Lean production in investment-construction industry. Adaptation to phases of customer business cycle

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Abstract: Lean production is being effectively used in many areas. Construction sector has its own conceptual differences such as necessity of relocation of materials and production divisions between construction sites. Besides, every construction project is unique in a sense that even a standard project requires consideration of local conditions, and differs in terms of resources delivery, storage conditions, etc. Construction project involves many different parties (project designer, contractor, subcontractors, and suppliers), creating numerous management challenges. Lean production technology in this situation recommends the interpenetration of customer and contractor units. However, such a measure only partially increases flexibility of the construction industry, but does not eliminate the reasons for the discrepency between the periods of activity of customers and contractors. The article discusses ways to ensure maximum adaptability of the construction firm to the changes in customer business cycle. Construction companies are invited to create supersystem of common universal production, labor, and service units, which will significantly increase the flexibility of the construction industry. In addition, lean production technology should be complemented with tools for monitoring changes in the physical, communicaiton, technological and design activities of construction customers.
In the construction process, the activities of the project designer, contractor, subcontractor, and supplier are closely interrelated. For this reason, any deviation from the plan leads to unpredictable changes in scheduled dates and overall results of the construction process. As a result, no more than 60% of the planned tasks are actually executed [1, p. 11]. In addition, there is an unstable demand on the part of customers, which further destabilizes the activities of construction participants and could lead to the fact that “the variability of demand at the consumer level was about 3%, at the level of the manufacturer (supplier of raw materials) soared up to 40%” [2, p. 411]. As a result, “chaos is a natural state of construction projects, therefore, it is necessary to have a comprehensive plan for a construction project ensuring that each phase of the project is executed with perfect quality and within a defined cycle time” [3, p. 55].

Chernykh E.A. [3, p. 270] identified the issues facing construction industry: not meeting the project deadline and exceeding the construction expenses; low efficiency; poor quality of construction products; forced downtime; unskilled workers; poor working conditions; noncompliance with safety, health and environmental protection regulations for construction, etc. In our opinion, the root cause of all of the above issues is a lack of coordination between project designer, customer, contractor, subcontractors and suppliers. Each of them has its own business cycle, the phases of which most often do not coincide. Moreover, the more participants are involved in the construction process, the more difficult it is to synchronize their phases [4].

Construction phases of builders vary substantially depending on the type of installation and construction work they do (housing development, industrial construction, road construction, underground development, finishing and other work). Production cycle of installation and construction works and demand cycle for them depend on various factors. As a consequence, periods of hectic construction alternate with periods of downtime. Idle equipment and on-the-site labor could be effectively used on the construction sites of other companies with high pace of construction. But in real life it is carried out sporadically and non-systemically.

Synchronization of phases of customer and contractor business cycles takes place only in serial construction of the same project and when customer and contractors have long-term work strategy [5]. However, even in this case, the contractor cycles are behind the customer cycles (Fig. 1).
Figure 1. Lagging of contractor cycle in relation to customer cycle.

In addition, market uncertainty, unpredictability of demand for construction projects, as well as individual construction projects require different ways of consideration of customers, contractors and subcontractors business cycles. In our opinion, construction firms specializing in different types of construction and installation works and having different business cycles could share the types of equipment universal for all of them, as well as training centers, labor resources, design units, etc. If firms operate in different segments of the construction market and are not direct competitors, then the coordination of their activities will not lead to monopolization and market collusion with the aim of raising prices. To ensure public interest in this process a state oversight may be needed.

Companywide units within construction firms lead to the creation of supersystem that performs several major functions (Fig. 2).

Figure 2. The process of creation of supersystem by identifying companywide units in construction firms.
Thanks to creation of such supersystem construction companies can free up part of their resources and direct them to their main production activities that become more highly specialized and efficient. The legal form of this supersystem may be non-commercial partnership, joint-stock company, conglomerate, etc.

The supersystem created by construction companies can take on a number of functions:
1. Purchase and storage of materials, fuel, equipment, etc.
2. Joint production of standard products and execution of standard work.
3. Relocation of temporarily free labor force between construction sites (according to groups, industrial zones and seasons);
4. Creation of cultural and living conditions for workers.
5. Vocational training for workers (training centers, search and employment);
6. Combining of different types of transportation and distribution of goods between them, providing alternative transportation hubs and freight traffic, the development of freight and other transportation.
7. Preservation of the environment around construction sites and depollution.
8. Public relations, philanthropy

On this basis, lean production in the construction field should be developed through an increase of direct cooperation between building contractors from different segments of this market.

It is important to point out that in a strong market, construction companies have no incentive to create such supersystem, since the demand for their work and services allow them to make a profit while retaining independence. Therefore, crisis becomes a necessary condition to push construction industry to a whole new level. Only when faced with a fundamental challenge (a sharp decline in demand for construction products, the threat of bankruptcy, the need to immediately double production output without capital investment, etc.), construction companies are able to leave their comfort zones and review the entire production process.

Creating a common supersystem in the construction industry allows it to efficiently transfer temporarily uncommitted resources from construction firms that experience some downtime to construction companies that grow fast. As a result, the flexibility of the construction industry and its ability to adapt to market requirements increase. High level of trust between companies, complete transparency of the supersystem, the existence of detailed system of sharing resources, liability and insurance mechanisms are preconditions for building successful forms of cooperation between construction firms. At the same time, the creation of a supersystem in the
Construction industry does not achieve the main target of lean manufacturing - complete synchronization of the construction company business cycle and the construction customer business cycle. To achieve this target the construction industry should identify in advance the very first signs of change in customer cycle phase.

In the second half of the XX century, the construction industry catered to the needs of the customer by reducing production costs through serial construction using the same type of building materials and units. Today the potential of such development has almost been exhausted. Each further leap in productivity requires a lot of efforts and overstrain of the entire production system. But even the achieved new frontier is already insufficient, since the market today requires building several times faster and with a variety of choices. Build-to-suit is contrary to the nature of serial construction and requires new solutions. Attempts to find a solution by management restructuring of a single firm turned out to be unproductive. Long-term customer loyalty has become more important than customer satisfaction with a particular construction project. As a result, builders are extremely interested in building long-term relationships with customers, which fits perfectly with the system of lean manufacturing. From the point of view of lean manufacturing, it is necessary to consider value stream mapping throughout the entire construction industry: from the extraction of raw materials to the sale of the finished construction object to customers.

The standard solution for lean manufacturing technology is creation of kaizen – teams that rethink the entire production process (from project design to commissioning). It includes representatives from all major units of a construction firm, as well as a customer representative. It helps them overcome all the barriers. In parallel with the project design, marketing technologies are also being developed, and logistical chains are being established.

The main target of the kaizen team is to evaluate expediency of the project, work out the detailed project report, and estimate construction costs. After this the team deals with construction management while refining the process and standardizing the work. As a result, “if you get all the required specialists in one place, you can create an operating cell in less than a week, although it used to took three months before” [2, p. 472].

In our opinion, the creation of kaizen – teams is not enough to achieve complete synchronization of the construction company business cycle with the construction customer business cycle. Such teams are created when there is an increasing demand for development projects. It is necessary to have a mechanism to recognize the very first signs of imminent change in the phase
of customer business cycle. To do this, the construction company must cooperate with its customers at all levels of their activities.

1. The physical activity of the customer (the process of material production and rendering of service). In addition to direct signs of turn in the production cycle (incoming orders, volume of supplies, hiring, etc.), there are some indirect signs:

- an increase in the number of participants in the process of material production. It indicates growth of specialization and the subsequent increase in production (it may also imply an increase in demand for construction services);
- share of services to long-term customers in total sales. Its growth may imply a constant increase in production output;
- a steady increase in the mean utilization of equipment for production-type operation. It is appropriate to consider 65–70% as the lower threshold of the annual mean utilization of production-type equipment [6, p. 61];
- reduction in the employment of manual labor and, as a result, labor intensity;
- decrease in the share of individual orders and growth of serial and large orders.

2. Communication activities of the customer (organization of interaction between industrial zones, supply and transport operations, storage facilities, energy supply, human resources management, including the training system, etc.). In the construction company there are departments that communicate with the customer: marketing, personnel management, quality control, warehouse, transportation department, etc.

3. Economic activity of the customer (ensuring production activities through the flow of funds). The main economic signs of turn in the production cycle are: changes in prices, profit margins, market volumes, and terms of credit. All these indicators ultimately also determine the demand for construction products [7, 8]. Construction companies have the departments that can deal with those communication signs: financial department, economic department, planning department, budget department, etc. At every turn of customer business cycle the “financial firm's behavior” changes [9, p. 105].

4. Technological activity of the customer (introduction of new production, administrative, personnel and other technologies). The main customer signs at this level are: a decrease in the consumption of labor and capital per unit of production, a decrease in staff turnover, a reduction of the administrative staff (without a decrease in the firm’s revenue), etc. Construction companies have the following departments that deal with customer's technological signs: design and technology department, etc.
5. Project design activities of the customer (identification of development paths, strategies, relationships with external actors, etc.). This type of activities helps the company to integrate into the economic system of the region and broader society. Construction company has departments to deal with those project design signs: board of directors, strategy and project design departments.

Based on this, the construction industry should have external relations bodies at each of these levels (Figure 3).

Figure 3. Dealing with initial customer's signs.

To gather information about various signs of turn in business cycle of the customer, construction firms can establish face-to-face contacts, participate in professional unions, subscribe to specialized publications, etc.

Housing development market requires special signs for the compression phase and the expansion phase in the housing demand cycle. In the expansion phase, additional resources become available in the economy and society, which ultimately increase the demand for labor and, as a result, the demand for housing for additional labor force [10, 11, 12, 13].

Sources of new resource inflows can be:

1. Knowledge and expertise of members of the society that can create new technologies for extracting a larger volume of useful product from the same volume of raw materials.

2. New natural resources with low costs for their extraction. For example, the discovery of readily retrievable oil fields has multiplied the size and possibilities of the Arab economies.

3. New forms of money capital to facilitate economic activity including tax cuts, credit rates, and level of risk. For example, introduction of paper money made them accessible to the poor, which ensured a significant expansion of the economy at the expense of new consumers and producers.
4. The inflow of labor resources, reducing labor costs per unit of product. For example, the consolidation of agricultural producers drove the masses of people from the rural areas to the city, thereby ensuring the development of factories and plants.

5. New ways of combining labor, natural resources, information and capital. For example, the emergence of joint-stock ownership has dramatically increased the ability to attract capital and to finance large-scale projects.

6. The emergence of new national projects with long-term, synergistic effects. For example, electrification programs in different countries have led to a manifold increase in production and investment opportunities, including in housing development.

The above macroeconomic factors can be categorized into the same levels as in Figure 3 (physical, communication, economic, technological, and project design). As a result of their actions, the following events can affect housing demand:

1. Increase in family size
2. Increase in mortgage credit
3. Increase in the speed of cash conversion cycle
4. Mass changes in social statuses and an increase in social heterogeneity.

Thus, based on these signs, construction industry can effectively adapt the phases of its business cycle to the phases of customer business cycle [14, 15].

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