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Construction Industry Products Diversification by Implementation of BIM

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Abstract

One way to increase the effectiveness and economic stability of a construction company is product diversification. Intention to diversify construction products can be initiated for such reasons as necessity of capital injection, reducing of risks and costs of production, desire for optimization of delivery system, increasing economic competitiveness, etc. BIM can help to solve assigned tasks by diversification and optimize system operation as a whole. It becomes an actuality especially under conditions of severe competition when the possibility of attaining a work contract is reduced by increased focus.

Keywords: construction industry, diversification, building information modeling, implementation, strategy

1. Introduction

In this article, the term Building Information Modeling (BIM) is used for a process involving the generation and management of a digital representation of physical and functional characteristics of a facility. The Building Information Model obtained as a result becomes a shared knowledge resource to support decision-making about a facility from the earliest conceptual stages, through design and construction, then through its operational life before its eventual demolition.

In a general sense, diversification in the construction industry is a complex of activities connected to changes in production processes in order to expand a spectrum of offered works, services and goods, connected or otherwise with the primary activity as well. Further, it will be considered a substantiation of product and process diversification with regard to a wide term as a construction company. By the term of the construction company, the authors will understand any company which operates within the architectural/ engineering/ construction industry. The use of such a wide term is explained by the wide scope of diversification application. For example, a design company on the base of BIM can extend the sphere of their services and products to facility services because the most necessary information had been collected during the design stage, etc. When a construction company has chosen a specific direction of diversification, markets or market segments, the company has to decide its own positioning within it. There are two possible ways of taking a competitor's position into consideration.

The first way is to take a competitive position among competitors who already operate in the market and to start a struggle for market share. The second and more perceptive way is to use such kind of material and/or technology which either does not exist in the market, or has been poorly developed. The next step on this path is to offer products and/or services with a special difference made with special materials and/ or technology and thereby winning consumers. BIM implementation operates precisely along this second path. It is valid because of the increasing demand for BIM based products coming from the

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owners and for those companies that wish to take a firm competitive position, it is necessary to have BIM skills. On the other hand, construction companies can offer BIM technology as a marketing feature to new clients who have to demand it.

What is stated above is substantiated in the report issued by McGraw-Hill Construction with the Society for Marketing Professional Services (SMPS) which reported that 98% of European BIM users indicate that BIM capability is having an impact on enabling their companies to win new work [1].

2. Building Information Modeling

Information Modeling is a process involving the generation and management of a digital representation of physical and functional characteristics of a facility. This process results in a building information model.

Building Information Model is: well coordinated, agreed upon and interconnected, ready for calculations and analysis, having a geometrical binding, suitable to the computer usage, allowing the necessary update of numerical information concerning a projected or already existing object that can be used for:

(1) Accepting a concrete design choice;
(2) Creating of high-quality design documentation;
(3) Predicting of a functional performance of an object;
(4) Estimating and making building plans;
(5) Ordering and manufacturing of materials and equipment;
(6) Controlling of a building erection;
(7) Controlling of maintenance of the building and means of technical accessories during all life cycle;
(8) Controlling of a building as an object of commercial activity;
(9) Projecting and controlling of reconstruction or repairing of a building;
(10) Pulling down and utilizing of a building;
(11) Other purposes connected with a building.

Table 1 BIM benefits

BIM design phase benefits	BIM construction phase and fabrication benefits
Earlier and more accurate visualizations of a design	Quick reaction to design changes
Easy verification of consistency to the design intent	Discovery of design errors and omissions before construction
Automatic low-level corrections when changes are made to design	
Generation of accurate and consistent 2D drawings at any stage of the design	Use of design model as basis for fabricated components
Earlier collaboration of multiple design disciplines	Synchronization of design and construction planning
	Synchronization of procurement with design and construction
Extraction of cost estimates during the design stage	Better implementation of lean construction techniques
Improvement of energy efficiency and sustainability	

All advantages from BIM usage can be divided into straight and indirect ones. Sure gains are easily seen in practice, but quantitatively indirect advantages are prevailing. The advantages divided on processes are presented in Table 1 (source: own elaborations).

3. Classification of Diversification Processes in the Construction Industry

The diversification usually divides into connected and unconnected types, under the economics theory. The connected diversification, in turn, divides into vertical and horizontal one. The vertical diversification (integration) is the process of including of a new components included to uniform technological chain of a production process, in an already operating system. The three types of integration distinguishes in the following way: full, partial, and pseudo integration (it means creation of alliances between companies without transfer into the ownership). The vertical diversification, in addition, can be as direct (the integration with products consumer companies) as opposite (the integration with products supplier companies). The horizontal diversification is an integration process between the same area operating companies. This type of diversification is used for competitiveness reinforcement or for establishing control over competitors. The unconnected diversification is a process of penetration to a new markets unrelated to a company core business. A classification of diversification processes in the construction industry is shown in Fig. 1 (source: own elaborations). BIM has both coverage ways in this case: internal growth (company diversification); external growth (merger and take-over).

From this we can conclude that BIM is a universal tool for economic position, it can help to solve assigned tasks and optimize system operation as a whole. The diversification can be initiated for such reasons as necessity of capital injection, reducing of risks and costs of production, desire for optimization of delivery system, increasing economic competitiveness, etc. In case of expansion of activity scope directly on the path production, the production basis, skills and business connections will find industrial application.

In any case, the diversification process is difficult enough and needs complex economic preliminary estimate within the framework of every individual company. However, the general factors that have an impact on diversification effectiveness can be marked out.

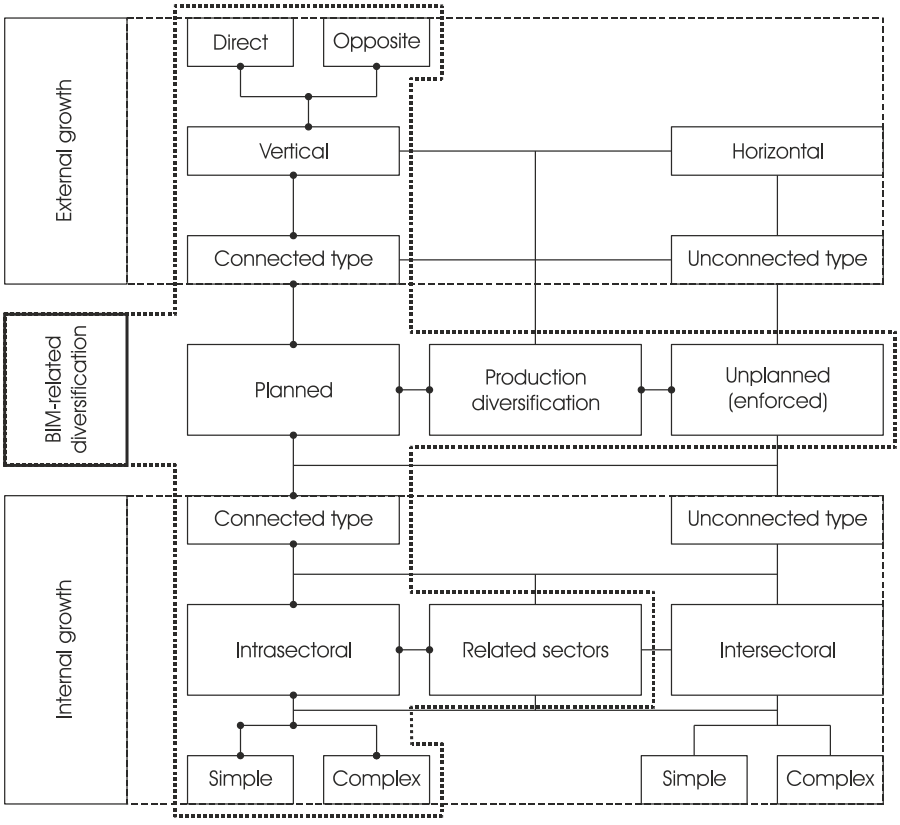

Fig. 1 Classification of diversification processes in the construction industry

4. Factors that Influence the Effectiveness of Diversification

The effectiveness of diversification is influenced by some factors and require management decisions seeking adaptation, or to eliminate negative influence on them. Classification can significantly simplify detection of these factors. After the analysis of construction companies experience that had been operated on the former Soviet Union territory (from 1991 to 2001), general factors that influence the diversification effectiveness were marked out. The majority of these construction companies were forced to diversify their production being on the verge of bankruptcy. It is very important to notice that such kind of experience is useful in case of an economic crisis when the diversification becomes a compulsory measure. All described above essentially differs from the experience and diversification cases of the Western Europe construction companies. The diversification in these cases serves as a tool to raise the production profitability, expansion into new markets, and has a well planned character.

The described factors were found by the analysis of economic indicators changes and tendencies by the following desired conditions:

(1) Comparison of planned and actual indicators with the purpose to evaluate diversification plan fulfillment.

(2) Comparison of actual and historical measures with the purpose to identify company development tendencies.

(3) Comparison of own indicators and industry leaders indicators with the purpose to identify working balances.

(4) Comparison of own indicators and industry average indicators with the purpose to identify own competitiveness on the market.

(5) Comparison of different variants of management decisions with the purpose to choose the most optimal ones from them.

(6) Comparison of operating results before and after some individual factor change with the purpose to identify the level of the factor.

As for the effectiveness of diversification, there are impacts from three groups of factors: the macroeconomic, the sectoral, and the in-house. The interrelationship between the influencing factors and the adoption of drivers for BIM implementation is shown in Table 2 (source: own elaborations).

Table 2 The interrelationship between the influencing factors and the adoption of drivers for BIM implementation

		Factors	BIM adoption drivers
External environment	Macroeconomic	Government investment policy	Government support and/or requirements of BIM projects
		Government tax policy	Rate of tax reduce with project ecological compatibility
		Government monetary policy	Highest return of investments as a result of improved project delivery
		Inflation rate	Acceleration in the rates of ratio of capital turnover of basic capital as a result of reducing project realization
	Sectoral	Quantities demanded/Quantities supplied	Growth of demand for BIM projects
		Competitive rate between construction companies	Relatively low level of competition on BIM projects market
		Amount of financing of construction works	Rising market of green building
		Competitive rate between suppliers of products and services	Rising market of BIM building
		Rate of market loading of products and services	Retention of existing and making new connections with suppliers

Table 2 The interrelationship between the influencing factors and the adoption of drivers for BIM implementation (continued)

		Factors	BIM adoption drivers
Internal environment	In-house	Availability of required capital	Reducing of cost of construction works
		Personnel skills level	Personnel skills growth as a result of BIM trainings
		Innovation potential	Growth of innovation potential as a result of adoption new technologies
		Available information technology	Renewal of hardware, software and communication devices
		Organization structure	Positive effect as a result of reorganization of company structure
		Management methods	Creation of new management roles and project delivery methods

5. Criteria for Consideration of Diversification Direction

Construction companies conversion from a dedicated activity to diversification activities needs to be considered for every separate case. Consideration should be based on a set of criteria which are derived from the nature of diversification goals. Final goals of diversification must be profit maximization, creation of new positions, growth of the capital utilization rate, and the winning of new market segments.

The deliberative process regarding diversification direction can be done as follows. A construction company considers that the best prospect is to produce products and services based on BIM technology. BIM implementation addresses the purpose and available resources which is the production basis, personnel membership and skills that allows it to provide for production of the new products and services. At the same time, financial resources and economic relationships capable of providing the required resources to organize production distribution must be available.

Economic indicators of an existing construction company can be represented by a similar case. Data found in the article "The volume of initial investment for adopting BIM" [2] was added and presented in Table 3 (source: own elaborations). These data sources show improvement of indicators that are typical for planned product diversification.

Table 3 The indicators of diversification efficiency

No.	Indicators	Before diversification (actual)	After diversification (predictable)
1	Net income (EUR)	81968	208463
2	Current ratio	2,2	3,1
3	Value of assets (EUR)	55078	55078
4	Return on assets (ROA)	1,48	3,78
5	Staff numbers	19	19
6	Numbers of high-qualified staff	18	18
7	Average monthly salary of staff (EUR)	2157	2372
8	Average monthly salary of high-qualified staff (EUR)	2209	2430
9	Diversification related cost (EUR)	104238	0

6. Strategic Direction of Diversification

	Initiation	Design	Execution	Operation
Modeling/Contracting	Schematic Architectural Model Department	Architectural Model Department	Architectural Contracting Works	
	Schematic Structuaral Model Development	Structuaral Model Development	Structuaral Contracting Works	
	Schematic Air Systems Model Development	Air Systems Model Development	Air Systems Contracting Works	
	Schematic Electrical Model Development	Electrical Model Development	Electrical Contracting Works	
	Schematic Fire Plumbing Model Development	Plumbing Model Development	Plumbing Contracting Works	
	Schematic Fire Protection Model Development	Fire Protection Model Development	Fire Protection Contracting Works	
			Manufacturing	
Coordinating/Analyzing	Scheduling	Scheduling	Scheduling	Occupancy Procedure
	Schematic Model Coordination	Model Coordinating	Model Coordinating	Facility Maintenance
	Intial BIM Estimating	BIM Estimating		Decommissioning Procedure
		Field Coordinating	Field Coordinating	
		Mobile Protecting Tracking	Mobile Protecting Tracking	
		Logistics	Logistics	
			Commissioning	

Fig. 2 Morphological analysis

If a construction company assumes to enter to the market of the goods and services produced on BIM technology, it should consider existing and future market sizes. The strategic direction for the company development will be formed according to a received data. The primary analysis of the operational environment and its potential possibilities was carried out by Morphological analysis and shown in Fig. 2 (source: own elaborations). The morphological analysis combines identification, designation, counting and classifying all selected options and function of the innovation into a single system. Any innovation is associated with the desire to reduce the amount of capital investment and reduce the risk that always accompanies innovation. And these two characteristics of innovations are in direct proportion to the number of required changes. It is possible to select four main types of transfer to using a new system: strategy of parallel transfer, strategy of straight transfer, strategy of pilot transfer, and phase-to-phase strategy.

(1) At strategy of parallel transfer, both old system and the system replacing it simultaneously functions in the organization until each employee gets convinced that the new system functions correctly. It is the safest method of transfer when errors occur; the data from the old system can be used as a backup copy. Such approach is very expensive; however, at simultaneous functioning of two systems, additional resources can be demanded.

(2) At strategy of straight transfer, on the aforesaid day the old system is completely replaced with the new one. At first sight, such strategy seems to be less expensive than strategy of parallel transfer. However, this approach is risky enough

and potentially, it can be more expensive than a parallel transfer in case of massive problems at functioning of a new system. At such approach, the system to which you can return lacks.

(3) At a pilot stage of the transfer, the new system is represented to a restrained part of the organization, or to a separate subdivision or department. When the pilot version is implemented and works correctly, it is installed in the whole organization, either simultaneously, or step-by-step.

(4) At phase-to-phase strategy of transfer, the new system is entered step-by-step, either according to separate functions, or by organization subdivisions.

In the considered direction of a diversification, the preference that realization of the new goods and services of the construction company will occur on a growing market is exercised. Such type of organization may also take full advantage of opportunities in its own or related industries, look for acquisition candidates, increase market share and/or allocate resources to products that have a definite competitive edge.

7. Conclusions

If forecast of the BIM direction of diversification is positive, as a further step the construction company should decide how to enter the market is to use BIM technology. Actually, adopting of BIM technologies and farther product and process diversification for a construction company means not only a transition to new software, but also a new method of work that makes rethinking of organization chart and personnel training necessary. All these procedures will need to incur considerable expense at the first stage of BIM implementation. But McGraw Hill Construction reported what the European BIM users (74%) experience as a positively perceived Return on Investment (ROI) on their overall spending on BIM [3].

Before beginning the implementation process, it is helpful to consider its barriers. Accordingly, the analysis of such barriers has had an important influence on the full implementation process and efficiency of further system use. The barriers which can be expected with a high probability are shown in Table 4 (source: own elaborations).

To define the potential buyers and their needs, this becomes possible only for each concrete set of goods and services since for market sharing into consumer groups it is necessary to be guided by certain parameters because each group may request separate work, goods or services and marketing complexes. However, the described case studies in the literature and the received data in this article contain sufficient proof of the expediency of the product diversification based on BIM. This leads to expanding a range of products and services, need of capital investment, reducing of risk and costs of production, optimizing the existing delivery system, increasing competitiveness, etc.

Table 4 Overcoming barriers to implementation

Barrier	There is an obvious need to change information flow management and principles of the management design process.
Solution	The solution is given by using a selected strategy on a limited part of the organization (single division or a department). Based on the result of test mode, BIM implemented in all organization either at the same time or step by step.
Barrier	Employee resistance to change.
Solution	Employee resistance can be caused by several human factors: fear of innovations, conservatism, fear of losing job, fear of increasing responsibility. Necessary in this case is the explanatory works with staff, and, besides: - The top level managers must be an example of an active participation in BIM implementation and training process to ordinary employees; - It is necessary to create the sense of implementation inevitability at all levels of employees; - BIM project manager must be authorized to solve arising problems; - Implementation decisions must be reinforced by written orders.

Table 4 Overcoming barriers to implementation (continued)

Barrier	An employee workload is increased considerably at the time of BIM implementation.
Solution	Concurrent activities such as performance of typical scope of work along with a training course creates superload on employees. In this case, it is necessary to: - Raise level of employees motivation by encouragement and gratitude; - Apply organizational measures for concurrent activities term reduction.
Barrier	Absence of qualified BIM implementation team.
Solution	It is necessary to create a small working team which does the most complete training. This team shall bear the considerable part of work and further support on BIM implementation. The basic rules of the working team creation are: - Specialists of the working team must be possessed of computer knowledge, communication skills, responsibility, and discipline. - Possible employee dismissal from the BIM implementation team can be reflected in its results extremely negatively. It is, therefore, important to choose devoted and reliable employees and to stimulate this devotion during all project phases; - Responsibility assignment, form of plans, reports, length of the reporting period definition are needed from a BIM manager.
Barrier	Absence of owner's interest in using BIM technologies and further ownership of the Information model.
Solution	This barrier can be overcome by promotion of BIM benefits to the owner, and also with the help of state stimulation of BIM implementation.

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