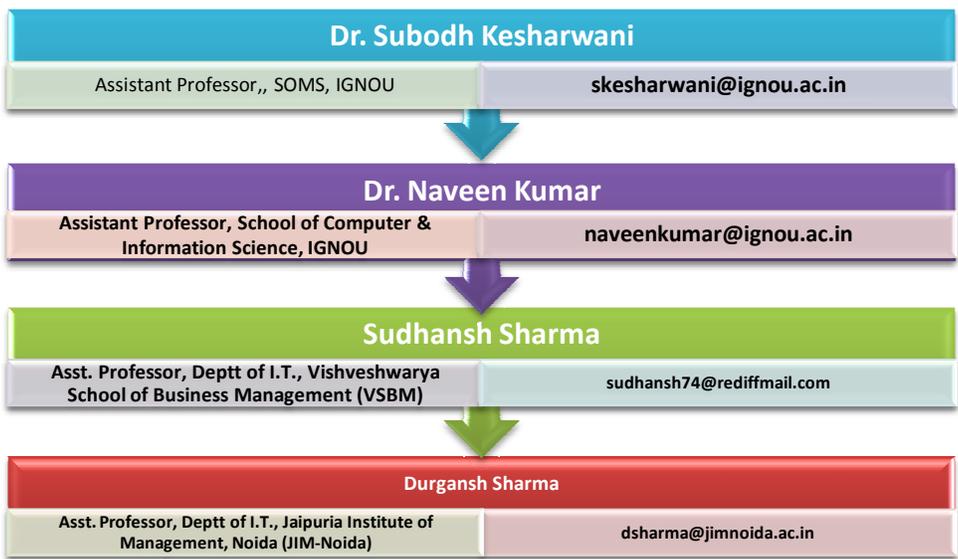




Interoperability  
Maneuver the  
Enterprise's Dimensions  
with ERP system



## ABSTRACT

•Narrowing the gap between cutting-edge technology and its applications, as well as identifying the missing links for applying technology will be the ongoing challenge. The rudimentary scope, goals, and objectives of the community have not changed radically the challenges of technology because the present juncture is superior than prior to State-of-the-art new-fangled technology like ERP (Enterprise Resource Planning) System has undergone an approximately puzzling transformation, corresponding to the evolution of information technology. Within this generation, information technology has transformed the everyday tasks of the workforce— computer use has infiltrated almost ubiquitously. Interoperability operates on two dimensions: organizational dimensions and technical dimensions. Here & now interoperability across organization boundaries with its diverse communication devices is ultimately achieved through ERP system software. The ERP is one significant approach to accomplish more with less. It is an established move toward creating tangible savings from greater speed, abridged processes in eliminating redundant effort procedures, and better accountability in programs and services. This paper addresses the important role for ensuring system interoperability in an ERP system centric coalition environment. The endeavor of this paper is to identify the problem and suggest a solution, recommend formulation of interoperability as a solution and thrash out implications. The paper makes an effort to recommend that interoperability is a real-valued element that applies to a ample range of relationships among ERP system processing entities. The paper also in brief documents the state-of-the-practice in information systems and technologies, as well as the developing role of information technology (IT). Thus the final motive of the paper is to present the key business issues concerning interoperability connection with ERP Systems standards with a sight to develop sustainable solutions beneficial to all the organizations.

## KEYWORDS

- Interoperability,
- ERP systems,
- Future
- Directions,
- Information
- Technology,
- Integration

**Introduction:** In today's multifaceted environment, global companies are trying to envisage and more effectively respond to fluctuating market demands and changes in the supply chain (Joe 2005). Assimilation of ERP system applications is imperative for enterprises in striving to overcome market and variability. ERP's system that is a subset of Information technology fulfills and rectifies the major task in this respect. ERP system software represents a sizeable percentage of the budget spending for companies and is rapidly developing into a valuable strategic asset. The ERP system has acknowledged the ever-increasing magnitude of systems and software interoperability to facilitate business process/government service development and the amalgamation of systems and business processes. Interoperability is one of the major themes of research and development in information technology for the architecture, engineering, construction, and facilities management industries. Merely defined, interoperability is the ability of two or more ERP systems assets (hardware devices, communications devices, or software components) to straightforwardly or robotically collaborate and, in the business sense, expands to embrace the propensity of two or more business processes, or services, to without difficulty or automatically convene. It is apparent that the capability to interoperate is the input to reducing ERP systems integration costs and inefficiencies, increasing business quickness, and enabling the acceptance of new and emerging technologies. ERP system will step forward the interoperability of business registers all the way through to accomplish this, semantic technologies will be used to capture the dissimilar business. Based on this replica of data and processes, communication and collaboration of business registers will be considerably enhanced. ERP system not only addresses cross-border, multi-national issues of collaboration, but also targets at national level, inter domain interoperability, e.g., between business registers and academic institutions.

**Curtain Raiser to Interoperability:** Interoperability is the ability for information to flow from one computer application to the subsequent throughout the lifecycle of a project—relies on the development and use of common information structures (Froese 2003). Interoperability may be seen as “the aptitude

for a system or a product to effort with other systems or products without extraordinary endeavor of the part of the customer” (**Interop 2005**). Interoperability refers to the aptitude of two or more systems (computers, communication devices, networks, software) and additional information technology components) to interrelate with one another and substitute data according to a prescribed method in order to accomplish routine results. The term ‘interoperability’ includes numerous aspects: to a network operator, it can connote the skill to inter-operate with other networks and endow with flawless services to users; to a content provider or service provider, it can mean the capacity to be able to run an application or service on any suitable platform; and, to the consumer, it can mean the aptitude ideally to get hold of the pertinent hardware device “and embark on to consume and recompense for services, without having preceding knowledge about which services would be consumed, in a straightforward mode”. All of these types of interoperability are advantageous. Alternatively, in wide-ranging terms interoperability describes the potential of two or more hardware devices or two or more software routines to work in partnership. Distinctively in connection with software, interoperability describes a feature of the software in the identical manner that like alleviate of use, security, and trustworthiness. Since interoperability becomes a significance of increasing magnitude for information technology products, the term ‘Interoperability’ is extensively used in IT product descriptions. Thus in general term Interoperability means how to bend UNIX-type operating systems to work with Microsoft’s operating system.

**Alternative definitions of interoperability:** From technological viewpoint, interoperability concerns the aptitude of two or more ICT assets (hardware devices, communications devices or software components) to effortlessly or mechanically collaborates. On the other hand, business and government also necessitate interoperability of processes, so that business processes or administrative services can link up straightforwardly all the way through computing/communications processes. In general the accumulated definition of interoperability framework had been split into three portions as mentioned in the figure below: **Organisational** – organizing business processes and internal organization structures for enhanced exchange of data. **Semantic** – ensuring that transported data shares the same meaning for link-up systems and **Technical** – linking up computer

systems by agreeing on standards for presenting, collecting, exchanging, processing, and transporting data.

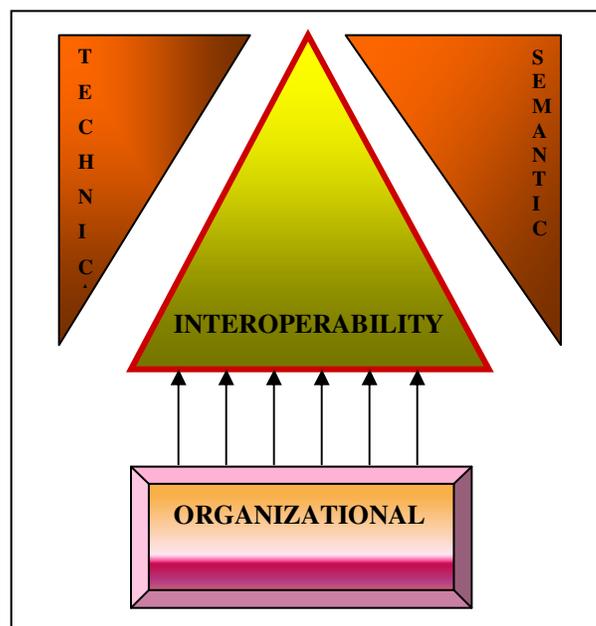


Fig-1 Interoperability Framework

In the broader framework, interoperability can be defined or viewed from numerous different perspectives. A few of them are outlined underneath:

- ⊕ **EU Software Copyright Directive** defines interoperability between computing components generally to mean “the capability to exchange information and mutually to use the information which has been exchanged”. This does not mean that each component must perform in the same way, or enclose all of the same functionality. Rather, interoperability means that the components, which may fluctuate in functionality, can share information and use that information to function in the manner in which they were designed to.

⊕ **UK e-GIF** (e-Government Interoperability Framework) model focuses on four facets: interconnectivity, data integration, access, and content management.

⊕ **ICT industry** from the standpoint of the, interoperability can be conceptualized as a means of connecting two or more “end-points” with a “chain”, where a “chain” means an exchange of data using data and communications standards. Under this definition the endeavor of interoperability is to characterize “chains” so that software/computers can interrelate and interoperate on demand. A common set have standardized, widely adopted “chains” enable connections and interoperability speedily at minimum cost. Instantaneously as the edges of a jigsaw puzzle classify how a puzzle piece connects with other puzzle pieces, the goal of interoperability to define the “chains” or the puzzle edges so that software/hardware/business processes can interconnect and interoperate on demand. In designing ICT components and utilizing the “chains” that connect the components, the designers endeavor to keep components from being too dependent on one another so they can be used to interconnect with other hardware/software components. *This means that interoperability is not motionless; rather it is a frequently evolving state of affairs driven by rapid changes in technology and customer requirements.*

**Meaning:** The term interoperability means many things to many people. In nearly all cases, interoperability means that two systems (or system components) collaborate in some way; interoperability requires more than one system (or system components). For some users, these systems are types of geospatial systems at the same time as to others these systems can be any type of information system, even those that are not computerized. There are those who spotlight on interoperability across hardware platforms, operating systems, and programming languages. In this case, interoperability is defined as an attribute of the system with respect to feasible implementation choices. Thus its interpret that users can desire from

a multiplicity of implementations with reverence to hardware, operating systems, or programming languages because the system is based on well-known specifications that provide interoperability. In this way, users can judge interoperability on as numerous axes as required and not be misinterpreted.

**Types of Interoperability:** The enlargement in the utilization of the Internet brings strengthen in the number of interconnections among information systems as well as other businesses. Each of these interconnections must be vigilantly prearranged to guarantee interoperability (Steven 2002). Conversely, the sheer number of interconnections and the resulting complexity threaten to overwhelm the aptitude of the standards community or industry to endow with the necessary specifications.

⊕ **Application Interoperability:** The prerequisite to application interoperability is mainly often experienced at the level of interoperability between desktop software applications, but it can also be a necessity in today's distributed systems built on enterprise application foundations. For this category of interoperability, the focus will necessitate to be on the development environment (such as Visual Studio), application frameworks (such as .NET or J2EE), and on programming and scripting languages (such as C++ and Java as well as Visual Basic and JavaScript). Mission requirements, current installed infrastructure, and future development plans will engage in recreation roles in deciding which methods to be employed to accomplish application interoperability. The ERP system vendors must make decisions about the major appropriate ingredient interoperability to sustain, decide on a primary target method and fabricate to that, and consequently insert support for secondary targets.

⊕ **Web Services Interoperability:** The term services interoperability refers not only to web services but also to all service oriented architectures. The Web Services Interoperability Organization states, that "Interoperable must be suitable to accomplish being implemented in a neutral mode on multiple operating systems and in multiple programming languages..." when referring to Web service technologies. Web services are based on nonspecific protocols for the interoperable exchange of messages all the way through their interfaces.

⊕ **Semantic Interoperability:** The potential to hold the promise of at least one more form of

semantic interoperability, may consider be the concluding dimension in the interoperability landscape. At this height of interoperability the point of discussion is to understand what the interoperable is and what it means in an application context. Explore the benefits and approaches to adding semantic interoperability to its products. Semantic technologies are still experimental and evolving, but there is much promise concerning how they can benefit users.

⊕ **Integration Interoperability** The ability to integrate components from all parts of an enterprise requires as many of the dimensions of interoperability to be supported as promising. All the types of interoperability listed and previously defined will help out to support integration interoperability. The capability to comprehend trends regarding enterprise application frameworks and how integrated system technology fits into all layers of an enterprise technology load up is the key to recognize how integration interoperability will occur. If we look at the types of interoperability discussed, we can define them as dealing with data, data management, data access, and applications, which correspond to the conventional layers in an enterprise technology stack. Vendors whose offerings fit into these layers will be providing the technology required to comprehend integration interoperability.

**Scope of Interoperability at different levels:** Interoperability extends from business to business, including the ICT Industry (as an end-user of technology); other industries such as the financial, automotive, chemical, etc. industries; as well as academic institution. It includes private sector technology exercise by the prime, which includes technology use by the governmental agencies and entities as well as the foremost. It follows that the interoperability is not instantaneously a country-specific or national concern, but is comprehensive in scope. The international perspective, which the ERP System compatible industry has done much to accentuate, has led key policy and decision-makers to comprehend that there is a requirement for interoperability mutually inside and stuck between public administrations and with enterprises. The interoperability in association with ERP Systems provides companies and IT organizations with an assortment of flexibility. There is no need to make a decision on just one technology while rejecting all

others. Using ERP systems can intertwine their environments into one solitary, smooth fabric. Interoperability options can be established at all levels of ERP systems software at the people, information, and procedure levels as well as in the application platform, together with expansion tools, system management, and support of open technology standards. The following conversation provides a glance at the interoperability options at each integration level of ERP system software; Application Platform, Information Integration, Public Integration, Knowledge Management, Business Intelligence & Master Data Management

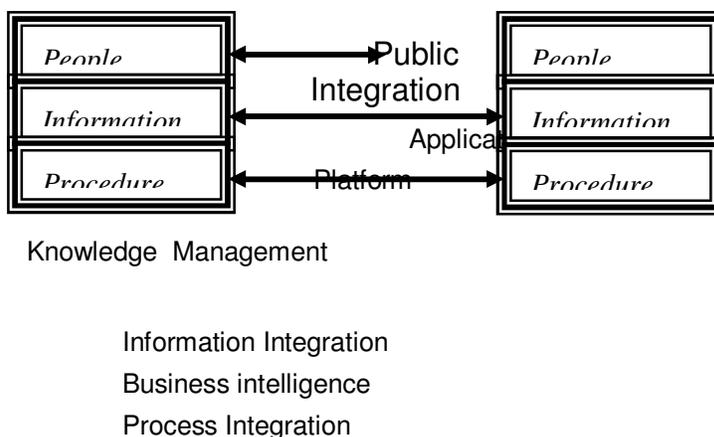


Fig2: ERP Systems software and Interoperability

**ERP System Implementation in an Enterprise:** ERP System’s high-level functional and process modeling, software portfolio management and program management, data management at the higher levels, and platform strategy (technologies, vendors, standards, and so forth) (Betz 2003). ERP software broadly manages the needs of a principal enterprise resource area: money, productive capital, people, stock of goods, or information. Vendors such as Oracle, PeopleSoft and SAP build sophisticated, process-centric solutions, on complex information structures implemented in relational databases, for the business organizations that manage the enterprise resource. ERP modules are designed to reflect a particular way of doing business (Cardoso, Bostrom & Sheth 2004). An ERP system is an integrated solution, sharing a centralized database, with all ‘users’.... human

Resources/Payroll/Benefits, E-procurement, Accounting, Budgets, etc.... being served by the same database from end to end one point of entry. Data have to only be entered or updated once, reducing errors, time and labour for reports, analysis, and planning and program management. Eventually, time and resources are shifted to innovating, problem solving and direct service to customers rather than inputting, processing, organizing, verifying and related "busy work" that burns through time and money (ERP 2001). ERP system can integrate much of their operation by replacing financial, HR, and manufacturing systems with an integrated system endow with by one of several large software vendors. All applications will share the same data model, the same databases, and the same interfaces. Reporting across functions or divisions becomes possible. This move toward has worked for many companies. But ERP is more a comeback within reach of a technology, and there are signs that the next generation of ERP systems will take lead of the new-fangled technology mechanisms such as standard application servers. These new ERP systems will be more freely coupled, and therefore, more amenable to change, and more likely to accomplish.

**Interoperability Vs ERP System:** Interoperability Layer as a basic technical level for data, process and service integration across national and technological borders (Ludger Et Al 2004). The requirement for *component* (or *application*) *interoperability* is mainly often experienced at the level of interoperability between desktop software applications, but it can also be a requirement in today's distributed systems built on enterprise application foundations (Buehler 2005). Relationship between information system (IS) and the rest of the IT infrastructure, means compatibility and interoperability with major enterprise systems such as enterprise resource planning (ERP), customer resource management (CRM), enterprise application integration (EAI), work management systems, decision support systems, and others (ESRI 2003).

**Benefits of interoperability in ERP system Integration:** Connectivity and interoperation among computers, surrounded by entities (governments, businesses, citizens, and individuals), and among software components can augment the plasticity and suppleness of ERP systems, thus reducing administrative and software costs for the enterprise.

They may also diminish the time desirable to execute software.

- ⊕ Interoperability can, for example, assist in the delivery of the services based on life events, and facilitate the business sector interact electronically with administrations, reducing administrative costs burden and encouraging SMEs to "go digital".
- ⊕ Interoperability supports the Single Market and its associated "four freedoms of interest group of people, capital, goods and services".

**Interoperability Challenges in an ERP System:** In view of the fact that the, Enterprise Applications development suffered from a lack of accessible technological solutions for organizing business processes. To pact with this substance, software engineers worked in the direction of developing software in the areas of Relational Database Management Systems (RDBMS). During the last two decades, many sophisticated systems were also developed to endow with common ground for enterprise application development. These Enterprise Resource Planning systems (ERP) are widely used nowadays in the design of Modern Information Systems (IS) and facilitate organization to replace their existing information system with a single integrated system (Kesharwani 2005). In the last few years, nonetheless, the focus has shifted from the development of software systems to the assimilation between them, in other words dealing with the problem of interoperability. The need for interoperability is the substantial interest in the subject of interoperability across organization boundaries. ERP System facilitates in narrowing the gap between cutting-edge technologies and the several dissimilar aspects to this. Thus Technical standards are being developed all the way throughout open processes, and their implementation is being motivated by the pressure software companies are under to congregate their customers' requirements for standards adherence. Standards and interoperability work paramount when processes are insecurely attached. The problems of interoperability are not exceptional to government. The interoperability problems of integrating disparate databases, distributed networks, e-procurement solutions, B2B data exchanges, enterprise application incorporation, portal integration, B2C (consumer/citizen) solutions, mobile communications, and others all subsist in

private industry as well as the public sector. In wide-ranging, there is a widespread need across all industries for research, new technologies, and enhanced standards to address interoperability. Different business domains, companies and applications programs need to inter-operate but the complexity of the system increase exponentially as depict in figure 1(a).

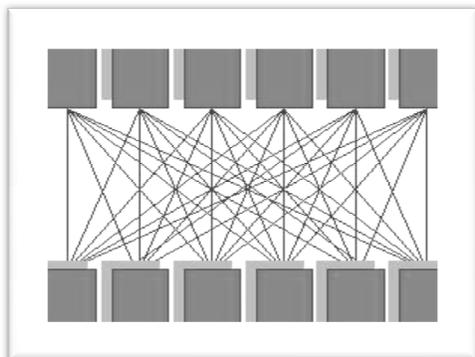


Fig3 (a)

Fig3 (b)

The figure 3 (a) shows that there are two horizontal different sets of applications connecting and interacting with each other however the application lacks the interoperability. As a solutions fig (b) shows how the layer of standards b/w these set of applications solve the problems of interoperability. Standardization is the best solution to achieve interoperability, where standards are transparent (Is typically considered to be a high-quality attribute of a system as it shields the user from the system's complexity). To the users and the layer of standards is available between the different business domains, companies and applications programs as shown in fig3 (b).

**Information Interoperability**

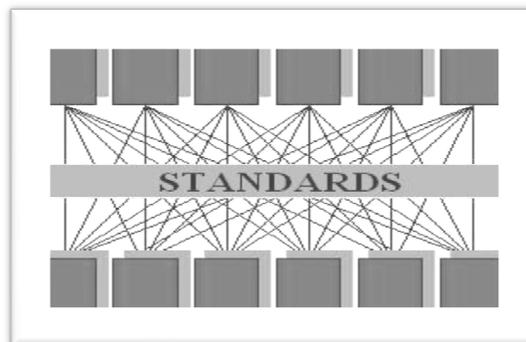
As per current business integration definition rightly mention for managing following points:

- Scalability
- Heterogeneity
- Flexibility

Each IT surface should support multiple business contexts while occulting domain specific details. We need system interfaces that are robust, flexible and discoverable and encourage connectivity between systems without breaking the entire system. There is a need of consistent semantics and abstraction models, which drives various types of implementation and a common way to model and describe the business and methods for the automation of business processes.

We have to overcome the loosely coupled, event based application abstraction for any business context. In today's environment the scenario reflects enterprise and embedded controller domain are loosely coupled using different programming models.

Conventional Enterprise computing consists of following operations:



- Accounting and financial
- Production activities
- Corporate communication etc.

Conventional Operational activities consist of the following:

- SCADA
- Gateways
- Controller fieldbus device
- Device controllers

Traditional operations required to bind the above two are ERP, CRM, MES, Database operations etc.

To solve the aforesaid problem one solution complies of "closed loop methods" which are emerging in the enterprises having same "Sense

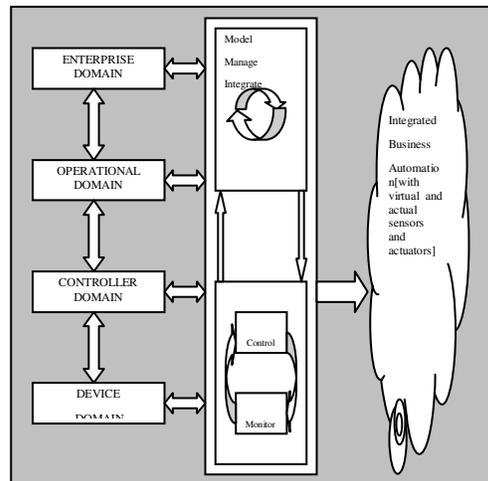
and Respond” paradigm. It enables unified view of enterprise and operational processes through common programming abstraction and shared or interoperable infrastructure. This integrated business automation contains “Sense and Respond” Business objects which is divided into Physical and Virtual “Sensors and Actuators” that make the system workout.

There is a need of Choreography domain for solving interoperability problem as total business is divided into following categories:

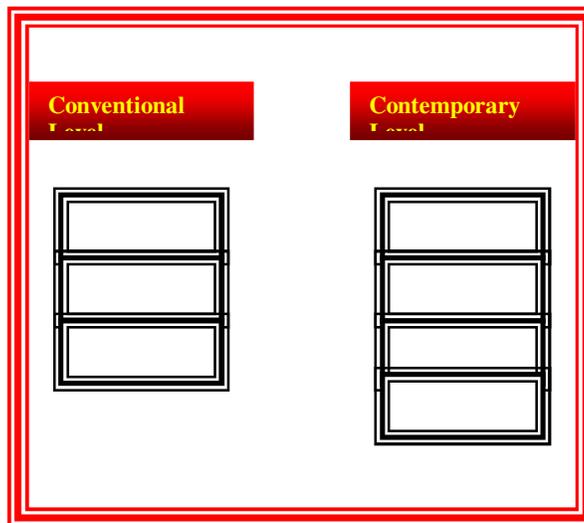
- Business domain
  - Enterprise Domain
  - Operational Domain
- Operations Domain
  - Operational Domain
  - Controller Domain
  - Device Domain

The above categorization describes that Operational domain is common to both the business and operations domain. Now to synchronize all of them we need a choreography domain which provides an integration framework for the operations domain to connect with the business domain via establishing appropriate programming and event system model, define base information schema, extends runtime environment like event bus, event correlation, and filtering etc. The basis for linking the operations and business domains are:

- It supports highly heterogeneous asynchronous event driven distributed applications.
- Defines a programming model that spans both domains effectively.
- Enables efficient links between multiple event buses.
- Provides a homogeneous closed loop control system-view across the enterprise using leverage optimization techniques and control theory across the enterprise.



**ERP system levels and Interoperability standards:** There are typically three levels of ERP software packages, people, procedure and information level, however as required we propose an additional level of ERP systems which is “Interoperability” level which is clearly explained in the following figure under the contemporary head.



- ❖ **Standards at people level:** The main ERP vendors employ proprietary fourth generation interpretive languages as the core development tools within their ERP applications like Oracle, People Soft and SAP, which uses the development Language as PL SQL, People Code and ABAP correspondingly. Java 2 Platform,

Enterprise Edition (J2EE) is a programming platform for developing and running distributed multi-tier architecture applications with Java, based largely on modular components running on an application server.

- ❖
- ❖ **Standards at procedure level:** Extensible Markup Language (XML) is a trouble-free, has very elastic text format. It is used as a frequent data format at all levels of web services architectures. It uses tags, which define the data to be exchanged. It is constructive for hierarchical structuring of data. Another standard at this level is Web Services Business Process Execution Language (WSBPPEL), provides a language for the formal specification of business processes and business interaction protocols.
- ❖ **Standards at information level:** Java Database Connectivity (JDBC) gives access to a tabular data source using the Java programming language. It provides connectivity to a wide array of SQL databases and other data sources, such as spreadsheets or flat files. Open Database Connectivity (ODBC), is a database programming interface from Microsoft; it provides a common language for Windows applications to access databases on a network. Active Data Objects (ADO), is a Microsoft database interface that is the Microsoft standard for data access, provides an interface to OLE DB. Active Data Objects .Net (ADO.Net): This is a data-access element of Microsoft's .NET framework. Object Linking and Embedding/ Database (OLE/DB): This is a low-level Application Program Interface (API) from Microsoft for accessing both relational and non-relational data. OLE DB for OLAP (ODBO): This is an extension to OLE DB that enables users to access multidimensional databases in addition to relational databases.

- ❖ **Standards at Interoperability level:** These interoperability standards will hand out as the source for connecting ERP systems to external systems with a focus on using commercial best practices and vendor-neutral standards. The state-of-the-art goal of using ERP systems as components of a generally service-oriented design relies on the establishment of a standards-based move toward the interoperability. Simple Object Access Protocol

(SOAP) provides HTTP/SML based remote procedure call capability for XML Web Services. It is used for exchanging structured and typed information between peers in a decentralized, distributed environment. Universal Description, Discovery and Integration (UDDI) is used for publishing and discovery of web services. UDDI provides a searchable registry of XML Web Services and their associated URLs and WSDL pages. The goal is to augment interoperability and speed adoption for web services. Web Services Description Language (WSDL) is a XML based interface description language to describe XML Web Services and how to use them. WSDL describes the syntax and location of web services. Web Services Security Core (WSS\_Core) provides mechanisms to send a security token as part of a message to ensure message integrity and message confidentiality. Web Services for Remote Portals (WSRP): WSRP is a specification, which defines how to leverage SOAP-based Web services that generate mark-up fragments within a portal application. Java Specification Request (JSR) 168 defines a Port let API that provides means for aggregating several content sources and applications front ends. It also addresses how the security and personalization is handled. Java Metadata Interface (JMI): The Java Metadata Interface specification addresses the need for a pure Java metadata framework API that supports the creation, storage, retrieval, and interchange of metadata.

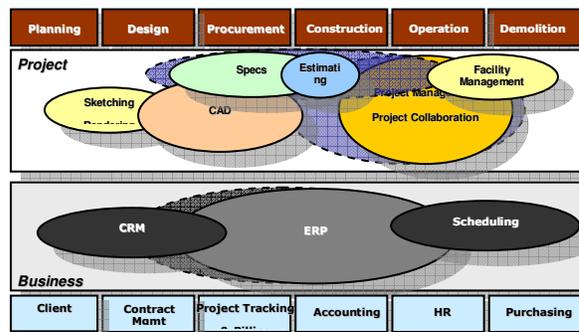


Fig5: Separate entities of automation within an organization

**Advantage of Interoperability Standards:** These standards provided for the optimal deployment,

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lowest cost and maximum compatibility in your environment. Interoperability standards maximize business value in a mixed-vendor atmosphere however; it is suggest that the open standards are the most effective way to address the challenges of the mixed vendor environment that exist in most organizations. These standards can enable the following advantages:

- ❖ **Hierarchy synchronization:** the dynamic exchange of structure information between ERP system and external systems ensuring that all parts of your organization are operating with standardized metadata.
- ❖ **Data synchronization:** the dynamic exchange of data between ERP system and external systems, eliminating manual intervention in synchronizing and integrating data.
- ❖ **Security synchronization:** ensure controls across your organization. The security synchronization ensures that your process is consistent by providing a framework for processing user authentication and authorization based on your global standards.
- ❖ **Process Automation:** It can eliminate the need for manual intervention in executing processes such as:
  - Hierarchy maintenance
  - Data movement / synchronization
  - Security synchronization
  - Rollover and restatements

**Interoperability SWOT analysis:** Enterprise integration doesn't happen unsurprisingly. It needs to be premeditated. Yet the planning cannot be accurate, as business processes and facilitating technologies will revolutionize, creating different needs and different potential solutions. The following four analysis, **strength, weakness, opportunity & threats** can make the picture more accurate. The **Strengths** of the ERP system with flavours of Interoperability is to achieve interoperation, bridge better communication between ERP system vendors & the users, gaining feedback from "real users/customers", Openness to new-fangled ideas on all sides, thus the whole concept of achieving systems integration through interoperability. Though this amalgamation had some benefits but still its lacks from certain **weaknesses** such as; commercial confidentiality can inhibit interoperability, lack of generalization to other parts, project time-frame too short, potential for interoperability was over

ambitious during the lifecycle of the project, tool-bash needed to establish multi-way interoperability, uncertainty regarding interpretation of specifications. There are certain **threats** attached with this weakness and if these pitfalls are not seriously undertaken it can put the system on the deathbeds, such as: analysis of business processes, technical development, implementation, testing & staff developments lacks support, lack of resource to take work forward, lack of understanding and a failure of some experts in Interoperability in name, but in practice systems bought from one vendor may not fully implement from one vendor may not fully implement, Progress made may not be continued after pilots. To come out from this weaknesses there are creation **opportunities** like; Vendor products could be 'kite-marked' to indicate compliant system, continue to develop good relationships with ERP vendors & users, senior management to examine issues relating to take interoperability forward and to make interoperability a reality.

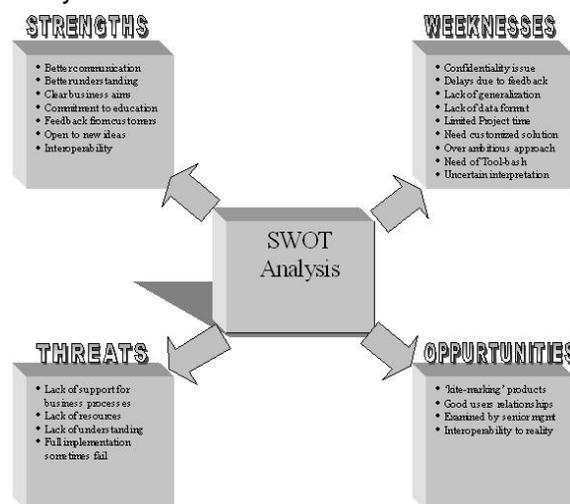


Fig6: Swot Analysis

**Conclusion:** Interoperability is not only a problem concerning software and technologies. It is also a problem that concerns knowledge and business references that must be shared in order to achieve interoperability (Chen and Doumeingts 2003). Hence it has been pointed out that organizations must be able to contact each other using agreed protocols, share a common language, agree on goals and tasks, and have people assigned to

complete these tasks in order to achieve interoperability (Mak and Ramprasad 2001). Interoperability is a multifaceted system aspect whose value is superlatively described on a scale. A conceptual model to analyze an index of interoperability exists in a primitive form. The magnitude of interoperability demands additional research. ERP system in concert with Interoperability reflect on themselves trusted partners and innovators that facilitate IT organizations to condense their total cost of ownership, facilitate expansion, and convey added value to their enterprises. Sharing this fantasy and an enthusiasm to act in response to customer demands creates an adaptive business environment in which IT promotes growth for the entire enterprise. Information & communication technology in a guidance with interoperability recommitted to maintaining open standards and remaining in the same technology campground. Continuing to investigate ways of building cooperation will facilitate enterprises to meet the toughening real-world requirements they mug at present. ERPs systems delivers an integration and application platform designed to be effusive interoperable. As ERP systems are data-centric, and therefore, they are more focused on information management and data integration. This type of system is also domain-dependent. Business templates are provided to be used in specific functional and market sectors. ERP systems are very suitable for a departmental, organizational, and cross-organizational scope operating on a national or international scale, where there is a good fit between desired organizational processes and those embedded in ERP applications.

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