Guelma University, Algeria Computer Science Department 2^{ère} Master STIC/ICST – UEF3

Knowledge Engineering Course

Chapter IV Design & development of Knowledge Management Systems

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Development Life Cycle





Step 1: Audit & Analysis (1/2)

- Identify Stakeholder Needs: Understand the needs and requirements of various stakeholders, including employees, managers, and customers. Determine what knowledge needs to be managed and why.
- Gap Analysis: Assess the existing knowledge management capabilities and identify gaps or areas where improvements are needed.
- Define Clear Objectives: Clearly define the goals and objectives of the KMS project. What does the organization aim to achieve through the implementation of the KMS?
- Measurable Outcomes: Establish measurable key performance indicators (KPIs) that will be used to evaluate the success of the KMS.
- User Profiles: Create user personas to understand the different user groups within the organization. Determine their roles, responsibilities, and knowledge needs.
- User Requirements: Identify specific user requirements, such as access to certain types of information, collaboration features, and usability expectations.

Step 1: Audit & Analysis (2/2)

- Content Inventory: Catalog all existing knowledge assets, including documents, databases, manuals, and other information sources.
- Content Mapping: Map the content to user needs and organizational goals. Identify redundancies, gaps, and areas for improvement.
- Existing Systems: Evaluate the organization's existing IT infrastructure, including software, hardware, and network capabilities.
- Technology Selection: Determine the technology stack and tools that will support the KMS. Consider factors like scalability, security, and integration with existing systems.
- Knowledge Sources: Determine how knowledge will be captured, whether through documentation, collaboration platforms, expert interviews, or other means.
- Resource Allocation: Determine the budget, staffing requirements, and resource allocation needed for KMS development.
- **Project Timeline:** Create a realistic project timeline with milestones and deadlines.

Linking Knowledge to Strategy

The strategic choices that an organization makes regarding technology, markets, products, services, and processes have a direct impact on the knowledge, skills, and competencies that it needs to compete in its intended markets.



Identifying Knowledge

□ At the high level analysis, knowledge can be categorized into:

- **Core knowledge:** the basic level of knowledge required just to ply the game.
- Advanced knowledge: designates what makes the company competitively viable.
- Innovative knowledge: allows an organization to lead its entire industry to an extent that clearly differentiates it from competition.
- Example of Website developing organization:
 - Core knowledge: server hosting capabilities, Web programming skills, graphic design skills, clearly identified target markets, Web security fundamentals.
 - Advanced knowledge: responsive Web design, search engine optimization, digital marketing skills.
 - Innovative knowledge: Al and machine learning integration, cybersecurity expertise.

Step 2: Forming the KM Team

Forming the KM Team

- Identify key stakeholders: typically includes members from various departments and roles, such as IT specialists, content creators, subject matter experts, data analysts, and knowledge managers.
- Assigning roles: each team member is assigned specific roles and responsibilities based on their expertise.
- Leadership: responsible for guiding the team's efforts, coordinating activities, and ensuring the project aligns with the organization's goals.
- Balance the knowledge management team's constitution—organizationally, strategically, and technologically.
- Training and Communication: the KM team may also be responsible for developing training programs and communication strategies to educate employees about the KM system and encourage its use.

KM Team Structure (1/3)

Domain Experts:

- Instrumental in identifying, defining, and collecting critical knowledge within their area of expertise.
- Their expertise allows them to curate, organize, and validate the content that goes into the KMS.
- They are pivotal in developing the taxonomy and structure of the knowledge base.
- Their expertise helps in training other team members or end-users in understanding and using the intended KMS.
- Play a critical role in keeping the KMS up-todate.



KM Team Structure (2/3)

IT Experts:

- Designing the technical architecture of the KMS.
- Select the right KMS platform or software that aligns with the organization's needs.
- Implement robust security measures to protect sensitive data within the KMS.
- Provide user training and technical support for KMS users.
- Continuous monitoring, regular updates, and maintenance of the KMS.
- Measure the KMS performance by analyzing system metrics, user engagement, and feedback.
- Keeping up with technological advancements.



KM Team Structure (3/3)

Managers:

- Outline the objectives, purpose, and expected outcomes of the KMS.
- Allocate necessary resources, including budgets, personnel, and time, to ensure the successful development of the KMS.
- Provide leadership and guidance to the KM team.
- Make critical decisions during the development process, resolving conflicts, providing clarity on priorities.
- Ensuring that the KMS project is progressing according to the set timelines and objectives.



Step 3: Knowledge Capture & Codification

See Chapter 3

Step 4: Designing the KM Blueprint

Step 4: Designing the KM Blueprint (1/3)

- Involves creating a detailed plan and framework for the implementation of the knowledge management system, this includes:
 - Technology Selection: decide on the technology and tools that will support your knowledge management system. This includes selecting knowledge repositories, collaboration platforms, search engines, and any other necessary software. Consider factors like scalability, integration capabilities, and user-friendliness.
 - Information Architecture: determine how knowledge will be organized, categorized, and accessed. So often, taxonomies or ontologies are created to structure the knowledge assets, making it easier for users to find relevant information.
 - Content Management: plan for content creation, curation, and quality control. define roles and responsibilities for content contributors, reviewers, and administrators. Ensure that the content is accurate, up-to-date, and aligned with organizational goals.

Step 4: Designing the KM Blueprint (2/3)

- Knowledge Capture and Transfer: develop processes for capturing and transferring knowledge from individuals to the KMS. This may involve creating templates for documenting best practices, lessons learned, or expert insights. Consider how tacit knowledge can be converted into explicit knowledge.
- User Training and Adoption: plan for user training and adoption strategies. Ensure that employees are comfortable using the KMS and understand its value. Training programs, documentation, and ongoing support are essential.
- Metrics and Measurement: define key performance indicators (KPIs) to measure the success of the knowledge management system. Determine what metrics are used to track knowledge creation, usage, and impact on organizational outcomes.
- Change Management: implement a change management strategy to facilitate the transition to the new KMS. Address resistance to change and communicate the benefits of the system to all stakeholders.

Step 4: Designing the KM Blueprint (3/3)

- Budget and Resource Planning: develop a budget and allocate resources for the design, implementation, and ongoing maintenance of the KMS. Consider costs related to software, hardware, personnel, and training.
- Timeline and Phases: create a project timeline and define the phases of implementation. This may involve a pilot phase, followed by a broader rollout. Ensure that deadlines and milestones are realistic.
- Risk Assessment: identify potential risks and challenges that could hinder the successful implementation of the KMS. Develop mitigation strategies to address these risks.
- Documentation: document the entire KM blueprint, including all the strategies, plans, and processes. This documentation will serve as a reference point throughout the implementation and can be updated as needed.

Step 5: Implementation

KM system Seven Layers Architecture

The effectiveness of this layer is a dominant determinant of the usability of a knowledge management system.

Incorporates the set of applications used for knowledge creation, sharing, organization, and collaboration.

Include components that support the applications provided in the application layer.

Provides a connection between old and new data or systems. User Interface Layer (Knowledge Portal)

Access & Authentication Layer

Authentication, Authorization, Recognition, Firewall

Collaborative Intelligence and Filtering layer Intelligent agent tools, Al tools, case-based reasoning.

Application Layer

Yellow pages, Video conferencing, Digital whiteboards, Electronic forums, Expert systems, E-learning

Transport Layer

Web, TCP/IP Deployment, Streaming Audio, VPN core, Email

Middleware Layer

Storage Layer

Step 5: Implementation

- 1. Develop the interface layer. Create platform independence, leverage the intranet, enable universal authorship, and optimize video and audio streaming.
- 2. Develop the access and authentication layer. Secure data, control access, and distribute control.
- 3. Develop the collaborative filtering and intelligence layer, using intelligent agents and collaborative filtering systems. Look at options to buy intelligent agents versus easy and free tools that can be used to build your own.
- 4. Develop and integrate the application layer with the intelligence layer and the transport layer.
- 5. Leverage the extant transport layer to take advantage of existing networks that are already in place in your company.
- 6. Develop the middleware and legacy integration layer to connect the knowledge management system both to true legacy data and recent, inconsistent legacy data

Step 5: Implementation – Interface Layer/Portals

- Portals are virtual workspaces that intend to:
 - Promote knowledge sharing among different categories of end users:
 - Provide an interface for knowledge producers.
 - Provide an interface to knowledge users/consumers.
 - Provide access to stored structured data.
 - Organize unstructured data.
 - Simplify access to all data stored.
 - Facilitate collaboration among employees.
 - Synchronous collaboration: teleconferencing, online chat forums.
 - Asynchronous collaboration: Electronic mailing lists, discussion forums.

- Assist the organization in reaching its customers.
- Incorporate advanced search capabilities and taxonomies.
- Provide a platform independent access for enabling universal access from any location or computer terminal connected to the Web ->
 Web browser based technology

Information portals	Knowledge portals
Contain only information	Goal directed toward knowledge creation, acquisition, transmission and management
Involves a single application	Related to different applications

Step 5: Implementation – Access & Authentication Layer

- 1. Access privileges: assign rights to permit different levels of access to data such as read-only, edit, and delete capabilities.
- 2. Security: provide an efficient support for protecting the KMS from being hacked:
 - Construct a firewall between the extranet and Internet and thoroughly test the firewall by mock attacks.
 - Incorporate advanced cybersecurity protection tools (machine-learning based).
 - Enable communication via Virtual Private Networks (VPNs).
 - Use biometrics, voice and/or fingerprint recognition authentication forms.
- **3. Backups:** provide efficient and reliable recovery processes such as staging areas, and mirror sites.

Step 5: Implementation – Collaborative Filtering & Intelligence Layer (1/2)

- Collaborative Filtering is a technique used in KMS to recommend or filter information based on the preferences, behavior, and actions of users within the organization. It relies on the collective intelligence of the user community to identify and present relevant knowledge and information:
 - User-Based Collaborative Filtering: recommends content to a user based on the behavior and preferences of users who are similar to them.
 - Item-Based Collaborative Filtering: identifies similar items (knowledge, documents, articles) based on user interactions.
- Collaborative filtering enhances KMS in the following ways:
 - helps users discover relevant knowledge and content (e.g., full indexing & tagging).
 - fosters knowledge sharing by connecting users with common interests.
 - increases user engagement and satisfaction by providing personalized recommendations (e.g., use virtual folders instead of static hyperlinks.).

Step 5: Implementation – Collaborative Filtering & Intelligence Layer (2/2)

- The intelligence layer typically incorporates artificial intelligence technologies to extract valuable insights and structure unstructured data.
 - Content Extraction and Tagging: automatically extract key information from unstructured content, such as documents, emails, or chat messages. It then tags the content with relevant metadata, making it easier to organize, search, and retrieve.
 - Natural Language Processing: enable the system to understand and process human language, which is essential for tasks like sentiment analysis, chatbots, and language translation. This enhances the user experience and the system's ability to interpret and categorize knowledge.
 - Recommendation Systems: suggest relevant content to users, support collaborative filtering, and even anticipate knowledge needs based on user interactions.
 - Search and Retrieval: allow users to find specific knowledge quickly, even from vast volumes of unstructured data.
 - Analytics and Reporting: generate reports and analytics on knowledge usage, user behavior, and content trends. This data informs decision-making and helps organizations fine-tune their knowledge strategies.

Step 5: Implementation – Application Layer (1/3)

- The application layer encompasses the software tools, platforms, and applications that enable the capture, storage, retrieval, sharing, and dissemination of knowledge within an organization:
 - Knowledge Management Software: software tools that are designed to facilitate the creation, organization, and accessibility of knowledge assets, including tools for creating and maintaining taxonomies and ontologies. These structures help categorize and organize knowledge assets for efficient retrieval and classification.
 - Content/Document Management Systems (CMS/DMS): tools to manage and organize knowledge content. CMS allow for the creation, storage, and retrieval of documents, images, videos, and other forms of content. It should also focus on the efficient management of documents, including version control, document security, and workflow management.
 - Collaboration Tools: platforms such as intranets, wikis, and social collaboration tools to facilitate knowledge sharing and collaboration among employees.

Step 5: Implementation – Application Layer (2/3)

- Search and Retrieval Systems: essential for locating and accessing knowledge assets within the organization. They enable users to quickly find relevant information and expertise.
- Expertise Location Systems: tools that help identify and locate subject matter experts within the organization. They are valuable for connecting employees with questions to those with the relevant expertise.
- Learning Management Systems (LMS): often used for knowledge management, particularly for training and knowledge dissemination. They track and manage training materials, certifications, and employee skill development.
- Business Intelligence and Analytics Tools: used to gain insights from knowledge data. They help organizations monitor the effectiveness of their knowledge management initiatives and identify areas for improvement.

Step 5: Implementation – Application Layer (3/3)

- Security and Access Control: security measures and access control mechanisms are an integral part of the application layer to protect sensitive or confidential knowledge assets from unauthorized access or data breaches.
- User Interfaces and Customization: user-friendly interfaces and customization options to tailor the user experience, making it intuitive and adapted to the specific needs of users.

Step 5: Implementation – Transport Layer (1/2)

- The transport layer plays a crucial role in ensuring that knowledge and data are transmitted efficiently, securely, and accurately across the network or system:
 - Data Transmission: responsible for breaking down the knowledge and data into smaller segments or packets for efficient transmission over the network.
 - Data Integrity: provides error checking and data integrity mechanisms to ensure that the data received at the destination is the same as what was sent.
 - Security: incorporates encryption and authentication mechanisms to secure data during transmission, preventing unauthorized access or data breaches.
 - Reliability: use various protocols (e.g., TCP) to guarantee the delivery of data without loss or duplication.
 - Network Connectivity: handle the establishment, management, and termination of network connections, enabling remote access and collaboration.

Step 5: Implementation – Transport Layer (1/2)

- Interoperability: ensure that data can be transmitted and received across various technologies and architectures, promoting interoperability.
- Performance Optimization: use various techniques like data compression and efficient routing to reduce latency and bandwidth consumption.
- Scalability: allow for scalability by accommodating more users, data, and nodes without significant performance degradation.
- Protocol Selection: enable the choice of the appropriate communication protocol (e.g., HTTP, FTP, SMTP) for specific knowledge management tasks, such as sharing documents, conducting discussions, or accessing a central knowledge repository.

Step 5: Implementation – Middleware & Legacy Layer (1/2)

- □ The middleware layer is a bridge between the different components of KMS:
 - Integration: enables the integration of diverse data sources, applications, and systems that store and manage knowledge.
 - Data Transformation: transforms data from different formats or structures into a standardized format, making it easier to search, retrieve, and present knowledge.
 - Security: implements security mechanisms to protect sensitive knowledge assets and ensure that only authorized users can access specific information.
 - Scalability: provides scalability by handling the distribution and replication of knowledge across a network or cloud infrastructure.
 - Interoperability: ensures that different systems and platforms can work together seamlessly in a transparent way.
 - Performance Optimization: caches frequently accessed data to improve system performance and response times, reducing the load on data storage systems.

Step 5: Implementation – Middleware & Legacy Layer (2/2)

- The legacy layer may include databases, document management systems, content repositories, and older software applications.
 - Data Migration: mechanisms to extract, transform, and load data from legacy systems into the KMS repository. This may involve mapping data from legacy formats to the standardized format used by the KMS.
 - Legacy System Integration: ensures that it can interface with and use data from existing legacy systems. This integration may involve creating connectors or adapters to bridge the gap between new and legacy systems.
 - Data Preservation: ensures the preservation and accessibility of historical data while accommodating future growth.

Step 5: Implementation – Repositories Layer

- The repositories layer serves as the foundation for knowledge management within an organization.
- □ It encompasses the storage, classification, and accessibility of explicit knowledge:
 - Operational databases
 - Knowledge bases
 - Web forums archives
 - Legacy data
 - Digitalized document archives
 - Etc.

Step 6: Verification/Validation & Performance Evaluation

Step 6: Verification & Validation & Performance Evaluation (1/5)

- Different ways can be used for the evaluation of the impact of KMS:
 - Cost-based approach Return On Investment (ROI): putting monetary figure on intellectual assets and determine the money saved or earned by using existing knowledge. However, this metric does not tell how it can create further values.
 - Market-value-based approach: measures the improvement on market leadership, and stability to the organization.
 - Effect-on-income approach: measures the effect on expense reduction, customer retention, profit margins.
- Metrics-based evaluation approaches are often vulnerable and no a single metric can evaluate the effectiveness of a KMS.

Step 6: Verification & Validation & Performance Evaluation (2/5)

Several metrics and methods can be used to assess the effectiveness of a KMS:

- User Adoption and Engagement: The level of user engagement with the KMS can be a critical metric. Metrics might include the number of registered users, active users, and the frequency of their interactions with the system.
- Content Contribution: Assess how many users contribute content to the system. Higher contribution rates indicate that users find value in sharing their knowledge.
- Content Quality: Evaluate the quality of the content contributed to the KMS. You can use metrics like content ratings, reviews, or the number of times content is reused or cited.
- Search and Retrieval Effectiveness: Measure how well users can find the information they need. Metrics may include search success rates, average search time, and the relevance of search results.

Step 6: Verification & Validation & Performance Evaluation (3/5)

Several metrics and methods can be used to assess the effectiveness of a KMS:

- Knowledge Sharing: Assess the extent to which knowledge is shared and distributed within the organization. Metrics could include the number of shared documents, discussions, or collaborative projects.
- Problem Solving: Measure how well the KMS helps solve problems. This can be done by tracking the resolution time for issues or the success rate of solutions proposed using KMS resources.
- Innovation: Determine if the KMS fosters innovation. Metrics may include the number of innovative ideas generated or the successful implementation of these ideas.
- Cost Savings: Evaluate how the KMS reduces costs related to knowledge sharing and retrieval. This can be calculated based on time saved, reduced duplicated efforts, or decreased reliance on external consultants.

Step 6: Verification & Validation & Performance Evaluation (4/5)

Several metrics and methods can be used to assess the effectiveness of a KMS:

- Knowledge Gap Reduction: Measure the extent to which the KMS helps bridge knowledge gaps within the organization. This could involve tracking improvements in employee skills or expertise.
- Feedback and Surveys: Collect feedback from KMS users through surveys or interviews to gather qualitative data on their experiences and satisfaction.
- Technology Performance: Assess the technical performance of the KMS, such as system uptime, response times, and scalability to handle increased usage.
- Compliance and Security: Ensure that the KMS complies with relevant industry standards and security protocols. Evaluate any security breaches or non-compliance incidents.
- Return on Investment (ROI): Calculate the ROI by comparing the benefits derived from the KMS to the costs associated with its implementation and maintenance.

Step 6: Verification & Validation & Performance Evaluation (5/5)

Several metrics and methods can be used to assess the effectiveness of a KMS:

- Benchmarking: Compare the performance of your KMS to industry benchmarks or best practices to identify areas for improvement.
- Long-Term Impact: Assess the long-term impact of the KMS on the organization's knowledge culture, competitiveness, and strategic goals.

Evaluating a KMS is an ongoing process. Regular assessments using a combination of these metrics help organizations adapt their KMS to evolving needs and maximize its impact on knowledge sharing and organizational success.



Step 7: Scaling & Enhancement (1/3)

- The Scaling & Enhancement phase focuses on optimizing and expanding the KMS to accommodate the growing needs of the organization and continuously improve its performance. This phase is essential for ensuring that the KMS remains effective, efficient, and aligned with the evolving goals of the organization. It incorporates:
 - Scalability Assessment: evaluate the current performance of the KMS to determine if it can handle increased usage and data volume. Consider factors like system response times, storage capacity, and user concurrency. Identify any scalability bottlenecks.
 - Infrastructure Upgrades: if necessary, invest in infrastructure upgrades to support the scalability of the KMS. This may involve adding more server capacity, increasing network bandwidth, or adopting cloud-based solutions to accommodate growth.
 - User Feedback Analysis: gather feedback from KMS users to understand their experiences and challenges. Use this feedback to identify areas that require enhancement and to prioritize feature requests and improvements.

Step 7: Scaling & Enhancement (2/3)

- Feature Enhancement: based on user feedback and changing business requirements, enhance the features and functionality of the KMS. This may involve developing new capabilities, improving the user interface, or adding integrations with other software systems.
- Content Enrichment: continuously update and enrich the knowledge content within the KMS. Ensure that information remains accurate, relevant, and up-to-date. Implement content review and maintenance processes.
- Advanced Search and Retrieval: enhance the search and retrieval capabilities of the KMS. Implement more advanced search algorithms, filters, and indexing mechanisms to help users find information more quickly and accurately.
- Security and Compliance: review and enhance security measures to protect sensitive information stored within the KMS. Ensure that the KMS complies with relevant data protection regulations and industry standards.

Step 7: Scaling & Enhancement (3/3)

- User Training and Support: provide ongoing training and support to KMS users. Ensure that users are aware of new features and how to use them effectively.
- Performance Monitoring: implement performance monitoring and analytics tools to track the KMS's performance, usage patterns, and user engagement. Use these insights to make informed decisions for further improvements.