# Innovative-integration processes of interaction of subjects of socio-economic relations on the participants of the construction engineering market in Russia and China

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**Abstract.** The article substantiates the need to form corporate digital ecosystems at the level of small and medium-sized businesses in the construction industry. The concept of a corporate ecosystem in the context of digitalization of the construction industry and the digital economy as a whole is revealed. The trends in developing innovative activities in the construction engineering market are highlighted. The results of a study of the relationship between the integration of Russian enterprises and innovation processes, the level of digital maturity of companies in the construction industry, and the impact of digitalization processes on solving real problems of the construction engineering market are presented. The analysis of the domestic and foreign markets of software solutions and information systems for construction engineering has the technical potential to be the basis for the proposed in the article a unified digital platform for construction engineering management. Based on the analysis of the activities of a domestic company operating in the segment of construction engineering and technologies of the Industry 4.0 stack, strategic and technical development measures in the context of digital transformation have been developed. The inevitability of the digitalization processes of the construction industry in search of internal sources of efficiency of companies and the leading role in this process of the organization's human capital has been proved. Recommendations for implementing a digital transformation project in the studied company are given.

**Keywords:** digitalization, strategic development, innovation, human capital

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# 1 Introduction

Innovation and integration processes are now actively developing in all sectors of the national economy. However, the construction industry has traditionally been characterized by a fairly low level of digital solutions relative to other sectors of the Russian economy and a conservative attitude towards innovation. According to the Federal State Statistics Service, the share of investment in IT infrastructure and intellectual property in the share of total investment in the capital stock of construction companies in 2020 was 0.5%, while in general for all types of economic activity it was at 9%.

Conservative and reserved approach to innovation affects not only the technology of design, construction, and operation of buildings and structures but also the approach to the organization of labor of employees, methods of personnel management, organizational design, and the formation of the corporate culture of economic entities.

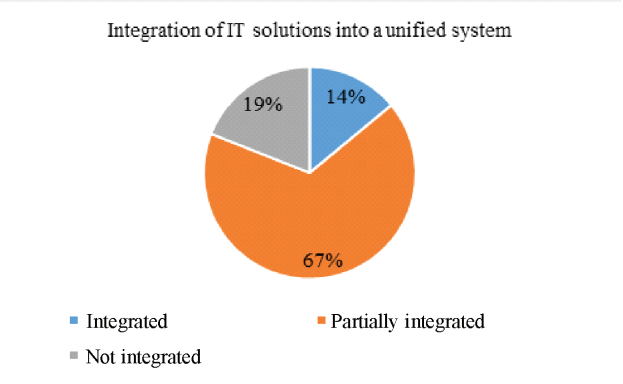


**Fig. 1.** Indicators of integration of design systems into a unified information system in domestic companies (KPMG survey ).

The construction industry in Russia critically lags behind other areas of the economy in terms of technological development and investment in innovative and digital solutions. It is worth noting that the problem of innovation in the construction industry is not unique to our country. According to a 2019 KPMG and PropTech Russia study, the following major issues are noted in construction companies:

- 80% of capital construction projects fail to meet planned deadlines;
- 98% of construction companies are not satisfied with the current level of automation of basic business processes;
- the average amount of financial losses at the design and construction stage reaches 20% of the total project budget;
- informing about risks and problems in project implementation happens after the fact (the reactive model of project management works);
- 79% of construction companies use oral or written communication on the project status and problems (without the use of automated accounting tools);
- 98% of management functions in construction companies are performed manually without using IT tools and systems.

- 20% of construction companies have implemented and use integrated calendar-network planning and project management systems.

During the analysis of efficiency of the specific investigated company "Sonet", located in Nizhny Novgorod, we have considered the problems associated with the activities of the design department and carried out a search for opportunities to develop the department as a center of changes and competencies to ensure its sustainable strategic development and promotion of design services as an independent product on the market of construction engineering [1].

## 2 Materials and methods

The study aims to substantiate the need for changes to the company following the digitalization trends of the domestic economy [2].

The following tasks were carried out to achieve this objective:

- features of the company's activities on the construction market were studied;
- design engineering market of the Russian Federation and its best business practices have been studied;
- opportunities for the development of the design department as the center of change and engineering competencies of the company were considered;
- measures, tools, and technologies have been developed, the application of which will improve the efficiency of the project area and ensure sustainable long-term development;
- new approaches to human capital management in the light of the new challenges facing the organization have been proposed.

## 3 Results

Based on the study results, we have formed the following strategic initiatives for future company development:

1) Digital transformation.

The design department is the center of engineering competence of any construction market participant; it was proposed to start the process of strategic and technological changes from this department. It is worth noting that the digital transformation of the construction industry is actually the transfer of relations and communications of the professional community into the digital environment and creating a digital ecosystem of the investment and construction complex as a whole [3].

In our view, digital transformation should be based on an ecosystem approach and aim at:

- the transition of design technologies to engineering simulation systems;
- creation of an information system that brings together internal and external participants in construction projects;
- changing the approach to assessing staff qualifications;

- retraining personnel in new digital competencies;
- creating a clientocentric product of project work;
- creating an information platform for company management based on the ERP system.

The study analyzed digital solutions in engineering systems modeling, existing in the domestic and European markets [4]. There are the following criteria for their evaluation:

- priority of systems developed by domestic companies;
- maintenance of standard data formats used in BIM modeling;
- support of domestic standards for design and working documentation following the norms of the system of design documentation in construction (SPDS);
- ability to form an information model of the system under design in an open specification data format (IFC);
- interfaces to ERP and PLM/PDM class systems [5];
- the presence of a program for implementing the system in designing, training, and adapting personnel formed by the developer [6].

The results of the analysis and choice of information modeling solution are shown in the diagram of the department's digital transformation in Figure 2. It presents a general structural diagram of the integration of selected modeling systems with the company's ERP system and the levels of emergence, storage, and use of data. The classification of levels is defined bottom-up from the first to the fourth level.

At the lower level there are information modelling systems, which will be a source of basic data on the technical state of the project the cost indicators for the budget assessment of the implementation of the projected construction object.

The second level hosts the database, which is the link between the ERP system and the simulation systems. The same level will be binding data received from systems modeling and ERP-system for further transfer to the upper level.

The third level represents the physical archive of data created during production activities.

The company's existing ERP system is at the fourth level, which is expected to finalize project management tools.

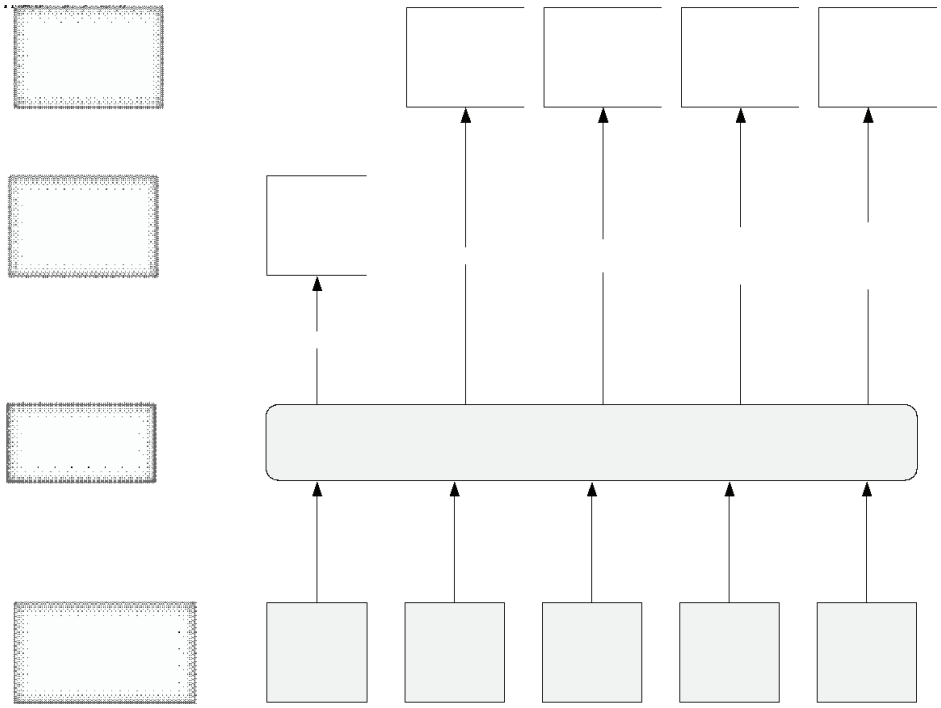

**Fig. 2.** Block diagram of digital transformation.

We see further development of the proposed digital platform in its integration with external entities of economic relations, such as suppliers, distributors, manufacturers of materials and equipment, contractors. Integration with external market players will allow a client-centered approach to product formation.

2) Changes in sales approaches. Customer focus.

We developed a product and market matrix ahead of the target client audience for sales of the company's project work. It is intended to be a reference point for project sales professionals in the external market environment. The product-market matrix is based on the types of customers horizontally and vertically on the customer's requirements to the quality criteria of the design work product, which were evaluated on a three-point scale ("high level of requirements", "medium level of requirements" and "low level of requirements").

In this case, the following were considered as customers:

- general design engineer;
- general contractor, whose portfolio with higher priority includes projects that include the development of working documentation;
- industrial enterprises with their own capital construction management structure;
- EPC Contractor;
- investors in capital construction projects.

The following parameters were evaluated as product quality criteria: product quality parameters of design work; timing; boundary conditions or exact technical requirements for

the result; cost; qualification requirements for staffing and availability of its ecosystem [4, 7].

As a result of the analysis of customer requirements for quality criteria, a matrix of the company's target customers for the development of design work was formed. Analysis has shown that the most interesting customers from an economic point of view for developing the design work in the domestic market are general design engineers, general contractors, and operating companies with their structure of capital construction management [8].

Customer focus as a way of interaction between the subjects of socio-economic relations allows shifting the company's focus from the product to the client. Forming a single digital platform and a portrait of the product's target customer allows implementing a customer-centric product that can quickly respond and change its parameters to meet the market's requirements and the target audience [9].

3) A new approach to forming competitive advantages of the product of design works.

The presence of own sales and marketing services imposes high demands on the competitiveness of the product of the project work. The specifics of the construction industry and the market of design work, in particular, do not give the possibility to form a clear competitive advantage, which can greatly limit the number of potential competitors in the market environment. The construction industry market requires participants to be as efficient as possible on the inside. We proposed the following formula for internal efficiency:

Internal efficiency = competencies * corporate culture * organizational maturity * technological maturity.

It is proposed to evaluate these indicators characterizing internal efficiency, based on a five-point scale:

Thus, to assess the level of competence, the indicators of the competence matrix, which contains assessments of the average level of engineering qualification of each engineering direction, were taken. According to John King's concept, the level of corporate culture was assessed on a five-point scale. The level of organizational maturity was assessed by employee questionnaires based on 14 indicators. The level of technological maturity is adopted by expert evaluation of technological equipment of the department with computer-aided design tools. The overall level of competence of the department is shown in Table 1 and is rated as "above average" [10].

**Table 1.** Average values of internal efficiency indicators

| Competence level | Corporate culture level | Organizational maturity level | Technological maturity level |
|---|---|---|---|
| 4.18 | 3 | 3 | 2 |

Indicators in Table 1 were calculated based on a survey of fifty domestic companies, carried out by the marketing department of the studied company

The processes of digital transformation should increase, in our opinion, the internal efficiency indicators to at least level four in each parameter. Work on improving internal efficiency should be done from left to right, from people to technology[11].

## 4 Discussion

We recommend starting your digital transformation project by assessing your company's existing IT infrastructure and digital assets. Evaluate the degree of technological maturity of target customers and partners. Use a project approach with an autonomous project change team to implement the project [12].

Given that the digital transformation is a process of technological re-equipment and a change in the requirements for the participants in this process, all risks can be divided into several groups according to the source of their occurrence [13].

So, the technical risks should include the risk of unpreparedness of IT infrastructure of the company to new challenges and problems of synchronization of integration processes with existing information systems.

Financial risks include:

- lack of company funds to finance the digital transformation project;
- a long payback period for investments in the digital transformation of the design department;
- Inflationary changes in the cost of subscriptions or software purchases.
- The risks of human resource management include:
- lack of available time resources for effective implementation;
- lack of motivation of the company's management to develop human capital;
- lack of staff involvement in the process of professional development and retraining; high staff turnover.

## 5 Conclusion

In conclusion, it should be noted that the digital economy of the Russian Federation is on the path of development of digital platforms and ecosystems, as evidenced by the examples of Yandex, Sber, Gosuslugi, Glavgosexpertiza, and others. Today's information and digital technologies enable the customer to directly influence the product. [14] The development of the digital economy and the fourth industrial revolution requires the subjects of socio-economic relations to revise business models, approaches to project management, personnel, and customer relations. Currently, the product is not the core of socio-economic relations, but the customer and his rapidly changing need. The proposed project of digital transformation, based on creating a combination of information modeling systems united at the level of the corporate ERP system, meets the modern integration and innovation processes of the domestic economy and the construction industry in particular. [15]

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