

# Development of an effective business intercommunicating system based on the electronic document management introduction for a construction company

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**Abstract.** In context of industry 4.0, where the information component and intercommunicating technologies prevail over the traditional interaction forms, and the business intercommunicating sphere goes into virtual space, enterprises face the need to develop a new business intercommunicating system in order to improve the business intercommunicating system and improve management efficiency in general. The business intercommunicating basic unit is a document. The documents' movement in all cases reflects the management apparatus organizational structure and the responsibilities distribution between its constituent parts. The basic business processes' point automation during the documents' exchange with external contractors becomes insufficient and in modern conditions requires a total transition to the document management in electronic form. The article proposes the measures aimed at modernizing the information flow schemes and the document management system for integrating electronic intercommunicating processes into the construction company management model. The purpose of this article is to propose a method for improving the business intercommunicating system of a construction enterprise based on its business model reengineering and the digital technologies' introduction. Actually, the method will include the structural analysis stages, logical design, construction and verification of the "as-is" model, the requirements' formulation for a digital business intercommunicating system, the business processes' reengineering, the "to-be" models' formation. As a result of the system project's implementation, it was possible to streamline all accounting and settlement processes; reduce losses associated with the documents' movement, effectively organize the employees' work and ensure their high-quality interaction; speed up the process of exchanging information with external contractors; provide the opportunity to receive various analytical data for management decisions.

## 1. Introduction

The problem of improving business intercommunicating is relevant for all the business entities in order to achieve business success. Business intercommunicating contributes to the establishment and development of the cooperation relations and partnership between all participants in economic activity. As emphasized in [1], digitalization is changing the whole paradigm of human life.

Since all management types are built on intercommunicating, we believe that it can rightfully be considered as the main connecting process. The degree of the tasks' implementation directly depends



on the information exchange quality. At the same time, poor-quality, inefficient intercommunicating can generate a lot of problems in construction.

However, when implementing the interaction innovative methods in construction projects, certain difficulties arise due to the specifics of the industry. Much attention is paid to the problems of transforming business models in [2,3,4,5] and at the moment, the search for the ways to improve the intercommunicating system between its participants continues.

The purpose of this article is to propose a method for improving the business intercommunicating system of a construction enterprise based on the reengineering of its business model and the digital technologies' introduction.

To solve this problem, the reengineering algorithm of the construction enterprise's business model is used taking into account the specifics of the entities' information exchange. In our study, we rely on the works [6–8] devoted to the business processes restructuring.

For the various types of construction work implementation, the organizations cannot limit themselves to the internal staffing units and attract such external market entities as design and survey and research enterprises, the construction industry and building materials and transport enterprises. The variety of the construction complex contractors determines the need for their clear intercommunicating. A study by Alaloul, Liew and Wan Zawawi (2017) proposes the 3C concept: “intercommunicating, coordination and collaboration”, as a strategy for developing and improving the business model [9].

The construction enterprise is a rather complex system, characterized by heterogeneity, multicomponent subjective-object structure and complex relationships. In accordance with the current rules of economic development, a systematic approach is used to study the behavior of complex systems, summarizing the methodological knowledge and results of the analytical method. Thus, our study basis is methods of analysis and expert evaluation, functional and structural modeling.

## 2. Research and analysis of the enterprise business model

The specifics of intercommunicating and production processes during construction work are associated with the object and labor tools, which, as a rule, are not concentrated in one place. If the labor product is attached to a certain place, then the labor force is mobile and constantly forced to move from one site to another, which entails the need to interrupt the production process for transportation, dismantling and installation, equipment and labor items' transportation.

Most of the operations in the construction industry organizations are performed manually, this reduces the amount of work performed and leads to a decrease in profit. Not optimal use of information at the enterprise significantly slows down its processing and application efficiency for the enterprise management.

### 2.1 Algorithm for finding the ways to improve the construction enterprise's business intercommunicating system

The transition to a modern intercommunicating system at a construction enterprise is preceded by the analytical work. In general, we outline the several stages:

- activities analysis and enterprise architecture, with considerable attention being paid to the study of the information exchange internal system and the structure of the enterprise's interaction with the external market entities;
- study of the information flow patterns between all participants in the intercommunicating process;
- analysis of the intercommunicating process at the enterprise, including the study assessment of the documents' movement at the enterprise and the paper workflow value analysis;
- modeling business processes of the as-is enterprise intercommunicating.
- “weak points” analysis in business processes.

Various methodologies can serve as a tool for the building business process models: ARIS, DEMO, IDEF [8], UML, PICTURE, GosMaster, EPC, BPMN [10-12].

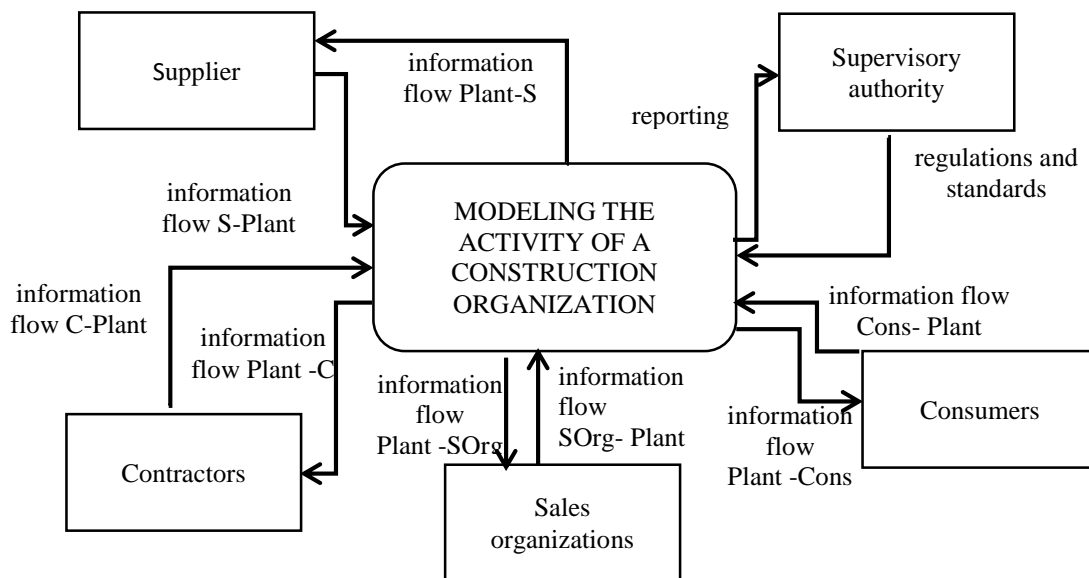
As the analysis result of the constructed models “As-is” and identification of “bottlenecks”, the

requirements for the intercommunicating system are formed according to the specifics of the enterprise. In the digital environment, the intercommunicating process is associated with the workflow process, therefore, in many aspects, the terms “intercommunicating” and “document” can be used synonymously. In the context of digital transformation, the most urgent is the development of an Electronic Document Management System (EDMS), designed to integrate all the information applications into a single information environment, ensuring the operational interaction of all users when they perform business procedures.

The most difficult step in improving an intercommunicating system at a construction company is the business processes reengineering, i.e. the radical restructuring of the managing relations’ model between the business participants by introducing the innovative methods of information exchange [13].

## 2.2 Modeling of external information flows of a construction company

The model of the construction company, presented in Figure 1, clearly shows the interaction of the Plant (Plant) with the external contractors. The data flows description notation DFD (Data Flow Diagram) is applied as a methodology.



**Figure 1.** Context diagram of the activities of a construction organization

The external nature of the finished goods marketing organization (SOrg) is modeled by the companies that sell their manufactured products with a dealer network and their own retail stores.

External entity. Supplier (S) models organizations that supply, in accordance with the terms of the contract, the inventories to the customer company.

External entity. Contractor (C) models any contractor who performs certain tasks on behalf of the construction company in question.

External entity. Supervisory authorities (SA) model the supervisory authorities that send the Enterprise Prescriptions and norms. An enterprise performing the construction work reports on its activities to the supervisory authorities.

External entity. Consumer (Cons) models the buyer of the enterprise bulk quantities.

The listed objects are exchanged with each other using the generalized information flows, the name of which reflects the exchange direction. For example, the Documents-Provider-Enterprise document flow (information low S-Plant) identifies the package of the documents received from the Provider to the Enterprise (the details flow by types, names and data fields is carried out at the lower levels of the model).

### 2.3 Analysis of the internal intercommunicating process

An analysis of the workflow volume by subdivisions of a construction enterprise will show the documentary load in the business procedures' implementation by the employees of the enterprise.

In table 2, the units are grouped line by line, the document flow of which is significant. For comparison, the values for the previous three years are presented.

**Table 1.** Analysis of the workflow volume by the divisions of a construction company

Subdivision	2017		2018		2019	
	Amount	%	Amount	%	Amount	%
HR Management	960	20%	995	19%	1120	20%
Bookkeeping	980	20%	985	19%	970	17%
Sales and marketing department	450	9%	487	9%	510	9%
Purchasing department	520	11%	565	11%	590	11%
Sales department	250	5%	296	6%	320	6%
Production services	1668	35%	1898	36%	2103	37%
TOTAL	4828	1	5226	1	5613	1

Source: compiled by the author

As it can be seen from Table 1, the largest share of documents falls on accounting, sales and marketing, human resources, as well as procurement and sales departments. Currently, the construction companies most often implement the point-based software solutions for the units in which the documentary load is high. However, each production cycle stage of the organization is accompanied by a paper set of documents.

The loss of useful working time is traced during the following operations:

- opening packages (envelopes) and processing of primary documentation supplied in hard copy.
- rescan of agreed documents with signatures of responsible persons;
- documents' transfer between departments and internal departments;
- document approval;
- duplication of variable parts of the document in printed copies and electronic versions of the document.

- sight and approval of the document by the head in case of its absence.

- search for the source document if necessary, link to it when compiling a new document.

The workflow inspection of a construction company has shown that in construction companies, intercommunicating is a complex system of information exchange between the departments and individual employees. In general, the intercommunicating system can be assessed as satisfactory.

### 3. The main directions of improving the business intercommunicating system at construction enterprises

Based on a perfect analysis of problems in business processes to eliminate weaknesses in the business intercommunicating system at construction enterprises, a phased implementation of the following measures is proposed:

- combining within the workflow framework of all the structural units for the Customer;
- the workflow procedures' automation;
- improving the efficiency of information and documentation support for the Customer's activities;
- processing time reduction for incoming and outgoing documents;

- ensuring effective control over the documents and instructions' execution;
- reduction of preparation terms and documents' approval;
- the introduction of a single standard for working with electronic documents, providing security, manageability and accessibility of documents;
- creation of a single repository of electronic documents.

### 3.1 Reengineering of the electronic document management system “as it should be”.

The document movement sequence can be described as follows:

1. Creation of an electronic document. An employee creates an electronic document, for example, an application from a client for order fulfillment, in an information system (EDMS), fills out an electronic document card, assigns a registration number, assigns rights, saves.
2. Registration of a document in the system by assigning an appropriate date, specifying the type of document, registering accompanying information. The document goes into the life cycle stage - “registered”.
3. Sending the approval route, according to the internal workflow regulations.
4. Obtaining an electronic document for processing and approval by responsible persons. Departure for revision in case of comments or endorsement by electronic digital signature (see 6).
5. Correction of an electronic document obtained from 4, taking into account the comments. The document has a life cycle stage - “revision” (next, see 3).
6. Printing a document if necessary and transferring one copy to an external counterparty.
7. Recording the transfer of a document to an external counterparty in the information system.

The information system principle is as follows: all the primary information about the company's activity is received in a single information database, and on their basis the program independently contains various reports, graphs, forecasts. It compiles complete analytical information. All business transactions are recorded in the system only once, and their impact on the enterprise performance can be evaluated instantly by requesting an appropriate report. To analyze the used information flows that are affected during the workflow automation, it is necessary to build a data flows diagram. Most operations are performed in the information system. When creating the new records, the information system displays the appropriate notifications to the user.

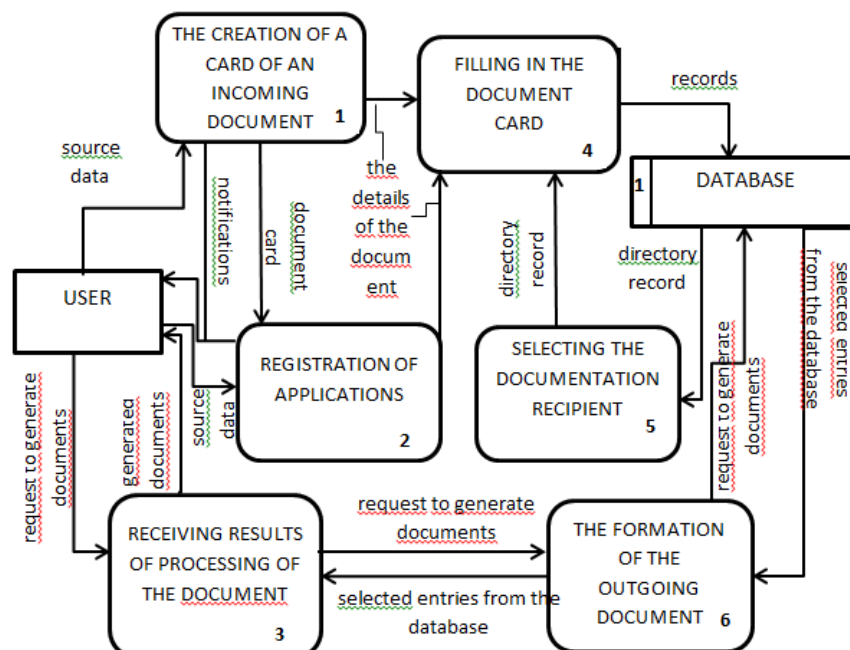


Figure 2. The data flows model “as it should be”

As Figure 2 shows, the IP user, the main essence of the business process, initiates and receives data streams from the sub-processes for creating an incoming document card; applications' registration; filling out a document card; obtaining the result of processing documents; the documentation recipient selection depending on the nature and type of the document; the outgoing document's generation.

The information base is the main data warehouse, including a set of directories and document templates. According to the generated request, the information base sends the selected records from the database in response to the user and updates the existing records if necessary.

The information base includes the following repositories: "Documents for the project" - in the project card it is possible to find all the documents, contracts, orders related to this project: "My documents" - a library of templates, "Tasks" - a work plan that is filled out by department heads, simulating the work of their employees with an indication of the completion date and deadlines.

The employees of the organization can upload any documents to the system for daily use or use by other employees. The library of document templates makes it possible to spend a minimum time on the daily documents' execution.

For the documents' movement between the departments a digital signature of documents and mechanisms for accepting or rejecting a document have been implemented.

The messaging system will not allow the organization's information to be left unattended, in the system's logs the time of sending, opening and reading the message is kept.

The information system is supplemented by the following modules: document management, project management automation, sales department automation, production automation, warehouse loading analysis, delivery automation.

## Summary

In conclusion, we would like to outline some basic aspects of the research method. Based on the weaknesses' analysis in the system of information interaction between the participants of the construction organization, which were discovered as a result of the enterprise structure and its intercommunicating processes' study, it was decided to reengineer the business intercommunicating system and optimize the document flow.

The article formalizes the reengineering algorithm of the business model at a construction enterprise, taking into account the entities' information exchange specifics on the basis of an electronic document management system.

The introduction of a new electronic document management system in construction companies will achieve such positive results as:

- increase team productivity by means of the clear document management;
- increasing the documents' reliability and improving the quality of employees' work by reducing routine operations;
- increasing the information exchange efficiency with external contractors by accelerating data processing, etc.

The algorithm was tested using the example of Vakhrushevsky Building Materials Plant LLC, LPR. A detailed description of the new intercommunicating system's implementation results and its valuation with the developed method will be carried out in a separate article.

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