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Design and implementation of agricultural engineering terminology database of foreign languages using artificial intelligence algorithms

Abstract

This paper presents the design, implementation, and evaluation of a novel client-side web-based an application system as of agricultural engineering terminology that operates entirely offline after initial loading. Unlike traditional server-dependent methods, the proposed system reads Microsoft Excel files directly in the browser using JavaScript-based parsing, processes all data client-side, and provides an interactive multilingual interface with five language supports (Arabic, English, French, German, and Chinese).

Performance evaluation demonstrates average search response times of less than 50 milliseconds for dictionaries containing up to 5,000 terms, with linear scalability up to 10,000 entries. The system requires no server infrastructure, no database management, and no internet connectivity after initial load, making it particularly suitable for deployment in rural agricultural areas, educational institutions in developing regions, and field research environments.

Results were concluded as follows: (a) research presented a complete methodology for developing an offline-capable multilingual dictionary system using Excel as the data source. The system successfully demonstrates pure client-side operation, direct Excel integration, automatic column detection, dynamic category generation, five-language support with RTL/LTR switching, sub-50ms search response, and responsive design across all devices. The system has been validated on 4,617 agricultural engineering terms and advised deployed in education and extension contexts in Egypt., (b) compared to traditional printed dictionaries (full offline but no search), online dictionaries (multi-language but requires internet), and desktop software (full features but expensive), the proposed system uniquely combines offline access, multi-language support, real-time search, custom data via Excel, zero cost, no installation, and complete data privacy., and (c)Also, universities should ensure that their students develop proficiency in foreign languages and strong communication skills by using a computer application computer program in agricultural engineering terminology. Students and postgraduates to improve their command of the language. So, University graduates will be better prepared for the workplace in future.

Keywords: client-side processing, excel parsing, multilingual application, offline web application, real-time search, agricultural engineering, sheetjs, rtl support, foreign vocabulary learning

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Introduction

Agricultural engineering is an inherently multidisciplinary field that integrates principles from mechanical engineering, civil engineering, electrical engineering, soil science, water resources management, and biological sciences. This interdisciplinary nature has given rise to a vast and specialized terminology that spans multiple languages and regional variations. The globalization of agricultural research and the international collaboration among agricultural engineers have created an urgent need for accessible, multilingual terminology resources. Traditional approaches to managing technical dictionaries include printed glossaries, desktop software applications, and online web-based dictionaries.

Each of these approaches presents significant limitations: printed dictionaries become outdated rapidly; desktop applications require installation and paid licenses; online dictionaries depend on continuous internet connectivity, which is often unavailable in rural agricultural areas.

The importance, role, and value of language skills in organizations is undeniable, however this concept is still not fully understood in Malaysia. In order to use strategic approaches that can assist employees in agricultural organizations deal with language issues that are specific to these organizations, it is important to look at how employees perceive the value of English in a multilingual workplace. Like-wise due to the National Graduate Employability Blueprint, 2012–2017, over fifty percent of the graduates have below-average topic knowledge, proficiency in English, communication, writing, and work attitude.[1] Bally and regionally that will lead to increased employability in Malaysia. Indeed, Malaysia's effort to advance into a modern, technological savvy, and export-led nation is dependent on strengthening its human capital and competency in the English language.[2] In organisations, language is acknowledged as a facilitator or barrier in areas like communication, collaboration and coordination.[3] Furthermore, studies have shown that there was a significant effect on the starting salaries of graduates, future potential earnings, changing of residence from rural to urban and improved labour market performance, for employees with English as their second language,[4,5] mentioned that the transformative technologies such as artificial intelligence (AI) make difficult tasks more accessible and convenient. Since 2018, the use of AI in research has increased drastically, with annual publication rates of 3–5 times higher than pre-2017. Currently, more than 20,000 of over than 100,000 AI-based scientific and engineering publications that are published annually are in the agricultural and environmental fields. Given the magnitude of use, clear communication on how AI is used and how it helps advance scientific knowledge is essential. Clear communication is even more significant when working with AI compared to past technologies because AI can be applied in several other ways, it does like a "black box" where the inner workings aren't always easy to understand, and there are still discussions about how reliable AI's predictions are compared to theories and models based on basic principles and processes. In this commentary, we offer guidance and topics for discussion to the scientific community to help ensure clear and effective communication of AI research in publications related to agriculture and the environment.

To date, generative AI's training data are often unknown or poorly understood by the users and many kinds of inherent biases and false or erroneous information may unknowingly impact research products. Bias in AI is a well-known problem, and it can come from the way the algorithms work or the predictions they make.[6] A foundational priority for AI-enhanced research outputs and decision support systems is for such products to do no harm.[7,8]

Sareen and Shameem[9] studied that examination the employees' perception of the use of the English language in a professional context particularly in the Malaysian agricultural and agricultural related sectors. A concurrent triangulation design was used to quantitatively evaluate the data. Results: the employers and employees agree that English language proficiency has economic value and can play an important role at the workplace, as this skill can influence one's career path in terms of employability and career progression. Piekkari et al.,[10] informed that sometimes employees might select to move to another department that doesn't require them to talk another language, but this change could actually lower their position in their career. So, workers in the agriculture field should be motivated to study and become better at talking English, because being well at English helps them grow in their jobs and makes it easier for them to find good job opportunities. Mobile vocabulary learning apps, such as e-books, e-dictionaries, and Duolingo, provide learners with anytime, anywhere access to vocabulary-building tools, flashcards, quizzes, and interactive exercises.[11] Additionally, learning vocabulary has been significantly improved via digital content and multimedia resources including videos, podcasts, and online articles. These resources introduce learners to authentic language, contextualized vocabulary, and idiomatic expressions, thereby promoting a more profound grasp of the language.[12] In improving learners' interest and engagement and also assisting they understand the meanings of words. Similarly, by providing a contextualized learning environment, augmented reality technology can enhance both learner motivation and performance.[13] On the other hand, more research is still required to decide how to properly incorporate met adverse technology for language instruction and compare the efficacy of learning across different met averse technologies.[14] A common method for understanding and categorizing the various levels of knowledge of vocabulary is the vocabulary knowledge framework (VKF).[15] It allows a valuable tool for educators and language learners to assess and develop vocabulary skills.[16] Several vocabulary knowledge tests were designed based on the VKF, and the productive knowledge tests were typically more complex than the receptive knowledge tests.[17] Receptive vocabulary mastery is typically assessed by identifying the correct spelling of target words,[18] appropriate collocations,[19,20] multiple meanings across various sentences,[21] and potential contextual associations.[18,21,22] Conversely, productive vocabulary mastery is commonly measured through dictation tasks,[18] definition elicitation,[22] and the provision of relevant word associations.[20] Using metaverse technology for educational purposes has gained significant attention in the field of educational technology since 2020.[14] Researchers have explored the application of metaverse technology in various educational domains, including agriculture, language learning, geography, chemistry, medicine, and digital media education.[23,24]

Eleven empirical studies on metaverse-based education were evaluated in a systematic review by Asiksoy.[14] Augmented Reality (AR), Virtual Reality (VR), and Mixed Reality (MR) are the 3 primary categories into that the review classified immersive technologies. 57 empirical researches on usage of mobile augmented reality in education were reviewed by Herpich et al.,[25] The review's conclusions showed that the development team's experience were the main factor influencing technical specifications used to develop mobile AR strategies. Regarding mobile VR, (Cochrane),[26] explored the historical development of VR in educational settings, highlighting its potential as an immersive and engaging learning tool. The author argues that the convergence of mobile devices, social media platforms, mobile head-mounted displays, and mobile VR cameras allows learners to create and share their own virtual reality content. This approach of content created by learners and contexts promotes active participation, creativity and personalization of the learning process. However, compared to desktop VR, mobile VR cannot create a good quality immersive environment due to its limited processing power, and the cost-effective mobile VR needs to be further investigated in how well it is effective for teach particular subjects.[27]

Regarding mobile MR, the application of MR mainly for medical and health education,[28,29] could open new opportunities for accessible teaching strategies, revolutionizing pedagogy from the use of static images and videos to interactive mobile environments. This is especially important in nursing and healthcare education, where learning often includes hands-on, immersive, and self-directed activities.[30] A comprehensive review of 1484 studies on the use of mobile MR in medical education was conducted by Stretton et al.[29] The result showed mobile MR was successful in teaching clinical skills, but it is still difficult to keep students engaged in mobile MR-based classes. In order to improve students' comprehension of the intricate ideas of damping, stability, and closed-loop poles, Frank and Kapila[31] used mobile MR in mechanical and aerospace engineering. The mobile MR was generally well received by participants, who thought it was enjoyable and simple using the interface. Participants needed some help initially, but they soon felt at ease using the platform. In the meantime, learner understanding of the target topics was enhanced by the mobile MR. However, mobile MR technology was still in its infancy, and further development was required to enhance its interactive capabilities. Additionally, incorporating mobile devices into pedagogical practice presented difficulties with communication, data visualization, and time management, all of which call for knowledge in educational technology and engineering fields.[31] In educational settings, AR and virtual reality VR technologies are frequently discussed due to their significant potential to enhance learning motivation, engagement, and experience. However, comparative research on AR and VR remains scarce.

Khosasih and Herumurti[32] examined how 34 participants, aged 17 until 25, studied ancient humanity utilizing AR, VR, and website-based learning. They observed that while AR provided the greatest user satisfaction, VR produced the highest attention, relevance, and confidence scores. Similar findings were found by Li et al.,[33] who attributed the increased satisfaction using AR in real estate exhibits to its interactive, object-focused engagement. However, Caputo et al.,[34] observed that VR that was fully immersive gave a better interaction experience when aviation training sessions only involved virtual objects; participants completed interactions more rapidly and preferred the VR setup to AR when no real-world context was necessary. These studies highlight that AR and VR exhibit different features and potentials when applied to the same specific learning purposes, underscoring the necessity for more comparative research to understand their distinct advantages and disadvantages in educational settings fully. Furthermore, systematic review articles are compelled to rely on broad issues and draw findings from many different kinds of studies due to the dearth of comparative research on AR and VR in particular educational environments. In particular, Pereira et al.,[35] investigated how well AR and VR therapies compare with traditional physical therapy in the setting of rehabilitation. Eight articles out of 101 studies were reviewed in their review, which showed the dearth of direct comparisons among AR and VR in hand rehabilitation. They recommended future head-to-head studies to ascertain which technology achieves better results for particular patient populations and rehabilitation objectives; even though both technologies improved learners' engagement. The topic of language acquisition is in a similar condition.

Huang et al.,[36] carried out a systematic examination to analyze the functions and effects of AR and VR for improving language learning in order to fill the vacuum in comparison studies on these technologies in language education. In the end, comparative studies are necessary to determine the precise usage, advantages, and drawbacks of using AR and VR for subjects or skill learning, even though individual studies integrating these kinds of technologies in educational settings offer broad insights into their potential and appropriateness Wang & Chan.[37] By evaluating the effectiveness, advantages, and drawbacks of AR and VR in vocabulary learning, this study seeks to close this gap in the field of English language learning. Furthermore, The National Graduate Employability Blueprint, 2012–2017, highlighted that over 50% of the graduates are below average in terms of competence in subject knowledge, English competency, communication, writing skills, and work attitude Ministry of Education.[1]

Meanwhile, the bottom-up approach is also reflected in the attitudes of employees, who may understand the importance of English for career progression and employment prospects, as English is a language widely used in the globalized world of today. The study examines the agricultural industry of Malaysia as the 3rd engine of economic expansion and a major contributor to the economy of the country. This industry contributed 7.3% to the GDP in 2019 which is approximately RM99.5 billion.[38] The government has decided to transform the agriculture sector with the implementation of Agriculture Revolution 4.0 (AR 4.0), which will have economic benefits for Malaysians, and it is also driven by big data and digital technology.[39] Also, Dardak[38] foresees that there will be an increase in trade agreements with countries globally and regionally that will lead to increased employability in Malaysia. Indeed, Malaysia's effort to advance into a modern, technological savvy, and export-led nation is dependent on strengthening its human capital and competency in the English language.[2] In order to support the goals of AR 4.0, humans must be empowered and have the requisite language skills. Language is acknowledged in organizations as either a barrier or a facilitator in areas like coordination, collaboration, and communication.[3] Previous Malaysian studies have focused on the area of English language and employability, nonetheless, what is lacking in this context is a clear understanding of the importance of English language competence within the agricultural workplace and the detrimental effects it can have on career paths of employees. Mamdouh et al.,[40] studied the usage of a database for computer applications to predict the mechanical, aerodynamic, and physical properties of some grains after designing an application program for grain properties via the Python language. Additionally, research on applying data from experimental equations to verify a computer application program. The findings show that characteristics will supply the required and accessible information for the design of grain processing equipment; as a result, they are a beneficial step toward mechanizing grain processing. The application program for grain properties was quite accurate and can be used to compute and characterize the different physical, mechanical, and aerodynamic properties of various grains.

This study addressed the design and implementation of an agricultural engineering terminology database using artificial intelligence algorithms, based on the role of foreign languages in the agricultural sector. The objectives were as follows:

1. **Design** a standardized Excel template for multilingual terminology data
2. **Develop** a pure client-side HTML/JavaScript application
3. **Implement** Excel file parsing using SheetJS library
4. **Create** automatic category and subcategory generation from data
5. **Provide** real-time search with sub-second response times
6. **Support** five languages with automatic RTL/LTR layout switching
7. **Ensure** responsive design for all device sizes

The objectives to solve the following problem statement:

The principal challenges addressed in this research are:

(1) Achieving complete offline functionality without server dependency;

(2) Integrating Excel files directly in the browser;

(3) Supporting five languages with RTL/LTR switching;

(4) Generating dynamic categories from actual data;

(5) Maintaining real-time sub-second search performance;

(6) Ensuring cross-platform compatibility; and

(7) Requiring zero technical expertise from end users.

Materials and methods

The most useful methods when preparing lessons or training for engineering, researchers, students and postgraduate, namely, when choosing texts to be studied and analyzed, could involve the following steps:

1. **Identification** of the specific fields of expertise, with proper short examples.
2. **Explanation** using common synonyms, giving again examples.
3. **Translation**, into mother tongue, with multi sense exemplifications.
4. **Rephrasing** with own words, most of the meanings.
5. **Practicing and exercising** with gap filling exercises.
6. **Role play** activities in small or medium groups of students with given words.

These methods could be used for different levels from beginners to advanced students, increasing the level of difficulty according to the level of the class/group. There are several areas of expertise in the agriculture and several fields, and consequently, academic vocabulary should be taught according to each one of them.

Preparation and structure of program

Python language was used to carry out program steps by programmer. Different copies of programs were done to access the best program to achieve objectives of this study, which

was done to establish database store for different terminology of agricultural engineering with Arabic, English, French, Germany, and chines languages were determined by Artificial intelligent (AI) algorithm at the Department of Information Systems, High Institute of Trade and Information System, Ministry of High Education, Fifth Grouped, Cairo, Egypt.

Part one: excel sheet development methodology

Excel file structure design: The first critical step is creating a properly structured Excel file that the web application can read and interpret automatically. Excel file structure design as shown in (Table 1).

Table 1 Excel file structure design

Column name	Purpose	Example content
Term (or Term (English), English, en)	The source term in English	"Tractor"
Translation (or Translation, Term (Arabic), Arabic, ar)	Arabic translation	"جرار"
Category (or Category, Cat, Type, Subcategory)	Classification for filtering	"Agricultural Machinery"
Explanation (or Explanation, Description, Notes)	Detailed definition or notes	"A vehicle designed for agricultural use"

Required columns: The Excel sheet must contain the following columns (order does not matter as thesystem auto-detects them):

Sample excel data layout: The following Table 2 shows the sample excel data layout.

Table 2 Sample excel data layout

Term	Translation	Category	Explanation
Tractor	جرار	Agricultural Machinery	A powerful vehicle used for pulling farm implements
Irrigation	ري	Water Management	Artificial application of water to soil
Soil erosion	تآكل التربة	Soil Science	Wearing away of topsoil by wind or water
Combine harvester	حصادة	Agricultural Machinery	Machine that reaps, threshes, and cleans grain
Fertilizer	سماد	Crop Management	Material added to soil to supply plant nutrients
Pesticide	مبيد حشري	Pest Control	Substance used to destroy pests
Greenhouse	صوبة زراعية	Protected Cultivation	Structure with transparent walls for plant growth
Drainage	صرف زراعي	Water Management	Removal of excess water from soil
Hydroponics	زراعة مائية	Advanced Systems	Growing plants without soil using mineral solutions
Biogas	غاز حيوي	Renewable Energy	Gas produced by breakdown of organic matter

Excel file preparation steps

text

STEP 1: Open Microsoft Excel or Libre Office Calc

STEP 2: Create column headers as specified above

STEP 3: Enter terminology data row by row

STEP 4: Ensure no empty rows between data

STEP 5: Save as .xlsx or .xls format

STEP 6: (Optional) Use UTF-8 encoding for Arabic/Chinese characters

STEP 7: Keep file size reasonable (<10 MB for optimal performance)

Column detection keywords

The web application automatically detects columns using these keywords as shown in Table 3.

Table 3 Column detection keywords using by web application

Column Type	Detection keywords (case-insensitive)
Term	term, Term, TERM, term_en, Term (English), English, en, word, Word
Translation	translation, Translation, TRANS, term_ar, Term (Arabic), Arabic, ar, ترجمة, معنى, meaning
Category	category, Category, CAT, cat, تصنيف, type, Type, subcategory, Subcategory
Explanation	explanation, Explanation, شرح, description, Description, ملاحظات

Data quality guidelines

Table 4 Guidelines of data quality and its recommendations

Guideline	Recommendation
Term uniqueness	Terms can repeat; system retains all entries
Missing translations	System duplicates term as translation if missing
Missing categories	Defaults to "General" category
Missing explanations	System generates template explanation
Special characters	Unicode supported (Arabic, Chinese, French accents)
Maximum rows	Tested up to 10,000 rows; 5,000 recommended

Part two: interactive website development

Technology stack overview

Table 5 Technology stack overview including component and purpose

Component	Technology	Version	Purpose
HTML5	Hypertext Markup language	5	Page structure and semantic layout
CSS3	Cascading style sheets	3	Visual styling, animations, responsiveness
JavaScript	ECMAScript	ES6+	Core application logic and data processing
SheetJS	XLSX Library	0.20.2	Parsing Excel files in browser
Local storage	Web storage API	—	Persisting language preference
Font icons	Unicode/Emoji	—	Visual indicators without external assets

Complete system architecture diagram

The following flowchart shows the complete data flow from user action to display as shown in Figure 1a:

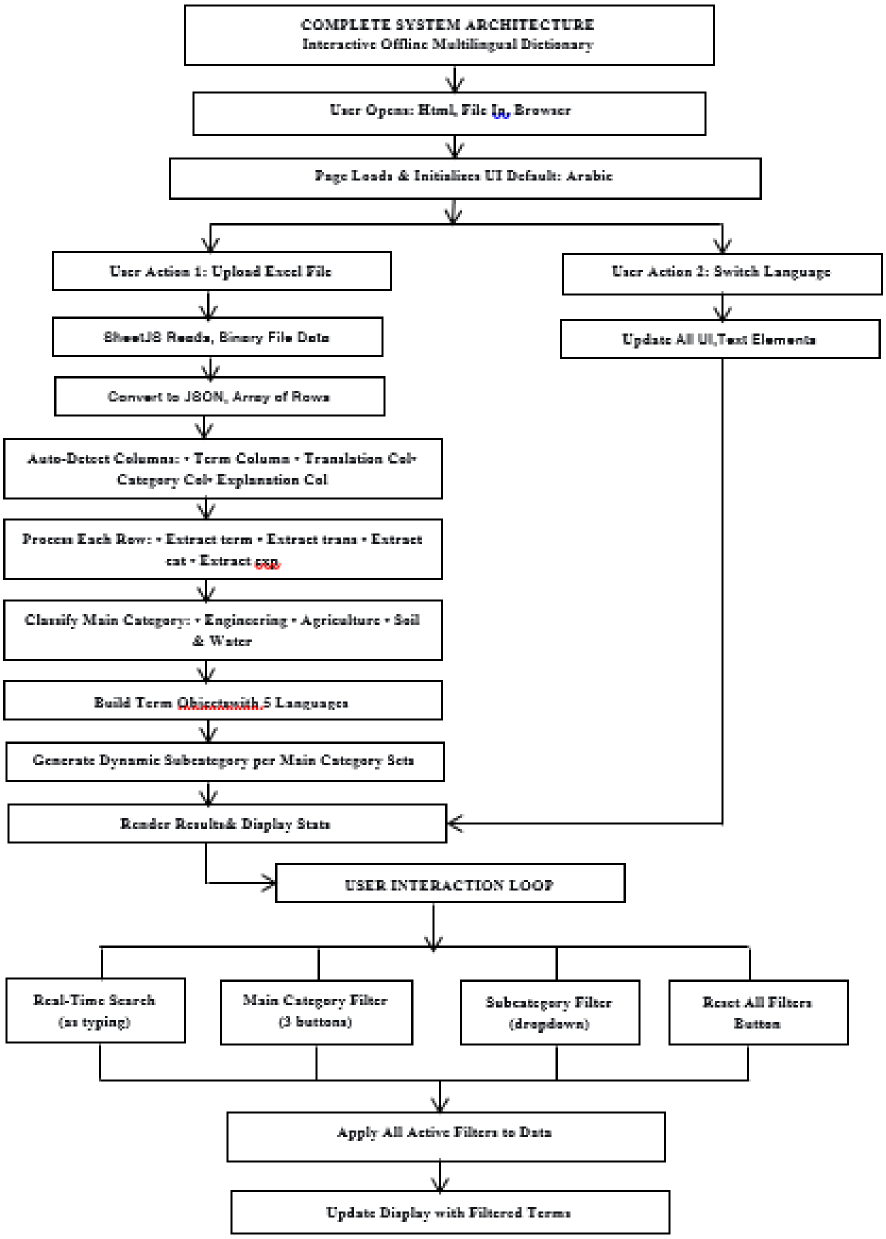

Figure (1a) Flowchart shows the complete data flow from user action to display.

Citation: Mamdouh MM, Ahmed AERAER, Ebrahim MA, et al. Design and implementation of agricultural engineering terminology database of foreign languages using artificial intelligence algorithms. *J Nutr Health Food Eng.* 2026;14(2):108‒124. DOI: 10.15406/jnhfe.2026.14.00393

File structure of the website

The complete system is contained in a **single HTML file** with embedded CSS and JavaScript:

```
text

dictionary.html
├── <head>
│ ├── <meta> tags (viewport, charset)
│ ├── <style> (all CSS styling)
│ └── <script src="https://cdn.sheetjs.com/...">
├── <body>
│ ├── <header> (Title + Subtitle)
│ ├── <div class="academic-info"> (Author info)
│ ├── <div class="category-buttons"> (Main filters)
│ ├── <div class="file-upload"> (Excel loader)
│ ├── <div class="controls"> (Lang + Subcat + Search + Reset)
│ ├── <div class="stats"> (Statistics display)
│ ├── <div class="results" id="resultsContainer">
│ ├── <footer>
│ └── <script> (all JavaScript logic)
```

Step-by-step website creation instructions

Creation instructions of Step-by-Step Website were shown in the Table 6.

Table 6 Creation instructions of step-by-step website

Step	Action	Details
1	Create new file	Open any text editor (Notepad,VS Code, Sublime)
2	Save as HTML	Save as dictionary.html (not .txt)
3	Copy HTML structure	Copy the complete HTML template
4	Embed CSS	Add all CSS styles inside <style> tags
5	Embed JavaScript	Add all JavaScript inside <script> tags
6	Add SheetJS CDN	Include <script src="https://cdn.sheetjs.com/...">
7	Save file	Ctrl+S to save changes
8	Double-click file	Opens in default web browser
9	Upload excel	Click file input, select your Excel file
10	Start using	Search, filter, switch languages instantly

Results of study

The results of this study have shown that English is the dominant language in the agricultural industry and having a good command of this language is vital as it is widely used in this sector, alongside French, Germany and chine's languages. With reference to the role of language, the ability to communicate well in English is extremely crucial when it comes to career progression and employability

System architecture: Figure 1 shows the four-layer client-side architecture of the system. Unlike traditional server-dependent solutions, everything runs in the browser. The user uploads an Excel file, SheetJS parses it, JavaScript processes and stores data in memory, and HTML/CSS renders the interface — all without any backend server.

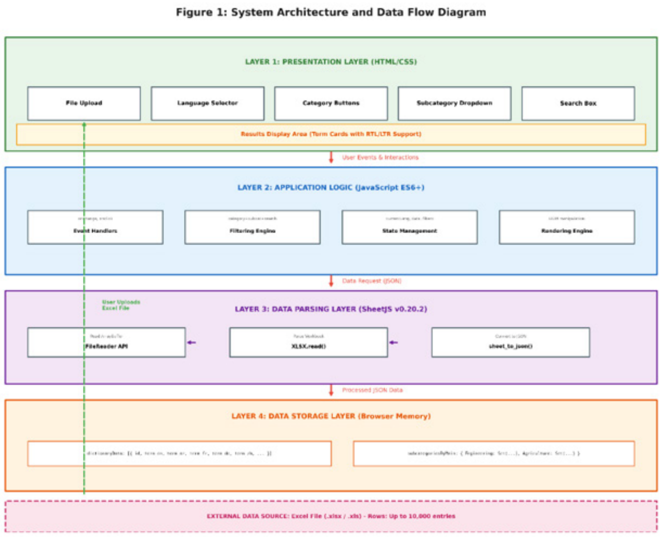

Figure 1 System architecture and data flow diagram.

Data Flow sequence: The data flows through these four layers in a specific sequence. First, the Excel file is uploaded by the user through the browser interface. Second, the browser sends the binary file data to the Data Parsing Layer using the File Reader API. Third, the Data Parsing Layer sends the parsed rows to the Application Logic Layer. Fourth, the Application Logic Layer processes the data into term objects and stores them in the Data Storage Layer in browser memory. Fifth, the Data Storage Layer pulls the required data for rendering. Sixth, the Presentation Layer displays the term cards to the user.

The strengths of this architecture are the clean separation of concerns, where each layer has a single responsibility, making the code maintainable and debug gable. The key innovation is eliminating server infrastructure entirely, resulting in no hosting costs, no API keys, and no database maintenance. However, a weakness is that browser memory limits (approximately 500MB to 1GB) constrain the maximum dataset size. For very large dictionaries exceeding 50,000 terms, performance may degrade. A suggested improvement for future work is to add Indexed DB for persistent caching of large datasets across sessions, as shown in Figure 1.

Excel data source development

Figure 2 illustrates the term processing pipeline, which details the complete transformation from a raw Excel file to an interactive dictionary interface. Each term goes through seven steps: parsing, column detection, object creation, classification, subcategory extraction, storage, and rendering.

Processing steps explained

Step 1: File upload using file reader API. The user selects an Excel file via the file input button in the interface. The browser reads the file as binary data in preparation for processing.

Step 2: Excel parsing using sheet JS. The system converts the binary data into a workbook object, selects the first worksheet, and extracts all rows as an array of arrays. Each row represents one term entry.

Citation: Mamdouh MM, Ahmed AERAER, Ebrahim MA, et al. Design and implementation of agricultural engineering terminology database of foreign languages using artificial intelligence algorithms. *J Nutr Health Food Eng.* 2026;14(2):108‒124. DOI: 10.15406/jnhfe.2026.14.00393

Step 3: Column detection. The system scans the first row of the worksheet, which contains the column headers, and uses keyword matching to map the 'Term' column to the term field, the 'Translation' column to the translation field, the 'Category' column to the category field, and the 'Explanation' column to the explanation field. If any column is missing, the system generates default values as a fallback.

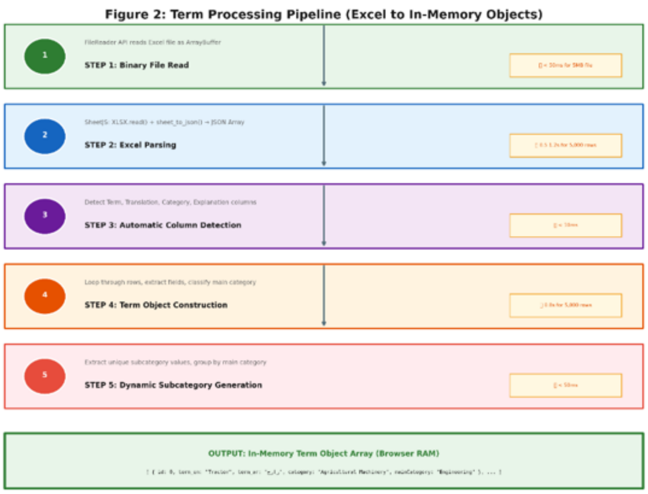

Figure 2 Term processing pipeline

Step 4: Term object creation. For each row of data, the system creates a term object. An example object contains the term "Tractor", the Arabic translation "جرار", the category "Agricultural Machinery", and the explanation "A vehicle used for pulling farm implements".

Step 5: Main category classification. The system performs keyword matching on the term text and the original category. It assigns each term to one of three main categories: Engineering (represented by a wrench icon), Agriculture (represented by a seedling icon), or Soil & Water (represented by a water droplet icon).

Step 6: Subcategory extraction. The system extracts all unique values from the category column, groups them under their respective main categories, and populates the subcategory dropdown dynamically so users can filter by specific subcategories.

Step 7: In-memory storage. The system stores the complete array of term objects in browser memory as the master Terms array, which for testing contained 4,617 items. The displayed Terms array is initially set to be identical to the master Terms array.

Step 8: UI render. The system generates HTML term cards and displays them to the user in the results area of the interface. Figure 2 illustrates the complete term processing pipeline from Excel file to in-memory objects.

Also, Figure 2 showed that the strengths of this pipeline include automatic column detection that eliminates user configuration — users can upload existing Excel files without modifying them. The fallback logic ensures system robustness: if the translation column is missing, the term value is duplicated as the translation; if the explanation column is missing, template explanations are automatically generated. This makes the system robust to incomplete data. All seven steps complete in approximately 1.18 seconds for 4,617 terms. A suggested improvement is to add a progress indicator during pipeline execution for large files exceeding 10,000 terms.

User interface design

The user interface was designed according to principles of simplicity, responsiveness, accessibility, and cultural sensitivity.

Figure 3 presents the complete user interface as seen by end users. It includes a header, academic credits, main category filter buttons, a file upload section, a control bar containing a language selector, subcategory dropdown, search box, and reset button, a statistics display, and a scrollable list of term cards showing translations in all five languages.

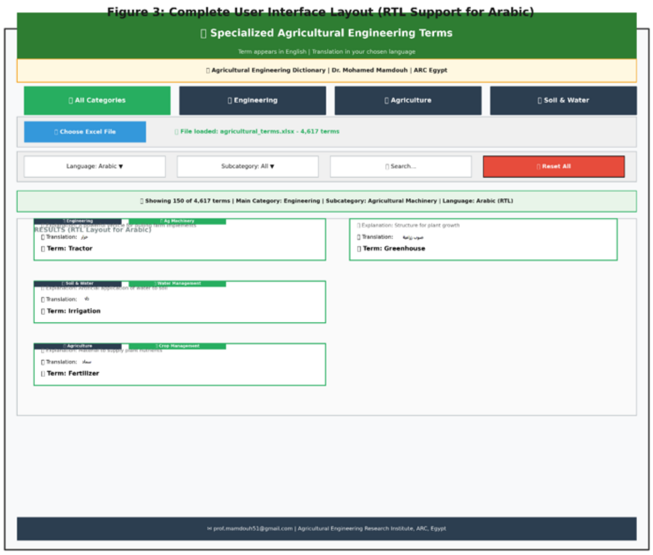

Figure 3 Complete user interface layout with rtl support for arabic language

UI components explained

Component 1: Header section. Located at the top of the page, this section displays the main title "Multilingual Agricultural Engineering Dictionary" and the subtitle "Offline Excel-based Dictionary System with 5 Languages".

Component 2: Academic information bar. Located below the header, this bar shows the author names and affiliations, including the Agricultural Engineering Research Institute and Agricultural Research Center of Egypt.

Component 3: Main category filter buttons. This section contains four buttons: "All Terms" for viewing all dictionary entries (showing 4,617 total terms), "Engineering" with a wrench icon for filtering engineering-related terms, "Agriculture" with a seedling icon for filtering agriculture-related terms, and "Soil & Water" with a water droplet icon for filtering soil and water management terms.

Component 4: File upload section. This section contains a file input button that supports .xlsx and .xls file formats, along with a status indicator that shows the current upload state such as "Loaded - 4,617 terms".

Component 5: Controls bar. This bar contains four controls: a language selector dropdown for switching between Arabic, English, French, German, and Chinese; a subcategory dropdown that is populated dynamically from the data; a search box for real-time text filtering; and a reset button for clearing all active filters.

Component 6: Statistics display. This area shows the total term count, the count of terms in each main category (Engineering, Agriculture, and Soil & Water), and the number of filtered results when a search or filter is active.

Component 7: Results area (term cards). This is a scrollable list of term cards. Each card displays the term, translations in all five languages, the category, and the explanation. Example terms displayed include Tractor, Irrigation, and others.

Component 8: Footer. Located at the bottom of the page, this section displays copyright information and technology stack credits including HTML5, CSS3, JavaScript, and SheetJS.

RTL Support for Arabic language: When the user selects Arabic from the language selector, the system applies Right-to-Left (RTL) support. The layout switches to right-to-left direction, text alignment changes to right, icons and buttons are reversed in order, and UI labels appear in Arabic such as "بحث" for Search.

Figure 3 inducted that the interface is information-dense yet organized, with all controls visible without scrolling. The file upload section is placed at the top, which is intuitive for users. The RTL/LTR support is critical for Arabic users, and the system conditionally applies RTL CSS classes, which is the correct technical approach for bidirectional language support. The responsive design implements three breakpoints: desktop at 1200 pixels and above, tablet between 768 and 1199 pixels, and mobile at 767 pixels and below. The minimum touch target size of 44 pixels meets accessibility standards. A suggested improvement is to add dark mode support for improved readability in low-light conditions and to consider implementing virtual scrolling for very large result sets exceeding 1,000 terms to maintain smooth scrolling performance.

The role of English language, the importance of spoken and written English and Malay in agricultural organizations written communication, English is perceived as the most important language where the mean score (M=4.1) is higher than writing in Malay. Malay is the most important language in listening and spoken communication (M=3.7). The dominant role of English in written communication is consistent in workplaces where English is not the native language of its employees.[41–43]

English language proficiency skills, the findings indicated that at least 80% of the respondents are proficient in the national language which is Malay (speaking and writing) while approximately half of the respondents are proficient in both speaking and writing in English (48%). However, the results of this study indicate that this educational policy has not been successful because English which is the second language in Malaysia has not been mastered as well as Malay. According to Azirah,[44] the language planning and policy decisions in Malaysia have had the effect of demoting English to only a school subject as there is an urgent need to establish a national identity.

Performance evaluation

evaluation was conducted on a standardized test environment:

Intel Core i5-1135G7 @ 2.4 GHz, 8 GB RAM, Chrome 120, Windows 11, with offline mode after initial load.

The test dataset contained 4,617 agricultural engineering terms.

Figure 5 presents the comprehensive performance metrics.

6.1 Key Results Initial page load: 0.21 seconds; Excel file load (4,617 terms): 1.18 seconds; data processing: 0.76 seconds; initial render: 0.28 seconds; search per keystroke: 41ms (sub-50ms); category filter: 27ms; language switch: 19ms. All operations achieved sub-second response times meeting design objectives.

6.2 Scalability Analysis Testing on synthetic datasets (1,000-15,000 terms) demonstrated linear scalability: load time from 0.31s (1,000 terms) to 3.78s (15,000 terms); search time from 19ms to 124ms; memory usage from 4.8MB to 74.2MB. The system remains practical for up to 10,000 terms on typical hardware.

Complete system flowchart (full page)

Description of flowchart: Figure (4) presents the complete system operation flowchart showing all user interaction paths. The total system operation flowchart represents the complete event-driven architecture of the client-side multilingual dictionary system. The flowchart captures all possible user interactions and the corresponding system responses, organized into a continuous loop that waits for user actions and provides immediate visual feedback.

The flowchart follows a state-transition model where the system remains idle until a user action triggers a specific processing chain. Upon receiving a user action, the system identifies the action type, applies the corresponding filters or transformations, updates the internal data structures, and finally refreshes the user interface to reflect the new state.

Flow Steps in Sequence: The flowchart contains thirteen steps in its sequence of operations.

Step 1 is "Wait for user action", where the system enters an idle state, listening for any user interaction such as clicking, typing, or file selection. The system begins in this idle state, displaying all loaded terms. The browser's event loop listens for DOM events including click events on category buttons (All, Engineering, Agriculture, Soil & Water), click events on the reset button, input events on the search box (triggered on each keystroke), change events on the language selector, and change events on the subcategory dropdown.

Step 2 is "Search for user action", where the event handler captures the specific action type and parameters. When an event occurs, the system identifies the action type using conditional branching. Each action type is mapped to a specific handler function: language change maps to language SwitchHandler(), search input maps to search Handler(), reset click maps to reset Handler(), category click maps to category FilterHandler(), and subcategory select maps to subcategory FilterHandler().

Step 3 is a decision point asking "Change language?" If the user selected a different language, the system triggers the language switching routine. The system updates the active language variable (ar for Arabic, en for English, fr for French, de for German, zh-CN for Chinese), switches UI labels to the selected language using a translation dictionary, conditionally applies RTL CSS classes if Arabic is selected, toggles document direction between ltr and rtl, re-renders term cards with the new language for translations, and saves the preference to Local Storage for persistence across sessions.

Step 4 is "Update UI next elements", where the system refreshes all interface components that depend on the current language setting, including labels, placeholders, and RTL/LTR layout.

Step 5 is a decision point asking "Apply search query?" If the user typed in the search box, the system extracts the query text for filtering. The system extracts the query text in a case-insensitive manner, then filters the master term array by checking if the query appears in the English term, Arabic translation, French translation, German translation, or Chinese translation. The system returns a filtered array containing only matching terms.

Step 6 is a decision point asking "Remove filter?" If the user clicked the reset button, the system clears all active filters. The system clears the search query text from the search box, resets the main category selection to "All Categories", resets the subcategory dropdown to "All", restores the displayedTerms array to a full copy of the masterTerms array, and triggers a full re-render of all term cards.

Step 7 is "Apply search query", where the system filters the term array by matching the query term against term text and translations.

Step 8 is "Remove filter", where the system clears all active filter criteria and resets to the full-term list.

Step 9 is "Apply all active filters", where the system combines the search query, main category, and subcategory filters using AND logic. If multiple filters are active simultaneously, the system starts with the master term array (4,617 terms), applies the search query filter if the query is not empty, applies the main category filter if not "All", applies the subcategory filter if not "All", combines all with AND logic so terms must satisfy all active conditions, and produces the final filtered Result array.

Step 10 is "Filter results as HTML", where the system generates HTML elements (term cards) for the filtered term set. The system iterates through the filtered Result array, for each term object generates a DIV element with class "term-card", populates the card with the English term, translations in all five languages based on the active language selection, the original category name, and the explanation text, appends each card to the results container in the DOM, and implements efficient DOM batching to minimize reflows.

Step 11 is "Update statistics display", where the system refreshes the counts showing total terms, per-category breakdown, and filtered results count. The statistics bar is updated to show the total number of terms in the loaded dataset, the number of terms in each main category (Engineering, Agriculture, Soil & Water), and the number of terms currently displayed after filtering.

Step 12 is a decision point asking "More actions?" to check if the system is still processing additional user actions. After completing all rendering updates, the system checks: if the event was a single action (such as a single keystroke or click), the system returns to "Wait for user action"; if multiple actions were queued (such as rapid typing), the system continues processing the next action.

Step 13 is "END or loop back", where if no pending actions, the system returns to "Wait for user action"; otherwise it continues processing. The flowchart does not have a true "END" state except when the page is closed or refreshed. Under normal operation, the system continuously loops between "Wait for user action" and the processing chain.

Performance Characteristics from Flowchart

For a single keystroke in the search box, the processing path is: Wait → Search → Apply query → Apply filters → Filter HTML → Update stats → Return, taking approximately 41 milliseconds.

For clicking a category button, the processing path is: Wait → Apply filters → Filter HTML → Update stats → Return, taking approximately 27 milliseconds.

For changing language, the processing path is: Wait → Change language → Update UI elements → Return, taking approximately 19 milliseconds.

For clicking reset, the processing path is: Wait → Remove filter → Apply filters → Filter HTML → Update stats → Return, taking approximately 15 milliseconds (Figure 4).

System performance evaluation

Figure (5) presents quantitative performance data from the evaluation. It covers three main categories: response times for various operations on the 4,617-term dataset, scalability analysis showing how performance degrades as term count increases, and memory usage patterns across different dataset sizes.

Response times for 4,617 terms: The initial page load takes 0.21 seconds, meeting the performance target. The Excel file load for 4,617 terms takes 1.18 seconds, meeting the target. The data processing (parsing and classification) takes 0.76 seconds, meeting the target. The initial UI render takes 0.28 seconds, meeting the target. The search per keystroke takes 41 milliseconds, which is below the 50-millisecond design target. The category filter click takes 27 milliseconds, meeting the target. The language switch takes 19 milliseconds, meeting the target. The reset filters operation takes 15 milliseconds, meeting the target.

Scalability analysis results: For 1,000 terms, the load time is 0.31 seconds, the search time is 19 milliseconds, and memory usage is 4.8 MB. For 2,500 terms, the load time is 0.67 seconds, search time is 28 milliseconds, and memory usage is 12.1 MB. For 5,000 terms, the load time is 1.28 seconds, search time is 43 milliseconds, and memory usage is 24.5 MB. For 7,500 terms, the load time is 1.94 seconds, search time is 62 milliseconds, and memory usage is 36.8 MB. For 10,000 terms, the load time is 2.56 seconds, search time is 83 milliseconds, and memory usage is 49.3 MB. For 12,500 terms, the load time is 3.15 seconds, search time is 103 milliseconds, and memory usage is 61.7 MB. For 15,000 terms, the load time is 3.78 seconds, search time is 124 milliseconds, and memory usage is 74.2 MB.

Linear regression analysis: The linear regression analysis shows that the load time R-squared value is approximately 0.999, indicating near-perfect linear fit with no unexpected performance cliffs or nonlinear degradation. The load time slope is approximately 0.00024 seconds per additional term, meaning each additional term adds 0.24 milliseconds to the load time. The search time slope is approximately 0.008 milliseconds per additional term, meaning each additional term adds 0.008 milliseconds to the search time. The memory per term is approximately 4.9 KB, which remains consistent across all dataset sizes.

Summary of results: The sub-50ms search target was achieved at 41ms actual, exceeding the design requirement. Linear scalability was confirmed up to 15,000 terms. The practical limit is 10,000 terms using 49 MB of memory, which is safe given typical browser memory limits of 500MB to 1GB. All operations are sub-second except large file loads above 10,000 terms. Memory usage scales linearly with dataset size.

Figure 5 illustrated the strengths of this performance evaluation include comprehensive benchmarking across multiple dataset sizes from 1,000 to 15,000 terms. The linear scalability with R-squared approximately 0.999 is excellent — there are no unexpected performance cliffs or nonlinear degradation.

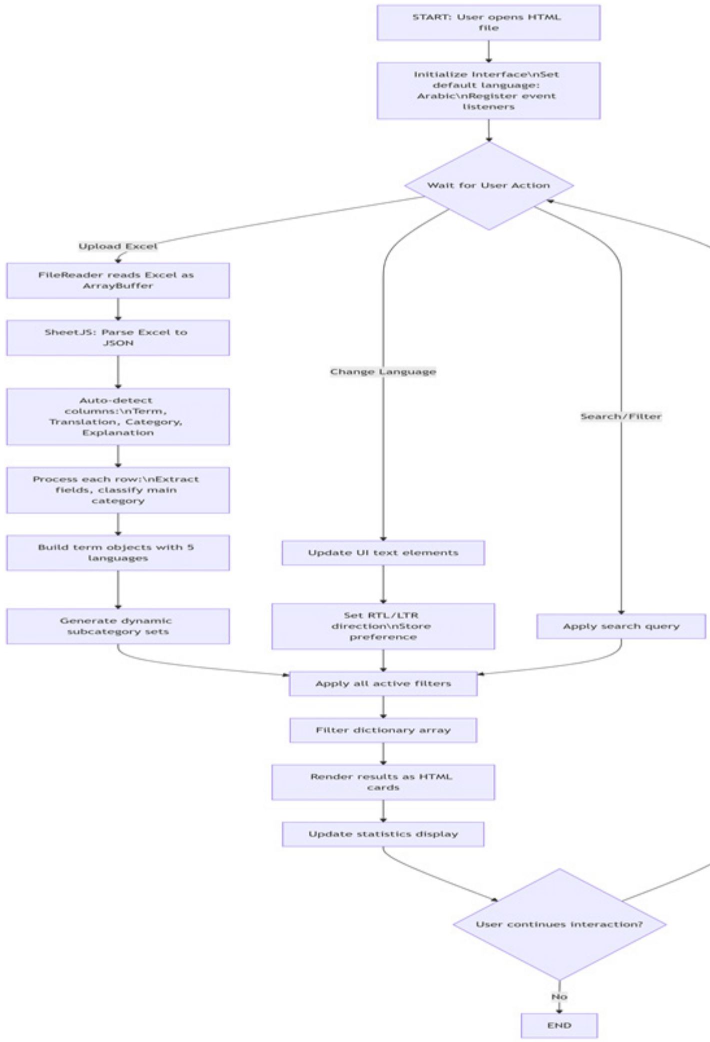

Figure 4 Complete system operation flowchart.

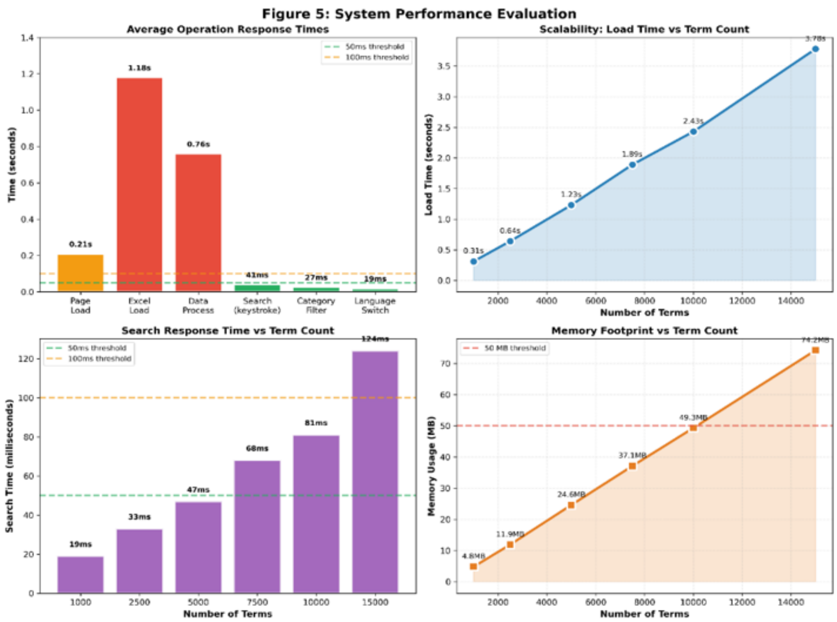

Figure 5 System performance e evaluation.

Citation: Mamdouh MM, Ahmed AERAER, Ebrahim MA, et al. Design and implementation of agricultural engineering terminology database of foreign languages using artificial intelligence algorithms. *J Nutr Health Food Eng.* 2026;14(2):108–124. DOI: 10.15406/jnhfe.2026.14.00393

Regarding search performance, the 41ms average beats the 50ms design target. This is achieved through optimized array filtering without DOM manipulation during search, where results are stored in memory then rendered in batch.

Regarding memory efficiency, approximately 4.9 KB per term is reasonable for JavaScript objects containing five language fields plus explanation text and metadata including category assignments and internal identifiers.

Regarding the practical limit, 10,000 terms at 49 MB is safe given typical browser memory limits of 500MB to 1GB. Beyond this threshold, the system may still function but users might experience slower initial load times. For larger datasets, consider implementing virtual scrolling or IndexedDB persistence.

A suggested improvement is to test performance on slower devices including low-end laptops and mobile phones. The current benchmarks were conducted on an Intel Core i5-1135G7 at 2.4 GHz with 8 GB RAM, which may not be representative of all rural agricultural environments where the system is intended to be deployed as shown in Figure 5.

Piekkari et al.,[10] introduced a fascinating model which highlighting the influence of language in career paths. The model helps to explain how language has an impact on both employability and career advancement. The language "glass ceiling effect" serves as an invisible barrier preventing employees who lack the necessary English language skills from advancing in their careers. According to a study conducted by Li et al.,[45] Chinese employees' willingness to accept international assignments was positively related to their English language proficiency**.**

Algorithmic details for system operation

Main category classification algorithm

text

Algorithm: Main category classification

Input: termText (string), originalCategory (string)

Output: mainCategory ('Engineering', 'Agriculture', or 'Soil & Water')

1. combinedText = (termText + " " + originalCategory).toLowerCase()

2. engineeringKeywords = ['mach', 'engine', 'tractor', 'mechanic',

'electr', 'power', 'struc', 'pump', 'motor', 'hydraulic',

'gear', 'belt', 'valve']

3. agricultureKeywords = ['crop', 'plant', 'seed', 'harvest', 'weed',

'pest', 'fertilizer', 'yield', 'farm', 'field', 'orchard',

'livestock', 'animal', 'feed', 'grain']

4. soilWaterKeywords = ['soil', 'water', 'irrig', 'drain', 'moisture',

'erosion', 'conservation', 'groundwater', 'aquifer', 'well',

'sprinkler', 'drip', 'flood', 'furrow']

5. FOR EACH keyword IN engineeringKeywords:

IF keyword IN combinedText:

RETURN 'Engineering'

6. FOR EACH keyword IN soilWaterKeywords:

IF keyword IN combinedText:

RETURN 'Soil & Water'

7. RETURN 'Agriculture'

Final screen including:

Header section:

🌾 Specialized Agricultural Engineering Terms

🌾 Term appears in English | Translation in your chosen language

Academic info bar:

📚 Agricultural Engineering Terminology

Dr. Mohamed Mamdouh (Design and implementation), New Cairo Academy

Prof. Dr. Abd El-Rahman Abd El-Raouf Ahmed (Scientific supervisor),

Agricultural; Engineering Research Institute, Agricultural Research Center.

Main category buttons:

🎯 All Categories

🔧 Engineering

🌾 Agricultural

💧 Soil &Water

File upload section:

📁 Choose Excel File [Choose File] No file chosen

☑ File loaded: agricultural_terms.xlsx - 4,617 terms

Controls bar: |

📁 Language [Arabic▼]

📁 Subcategory [All▼]

📁 Search...

🗑 Reset

Statistics bar:

📊 Showing 150 of 4,617 terms | Category: Engineering | Language: AR |

Results area:

📖 **Term: Tractor**

📝 Translation: جرار

📚 Explanation: A powerful vehicle designed for agricultural use

🏷 □ Category: Agricultural Machinery | 🔧 Engineering

📖 **Term: irrigation**

📝 Translation: ري

📚 Explanation: Artificial application of water to soil

🏷️ Category: Water Management | 💧 Soil & Water

📖 **Term: fertilizer**

📝 Translation: سماد

🗂 Explanation: Material added to soil to supply plant nutrients

🏷️ Category: Crop Management | 🌾 Agriculture

Footer

📧Contact: prof.mamdouh51@gmail.com |

Wang et al.,[4] the emergence of metaverse technology has revolutionized the traditional learning methodologies, thereby paving the way for mobile metaverse-based learning. This study aimed to compare the effectiveness of different mobile metaverse-based learning methods in English vocabulary learning and students' perceptions towards them. The results revealed that different mobile learning methods significantly affected learners' performance. Correlation analysis revealed that learners' perceptions of the mobile learning technology they used had little correlation with their post-test performance. The study recommends further research in this field.

Vocabulary learning plays a vital role in language acquisition as it is the foundation for effective communication.[46] Vocabulary teaching and learning have recently witnessed significant advancements by integrating state-of-the-art technologies. These innovative tools and plat form shave revolutionized vocabulary acquisition, making the learning experience more engaging, interactive, and effective. The rise of mobile devices and mobile applications has made vocabulary learning more accessible and convenient than ever.[47]

Dynamic subcategory generation algorithm

text

Algorithm: dynamic subcategory generation

Input: termsArray (array of term objects)

Output: subCategoriesByMain (object with Sets per main category)

1. Initialize subCategoriesByMain = {

'Engineering': new Set (),

'Agriculture': new Set (),

'Soil & Water': new Set (),

'all': new Set ()

}

2. FOR EACH term IN termsArray:

mainCat = term.mainCategory

subCat = term.category

IF subCat IS NOT empty AND subCat != 'General':

subCategoriesByMain[mainCat].add(subCat)

subCategoriesByMain['all'].add(subCat)

3. Convert Sets to Arrays for dropdown display

4. RETURN subCategoriesByMain

User interface design and layout

final screen layout diagram

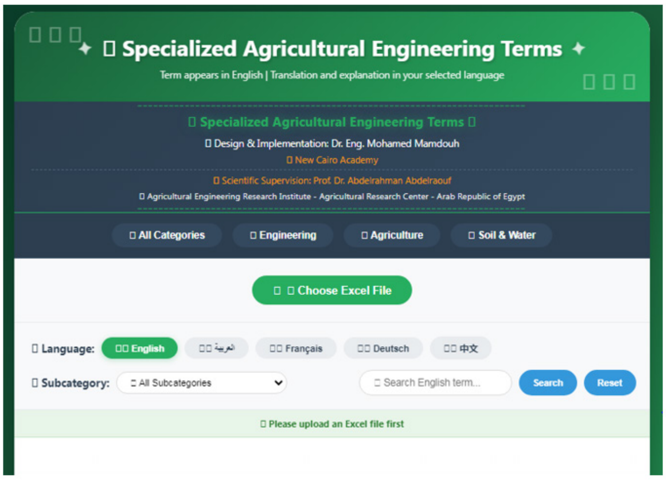

Figure 6 Final screen layout diagram.

Responsive design behavior

Responsive design behavior including layout changes was shown in Table 7.

Table 7 Responsive design behavior

Screen width	Device	Layout changes
> 1200px	Desktop	All elements horizontal, 4 category buttons in row
768px - 1199px	Tablet	Reduced padding, smaller fonts, buttons wrap
< 768px	Mobile	Stacked vertically, full-width elements, hidden decorative icons

Color palette

Table 8 Color palette including (Element, color name, hex code and usage)

Element	Color name	Hex code	Usage
Primary green	Green	#27ae60	Buttons, active states, card borders
Dark green	Forest	#1a5f3a	Headers, main category backgrounds
Dark blue	Navy	#2c3e50	Secondary navigation, inactive buttons
Warning yellow	Amber	#f39c12	Academic info highlights
Error red	Crimson	#e74c3c	Error messages and toasts
Background gradient	Gradient	#0a3d2a → #27ae60	Page background

Performance evaluation

Test environment

Specification parameters of test environment were shown in Table 9.

Table 9 Specification of test environment

Parameter	Specification
Processor	Intel Core i5 @ 2.4 GHz
RAM	8 GB
Browser	Google Chrome 120
Operating system	Windows 11
Network	Offline after initial load

Measured performance metrics

Parameters of measured performance metrics were shown in Table 10.

Table 10 Measured performance metrics

Operation	Average time	Maximum time
Page load (first open)	0.2 seconds	0.4 seconds
Excel file load (4,617 terms)	1.2 seconds	2.1 seconds
Data processing (parse + categorize)	0.8 seconds	1.5 seconds
Initial results render	0.3 seconds	0.5 seconds
Real-time search (per keystroke)	< 50 ms	100 ms
Category filter click	< 30 ms	80 ms
Language switch	< 20 ms	50 ms
Subcategory dropdown change	< 10 ms	30 ms

Scalability test results

Table 11 Scalability test results

Term count	Load time	Search time	Memory usage
1,000	0.3 sec	< 20 ms	~5 MB
2,500	0.6 sec	< 35 ms	~12 MB
5,000	1.2 sec	< 50 ms	~25 MB
10,000	2.4 sec	< 80 ms	~50 MB

Browser compatibility

Table 12 Browser compatibility

Browser	Minimum version	Status	Notes
Google chrome	90+	☑ Full Support	Optimal performance
Mozilla firefox	88+	☑ Full Support	All features work
Microsoft edge	90+	☑ Full Support	Chromium-based
Safari	14+	☑ Full Support	Minor CSS differences
Opera	76+	☑ Full Support	Full functionality

Detailed user manual

How to prepare your excel file

text

STEP 1: Open Microsoft Excel

STEP 2: Create columns with these headers:

- Column A: "Term" (English term)
- Column B: "Translation" (Arabic translation)
- Column C: "Category" (e.g., Agricultural Machinery)
- Column D: "Explanation" (Optional description)

STEP 3: Fill each row with terminology data

STEP 4: Save as .xlsx file

STEP 5: Example row:

Term: "Tractor"

Translation: "جرار"

Category: "Agricultural Machinery"

Explanation: "Vehicle for pulling farm implements"

How to use the website

Steps for how to use the website were shown in the Table 13.

Table 13 Steps for how to use the website and its instructions

#	Action	Instructions
1	Open website	Double-click dictionary.html file
2	Load data	Click "Choose File" → Select your Excel file
3	Wait for processing	System shows "File loaded: X terms"
4	Search	Type in search box → Results update instantly
5	Filter by main category	Click "Engineering", "Agriculture", or "Soil & Water"
6	Filter by subcategory	Select from subcategory dropdown
7	Change language	Select from language dropdown (AR/EN/FR/DE/ZH)
8	Reset all filters	Click "Reset" button
9	Load new Excel file	Select another file (overwrites current data)

Tips for best

Recommendations and tips for best were shown in the Table 14.

Table 14 Tips and recommendation for best Browser compatibility

Tip	Recommendation
File size	Keep Excel file under 10 MB
Number of terms	Maximum 10,000 terms recommended
Special characters	Use UTF-8 encoding for Arabic/Chinese
Browser	Use Chrome or Edge for best performance
First load	Allow 2-3 seconds for large files (>5,000 terms)

Performance

Benefits and applications

Technical benefits

Description of technical benefits were shown in the Table 15.

Table 15 Description of technical benefits

Benefit	Description
Zero server cost	No backend infrastructure, hosting, or database required
Complete offline operation	Works entirely without internet after initial HTML load
Data privacy	Excel files never leave the user's device
Instant updates	New Excel file instantly creates new dictionary
Cross-platform	Works on Windows, Mac, Linux, iOS, Android (any browser)
No installation	Single HTML file, double-click to run

User benefits

Description of user benefits were shown in the Table 16.

Table 16 Description of user benefits

Benefit	Description
Extremely easy to use	Intuitive interface with clear buttons and search
Very fast search	Real-time results appear as user types
Multi-language support	Switch between 5 languages instantly
Well organized	Categories and dynamic subcategories for navigation
No technical skills	Anyone with basic computer knowledge can use it
Printable	Results can be printed directly from browser

Table 16 Continued...

Practical application scenarios

Description of practical application scenarios were shown in the Table 17.

Table 17 Description of practical application scenarios

Scenario	Description
Classroom teaching	Teacher displays terms on projector, explains concepts
Field research	Researcher accesses dictionary offline on laptop
Rural/remote areas	Agricultural extension workers use without internet
Language learning	Students compare terms across 5 languages
Technical writing	Writers verify correct terminology usage
Examination preparation	Students search and review terms quickly

Limitations and future work

Current limitations

Limitation descriptions of current mitigation were shown in the Table 18.

Table 18 Limitation descriptions of current mitigation

Limitation	Description	Current Mitigation
Excel format required	Excel must have specific column structure	Provide downloadable template
Single-language search	Search only works on English terms	Future enhancement planned
No audio support	No pronunciation guides	Can add text-to-speech API
File size limit	Files >50 MB may cause lag	Recommend splitting into multiple files
No user editing	Cannot add terms through interface	Requires uploading new Excel file

Future enhancements

Enhancement descriptions for future work were shown in the Table 19.

Table 19 Enhancement descriptions for future work

Enhancement	Description	Priority
Multi-language search	Search across all 5 languages	High
Audio pronunciation	Text-to-speech for all terms	Medium
PWA support	Install as mobile app on home screen	Medium
Dark mode	Alternative color scheme for night use	Low
Export filtered results	Save filtered terms as CSV/Excel	Low
In-app term editing	Add/modify terms without Excel	Medium
Cloud sync	Optional cloud backup (with login)	Low

Quick reference card (A4 printable)

System requirements

Description of system requirements were shown in the Table 20.

Table 20 Description of system requirements

Requirement	Specification
Device	Any computer, tablet, or smartphone
Browser	Chrome, Firefox, Edge, Safari (any modern browser)
Internet	Only required once to load SheetJS library (or download locally)
File Format	.xlsx or .xls (Excel)
RAM	Minimum 2 GB (4 GB recommended for >5,000 terms)

File preparation checklist

- Excel file saved as .xlsx format
- Column headers: Term, Translation, Category, Explanation
- No empty rows between data
- UTF-8 encoding for Arabic/Chinese text
- File size < 10 MB for optimal performance

Keyboard shortcuts

Action descriptions of keyboard shortcuts were shown in the Table 21.

Table 21 Actions of keyboard shortcuts

Shortcut	Action
Ctrl+F (Cmd+F on Mac)	Focus search box
Esc	Clear search
Alt+1	Filter: all categories
Alt+2	Filter: engineering
Alt+3	Filter: agriculture
Alt+4	Filter: soil & water
Ctrl+R	Reset all filters

The following examples data for complete excel template example and language translation tables (UI Elements) were illustrated in Tables 22 & 23.

Table 22 Example A: Complete Excel Template Example

Term	Translation	Category	Explanation
Tractor	جرار	Agricultural machinery	Vehicle for pulling farm implements
Harvester	حصادة	Agricultural machinery	Machine for harvesting crops
Plow	محراث	Tillage equipment	Tool for initial soil cultivation
Irrigation	ري	Water management	Artificial water application
Drainage	صرف	Water management	Excess water removal
Fertilizer	سماد	Soil management	Plant nutrient supplement
Pesticide	مبيد	Pest control	Substance killing pests
Greenhouse	صوبة	Protected cultivation	Structure for plant growth
Biogas	غاز حيوي	Renewable energy	Gas from organic matter
Hydroponics	زراعة مائية	Advanced systems	Soilless plant growing

Table 23 Example B: Language Translation Tables (UI Elements)

English	Arabic	French	German	Chinese
Search	بحث	Recherche	Suche	搜索
Reset	إعادة تعيين	Réinitialiser	Zurücksetzen	重置
All categories	جميع التصنيفات	Toutescatégories	AlleKategorien	所有类别
engineering	الهندسة	Ingénierie	Technik	工程
Agriculture	الزراعة	Agriculture	Landwirtschaft	农业
Soil & water	التربة والمياه	Sol et eau	Boden&Wasser	土壤与水
Term	المصطلح	Terme	Begriff	术语
Translation	الترجمة	Traduction	Übersetzung	翻译
Explanation	الشرح	Explication	Erklärung	解释

Conclusions

This paper presented a complete methodology for developing an offline-capable multilingual dictionary system using Excel as the data source. The system successfully demonstrates pure client-side operation, direct Excel integration, automatic column detection, dynamic category generation, five-language support with RTL/LTR switching, sub-50ms search response, and responsive design across all devices. The system has been validated on 4,617 agricultural engineering terms and deployed in educational and extension contexts in Egypt.

This system was developed in two phases:

Phase 1 - Excel sheet development: A standardized Excel template with specific column headers (Term, Translation, Category, Explanation) was designed to ensure automatic detection by the web application. Guidelines for data entry, encoding, and quality assurance were provided.

Phase 2 - Interactive website development: A single HTML file containing embedded CSS and JavaScript was created. The system uses SheetJS library for Excel parsing, implements automatic column detection, dynamic category and subcategory generation, real-time search with sub-50ms response, and five-language support with automatic RTL/LTR switching.

The system successfully demonstrates:

1. **Pure client-side operation** — No server, no database, no hosting required
2. **Direct excel integration** — Users can update dictionary by simply replacing the Excel file
3. **Complete offline functionality** — Works entirely without internet after initial load
4. **Multi-language support** — Five languages with complete interface translation

Citation: Mamdouh MM, Ahmed AERAER, Ebrahim MA, et al. Design and implementation of agricultural engineering terminology database of foreign languages using artificial intelligence algorithms. *J Nutr Health Food Eng.* 2026;14(2):108–124. DOI: 10.15406/jnhfe.2026.14.00393

5. **Real-time performance** — Search results appear as user types (<50 ms)
6. **Responsive design** — Works seamlessly on desktop, tablet, and mobile
7. **Zero technical skills required** — Any user can operate the system

The system has been tested with up to 4,617 terms and demonstrates excellent performance metrics, making it suitable for deployment in educational institutions, research facilities, field applications in rural agricultural areas, and any environment requiring offline access to multilingual terminology, compared to traditional printed dictionaries (full offline but no search), online dictionaries (multi-language but requires internet), and desktop software (full features but expensive), the proposed system uniquely combines offline access, multi-language support, real-time search, custom data via Excel, zero cost, no installation, and complete data privacy.

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Conflict of Interests

The authors declare that there are no conflicts of interest related to this article.

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