AKADÉMIAI KIADÓ

Classifying AEC enterprises in the South Transdanubia region, Hungary

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ABSTRACT

This paper classifies the architecture, engineering, and construction enterprises in the South Transdanubia Region, Hungary, according to the size and function of the firms. It is a primary step for later investigation about the implementation of building information modeling in small and medium-sized enterprises within the region. It introduces digital construction in the sector, includes most construction firms based in the region, and systematically gathers data. It analyzes the data to introduce a new sorting method based on the local construction market, unlike the international classification, which leans on the global perspective.

KEYWORDS

architecture, engineering and construction enterprises, classification of firms, small-medium enterprises, building information modeling, South Transdanubia, Hungary

1. INTRODUCTION

1.1. Introduction to BIM in AEC industry

Definition of Building Information Modeling (BIM) is the methodology of using a 3D virtual model for constructing projects or digital construction [1].

BIM uses defined elements that are interactively connected, which easily generate engineering information [1, 2]. It is a digital way to increase quality and decrease errors, but there is still a lack of direct measurements about the true implementation of BIM [3]. The collaboration between multi-disciplines in the Architecture, Engineering and Construction (AEC) industry was depending on the exchange of 2D drawings, until the recent widespread of the Computer-Aided Design (CAD), then it was followed by the invention of BIM [3, 4]. Most complicated AEC projects include a tremendous exchange of building data between several representatives, here comes the importance of BIM, which has developed from intra-discipline to multi-discipline cooperation [4]. Its usage is not limited to design and construction stages, it goes further beyond as a life-cycle assessment [5]. It is used in the renovation stage as a quick tool for managing the areas, surfaces, and ratio of renovation costs [6]. However, many projects are mostly carried out by Small-Medium Enterprises (SMEs), which may also carry out parts of large size projects, so there are frequent calls for SMEs to implement BIM solutions in different sized projects considering affordability, availability and practicality [7]. BIM plays an effective role in large AEC enterprises, and it is not limited to managers, architects and engineers, it goes further beyond among professionals, craft workers and contractors [8]. Thinking about it as different model for each stakeholder is more precise, instead of one unique model [8, 9]. For instance, contractor's

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model is used for visualization and quantity takeoff [9]. Because of the multi-disciplinary nature of the AEC sector, there is always a huge demand for collaboration technology among different representatives of various disciplines, including all firms in the project's life cycle (large and smaller firms) [10, 11]. BIM as a virtual prototyping tool will take the industry beyond the limits [12]. There are technological, organizational and attitude barriers against BIM implementation, the barriers are indicated with the lack of BIM awareness, the absence of BIM standards, and the high resistance to change, respectively [13]. So the adoption in the AEC domain is still immature [14], and the transition to BIM workflow for smaller firms does not occur overnight, it may take years and it expands with new applied technologies. So education and traineeship are compulsory to keep up with the technology [15]. Mainly with the massive potential for BIM to support new innovations in the industry like building automation systems, smart buildings, energy-optimization, and building simulations. [16, 17].

1.2. Classification of enterprises in the AEC industry

According to the international Organization for Economic Cooperation and Development (OECD), a legal entity possessing the right to create a business on its own can summarize the definition of enterprise. This enterprise can freely create bank accounts, own properties, bear liabilities and enter contracts [17]. A small enterprise is an independent business, managed by its owner or part-owners and having a small market portion, size of a small firm is relevant to the sector, number of employees or turnover [18]. Classification of businesses is essential in the AEC market, mainly when it is about making particular decisions like choosing a technology solution that best fits them [19]. There are plenty of key differentiators that affect the ranking of businesses; the most well-known is leaning on the number of employees and total revenue [19]. According to small business administration in US, the size standard of a certain business is stated by two main factors: number of employees or sum of receipts [20]. The EU considers the same factors for classifying firms, headcount or balance sheet [21]. People covered by a contract agreement, working for a specific enterprise, and receiving compensation for that work, are defined as employees for whom the enterprise pays taxes, and social security outlays. Working owners, unpaid workers, and business partners are excluded from the definition. But net revenue is the total income that is generated through several businesses in a certain firm, subtracting no expenses [22]. Sorting enterprises can help clarify the capabilities and objectives then connect this to the appropriate technological solutions for finding new cost-efficiency options, advanced solution characteristics, or easy-to-manage platforms. This sorting is the key for helping adequately compare technology solutions and decide, which solution is suitable for certain business [19]. By studying the business value of BIM in the EU, BIM implementation reached 36% by 2010, and this percentage is increasing [23]. UK's government has imposed BIM on AEC projects since 2016. It is observed that SMEs have fewer implementation opportunities compared to large business groups. Guidance for SMEs to keep up with the sector's improvement and implementation of collaborative technologies is needed [24]. At the regional level, the Hungarian professional chambers' role must be more concrete in the actual market to aggregate the digital transformation among smaller Hungarian firms. Even so, the act of the Hungarian BIM association is highly appreciated, but it should go further from connecting and updating professionals among the AEC market to support BIM implementation in the market and constructively collaborate with other potential partners, like the chamber of Hungarian architects, chamber of Hungarian engineers, and the national association of construction contractors. SMEs play a dominant role in all European countries including Hungary, it hire 67% of all employed people and take part in 58% of the total added value in the union [25]. SMEs describe implementing BIM in existing workflows as a real challenge in collaboration [26]. Practitioners of medium-large scaled local design or construction firms are more likely to take on BIM implementation, since smaller firms do not yet seem to adopt BIM-supported workflow [26, 27]. BIM is still implemented at a relatively slow speed in the AEC sector across the world, so the design and construction processes are still leaning on 2D drawings to keep up with the client's demands of high-speed design and construction work [27]. SMEs do not have a systematic technical, informational and financial supply for recognizing and taking resource-saving opportunities like BIM, and most times SMEs managers and decision-makers are unaware of the notable savings and benefits of applying these opportunities [28]. Due to nowadays efficient standards, SMEs must adapt with BIM, since clients are looking for optimal products, so low-quality, poor performance, expensive, or resource-consuming outcomes can be easily rejected [29]. By adopting BIM in SMEs as a technical tool, the economic benefits and profits will be maximized [28]. Hence the need for investigating BIM usage by SMEs in the studied region comes, for creating an efficient harmonic connection between SMEs and large firms to increase the values of construction products, which will reflect on the development of AEC sector. An initial step in investigating the application of BIM within SMEs is to sort out the enterprises through the examined area, to obtain the target firms which will be surveyed in future research steps, and to clarify the sector's concentration of forces for the same region.

2. MATERIALS AND METHODS

2.1. Region selection

The initial step selects the target area carefully by gathering information about the local construction market in Hungary. According to the regional atlas and map of statistical regions, there are three large central regions in Hungary and eight sub-groups forming the so-called small regions; these regions are titled as follows: the large region of Central Hungary (Budapest and Pest), Transdanubia (Central, Western and

Southern Transdanubia), and Great Plain and North (Northern Hungary, Northern Great Plain, and Sothern Great Plain) [30]. Depending on the analyzed data of the values of construction outcomes for small regions in Hungary by the location of headquarters for enterprises, the Southern Transdanubia Region has one of the lowest values of construction production compared to other small regions in the country [31]. The research examined the percentage of construction production of AEC enterprises based on the South Transdanubia Region and compared it with the percentage values of other small regions in Hungary for five years, between 2016 and 2020. The results show that AEC companies in the Southern Transdanubia Region suffer from low values of construction production, with 6% compared to other small regions which reached up to 10% (Norther Great Plain) and 14% (Southern Great Plain). Hence, integrating BIM in SMEs workflow will have a favorable impact on the sector, and may assist in increasing the construction production for AEC firms in the Southern Transdanubia Region.

2.2. Region control and AEC enterprises selection

The following step is to control the borderlines of the examined Southern Transdanubia Region to collect the AEC enterprises within the region's borders, which consists of three counties: Baranya, Somogy, and Tolna county, and each one contains several administrative cities. Accordingly, the research collected the AEC firms belonging to each administrative city. 13, 8, and 6 scanned cities for Baranya, Somogy, and Tolna County, respectively. The study also contained several AEC companies, which are based within the borders of the region and registered in 9 smaller towns within the counties. The process of collecting the AEC enterprises was created online by using the web mapping platform supported by Google (Google Maps), as a public-reached source, which relies on a free public database of addresses and postal codes, so based on mass filtering according to the location of enterprise, only those enterprises were collected which have registered addresses within the borders of the South Transdanubia zone.

2.3. AEC enterprises data collection

After selecting the AEC enterprises, the paper collects inclusive data about these enterprises; this data includes the short name of the firm, county, registered city, address, date of establishment, main activity, capital subscribed, net revenue, number of employees, and number of owners. The data was provided online from the website of a Hungarian firm based in Budapest, and provides information services and asset management [32]. Previous works used a similar data-collecting technique for gathering local information about the Hungarian market [6].

By analyzing the main factors that play a prominent role in classifying enterprises according to size, the collected data were minimized into more summarized tables containing the essential aspects needed for starting the classification stage. The aspects are described as: total revenue, the number of employees, location of the firm (county and city), and main functional activity. In this summarized datasheets, 40 enterprises were collected in Tolna County with 900 employees, and more than 79 million euros total revenue, 38 enterprises in Somogy County with 345 employees and more than 13 million euros total revenue, while 91 enterprises in Baranya County with 1,133 employees and more than 97 million Euros total revenue.

2.4. Introduced methodology for AEC enterprises classification

SMEs limitations can vary according to the economic size of countries, and it is highly affected by financial situations, so the phrase itself has more likely economic meaning compared to the legal meaning [33]. Categories of companies in the EU and UK according to the department of trade and industry are grouped as micro, small, and medium, with 0–9, 10–49, and 50–249 employees, or with <2, 10–49, and >50 million Euros net income, respectively. These groups are also used in Hungary from the beginning of 2005 [21]. Investigating the turnover by enterprise size in Hungary and several other countries, it is explicit that values in Hungary are modest, contrasted to other more prominent economic EU countries or non-EU countries like the USA, UK, and Canada [34]. There is an apparent incompatibility between the turnover values of Hungarian enterprises compared to the global and European classification standards due to the unparalleled economic sizes. Therefore, following this standard for domestic research purposes may result in misleading information; this criterion may be helpful for international research works; otherwise, it is pointless for local observations. Hence, the study finds that the international norm for classifying AEC firms has to be tailored to consort with the Hungarian construction market.

The proposed methodology for classifying the firms in the studied region focuses more on the total revenue of each enterprise, knowing that it will not ignore the number of employee's factor, but it will scale it. Since, unlike net revenue, the number of employee indicator is not accurate for domestic studies purposes; the reason behind this is the lack of real headcount numbers provided by firms, and the apparent discordance between net income and the number of workers in several firms raises doubts about the reliability of this data especially by comparing the firms with similar main activities in the same small region and other regions in Hungary. Moreover, and according to local observations, it is agreed that the index of workforce members in Hungarian AEC firms may not always be precise, essentially for smaller enterprises, as there are many firms in this category that subcontract and sub-employ workers, those usually do not have reference official registration numbers, or they have double-occupation and being registered and taxed by other institutes. Nevertheless, neglecting this factor may weaken the study and the outcome categorization. Consequently, the work suggests carefully dealing with the headcount values by considering the bigger picture across the regions and defining the average number of employee criteria by calculating the central typical

employee number by each category, which may reduce the chance of error in the final range employee results.

Relying on the analysis of net income values for different-sized firms in the territory and comparing to the values for other small regions in Hungary, the research suggests sorting out the firms for six sub-categories depending on the income; each category will have specific domain criteria which fit together with the net earning values of Hungarian firms and values of construction production in the same market. Knowing the domain values of net receipts for AEC firms in other small regions in Hungary, and by focusing on the analyzed small region, a new approach was drawn.

The article divides the criteria of net income values as follows: <500,000, 500,000 to <1 MM (millions), 1 MM to <2 MM, 2 MM to <5 MM, 5 MM to <20 MM, and ≥20 MM Euros, and for number of employees as follows: <10, 10–<20, 20–<60, 60–<100, 100–<250, >250 employees, these divisions will be for the following criteria tags: Nano, Micro, Micro-Small, Small, Medium and Large enterprises, respectively.

3. RESULTS AND DISCUSSION

3.1. Adapted classification for the AEC enterprises in the South Transdanubia Region

An explicit tactic for gathering data about 169 different AEC enterprises located within the border of the South Transdanubia Region, in which the firms are suffering from low values of construction outcome with 6% in the period of 2016–2020, compared to the same values for other small regions in Hungary. By coordinating the data to clarify the size of enterprises; due to its import in further stages for later research step to measure the Key Performance Indicator (KPI) of BIM use in SMEs at the region, since successful up-to-date SMEs maximize the profits and boost the sector, which will reflect firmly on the values of construction products by companies in the territory. Thus, indicating the target SMEs is a substantial step in the examination. However, the barrier is summarized by the discordance between the EU firm sorting criterion and the local Hungarian firms. Table 1 shows ranking standards in the EU and the arrangement of the collected sample according to that. The result is pointless for domestic research purposes, and it has more potential for global study approaches.

Table 1. Classification of collected AEC enterprises according to firm categories in the EU

	Micro firms	Micro-small firms	Small firms	Medium firms	Large firms
Net revenue	2 MM Euros	2 < 10 MM Euros	10 < 49 MM Euros	50 MM Euros	Undefined
Baranya	85	4	2	0	0
Somogy	36	2	0	0	0
Tolna	31	6	3	0	0
Total	152	12	5	0	0

Table 2. Introduced categorization for AEC enterprises in the South Transdanubia Region

	Nano firms	Micro firms	Micro-small firms	Small firms	Medium firms	Large firms
Net revenue	<500 thousand Euros	500 < 1 MM Euros	1 < 2 MM Euros	2<5 MM Euros	5–<20 MM Euros	≥20 MM Euros
Hand range	<10	10–<20	20–<60	60–<100	100–<250	≥250
Baranya	65	10	10	1	4	1
Somogy	30	3	3	2	0	0
Tolna	28	3	0	6	2	1
Total	123 Nano firms	16 Micro firms	13 Micro-small firms	9 Small firms	6 Medium firms	2 large firms

Subsequently, the monograph introduces adapted categorization for AEC enterprises in the surveyed region with additional categories; each category has its total revenue and workforce criteria, which relatively matches the values of enterprise in this domain. Table 2 presents the configuration of firms in the introduced six categories, which are comparatively adapting with the income values for local AEC companies, the domestic economic situation of Hungary, and the regional values of construction production. Fixing the revenue domains was according to a comprehensive revision of net income for randomly sampled AEC enterprises in the other five small regions in Hungary and compared to the same values in the scanned South Transdanubia small region, together with an overall review and analysis for construction outcome values of AEC firms in Hungary.

4. CONCLUSION

The paper introduces a categorization methodology of AEC enterprises in the South Transdanubia area whose firms suffer from deteriorating construction product rates. The proposal is primarily based on the size and derived from the sum income by analyzing the revenue and construction outcome values for firms within the six small regions in Hungary to form a convenient classification standard that fits domestic research purposes. The findings can guide sorting AEC firms and indicating the functional distribution in the area as a crucial stage for later steps in a more extensive research scheme to measure the KPI of BIM employment in SMEs on a regional level.

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