

INTEGRATION CAPABILITIES FOR ENTERPRISE VALUE CHAIN MANAGEMENT

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The widespread use of decision support systems has become an indispensable tool for managing complex value chains to the customer. We explore integration processes that encompass both technological and organizational integration. Renowned methodologies in enterprise integration state that integration processes need to be planned. However, planning cannot be precise as business processes and technologies are changing rapidly, offering different potential solutions. Integration approaches can be used to create flexible, loosely coupled structures that can quickly meet specific integration needs. These new technical means depend on standards that work both inside and outside the enterprise.

Introduction

The current state of economic development of Ukraine requires the study of effective ways of information support of goods at all stages of the life cycle. An important aspect of the activity of enterprises is the creation of an integral information environment. In the professional literature, the integration of the enterprise is usually considered at two levels – the system level and the organizational level. Integration at the system level requires common standards and definitions of data, as well as certain means of synchronization of communication between different software applications. Usually, this is what is meant by the recently coined term «Enterprise Application Integration». However, as Marcus and others have pointed out [1], system integration in the sense of a software system alone is not sufficient to ensure organizational efficiency and effectiveness. Organizations are made up of individuals, departments, divisions, and functions that must also be integrated for the success of the organization. Today, integration is a more generalized term that refers to both behavioural patterns focused on both people and systems. However, integration is most often used when discussing relationships between software systems. According to many researchers, the integration of project management methodology into management processes provides companies with a real chance to provide both organizational and technological support for the implementation of the enterprise development strategy.

The purpose of this study is to understand the experience of practitioners of both disciplinary approaches and identify common mechanisms for their implementation.

Review of scientific literature on the topic

The publications were analyzed according to both strands of modern scientific research, which led to a number of methodological recommendations for potential scientists. Two main provisions can be observed here: firstly, digital technologies provide customers with the opportunity to create products together with the manufacturer, for example using digital platforms [2], and secondly, at the external level, value is increasingly being created from a series of partnerships in a network of shared values [3] and others [4], define coordination as the management of dependencies between all activities of the organization. Many academic researchers propose to apply a systematic technical approach to the integration of enterprises. From the point of view of software developers, integration has little to do with the specifics of the business. Instead, it is a question of how to understand the value creation processes of a particular business. First, Mary Shaw [5], noted that the issue of interconnection of systems was often not sufficiently thought out in relation to integration processes. But they should be the main issue in the technological renewal of the enterprise. Cris Dellarocas of the Massachusetts Institute of Technology pointed out [6] at one time that there may be a need to give first-class status to component interdependencies, since interdependence is a higher-level concept than a simple relationship.

Unfortunately, current production management systems cannot support comprehensive solutions for all scenarios. Most business applications are legacy systems that have been developed over the years. While each of these software systems does a good job with its assigned tasks, they are not equipped to handle business scenarios across multiple application domains. The growing need for customized products and services across many industries has made today's global supply chains more complex. This increased level of supply chain complexity, in turn, has increased the level of uncertainty and risks faced by modern companies [7]. To reduce this level of uncertainty, businesses are trying to manage flexible supply chains in a way that allows them to respond to demand [8, 9]. A large number of different definitions of enterprise supply chain flexibility have been developed using conceptual models, normative indices, and structural modeling [10]. Traditional systems do not provide the right solutions for flexible supply chains. Their design ideology does not provide the high level of decentralized governance required for flexibility [11]. They are characterized by inflexibility in terms of supply chain reconfiguration, high development and maintenance costs, and limited computing resources to manage complex systems [12]. According to many researchers, the integration of information technologies into management processes provides

companies with a real chance to provide support for the implementation of the strategy of digital transformation of the enterprise.

Presentation of the main material

In the space of growing chaos, it is already clear to everyone that as corporations grow, the need for integration in the enterprise also grows. Integration is really a business need, and it affects not only technological mechanisms, but also requires reorganization (renewal) of proper organizational structures, goals and incentives. Table 1 shows the aspects of technical and organizational integration with a description of the known integration mechanisms. The list of resources and activities required is shown in the first column, examples of software and means of coordinating people in the second column, and in the third column – elements of supporting infrastructure – in the right column.

Table 1

Analysis of technical and organizational integration of the enterprise with a description of known tools

Resource Integration Need	Integration Tools	Infrastructure environment
1. Organizational Units (Functions/Departments)	E-mail, collaborative software, lateral teams, strategy, budgets, performance metrics	Organization policies/ structure
2. Decision Makers	Email, collaborative software, knowledge management systems, face-to-face meetings, job design, performance metrics	
3. Business Processes (both internal & external)	Workflow, Collaborative Systems, SCM, CRM, Web Services, process owners, teams, performance metrics, service level agreements	Systems Architecture
4. Applications	Inter-process communication, Messaging, ERP, Web Services, Organizational Integration	
5. Data	Data Dictionaries, Databases, XML	

From the analysis of the table, it is concluded that effective integration requires attention to the elements at all levels in both horizontal and vertical dimensions. An integrated architecture exists to maintain coordination in the use of the firm’s material, financial and human resources. Integration levels are described from top to bottom – from the most general to the most specific. It should be noted that integration is necessary not only within different layers, but also between layers.

Our research focuses on the central column of the table, which also mentions the role of infrastructure elements – standards, architecture, networks and organizational structure – in promoting integration both within and between layers.

The upper level of organizational integration of enterprises is focused on the layers of software tools within the existing structure along with the architecture and standards of the network infrastructure. Professional literature on organizational integration of enterprises is mainly focused on the levels of decision-making and integration of various departments with an auxiliary organizational structure and development strategy. To achieve this strategy, the integrated technical and organizational components, must coordinate the financial and human resources of the organization to achieve the objectives of the organization.

As you know, any organization is divided into several departments or departments [13]. This division occurs because each department of the organization must focus on the fulfillment of certain functional responsibilities. This specialization leads to different attitudes of managers to the triangle of achieving goals: orientation to time, costs and quality. Organizational integration requires, firstly, the establishment of communication in such a way that departments are informed about the activities of other departments and cross-functional processes are carried out smoothly for the sake of common higher-level goals.

Proponents of the reengineering movement proposed matrix organizational structures in which functional tasks are subordinated to a process approach. Adding process owners and cross-functional teams to the organization promotes horizontal coordination, but requires some kind of matrix management. The main challenge in achieving departmental coordination is that the vertical chain of command and authority must be aligned with the needs of the organization's horizontal processes. To address this problem, Rammler and Brahe [14] recommend that the share of resources and goals of each department be determined based on the department's contribution to cross-functional processes. This approach differs significantly from the usual practice, in which functional goals and performance indicators are set by functions together with senior management without special consideration of the needs of horizontal coordination.

The second layer of integration concerns decision-makers. The integration of these individuals usually occurs when they coordinate their actions for the benefit of the enterprise and are free to share their knowledge. To achieve this integration, strategic decisions must be made by the highest levels of management. While classic models of organizational hierarchies assume that top-level leaders are isolated at the top, more recent publications show that decision-makers are in constant contact

with each other, and their interactions are critical to the success of the company. A newer way of thinking has led to the recognition that interactions between executives in a company are not just about tasks. The psychological side of integration in organizations should not be underestimated, since there are many examples in which large projects have failed due to the interpersonal frictions of higher-level managers. It is for this reason that decision-makers opt for less formal forms of communication with their colleagues. And it is for this reason that companies encourage social interaction between their executives.

Computer systems, as a rule, provide decision-makers with concise rather than extensive information. Multimedia tools definitely increase the availability of information. To promote communication, special software tools have been developed to help decision-makers coordinate their activities, communicate and exchange information and ideas.

Integration at the business process level consists of related sets of actions that are performed by people and software agents according to business rules that can be applied more or less strictly. The communication between the software and the people who carry out the process is well integrated or coordinated when the process is efficient, precise and relevant to the task at hand from a technical and organizational point of view. In addition, the objectives of each workflow must be aligned with those of the organization as a whole. This is called intra-process integration. External process integration means that an organization can seamlessly link its internal processes with those of its suppliers, intermediaries, and customers. A distinction is made between automated and partially automated process integration. Fully automated internal/external process integration is considered achieved when a firm connects to external agencies in real-time. At a higher level of integration, external processes must be coordinated between all firms in the value chain to achieve improved productivity and service.

Workflow management systems are specifically designed to support the automation of business processes by moving work between participants according to certain rules [15]. These systems provide visual interfaces for process design, manage process instances, and easily interact with an organization's legacy, client-server, and ERP applications. They also contain simple organizational models, such as who reports to whom, who has the authority to approve what, who can perform which roles, and who has access rights to which data and which applications. And they perform the function of coordinating resources, managing work assignments and load balancing between process participants. In this sense, the workflow promotes integration at all levels, as indicated in Table 1. Historically, workflow has been used

primarily to coordinate cross-functional and internal processes. Right now, the main trend in workflow improvement is focused on integrating the entire value chain.

The fourth layer of integration considers the integration of software applications. When application sets are integrated, each of them can cause the other to perform a function. The goals of software integration are:

1. Break down complex processing tasks into separate steps performed by relatively independent programs.
2. Support the interactive operation of universal shopping services by combining different applications in a common interface.
3. Ensure the integration of data and information.

Application integration is now supported by a wide range of software. Initially, such integration was supported by calls to remote procedure call protocols, then transaction managers, and now application servers. A higher level of integration is demonstrated by ERP systems connected through a common database. But ERP systems cannot always bridge the gap between application and process layers. This gives rise to complaints that it is easier to adapt an organization to an ERP system, than to adapt the ERP system to meet organizational requirements [16].

At the lowest level of integration, data integration is defined. The goal of data integration is to allow organizations to combine, aggregate, and report on data from different sources. At the syntactic level, the software can process data stored on different devices and in different formats. At the semantic level, the values of all data items should have the same meaning across applications. Currently, the most popular solution for data integration is the use of Extensible Markup Language (XML). XML combines data and its description in one place, allowing applications to access and understand data stored in heterogeneous files and different databases.

It was established that the integration of the enterprise must take place at many technical and organizational levels. Some techniques that can be used at each level have been introduced. Every organization needs an information system architecture that supports enterprise-wide integration. If the enterprise is fully integrated, then data from all existing applications can be shared. Such an ideal of integration has existed throughout the history of the development of information systems. But the search for the perfect integrated enterprise system continues. General frameworks are preferable to point solutions. Now enterprises are striving to solve the problem of integration as a whole, and not with separate point solutions. This encourages developers to design systems that cover all business processes of enterprises. Currently, integration mechanisms tend to weaken connections

between the elements of the system, since in a loosely coupled environment, it is easier to make a change in one separate part of the system.

The use of the XML data description language is becoming the de facto standard in the enterprise. This is important because XML can describe all data transferred between systems in the same way; significantly reducing the many file formats supported by enterprises. Industry-wide efforts stimulate internal efforts. So, for example, a set of definitions of data used by financial services companies to interact with each other can also be used internally to integrate corporate systems. After that, internal and external communication can use the same standard set of messages. Both standards focused on specific manufacturing industries and the new ISO standard focused on the financial industry are examples of industry models that are reflected in enterprises.

Consider three approaches to integration that have been proposed in both industry and academia. The first approach is sequential integration of $A \rightarrow B$. Over time, this kind of sequential integration between applications has become more complex with the advent of different programming languages. More modern approaches to sequential integration, such as the UNIX shell system, provide a user-friendly interface, but also have certain limitations. That two different applications can exchange information using the same database server. This approach can solve problems that consistent integration cannot handle. For example, any transactional system, such as a booking system, can be implemented using database technology. The third approach considers each part of the system as a separate entity that can either create or receive messages [17]. This approach can work at any scale files exchanging between large information systems.

Taking into account the above approaches, it is possible to describe commonly used technical mechanisms of integration on an enterprise scale. Most companies do not integrate two technological systems until they absolutely do not need it. The easiest way to integrate is to set up a point-to-point interface. The order management system can generate a file every night that is read by the commission system the next morning. The disadvantage of this mechanism becomes obvious with the growth of the number of systems in the enterprise. An IT organization can be overwhelmed by the need to update and maintain file interfaces. The incremental cost of each new interface is low, but the cumulative running costs for the organization are high.

Many companies can integrate a significant portion of its operations by replacing financial, HR, and manufacturing systems with an ERP system provided by one of several major software vendors. All applications will use the same data model,

the same databases, and the same interfaces. This approach has worked for many companies. But ERP is more of an approach than a technology, and there are indications that the next generation of ERP systems will take advantage of new technological mechanisms, such as the Value Chain Management System (VCMS). VCMS is a framework that helps organizations manage all activities related to the creation and delivery of a product or service, from the initial phase to the final delivery to the customer. It focuses on optimizing every step of the process to add maximum value to both the business and the customer.

Table 2 summarizes the capabilities and advantages of modern IT tools for effective VCMS. It should be emphasized that the autonomous decision-making powers of information systems, combined with built-in capabilities for big data analytics, can significantly increase the flexibility of the value chain.

Table 2

**Capabilities and Advantages of Modern IT Tools
of Value Chain Management Systems**

Element	Ability	Overview
1	2	3
Information technology and integration	Capture demand information immediately	An agent can interact with other agents or humans through the use of an agent communication language
	Information accessible to supply chain wide	The realization of a holistic cross – organizational collaboration is possible. The short and simple nature of software is an important enable of this future.
	Integrate with Semantic Web Service	Overall, the use of wrapper agents can significantly facilitate integration with semantic web services. The leverage of semantic web services leads to a higher degree of information integration.
Customer / marketing sensitivity	Perceive opportunities to increase customer value	Can diagnose new opportunities that could enrich customer value. Genetic algorithms leverage seems an important facilitator.
	Customer-driven products	Can robustly response to customer preferences due to their inherent learning capabilities
	Incorporate Semantic Web Services	Overall agents through their learning ability can leverage perceptions taken from semantic web services in order to achieve a higher level of customer sensitivity

1	2	3
Process Integration & Performance management	Facilitate Rapid decision making	Can demonstrate real – time responsiveness capability. In fact, learning ability is an important facilitator of this capability. Moreover, they can be reconfigured with easiness to new business processes
	Pro-actively update the mix of available supply chain process	Can real-time perceive their environment (software agents, manufacturing equipment). In this manner, they can real time adjust manufacturing processes.
	Leverage Semantic Web Services	Overall, performance management can be enriched with big data interpreted under a meaningful way.
Collaborative planning	Representation of trust-based relationships with suppliers/customers	Based on previous research trust among partners can be represented among agents matching reality.
	Reduce Bullwhip effect – data accuracy	Agents through the use of learning algorithms can achieve solutions that approach to optimal sharing
	Leverage Semantic Web Services	The data inference can provide meaningful information for all the nodes of the chain.

Conclusions

The analysis makes it possible to visually assess integration management strategies in organizations that carry out project activities. We discussed which technologies are suitable for software applications in organizations where shared value chain processes are required. Thus, we theoretically linked big data analytics and value chain performance. However, we understand that our study lacks empirical research in the application of the proposed frameworks. ensures that our provisions are limited. However, our further research will be aimed at identifying and validating the potential benefits of Value Chain Management Systems. Future research may also focus on building a general theory of organizational integration. For example, the question of how certain qualities of value chain managers affect the implementation of human-centered technologies in the decision-making process would be useful in identifying the propensity of potential organizations to use Value Chain Management Systems as a tool to support decision-making.

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