Applicability of ERP Systems
for Knowledge Management
in the Context of Quality Management

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Abstract. Today technological advances are frequently affecting all aspects of a typical organization. One of such aspects is organisational quality management. As work environment changes dramatically, the need for appropriate business systems to support the new working conditions arises. The assumption behind this paper is that quality management oriented knowledge management system would be a proper mean for enchasing effectiveness of an organisation. The goal of the paper is to analyse direct and indirect support of different ERP modules and technologies to knowledge and quality management in order to identify which ERP solutions and technologies could be used in quality management oriented knowledge management system.

1 Introduction

Today's dynamic and turbulent environment makes it difficult for organisations to operate successfully and maintain competitive advantage. Therefore, organizations are looking for new solutions and possibilities for improvement of existing systems in order to achieve and/or maintain their competitiveness.

Rapid environmental changes challenge existing organisational quality management systems by requesting agile quality strategies and innovative quality solutions. Such requirements hardly can be met by traditional quality information systems, because managing in rapidly changing environment requires knowledge (not just information) based solutions. In the same time particular knowledge management oriented properties are presented by several information systems solutions, e.g., particular solutions incorporated in ERP systems.

This paper presents a part of the research on the development of quality management oriented knowledge management system [1]. Quality management oriented knowledge management system is a knowledge management system that is designed to enhance the effectiveness of quality management system and thus contribute to the overall welfare of the organisation. The goal of the paper is to analyse direct and indirect support of different ERP modules and technologies to knowledge and quality management in order to identify which ERP solutions and technologies could be used in quality oriented knowledge management system. Research method is analytical, i.e. the conclusions are derived on the basis of feature analysis of ERP systems compo-

nents. The research relies on a wide variety of information sources in order to identify the current situation in the research areas. In general, organizational information systems can provide a part of knowledge management systems infrastructure and components. Here, in particular, the potential contribution of ERP systems to quality management oriented knowledge management system is analysed.

ERP are comprehensive, packaged software solutions that seek to integrate the complete range of business processes and functions in order to present a holistic view of the business from a single information and information technology architecture. It provides seamless integration of all information flowing through a company, such as financial, accounting, human resources, supply chain, and customer information [2]. ERP combines all the information of an organization together into a single, integrated software program that converges on a single database so that the various departments can share information and communicate with each other more easily [3]. Once the data are input at one system, they immediately become available throughout all systems, which deliver a consistent management interface. ERP packages are usually upgraded on a regular basis to adopt new technology, further improve the productivity with advanced work process, streamline and standardize work process, and yet bring more data consistency and integrity across all modules, so the management can benefit from prompt real-time processing to provide information for decisions [4]. Many large organisations worldwide have already adopted ERP, and increasingly small- and medium - sized enterprises also are finding it cost effective and competitively advantageous to follow the example of large organisations [5].

Impact of ERP systems modules and technologies on knowledge management in the context of quality management is threefold: (1) ERP systems provide knowledge management oriented modules that may be used in quality management, (2) ERP systems incorporate technologies applicable for knowledge management systems, and (3) ERP systems have quality management oriented modules that can be included as an information sources in the quality management oriented knowledge management system of the organisation.

This paper investigates the field that has not been broadly researched yet. Although the interaction and intersection between ERP and knowledge management, and the ways, in which the knowledge management initiatives can help to facilitate the processes of implementation and maintenance of ERP systems, are extensively investigated [2, 5, 6, 7, 8, 9, 10], by authors knowledge, ERP systems in the context of their application to knowledge management have not been thoroughly analysed. Therefore, the goal of the paper is to analyse the ERP systems in order to identify the ERP modules and technologies that support knowledge management, as well as to determine whether it is possible to apply these solutions and technologies to quality management to enhance effectiveness of an organisation. The ERP systems are chosen as representatives of information system in general because of their wide application in organisations and their high competitive capacity within the information systems' market. No specific criteria were used to choose particular ERP systems for analysis. However, principles of popularity and diversity were taken as bases for ERP systems selection. Therefore the most advanced and popular ERP systems (e.g. SAP, Baan, Oracle, and PeopleSoft) that are oriented to large organizations and international corporations, as well as such ERP systems as Microsoft Navision and Great Plains, that are focused on the segment of small- and medium- sized enterprises, where included in the list of systems to be investigated. The paper presents data about specific ERP systems, as

well as provides summaries of all the analysed ERP systems where the specific features of each ERP system are not reflected.

The paper is organised as follows. The relationship between knowledge management and information systems is analysed, potential contribution of ERP systems to knowledge management is discussed, and the basic knowledge management oriented technologies offered by ERP systems are identified in Section 2. The short overview of the area of quality management is presented and ERP systems potential support for quality management is discussed in Section 3. These two sections set the background for the analysis of potential ERP systems support for quality management oriented knowledge management system that is presented in Section 4. Brief conclusions and directions of intended future work are given in Section 5.

2   ERP Systems Support for Knowledge Management

This section is focused on the relationship between knowledge management and information systems, discusses potential contribution of ERP systems to knowledge management, and identifies the basic knowledge management oriented technologies offered by ERP systems.

2.1   Knowledge Management and Information Systems

The resent trends in the organisational development have demonstrated the importance of knowledge management. Knowledge management is systematic, precise, and deliberative process of knowledge creation, retrieval and utilization. The aim of knowledge management is to maximise efficiency of activities related to knowledge as well as benefits acquired from this knowledge. Knowledge management is improving the ways the organisations are doing the business. Knowledge management systems have been applied in different areas of organisational performance. There are knowledge management systems for strategic planning, marketing, manufacturing, finances and human resources management [11].

In order to transform knowledge into a valuable organisational asset, knowledge, experience, and expertise must be formalised, distributed, shared, and applied. Effective management of knowledge requires hybrid solutions involving both people and technology. Therefore it is very important to determine the technology for storing the knowledge, persuade employees to contribute to the repository, create a structure for holding the knowledge.

Past management information systems basically used the computer as a means of providing information to solve recurring operational problems Today, there is a need for new types of systems that focuses on discovering knowledge that responds to the changing environment. By increasing capabilities of decision makers, information systems that support knowledge management initiatives improve the chances that an organization will achieve its goals.

Past and current management information systems that influenced today's knowledge management systems indirectly are integrated management information systems, real-time management information systems, and distributed management information systems. Mostly these systems focus on processing a company's critical applications

– applications without which the business could not continue its operation [12]. These systems are integral part in building company's knowledge management system.

Information systems that support information flow are one essential component in knowledge management system. Information systems create good virtual environment for knowledge management. One type of such information systems is ERP systems.

2.2 Potential Contribution of ERP Systems to Knowledge Management

Some academic research has been done in the area of ERP systems' application to knowledge management within the organisations. However, important claims in this regard are emerging from the practitioner literature [2]. For example, articles debate the effectiveness or ineffectiveness of ERP systems in extracting usable information from the underlying organisational data [13], the role of ERP systems as organisational "knowledge libraries" [14], or the addition of ERP modules that incorporate groupware and decision support systems [15]. In order to find out how ERP systems can support knowledge management, such ERP systems [16, 17, 18, 19, 20, 21, 22] as SAP, Baan, Oracle, PeopleSoft, Microsoft Navision, and Great Plains are analysed.

ERP purports to support all business functions of an enterprise. High functionality is one of the main differentiators of ERP. The main features of ERP are provided business solutions, which support the core processes of the business and administrative functionality. In addition to these general business functions, ERP often supports industry specific functions like student administration at universities or high volume warehousing transactions for retailers etc [5]. However, further in this section only those ERP solutions that support knowledge management will be discussed.

The results of the detailed analysis of ERP systems with respect to ERP systems potential support to knowledge management are identified and summarized in Table 1. The first column of the table presents ERP solutions that support knowledge management. The second column describes potential contribution of ERP systems to knowledge management.

Table 1. Potential contribution of ERP systems to knowledge management

ERP solutions	Potential contribution of ERP systems to knowledge management
Enterprise Portal (EP)	Enable users to: • Access any type of content via intelligent search functionality, publish-and-subscribe methods, or simple browsing, • Efficiently manage, classify, and search content, • Control the publishing cycle, using online collaboration and editorial workflow capabilities, • Integrate information with transactions, • Search internal and external sources and identify subject-matter experts. In addition, offers: • Web-based authoring that simplifies publishing processes with online editing, discussion forums, and automatic document version control, • Feedback, discussion, and annotation functions that make it easy to interact with content owners, experts, and other resources.

Table 1. (continued)

ERP solutions	Potential contribution of ERP systems to knowledge management
Customer Relationship Management (CRM)	• Optimises customer knowledge across the enterprise, • Consolidates key customer information from multiple touch-points to provide an understanding of the "cost to serve" each customer or prospect.
Supply Chain Management (SCM)	• Delivers the tools company need to increase cooperation with its partners and manage its total supply chain to achieve better business performance, • Ensures efficient, reliable, and timely information exchange throughout the extended enterprise. To help achieve this, ERP leverages core capabilities in the areas of integration, information, and collaboration, • Offers to optimise company's internal processes and use e-commerce to work more closely with customers and suppliers.
Product Lifecycle Management (PLM)	A comprehensive, Internet-enabled solution that: • Spans the complete lifecycle of a product, • Captures product information at any relevant stage in the lifecycle, and • Can help ensure that every department is working with the right information.
Electronic Document Management (EDM)	• Can be used to transfer data in document information records between the ERP internal system and the external system, • Support such functions as creating, changing, and displaying a document information record.
File Management (FM)	Offers the right architecture for file and content management: • Provides versioning, integrated workflow and approval processing that make teams more efficient, • Allows to consolidate hundreds or even thousands of file servers into a single, secure, scalable file service, • Offers to find the necessary information easily and fast with the help of integrated search tools.
Business Flows (BF)	Collection of application components designed to enable end-to-end business processes, that: • Automate the critical business processes utilized to support a complete business strategy for managing operations, customers, suppliers, partners, and employees, • Help to improve current business processes using best practices built into the product, streamline and efficiently manage the flow of transactions and information etc.
Services Management	Solution empowers to take advantage of the knowledge that company possesses. It allows to: • Access complete histories of clients, projects, and contracts, • Scrutinize operations, competitors, and employees, • Look at the whole picture, or scrutinize the details, and • Create online discussion forums and virtual chat rooms, • Capture, distribute, and exploit information.

Table 1. (continued)

ERP solutions	Potential contribution of ERP systems to knowledge management
Solution for Public Sector	• Seamlessly integrate data from various sources to help public sector organisations to understand better the interrelationships of tactical activities and strategic goals, • Creates knowledge libraries to handle structured and unstructured information in a wide variety of formats and supports e-learning scenarios.
Business Intelligence Suite (BIS) or Analytics	Helps: • Deliver actionable information to management at all levels, • Managers make the right decisions, close the gap between intent and execution, • Transform data into meaningful, valuable information.
E-Learning	An enterprise learning management system, that: • Provides a complete infrastructure for organizations to manage, deliver, and track training participation of employees, customers, and partners in both e-learning and classroom based environments, • Ensures quicker time-to-market for product training and consistent delivery of information, knowledge and training across the enterprise.
Workflow Management System (WMS)	• Helps an organisation acquire, store, and catalogue content of organizational knowledge.
Collaboration Suite	• Leverages a relational database to offer a secure, reliable and scalable way to simplify business communications and consolidate information, • Provides users with access to integrated email, voicemail, calendaring, file sharing, search capabilities and web conferencing.
Web Conferencing	• Enables individuals and groups to meet on-line to collaborate, share presentations, applications or their entire desktop.
E-commerce Series	• Offers seamless integration between e-commerce solution and business management system, • Ensuring accuracy of information across all systems, helping company serve its customers better, and improving decision making at all levels.
HelpDesk	Provides a collaborative framework for streamlining help desk operations. It delivers: • Powerful tools that automate the support of information technology systems and • Facilities to sustain company's global enterprise infrastructure smoothly and cost-effectively. With HelpDesk, company can: • Achieve a complete view of the employee, allowing the agent to determine quickly and easily the correct solution to the employee's query or issue, • Determine the best resolution to a problem with a robust search engine delivering solutions weighted, ranked, or scored by accuracy, • Recognize the most appropriate solution to a case with visual icon identification, • Access a central repository of diagnostic tools such as troubleshooting scripts, problem-solving techniques, and agent-recommended solutions, and • Leverage self-service to allow workers to create cases and search the knowledge base for efficient problem resolution, etc.

Thorough analysis of the ERP systems shows that ERP systems support many knowledge management functions and encourage knowledge management initiative in an organisation. According to R. Maier's system-centric classification of knowledge management systems functions [23], ERP systems at least in some extent support the following knowledge management functions:

- Knowledge search,
- Knowledge presentation,
- Knowledge publication, structuring and linking,
- Knowledge acquisition,
- Knowledge communication and cooperation,
- Computer-based training.

2.3 Basic Knowledge Management Oriented Technologies Offered by ERP Systems

During the analysis of the ERP systems the ERP built-in technologies that support knowledge management were also identified. The following knowledge management oriented technologies [24, 25] were identified in ERP systems:

- *Intranet technologies*. Intranets and Extranets are technologies that can be used to build a knowledge management system. The unified surface and access to various sources of information make this technology perfect for acquiring and sharing knowledge throughout a company [24].
- *Groupware*. Groupware is a substantial technology that is used for knowledge management. Groupware offers a platform for communication, collaboration, and coordination. It allows users to interact with both people and databases [12].
- *Information retrieval tools*. Information retrieval offers a solution to tasks from text searches to the automatic categorization and summation of documents.
- *Data warehousing*. Data warehousing is the assembling of selected, filtered, and structured data from a variety of sources into one coherent assembly for the purpose of being able to find meaningful relationships within the data [26 by 27]. Connections that are not readily apparent can be uncovered with the use of data mining and on-line analytical processing (OLAP). These techniques are part of data analysis.
- *Data analysis*. Pattern recognition and classification and forecasting are the techniques used for data analysis. Data analysis is a possible method for generating new knowledge.
- *Agent technologies*. Software agents based on the essentials of artificial intelligence enable the user to search independently for information according to a personal profile and to use various sources and other agents.
- *Computer based training*. It is interactive instructional experience between a computer and a learner in which the computer provides the majority of the stimulus and the learner responds, resulting in progress toward increased skills or knowledge [28]. This technology is also used to pass on knowledge to colleagues.

The results of the ERP systems analysis with respect to utilized technologies are summarized in Table 2. The first column of the table presents the basic ERP built-in technologies that support knowledge management. The other columns encompass the analysed ERP systems. The notation "X" identifies the ERP systems that support particular knowledge management technologies.

Table 2. The basic knowledge management oriented technologies offered by ERP systems

KM technologies offered by ERP	SAP Business Suite	Oracle E-business Suite	IBaan Solution Portfolio	PeopleSoft Product Lines	Microsoft Navision	Microsoft Great Plains
Intranet technologies	X	X	X	X	X	X
Groupware	X	X	X	X	X	X
Information retrieval tools	X	X	X	X	X	X
Data warehousing	X	X	X	X	X	X
Data analysis	X	X	X		X	X
Agent technologies[1]	X	X				
Computer based training	X	X		X		

3 ERP Systems' Support for Quality Management

This section presents a short overview of the area of quality management and discusses how ERP systems can support quality management.

3.1 Quality Management

Organisations implement quality management systems to enhance customers' satisfaction and to improve the effectiveness of the organisations. Quality management is a management approach of an organisation, centred on quality, based on the participation of all the involved parties, and aiming at long-term profitability through customer satisfaction. Quality management system may be defined as an assembly of components, such as the organisational structure, responsibilities, procedures, processes and resources for implementing quality management [29]. Quality management system should apply to and interact with all activities of the organisation. One of the main tasks of a quality management system is to support employees and managers of an organisation by information that is relevant for effective decision-making concerning operational and strategic issues of an organisation. In ERP systems this support is supposed to be provided by quality management subsystem.

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[1] As the strict borders of the agent technologies do not exist, it is difficult to detect the intelligent agent functions of ERP systems from the descriptions of the systems.

However, many areas exist that indirectly influence quality management initiatives- starting from the strategy definition, ending with the detailed technical aspects, that will support effective implementation and maintenance of quality management system. Therefore it is essential to identify all possible approaches and technologies of ERP systems that can promote quality management initiatives in organisations.

3.2 Contribution of ERP Systems to Quality Management

In order to identify potential ERP support for quality management whole spectrum of ERP solutions was analysed. Many ERP systems have quality management module as a subsystem that directly supports quality management activities. Nevertheless also performance measurement principles and human resources management solutions that indirectly influence quality management activities are widely supported by ERP systems.

The results of detailed analysis of ERP solutions that potentially can support quality management are reflected in Table 3. The first column of the table comprises those ERP solutions that support quality management. The second column presents in detail how particular ERP solutions can support quality management.

Table 3. Contribution of ERP systems to quality management

ERP solutions	Contribution of ERP systems to quality management
Quality Management (QM) solutions	Quality management solutions of the most advanced ERP systems provide two types of functions: 1. Cross application functions that are incorporated in such modules as Materials Management, Production, Sales & Distribution and Cost Accounting. They fulfil the following tasks: • Manage quality information for materials, vendors, and manufacturers, • Request quality certificates and monitor their receipt, • Manage problems using quality notifications and process complaints against vendors, • Integrate inspection planning and work scheduling, • Handle in-process inspection during production at freely defined inspection points, • Confirm quality and quantity information for manufacturing orders, • Monitor production quality with the help of control charts and determines process capability scores, • Manage customer-related quality information, • Settle appraisal and nonconformity costs, • and many others. 2. Internal functions of the solutions, that are meant for the following tasks of quality planning, inspection and control: • Manage master data for quality planning, • Support inspection planning, • Provide inspection results in the form of characteristic values, defect data, and texts, • Support flexible reporting with the user-defined reports, • Record the nature of the problem and the problem analysis.

Table 3. (continued)

ERP solutions	Contribution of ERP systems to quality management
Enterprise Performance Management (EPM) solutions	• Delivers real-time business insight to drive faster, smarter decisions and superior business performance, • Rapidly align company's strategic goals with tactical execution to help to gain better control of company's daily operations. It allows to react quickly to any unexpected changes in business conditions and improve the predictability of company's results, • Employees can continuously track and measure their own performance against objectives, allowing to increase accountability within an organisation, • With a full suite of analytic applications to plan, measure and adjust in real time, EPM helps to drive operational excellence within an organisation, • Help managers at all levels of a company understand the factors that affect performance, determine the level of performance that is required, and identify actions they can take to improve results.
Human Resources Management (HRM) solutions	HRM is a discipline that drives operating performance and creates value, enterprise–wide. It helps companies to improve the speed and cost-effectiveness with which company performs key human resources processes while enabling managers and executives to make better and more timely decisions. HRM solutions help to: • Provide a flexible central repository of employee information for improved personnel management, • Manage and streamline human resources business processes - from recruitment to retirement, • Manage workforce information for analytic reporting and analysis, • Deploy self-service across the enterprise, to speed transactions and improve productivity, • Align company's workforce with goals and objectives, to drive business performance, and • Implement and track meaningful benefit programs etc.

4   ERP Systems' Support for Quality Management Oriented Knowledge Management System

Potential ERP systems' support for quality management oriented knowledge management system is threefold (Figure 1):

1. particular knowledge management oriented technologies offered by ERP systems can be used in knowledge management system;
2. the following ERP modules/ solutions are a direct information source of quality management oriented knowledge management system:
   – quality management,
   – enterprise performance management, and
   – human resources management;
3. particular knowledge management oriented ERP solutions may be incorporated in the quality management oriented knowledge management system.

Figure 1 presents ERP systems' support for quality management oriented knowledge management system. ERP solutions that support knowledge management are located in box on the left side of the figure. ERP solutions that support quality management are presented in the box on the right side of the figure. The arrows from one solution to another denote support relationship between the solutions.
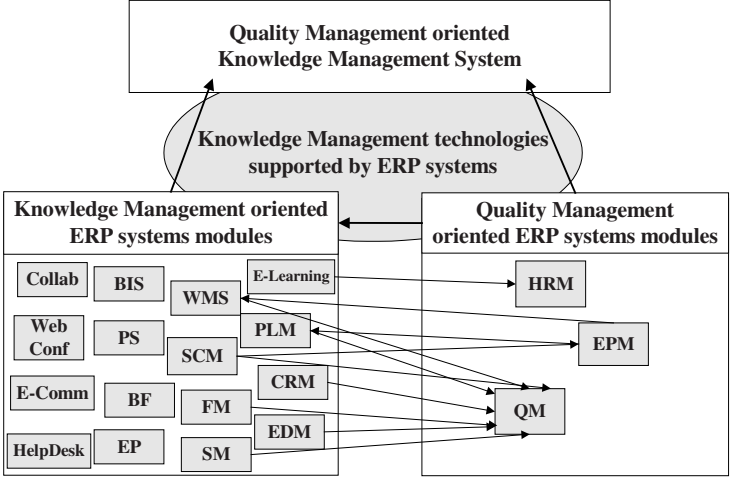

Fig. 1. ERP systems' support for quality management oriented knowledge management system

Notations:
EP - Enterprise Portal
CRM - Customer Relationship Management
SCM - Supply Chain Management
PLM - Product Lifecycle Management
EDM - Electronic Document Management
FM - File Management
BF - Business Flows
WMS – Workflow Management Systems
BIS - Business Intelligence Suite

SM - Services Management
PS - Solution for Public Sector
Collab - Collaboration Suite
Web Conf - Web Conferencing
E-Comm - E-commerce series
QM – Quality Management
EPM – Enterprise Performance Management
HRM – Human Resources Management

The results of detailed analysis of ERP systems' support for quality management oriented knowledge management system are identified and summarized in Table 4. The first column of the table comprises those knowledge management oriented ERP solutions that support quality management. The second column presents in detail how particular ERP subsystems can support quality management.

As shown above in this section, ERP systems successfully can be applied to facilitate quality management initiatives and may form a part of quality management oriented knowledge management system.

Table 4. ERP systems' support for quality management oriented knowledge management system

ERP solutions	ERP systems' support for quality management oriented knowledge management system
Customer Relationship Management (CRM)	A keystone of the quality management that helps customer-driven organisations to stimulate customer satisfaction and improve profitability. CRM can help: • Excel in anticipating and meeting unique customer requirements to increase customer intimacy, • Maximize sales efficiency, order accuracy and standardization, • Minimize service costs to optimise operational performance, • Accelerate commercialisation of ideas and utilize customer feedback to develop leading-edge products, and • Optimise customer knowledge across the enterprise.
Supply Chain Management (SCM)	SCM helps a company to control business-critical processes and streamline process cycle. Thereby company can provide superior customer service that keeps them coming back. SCM can help: • Link business processes across the extended supply chain by sharing detailed, real-time information, • Achieve the best combination of price, product quality, lead-time, and service, • Provide critical business intelligence at all levels in an organisation, including strategic, tactical and operational.
Electronic Document Management (EDM)	• Can be used to transfer data in document information records between the company's ERP system and the external system, • Such functions are supported as creating, changing, and displaying a document information record.
File Management (FM)	• Provides versioning, integrated workflow and approval processing that make teams more efficient.
Service Management (SM)	• Total solution for organisational profitability and customer satisfaction, • Makes it profitable for company to deliver superior customer service by allowing to meet and exceed customer expectations and ensuring customer loyalty, • The combination of a complete service management solution with other business management capabilities helps company manage all aspects of its operations.
Product Lifecycle Management (PLM)	Comprehensive, Internet-enabled solution that can help companies reduce costs, increase quality and speed time-to-market. It: • Spans the complete lifecycle of a product, • Captures product information at any relevant stage in the lifecycle and can help ensure that every department is working with the right information.
E-Learning	• With E-Learning an organisation can approach learning strategically and improve enterprise performance. • Provides a complete infrastructure for organisations to manage, deliver, and track training participation of employees, customers, and partners in both e-learning and classroom based environments, • Ensures quicker time-to-market for product training and consistent delivery of information, knowledge and training across the enterprise.
Workflow Management System	• The business processes of a company contain a large part of knowledge. Workflow is used to help an organization acquire, store, and catalogue content.

5   Conclusions and Future Work

The paper addresses applicability of ERP systems for knowledge management in the context of quality management. It fills the gap in academic research in the area of ERP systems' applicability to knowledge management and quality management within the organizations. Several ERP systems were analysed in order to find out how ERP systems can support knowledge and quality management.

The main conclusions derived from the analysis of several aspects of ERP systems are the following:

- ERP systems can facilitate knowledge management because of the following reasons:
    - ERP systems (by their functions and technologies) fit into the classification of technologies, tools and systems that support knowledge management;
    - several ERP systems' built-in technologies meet demands of knowledge management systems;
    - ERP systems support many knowledge management functions and encourage knowledge management initiative in an organisation.

- ERP systems and knowledge management oriented technologies offered by ERP systems can support quality management:
    - the quality management solutions are encompassed in the most of the ERP systems;
    - the quality management solutions offered by ERP systems have encompassed many principles of knowledge management;
    - ERP solutions oriented to knowledge management provide indirect support for quality management initiatives.

The results of this research will be used to analyse dependency relationships between quality management oriented knowledge management system and organisational information system in general.

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