabilities), identified by 7 participants (50%). Other strengths included Data Network (5 participants, 35.7%), Usability (2 participants, 14.3%), and Novelty (2 participants, 14.3%). A small number (7.1% each) also highlighted Accessibility, Network Pharmacology, and Preservation Data. Table 14 summarises these results.

The database’s strengths are mainly found in content quality and system functionality, indicating that experts regard it as a reliable and comprehensive resource. The emphasis on content quality is consistent with findings in digital library and traditional medicine repositories, such as TCM systems, where curated and well-structured content underpins user trust and long-term system use (Chen et al., 2024; Tejera et al., 2025).

Table 14: Thematic analysis for TMM-KTMDB strength question

Theme mentioned by the participant	Number of participants	Percentage of participants
Usability (User Experience - UX)	2	14.3
Functionality (System Capabilities)	7	50
Content & Information	13	92.6
Data network	5	35.7
Accessibility	1	7.1
Novelty	2	14.2
Network pharmacology	1	7.1
Preservation Data	1	7.1

Although mentioned less often, additional themes highlight the system’s wider contributions. Feedback on Data Network suggests that the database enables integrative connections across datasets, while references to Usability and Novelty indicate that some experts valued its ease of use and innovative features. Mentions of Preservation Data highlight its role in safeguarding Traditional Malay Medicine knowledge and supporting research credibility. Similar findings in heritage and traditional knowledge digitisation studies note that preservation features and relational data structures enhance research value and long-term knowledge stewardship (Josef, 2019; Kalbande & Suradkar, 2021; Pandu, 2023). Overall, the findings show that, beyond core strengths in content and functionality, added value lies in specialised features that improve usability, applicability, and preservation, demonstrating a system that is both practical and forward-looking.

**Expert feedback: TMM-KTMDB weaknesses**

Table 15 shows that Functionality was the most frequently mentioned area of concern, with particular emphasis on the search function (9 participants, 64.3%) and broader system capabilities (5 participants, 35.7%). Other notable weaknesses included Usability (UX), raised by 3 participants (21.4%), as well as more specific issues such as Network Pharmacology UX (2 participants, 14.2%) and UI Rewording (2 participants, 14.2%).

Table 15: Thematic analysis for database weakness questions

Theme	Participant	Participant (%)
Functionality (system capabilities)	5	35.7
Functionality (search function)	9	64.3
Guide & Manual	2	14.2
Usability (User Experience - UX)	3	21.4
Usability (Network Pharmacology UX)	2	14.2
UI rewording	2	14.2
Content & information	2	14.2
Data glossary	2	14.2
Measurement glossary	3	21.4
No weakness	1	7.1

Concerns regarding information quality and structure were also highlighted, with references to the Measurement Glossary (3 participants, 21.4%), the Data Glossary (2 participants, 14.2%), and Content and Information more generally (2 participants, 14.2%). Notably, one participant (7.1%) reported no weaknesses in the database.

The findings indicate that although experts recognised several strengths, notable areas for improvement were identified. The most significant weakness was the search function, with 64.3% of participants expressing concerns. This suggests that despite strong content, efficient information retrieval requires improvement, as weak search mechanisms can reduce system effectiveness (Trivedi et al., 2023). Similar issues are reported in traditional medicine databases, where limited search refinement and terminology control hinder discovery (Ciampi et al., 2020; Lv et al., 2023).

Beyond search, broader issues of system functionality and usability were highlighted. Comments pointed to UX design, Network Pharmacology UX, and UI wording, indicating that smoother navigation and clearer interaction pathways are needed, consistent with findings in complex knowledge systems (van Haasteren et al., 2020; Zheng et al., 2025). Concerns regarding content and glossary structures also suggest the need for clearer definitions and standardised terminology to support users of varying expertise. Overall, the analysis underscores that the database is valuable but must address functional and usability gaps to maximise effectiveness.

#### **Expert feedback: database opportunities**

The analysis revealed that the most frequently cited opportunity is database expandability (11 participants, 78.6%), followed by content and information enrichment (10 participants, 71.4%), indicating strong support for broadening and strengthening the knowledge base. Other identified opportunities include improving the search function (3 participants, 21.3%), addressing areas of weakness (3 participants, 21.3%), and enhancing usability (1 participant, 7.1%). A few participants also mentioned data networking and glossary refinement. These findings are summarised in Table 16.

Table 16: Thematic analysis for database opportunities questions

<b>Theme</b>	<b>Participant</b>	<b>Participant (%)</b>
Expandability	11	78.6
Functionality (search function)	3	21.3
Content & information enrichment	10	71.4
Usability (User Experience - UX)	1	7.1
Weakness improvement	3	21.3
Data network	1	7.1
Data glossary	1	7.1

The thematic analysis indicates that experts regard expandability as the most significant opportunity, reflecting strong support for broadening the database’s scope and functionality in line with future developments in Traditional Malay Medicine research. In this context, content enrichment was also emphasised, suggesting that adding datasets, refining existing records, and widening coverage could substantially increase the database’s relevance and long-term value. This is consistent with findings from other traditional medicine platforms, where scalability and modular design are critical (Alarcon et al., 2021; Chunchun & Ruiying, 2024; Zhang et al., 2023).

The identification of search enhancement as a strategic concern further aligns with digital library studies, which show that retrieval mechanisms must evolve alongside content growth to maintain accessibility and user confidence (Kamath et al., 2021; Deng et al., 2022). Opportunities related to UX refinement, data networking, and glossary development, though less frequently highlighted, indicate foundational needs that support usability and

interoperability. Overall, experts perceive TMM-KTMDB as a platform with substantial potential, contingent on expansion supported by concurrent improvements in retrieval and semantic structure.

### **Follow-up and implementation**

After the Expert Feedback Task/Test (EFTT), feedback from both instruments was reviewed and used to guide system refinement. Search optimisation was prioritised, resulting in multi-item search capability and the inclusion of logical operators (AND, OR, NOT). A manuscript search interface was also developed, supported by a manuscript model containing key bibliographic details. Additional improvements included clearer user interface wording, revised glossaries, and expanded content coverage. The system was also redesigned for future expandability. This process ensured that evaluation outcomes informed active enhancement, allowing the database to evolve in line with user expectations and future research needs.

### **Contribution to LIS practice and theory**

Beyond confirming that TMM-KTMDB demonstrates strong usability, this evaluation contributes to LIS practice and theory by showing that usability in expert-oriented repositories is closely tied to knowledge organisation rather than interface design alone. The findings indicate that challenges encountered in advanced tasks reflect the cognitive demands of navigating structured semantic networks, controlled terminology, and relational data models. From an LIS perspective, the study reinforces the view that usability is an emergent property of information structure, conceptual clarity, and terminological alignment. The combined use of task-based evaluation and expert feedback provides a nuanced assessment that explains not only system performance but also the underlying knowledge organisation factors influencing expert interaction. Practically, this evaluation extends LIS methodologies by demonstrating the value of expert-centred usability assessment for complex, domain-specific repositories. It offers a transferable evaluation approach for assessing knowledge-intensive digital libraries and traditional knowledge systems, positioning usability evaluation as a tool for guiding system refinement and long-term sustainability rather than merely confirming system quality.

## **CONCLUSIONS**

This study set out to evaluate the TMM-KTMDB through structured expert feedback, with a focus on assessing its usability, search engine performance, guest access, system functionality, repository interaction, and information quality. The evaluation successfully achieved this objective through the Expert Feedback Task/Test (EFTT), which integrated task-based performance scoring and expert interpretation. Findings demonstrated that experts were able to complete core tasks effectively, indicating that the database supports intuitive interaction and is functionally reliable. Thematic feedback further clarified key strengths, particularly in content accuracy and information organisation, while also identifying weaknesses in search performance, glossary clarity, and specific interface elements. These insights have led to the identification of opportunities for refinement that will directly inform the next phase of system development. This study contributes to LIS by demonstrating a structured approach for assessing traditional knowledge digital systems. The methodological approach used here also has broader applicability. It can be adopted for other types of repositories where expert interpretation is essential, such as Indigenous botanical knowledge, agricultural seed and varietal archives, or specialised engineering standards databases that rely on practitioner or expert validation. In these contexts, expert

involvement and context appropriate data structuring are critical, and the evaluation model demonstrated in this study offers a practical foundation for ensuring usability and credibility.

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## **CONFLICT OF INTEREST**

The authors have no known conflicts of interest to disclose.

## **AUTHOR CONTRIBUTIONS**

Conceptualisation: [Mohd Shafri, M.A.], Methodology: [Mohd Shafri, M.A., Basar, M.A., Mohamed, F., Abu Seman, M.A], Formal analysis and investigation: [Mohd Shafri, M.A., Basar, M.A., Mohamed, F., Abu Seman, M.A], Writing - original draft preparation: [Mohd Shafri, M.A.]; Writing - review and editing: [Mohd Shafri, M.A.]

## **REFERENCES**

- Adilla, R., Jazman, M., Ahsyar, T. K., & Hamzah, M. L. (2022). Evaluation usability of mobile banking applications using usability testing (UT) method and system usability scale (SUS). *2022 IEEE International Conference on Sustainable Engineering and Creative Computing (ICSECC)*, 2022, 78-83. <https://doi.org/10.1109/icsecc56055.2022.10331348>.
- Alarcon, M. L., Nguyen, M., Debroy, S., Bhamidipati, N. R., Calyam, P., & Mosa, A. (2021). Trust model for efficient honest broker based healthcare data access and processing. *2021 IEEE International Conference on Pervasive Computing and Communications Workshops and Other Affiliated Events (PerCom Workshops)*, 2021, 201-206. <https://doi.org/10.1109/PerComWorkshops51409.2021.9430954>.
- Chen, Y.-F., Shi, Y., Liang, C.-B., Min, Z.-C., Deng, Q.-Q., Yu, R., Zhang, J., Chang, K., Chen, L.-Y., Yan, K., Wang, C.-X., Tan, Y., Wang, X., Chen, J.-X., & Hua, Q. (2024). MicrobeTCM: A comprehensive platform for the interactions of microbiota and traditional Chinese medicine. *Pharmacological Research*, 201, 107080. <https://doi.org/10.1016/j.phrs.2024.107080>.
- Ciampi, M., de Pietro, G., Masciari, E., & Silvestri, S. (2020). Health data information retrieval for improved simulation. *2020 28th Euromicro International Conference on Parallel, Distributed and Network-Based Processing (PDP)*, 2020, 364-368. <https://doi.org/10.1109/pdp50117.2020.00062>.
- Deng, L.-W., Xu, J.-J., & Li, S.-Z. (2022). A TCM disease retrieval method based on weighted word vector. *2022 12th International Conference on Information Technology in*

- Medicine and Education (ITME)*, 2022, 418-422. <https://doi.org/10.1109/itme56794.2022.00096>.
- Eichenauer, E., Saukel, J., & Glasl, S. (2024). VOLKSMED database: A source for forgotten wound healing plants in Austrian folk medicine. *Planta Medica*, 90(7-8), 498–511. <https://doi.org/10.1055/a-2225-7545>.
- Feng, M., Hu, P.-F., Zhao, Y., & Wang, X.-L. (2024). Edge-enabled data-centric dynamic node trust evaluation. *2024 IEEE Smart World Congress (SWC), 2024*, 2163-2168. <https://doi.org/10.1109/swc62898.2024.00330>.
- Fredriksson, M. (2023). India's traditional knowledge digital library and the politics of patent classifications. *Law Critique*, 34, 1-19. <https://doi.org/10.1007/s10978-021-09299-7>.
- Hahn, A. L., Michaels, C. L., Khawly, G., Nichols, T. K., Baez, P., Ramirez, S. O., Padilla, J. J., Stonbraker, S., Olender, S., & Schnall, R. (2024). Comparison of evaluation methods for improving the usability of a Spanish mHealth tool. *International Journal of Medical Informatics*, 184, 105355. <https://doi.org/10.1016/j.ijmedinf.2024.105355>.
- He, J.-Y., Zhang, D.-F., Xie, J.-D., Zhong, J.-W., Hu, C.-J., & Hu, K.-F. (2024). Research on information extraction and data mining of the patent of Chinese herbal medicine prescriptions. *2023 IEEE International Conference on Bioinformatics and Biomedicine (BIBM), 2023*, 4575-4579. <https://doi.org/10.1109/bibm58861.2023.10385484>.
- Hensher, M., Cooper, P., Dona, S. W. A., Angeles, M. R., Nguyen, D., Heynsbergh, N., Chatterton, M. L., & Peeters, A. (2021). Scoping review: Development and assessment of evaluation frameworks of mobile health apps for recommendations to consumers. *Journal of the American Medical Informatics Association (JAMIA)*, 28(6), 1318-1329. <https://doi.org/10.1093/jamia/ocab041>.
- Huang, L., Wang, Q., Duan, Q.-C., Shi, W.-M., Li, D.-M., Chen, W., Wang, X.-Y., Wang, H.-L., Chen, M., Kuang, H.-D., Zhang, Y., Zheng, M.-Z., Li, X.-L., He, Z.-X., & Wen, C.-P. (2024). TCMSSD: A comprehensive database focused on syndrome standardization. *Phytomedicine*, 128, 155486. <https://doi.org/10.1016/j.phymed.2024.155486>.
- Iren, D., Yildirim, E., & Shingjergji, K. (2023). Ethical risks, concerns, and practices of affective computing: A thematic analysis. *2023 11th International Conference on Affective Computing and Intelligent Interaction Workshops and Demos (ACIIW), 2023*, 1-4. [10.1109/aciiw59127.2023.10388171](https://doi.org/10.1109/aciiw59127.2023.10388171).
- Josef, H. F. (2019). *Digitizing ancient manuscripts: Both ancient manuscripts physically and ancient manuscripts in digital format*. Regional Library and Archive Office of Yogyakarta Special Region. [https://www.academia.edu/41517179/Digitizing\\_Ancient\\_Manuscripts\\_Both\\_Ancient\\_Manuscripts\\_Physically\\_and\\_Ancient\\_Manuscripts\\_in\\_Digital\\_Format#:~:text=Digitizing%20Ancient%20Manuscripts:%20Both%20Ancient%20Manuscripts%20Physically,general%2C%20has%20two%20main%20elements%2C%20namely%20preservation](https://www.academia.edu/41517179/Digitizing_Ancient_Manuscripts_Both_Ancient_Manuscripts_Physically_and_Ancient_Manuscripts_in_Digital_Format#:~:text=Digitizing%20Ancient%20Manuscripts:%20Both%20Ancient%20Manuscripts%20Physically,general%2C%20has%20two%20main%20elements%2C%20namely%20preservation).
- Kalbande, D. T., & Suradkar, P. A. (2021). Traditional knowledge digital library: A magic bullet in the war against biopiracy. *Library of Philosophy and Practice (e-Journal)*, 6108. <https://digitalcommons.unl.edu/libphilprac/6108/>.
- Kayode, A., & Oguntayo, S. A. (2024). Evaluating the impact of digital competence and digital self-efficacy on the adoption of big data in library and information centers: A contextual study. *Library Philosophy and Practice (e-Journal)*, 8278. <https://digitalcommons.unl.edu/libphilprac/8278/>.
- Kong, X.-R., Liu, C., Zhang, Z.-Z., Cheng, M.-Q., Mei, Z.-J., Li, X.-D., Liu, P., Diao, L.-H., Ma, Y.-J., Jiang, P., Kong, X.-Y., Nie, S.-Y., Guo, Y.-Z., Wang, Z., Zhang, X.-L., Wang, Y., Tang, L.-J., Guo, S.-Z., & Liu, Z.-Y. (2024). BATMAN-TCM 2.0: An enhanced integrative database for known and predicted interactions between traditional Chinese medicine ingredients

- and target proteins. *Nucleic Acids Research*, 52(D1), D1110-D1120. <https://doi.org/10.1093/nar/gkad926>.
- Li, J.-H., Mao, B.-F., Liang, Z.-Z., Zhang, Z.-Q., Lin, Q.-S., & Yao, X. (2021). Trust and trustworthiness: What they are and how to achieve them. *2021 IEEE International Conference on Pervasive Computing and Communications Workshops and other Affiliated Events (PerCom Workshops)*, 2021, 711-717, <https://doi.org/10.1109/PerComWorkshops51409.2021.9430929>.
- Li, X., Liu, Z.-Q., Liao, J., Chen, Q., Lu, X.-Y., & Fan, X.-H. (2023). Network pharmacology approaches for research of traditional Chinese medicines. *Chinese Journal of Natural Medicines*, 21(5), 323-332. [https://doi.org/10.1016/s1875-5364\(23\)60429-7](https://doi.org/10.1016/s1875-5364(23)60429-7).
- Li, X., Ren, J., Zhang, W., Zhang, Z.-M., Yu, J.-C., Wu, J.-W., Sun, H., Zhou, S.-P., Yan, K.-J., Yan, X.-J., & Wang, W.-J. (2022). LTM-TCM: A comprehensive database for the linking of traditional Chinese medicine with modern medicine at molecular and phenotypic levels. *Pharmacological Research*, 178, 106185. <https://doi.org/10.1016/j.phrs.2022.106185>.
- Liu, X.-Y., Liu, J.-Y., Fu, B.-Z., Chen, R.-Z., Jiang, J.-Z., Chen, H., Li, R.-N., Xing, L., Yuan, L.-Y., Chen, X.-T., Zhang, J., Li, H.-L., Guo, S.-Z., Guo, F.-F., Guo, J.-C., Liu, Y., Qi, Y.-N., Yu, B.-Y., Xu, F., ... & Liu, Z.-Y. (2023). DCABM-TCM: A database of constituents absorbed into the blood and metabolites of traditional Chinese medicine. *Journal of Chemical Information and Modeling*, 63(15), 4948-4959. <https://doi.org/10.1021/acs.jcim.3c00365>.
- Lv, Q.-J., Chen, G.-X., He, H.-H., Yang, Z.-D., Zhao, L., Chen, H.-Y., & Chen, C. Y.-C. (2023a). TCMBank: Bridges between the largest herbal medicines, chemical ingredients, target proteins, and associated diseases with intelligence text mining. *Chemical Science*, 14(39), 10684-10701. <https://doi.org/10.1039/d3sc02139d>.
- Lv, Q.-J., Chen, G.-X., He, H.-H., Yang, Z.-D., Zhao, L., Zhang, K., & Chen, C. Y.-C. (2023b). TCMBank-The largest TCM database provides deep learning-based Chinese-Western medicine exclusion prediction. *Signal Transduction and Targeted Therapy*, 8, 127. <https://doi.org/10.1038/s41392-023-01339-1>.
- Mat Piah, H., & Baba, Z. (2014). *Kitab Tib MSS 2515 Perpustakaan Negara Malaysia: Kajian Tekst Dan Suntingan*. Penerbit Universiti Kebangsaan Malaysia.
- Meduri, K., Nadella, G. S., de la Cruz, E., Ravindran, R. K., Gonaygunta, H., & Oni, O. (2025). Exploring the perceptions and experiences of educators using e-learning platforms: A thematic approach. *2025 IEEE Integrated STEM Education Conference (ISEC)*, 2025, 1-8. <https://doi.org/10.1109/isec64801.2025.11147294>.
- Mishra, S. (2023). Information visualization in library and information science: Exploring principles, types, and tools for effective data communication. *Library Philosophy and Practice (e-Journal)*, 7743. <https://digitalcommons.unl.edu/libphilprac/7743/>.
- Muthu Pandeewari, R., & Gobalakrishnana, N. (2024). TrustSec-ChainX: A pioneering approach to enhancing trust management and data integrity in IoT healthcare. *2024 International Conference on Emerging Research in Computational Science (ICERCS) 2024*, 1-8. <https://doi.org/10.1109/icercs63125.2024.10895865>.
- Narayanan, V. R., Sharma, M. M., Thrigulla, S. R., Lavaniya, V. K., Chincholikar, M. B., Ashwathykutty, V., Kumar, A., Makhija, P., & Srikanth, N. (2025). "Ayurvedagranthasamuccaya" (APTA Digital Library) - A searchable digital bouquet of classical Ayurveda books. *Journal of Ayurveda and Integrative Medicine*, 16(3), 101093. <https://doi.org/10.1016/j.jaim.2024.101093>.
- Olagunju, T., Oyebode, O., & Orji, R. (2020). Exploring key issues affecting African mobile ecommerce applications using sentiment and thematic analysis. *IEEE Access*, 8, 114475-114486. <https://doi.org/10.1109/access.2020.3000093>.

- Pandu, P. (2023, September 25). Restorasi digital untuk pelestarian manuskrip. *Kompas ID*. <https://www.kompas.id/artikel/inovasi-iptek-restorasi-digital-untuk-pelestarian-manuskrip>.
- Patwardhan, B., Susan Wieland, L., Aginam, O., Chuthaputti, A., Ghelman, R., Ghods, R., Soon, G. C., Matsabisa, M. G., Seifert, G., Tu'itahi, S., Chol, K. S., Kuruvilla, S., Kemper, K., Cramer, H., Nagendra, H. R., Thakar, A., Nesari, T., Sharma, S., Srikanth, N., & Acharya, R. (2023). Evidence-based traditional medicine for transforming global health and well-being. *European Journal of Integrative Medicine*, 63, 102306. <https://doi.org/10.1016/j.eujim.2023.102306>.
- Permana, P. A. G., Dewanti, P., & Santika, K. Y. (2024). Analysis of sports match charts and scoring applications based on website and mobile using the system usability scale method. *2024 6th International Conference on Cybernetics and Intelligent System (ICORIS), 2024*, 1-6, <https://doi.org/10.1109/ICORIS63540.2024.10903865>.
- Psarra, E., Patiniotakis, I., Verginadis, Y., Apostolou, D., & Mentzas, G. (2020). Securing access to healthcare data with context-aware policies. *2020 11th International Conference on Information, Intelligence, Systems and Applications (IISA), 2020*, 1-6. <https://doi.org/10.1109/iisa50023.2020.9284393>.
- Reyes-García, V., Benyei, P., Aceituno-Mata, L., Gras, A., Molina, M., Tardío, J., & Pardo-de-Santayana, M. (2021). Documenting and protecting traditional knowledge in the era of open science: Insights from two Spanish initiatives. *Journal of Ethnopharmacology*, 278, 114295. <https://doi.org/10.1016/j.jep.2021.114295>.
- Soon, G. C. (2021). Regulatory challenges in uplifting traditional Malay medicine in Malaysia. *International Journal of Allied Health Sciences*, 5(5), 2312 - 2321. <https://doi.org/10.31436/ijahs.v5i5.735>.
- Sowmya Kamath, S., Veena Mayya, M., & Priyadarshini, R. (2021). A probabilistic precision information retrieval model for personalized clinical trial recommendation based on heterogeneous data. *2021 12th International Conference on Computing Communication and Networking Technologies (ICCCNT), 2021*, 1-5. <https://doi.org/10.1109/iccant51525.2021.9579891>.
- Stephen, G. (2020). Using website analytics in search engine optimization for the domain of LIS links, in INDIA. *Library Philosophy and Practice (e-Journal)*, 3955. <https://digitalcommons.unl.edu/libphilprac/3955/>.
- Tejera, J., Gokhale, S. S., & Gromisch, E. S. (2025). trustworthiness features of commercially available mobile health (mHealth) applications. *2025 IEEE 49th Annual Computers, Software, and Applications Conference (COMPSAC), 2025*, 1928-1933. <https://doi.org/10.1109/compsac65507.2025.00266>.
- Trivedi, D., Gopalakrishnan, V., & Dholariya, D. (2023). MediSearch: Advanced medical web search engine. *2023 IEEE 13th Annual Computing and Communication Workshop and Conference (CCWC), 2023*, 534-540. <https://doi.org/10.1109/ccwc57344.2023.10099048>.
- van Haasteren, A., Gille, F., Fadda, M., & Vayena, E. (2019). Development of the mHealth app trustworthiness checklist. *Digital Health*, 5, 2055207619886463. <https://doi.org/10.1177/2055207619886463>.
- van Haasteren, A., Vayena, E., & Powell, J. (2020). The mobile health app trustworthiness checklist: Usability assessment. *JMIR mHealth and uHealth*, 8(7), e16844. <https://doi.org/10.2196/16844>.
- Wang, A.-Y., Peng, H.-Y., Wang, Y.-D., Zhang, H.-R., Cheng, C.-P., Zhao, J.-Z., Zhang, W.-X., Chen, J.-X., & Li, P. (2025). NP-TCMtarget: A network pharmacology platform for exploring mechanisms of action of traditional Chinese medicine. *Briefings in Bioinformatics*, 26(1), bbaf078. <https://doi.org/10.1093/bib/bbaf078>.

- Wang, Q.-Y., Yao, X.-M., Ling, Y., Huang, Y., Chen, C.-M., Hou, L., Yang, Y.-T., Wu, H.-Y., & Ma, W.-K. (2022). Investigation of the mechanism of *Periploca forrestii* against rheumatoid arthritis with network pharmacology-based analysis. *Evidence-Based Complementary and Alternative Medicine (eCAM)*, 2022, 2993374. <https://doi.org/10.1155/2022/2993374>.
- Wu, J.-S., Zhang, F.-Q., Li, Z.-Z., Jin, W.-Y., & Shi, Y. (2022). Integration strategy of network pharmacology in traditional Chinese medicine: A narrative review. *Journal of Traditional Chinese Medicine*, 42(3), 479-486. <https://doi.org/10.19852/j.cnki.jtcm.20220408.003>.
- Ye, Y.-N., Liang, D.-F., Yi, J.-H., Jin, S.-A., & Zeng, Z. (2023). IGTCM: An integrative genome database of traditional Chinese medicine plants. *The Plant Genome*, 16(2), e20317. <https://doi.org/10.1002/tpg2.20317>.
- You, X.-L., Hou, F.-J., & Chiclana, F. (2024). A reputation-based trust evaluation model in group decision-making framework. *Information Fusion*, 103, 102082. <https://doi.org/10.1016/j.inffus.2023.102082>.
- Zhang, C.-C., & Sun, R.-Y. (2024). Research on User Data Compliance Governance Mechanism of Smart Library. *Library and Information Service*, 68(4), 15-26. <https://doi.org/10.13266/j.issn.0252-3116.2024.04.002>.
- Zhang, R.-Y., Zhang, P., & Wang, Y. (2022). Design and implementation of data analysis and retrieval system for Chinese traditional patent medicine. *2022 IEEE International Conference on Bioinformatics and Biomedicine (BIBM)*, 2022, 3752-3756. <https://doi.org/10.1109/bibm55620.2022.9995682>.
- Zheng, Y.-H., Zhang, Y.-K., Lin, W.-Q., & Wu, Q.-F. (2024). How can we design a standardized and efficient health data management system for large-scale heterogeneous TCM data? *2024 IEEE International Conference on Bioinformatics and Biomedicine (BIBM)*, 2024, 4848-4853. <https://doi.org/10.1109/bibm62325.2024.10822299>.

Appendix 1: Task assignment questionnaire

Questions	Scale
Task: TMM-KTMDB accessibility	
Task: TMM-KTMDB formulary search based on Symptom	
Task: TMM-KTMDB formulary search based on Ingredient	
Task: TMM-KTMDB formulary search based on Method of Preparation	
Task: TMM-KTMDB formulary search based on Dosage Form	
Task: TMM-KTMDB formulary search on Route of Delivery	
Task: TMM-KTMDB formulary search based on Multiple Filters	
Task: TMM-KTMDB formulation information page	
Task: TMM-KTMDB formulation info exploration	
Task: Material information limitation for Guest user	
Task: TMM-KTMDB Member Access	
Task: TMM-KTMDB Ingredient Botanical Network	Yes/No
Task: TMM-KTMDB Ingredient Botanical Arc Network	
Task: TMM-KTMDB Active Compound Network	
Task: TMM-KTMDB Active Compound Network with Protein	
Task: TMM-KTMDB Active Compound Repository Section	
Task: TMM-KTMDB Protein Network	
Task: TMM-KTMDB Protein Repository Section	
What is the frequency of Halia Bara as a treatment for phlegm?	
What do you think is the best formulation for COVID-19 based on TMM-KTMDB data? (key in formulation number e.g. MSS2515.F.xx.xx)	
What if the iN-Index value for Syzygium aromaticum?	Open
What COVID-19 receptor can Piperine bind to?	
What formulation has fN-Index value of 9.5?	
Analyse these formulations using TMM-KTMDB. Discuss your analysis (e.g. Use fN-Index, iN-Index, protein & receptor repositories, etc.).	

## Appendix 2: Expert feedback questionnaire

Questions	Scale
I can register and login to TMM-KTMDB.	
I can search for specific data in TMM-KTMDB.	
I can easily navigate from one feature to another in TMM-KTMDB.	
The User Interface of TMM-KTMDB intuitive and user-friendly.	
TMM-KTMDB User Interface is visually appealing.	
I can easily understand the data given in TMM-KTMDB.	
TMM-KTMDB design is consistent across the application (e.g., fonts, colours, layouts).	
TMM-KTMDB responds (loading/display) within acceptable time limits.	
I can complete all the key workflows successfully.	
All buttons, links, and navigational elements are functioning correctly.	
I think I understand the aims of TMM-KTMDB.	
I think TMM-KTMDB is ready to use.	Likert
I will utilise TMM-KTMDB in the future.	Scale
I think TMM-KTMDB is relevant to my agency.	
I consider TMM-KTMDB is beneficial to all.	
I find Formulation / Botanical / Active Compound / Protein Network is useful.	
I find Formulation / Botanical / Active Compound / Protein Arc is useful.	
I find Botanical / Active Compound / Protein Repository is useful.	
I find the data display in TMM-KTMDB is accurate.	
I think TMM-KTMDB can be used to find prospective formulation for disease with COVID-19-like symptoms.	
Application TMM-KTMDB in Patent Application	
Application TMM-KTMDB in Drug Development	
Application TMM-KTMDB in Policy Making	
Application TMM-KTMDB in Botanical Research	
Application TMM-KTMDB in Medical Research	
Application TMM-KTMDB in Historical Research	
TMM-KTMDB Strengths	Open
TMM-KTMDB Weakness	ended
TMM-KTMDB Opportunities	