BIM at small architectural firms

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In the architecture, engineering, and construction industry, the interest in Building Information Modeling (BIM) is growing. Scientific research discusses different aspects of this methodology; on the internet, in journals and in public opinion different views are presented and thoroughly discussed. Pros and cons are posed, but there is no consensus about which parts of the ideal view can be reached in the real building process at this moment. Architects are not convinced about the value and necessity of using BIM, but the economic crisis that influences the economy and the building industry since 2008 could be a reason to reconsider the need for new techniques and new roles of the architect. Besides, a commonly heard note is that BIM is to be used by large parties and it has too little benefits for smaller firms. Knowing that, looking from the point of view of the architect, the question arises whether or not small architectural firms should apply BIM. Resulting in the following research questions:

- What are the considerations of small architectural firms in the Netherlands in the choice whether or not to use BIM?
- How can BIM be used at small architectural firms in the Netherlands?
- What strategy should small architectural firms in the Netherlands apply in the implementation of BIM?

This research is part of the master course at TU Delft and was carried out in cooperation with the The Royal Institute of Dutch Architects (BNA), the professional organization of architects in The Netherlands. Approximately 1500 architectural firms are associated to the BNA, of which 1300 firms have a size of 10 FTE or less, the research group. The group of firms associated to the BNA is representative for the total group of architectural firms in the Netherlands.

Introduction

The ‘M’ in the abbreviation ‘BIM’ is interpreted different in different contexts: Building Information *Modeling*, Building Information *Model* and Building Information *Management*. *Modeling* focuses on the process of generating and using information about a building during its whole lifecycle and collaboration across disciplines; efficiency and clash control are aspects that are addressed in this process. The *model* is the digital presentation of the physical and functional features of a building and is the basis for the above explained process. *Management* is less commonly known and is about the organization and control of the business process by using the Building Information Model (buildingSMART 2012, Isikdag and Zlatanova 2009).

BIM has a strong relationship with collaboration and integrated building processes. Experts have different opinions about the exact interpretation of this link and the role that integration plays in the BIM

process and vice versa. It is clear that BIM supports collaboration processes, but the need for an integrated environment is not proven. As a precursor of the collaborative 'Big BIM, 'little BIM' is limited to the use of BIM in internal processes, but the transition between both terms is smooth and cannot be seen binary (Lu and Li 2011, Succar 2010, Jernigan 2008). Participation in integrated projects, regardless of the software tools they use, is supported by the open standard IFC. 'Open BIM', an initiative of buildingSMART International, is a universal approach to the collaborative design, realization and operation of buildings based on open standards and workflows (buildingSMART 2012).

Research to the advantages and barriers of BIM has been done before in Australia, the UK, the USA, Germany and France (Bernstein and Pittman 2004, Deutsch 2011, Gerrard et al. 2010, Gu et al. 2009, Yan and Damian 2008). Some advantages are described in professional literature. Improvement in coordination, less rework and fewer requests for information are a result of integrating disciplines and processes both within the office and between parties. Avoidable cost will be reduced, production can be increased and therefore cost can be limited and more effort can be put into quality.

De presumed disadvantages and barriers that restrain architects from implementing BIM are examined as well. The reduction of costs and time are not sufficiently proven yet (Howell and Batcheler 2005). The use of the traditional 'Design-Bid-Build' organizational model is seen as barrier by software vendors, but this could be because of their goal to put their products on the market. Another view is that some benefits can be reached without the fully integrated approach (Deutsch 2011).

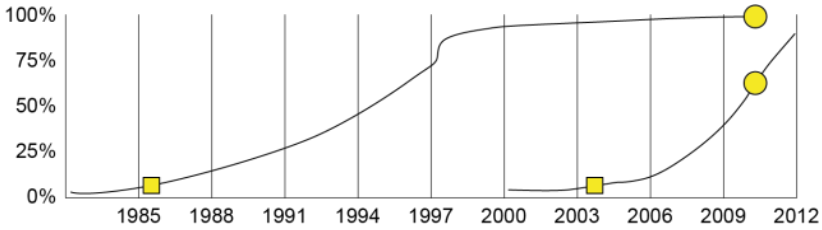

Figure I – CAD versus BIM adoption chart (Deutsch 2011)

The effort that has to be put into the design shifts from later design stages to earlier design stages resulting in an expected gain of time overall. Clients could refuse to adapt their fee structure to this new situation what could be seen as a problem.

Compared to the introduction of CAD in the 80's and 90's, the expectation for the time it takes to come to 100% use of BIM is that this will be twice as quick. This is illustrated in Figure I.

Methodology

The main goal of the research was to give owners of small architecture firms a guideline on which they can base their discussions concerning BIM implementation. To come to this goal, a minor goal had to be reached first: exploring the current state of BIM use within the research group.

The research was done in three parts: an explorative literature study, a survey and interviews. The literature study was carried out using the 'grounded theory' method, followed by the use of 'open coding' and the program atlas.ti. In advance, the results are compared to professional journals, expert's opinions and notes from the field.

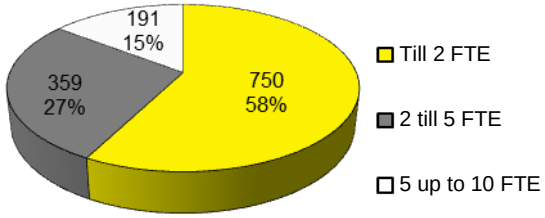

Figure II – Approached architectural firms (n=1300)

The goal of the survey was to get insight in the current state of BIM use and to explore the pros and cons that architects experience or expect. The survey conducted among 1300 BNA firms with a size of 10 FTE or less (see Figure II) using an internet questionnaire. The questions asked were based on the topics of the BIM Maturity Index by Succar (2010) and the BIM Quick Scan of TNO (Sebastian and van Berlo 2010), supplemented with questions regarding pros and cons coming from the literature study. Afterwards, the answers were analyzed using the program SPSS.

After completing the questionnaire, offices could separately apply for the interviews if they felt experienced in using BIM. In consultation with the region managers of BNA, some offices that might be interested were added to the list of which 8 offices were chosen, based on an equal distribution over the size categories. The questions for the interviews were based on the results of the survey and were intended to indicate the motives, barriers, positive and negative experiences with the use of BIM as well as to explore what the interviewees mean by the expression BIM and how they forecast the future BIM application in the AEC industry.

Based on the literature research, the survey and the interviews the state of the BIM use among small architectural firms is reported and an implementation strategy is suggested. Beside, recommendations are made for small architectural firms as well as the BNA as representative of the architects.

Results

The questionnaire was spread among 1300 small BNA-offices. A response rate was reached of 22% (283). The segmentation of the offices, categorized by size class, was consistent with the overall segmentation (Table I).

Firm's size	Response	Total	Percentage of total
Till 2 FTE Percentage of column	147 52%	750 58%	19%
2 till 5 FTE Percentage of column	82 29%	359 27%	22%
5 up to 10 FTE Percentage of column	54 19%	191 15%	28%
Total	283	1300	21%

Table I – Segmentation of respondents

For functional reasons, the respondents to the questionnaire were divided in two categories: A) Firms with more than four BIM-projects delivered or at least two and calling themselves forerunners. B) Firms with less BIM-projects delivered or no BIM experience at all (Figure III). Apart from the general questions specific questions were asked to the groups whether or not they did or didn't start using BIM.

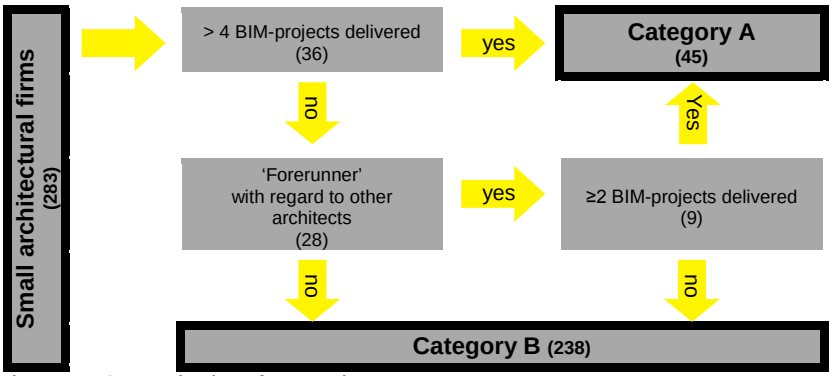

Figure III - Categorization of respondents

The level on which BIM is applied in small architectural firms is low. On a five-point scale, the most BIM-experienced offices only reach the second level, which is quite similar to 'little BIM'. 16% met the requirements for category A and were labeled 'experienced'. Among the other firms, the first steps of BIM implementation were made as well. Figure IV and Table II show that the use of BIM-compatible software as well as the use of BIM modeling methods is present in the less experienced group. This level of uptake of BIM is encouraging for future development.

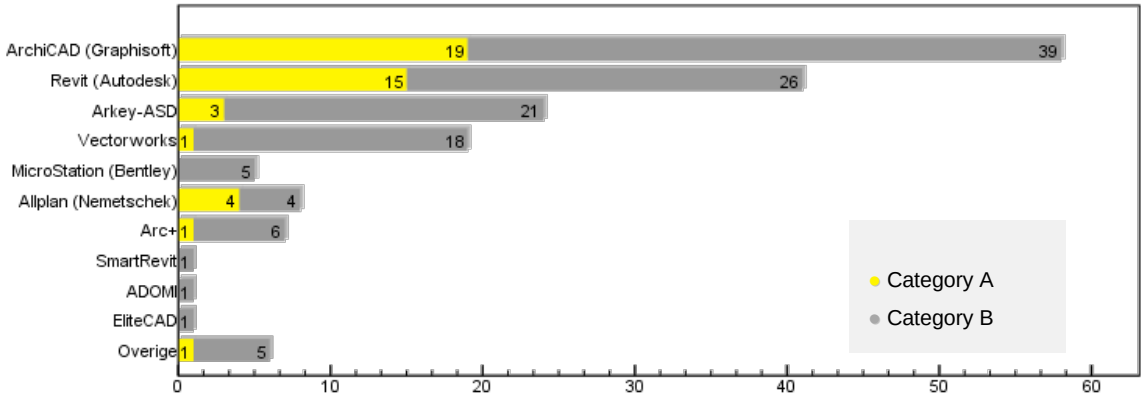

Figure IV – Number of firms using BIM compatible software

		Category		
		A	B	Total
What is the most used way of drawing/modeling within your firm?	Full 2D	0	48	48
	CAD with visualizations in 3D	2	93	95
	Both 2D CAD and object based 3D	14	62	76
	Full object based 3D	29	35	64
	Total	45	238	283

Table II – Crosstab way of modeling by category

Collaboration using BIM by small architectural firms is underdeveloped, it only occurs incidentally and in most occasions parties aim at data exchange within the same software family. Most interviewees point out their future expectation that BIM methodology is about collaboration, but none has reached this level yet. Some interviewees don't even describe their current approach as 'BIM', they call it 3D-modeling and plan to upgrade their level to BIM in the future.

Expectations of the phases in which BIM could be used are different. The ideal outline of BIM methodology shows a model that is enriched over time and therefore the use of BIM will grow during the lifecycle of the project, continuing in the operational phase. Knowing that the fully integrated design process occurs very little among small architecture firms, one can assume that use of BIM is concentrated around the Preliminary and Definitive Design phases. The experience of enquired firms confirms this point of view. However, the questionnaire shows a lot more use of BIM in the early and later stages of the projects these BIM experienced architectural firms were part of. 62% reports BIM-use in the Construction Phase and even in the early phases more than 50% of the firms apply BIM.

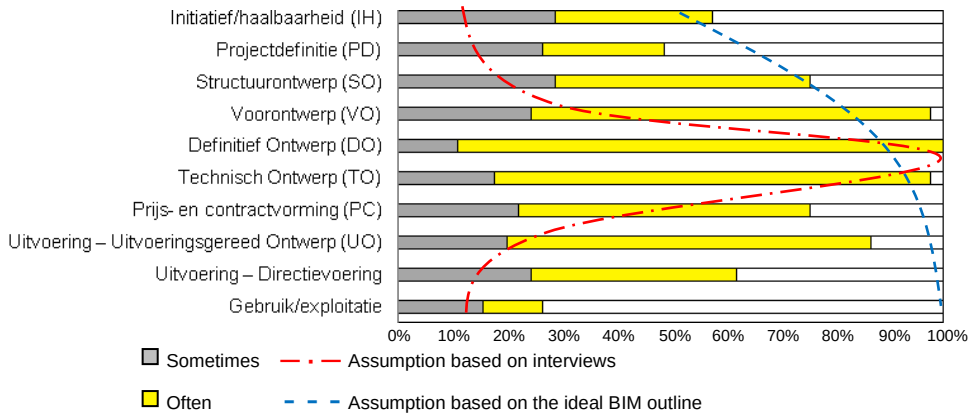

Figure V – Extend of application of BIM by experienced, small architectural firms (45)

The results that small architecture firms achieve by using BIM are positive and – even with the low maturity and integration level – the use of BIM is profitable for all interviewed firms. The often mentioned barriers are similar to the motives for implementing BIM: time and costs. The investment of both is a barrier, while experienced firms took cost and time reductions as a motive. The researched firms agree with the barriers, but are clear that implementing BIM is worth its investments.

Clients of small architecture firms differ much in size and typology. Private clients have a large share in numbers, but small architectural firms work for professional clients with mostly bigger projects as well. Architectural firms that do not use BIM see a lack of interest among their clients as a barrier. Experienced firms endorse the lack of familiarity with BIM under clients; however they do not experience this as a barrier. After having experienced the use of BIM, clients are positive and willing to aim at BIM use in following projects. Clients have to be informed about the shift in design methods, the time consuming early phases and the overall reduction of time used. To convince the client to fully cooperate is a challenge, but a solid foundation leads to understanding of the client.

Setbacks that occurred when implementing BIM were concentrated around costs and software. The large investment costs are experienced as drawback, but interviewees immediately compensated these drawbacks with the above mentioned benefits. Architects describe the problems with software as part of the development stage in which BIM-software is at this moment. Big investments in software applications, object libraries and hardware have to be under serious consideration. With that the gains of increasing productivity have to be taken into account.

The most important step in the implementation of BIM is the convinced choice to start using BIM. The organizational structure of the office is important to mention since the strategy for a flat organization is different from a hierarchical structure. Encouraging employees in an early stage and involving them in the process shows good results. Cooperation with other parties with experience in the field of BIM happens only by coincidence, but can be a real catalyst for the implementation. Also clients willing to start working with BIM are supporting the implementation process.

The choice which software and hardware to apply is part of the implementation process and should be well considered. The researched firms had different reasons for their choice: experience with a certain software developer, compatibility with the operating system used, the aim for open standards and refusal to work with the big software parties.

Another important part of implementation is training. The researched firms report good experiences with a basic course, followed by training in real projects. Following Deutsch (2011), this gives much better results than training on pilot projects. A side effect of this approach is that these real projects bring in money and therefore keep down the lid on costs. Exchange of knowledge between experienced engineers and younger employees with less experience but more modeling skills has to be a focus point.

Legal issues concerning contracts, intellectual property and the responsibility for the coordination of the model are known (Chao-Duivis 2009). These issues are also part of the experience of the small architecture firms. Interviewees also report other issues concerning questions about sharing information with other parties in the process; regarding the difference in opinions at this point, this can be seen as specific per firm and related to the firm's culture.

Conclusions

The main finding of this research is that the application of BIM is profitable for small architecture firms, even with the relatively low maturity level reached. At the moment, the use of BIM by small architectural firms is mainly limited to internal processes because of low experience of the architectural firms itself, their clients and other parties in AEC industry they work with. These first steps in the implementation process of BIM should be taken to be prepared for future developments.

The opportunities, advantages, disadvantages and barriers that emerge from this study are consistent with the results of research in a wider field of larger architectural firms and other parties within the AEC industry. Therefore the assumption is made that the results of this study are applicable to larger architectural firms as well and, conversely, results from research in this wider field have a strong relationship with the situation for small architectural firms in the Netherlands.

Recommendations

The above mentioned first steps of small architectural firms are important to prepare the architects for further evolution of the BIM-process in the Netherlands. To bring the use of BIM in the AEC industry in the Netherlands to a higher level, an industry wide approach is needed. This approach should consist of two elements: introduction of a new role, the BIM-manager and centralized coordination.

BIM goes beyond the responsibilities of de different parties and reaches the whole lifecycle of the building, in what most parties are only passing by; new tasks have to be defined to fully reap the benefits of BIM application during the whole lifecycle. For legal transparency, a clear reward for services rendered as well as for integration within the project team, a new role should be introduced and laid down in rules. The introduction of this new specification gives an opportunity for this role to be continued from the design phase, through the construction phase and the operational phase. Construction can be supported and consistent as-built data can be saved, adapted and used during the lifecycle of the building.

The new role can be carried out by current parties of the AEC industry or by new independent BIM consultancy firms. This is similar to the task of project manager that was separated from the responsibilities of the architect in the past. The architect has had overall coordination in the past and most architects still aspire to do so; the architect is the most natural party to take up this task since knowledge about the whole building is his main task. The way this task should be implemented in the firm's organization depends on the typology and the size of the firm and needs more research. Architectural firms that act as BIM manager of a building project will in that role be associated throughout the whole lifecycle of the building and therefore have the opportunity to be involved in new design assignments in the future.

An open approach to collaboration in building projects is needed to gain all the benefits. Some parties in the process are reserved to share information with others. The risk to lose control or to be held responsible for other's mistakes is one of the reasons for this restraint. For confidential (i.e. governmental) buildings, adequate rules and regulations are lacking. These rules and regulations should be drawn up in cooperation with all parties involved in the building process. The BNA is the most natural party to represent the architectural firms in this process.

Recommendations for architectural firms per type

Van Apeldoorn (2011) combined the three typologies of Coxe et al. (1987) with the applicable organizational structures that Mintzberg (2001) described. Architectural firms in the Netherlands can determine their position using the framework shown in Figure VI.

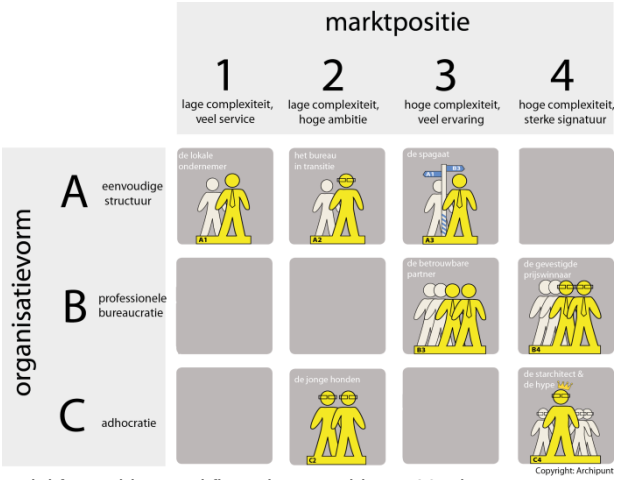

Figure VI – Position model for architectural firms (van Apeldoorn 2011)

Based on the descriptions of these typologies, a SWOT-analysis of the implementation of BIM was conducted. Table III shows all described types with their strengths, weaknesses, opportunities and threats concerning the implementation of BIM.

			Description	+ Strength	− Weakness	+ Opportunity	− Threat
Simple structure	A1.	De lokale ondernemer 	*Local entrepreneur* Small firm in a stable environment, local and regional. Leader is architect and manager. Both new and established firms. Mostly specialized.	• Direct coordination • Specialization • Emphasis on efficiency and entrepreneurship	• Difficulty with complex projects	• Cooperation to make a more complete offer • Small-scale supply chain integration • Fixed clients	• Little investment possibilities
	A2.	Het bureau in transitie 	*Firm in transition* Small firms in a dynamic, hostile environment. Regional. Top-down decision-making. High ambition. Shifting: growing or shrinking.	• Direct coordination • High ambition	• Variable client database	• Strengthen competitiveness • Fit in BIM in ongoing transition	• Attention needed for ongoing transition • Lack of support coming from top-down decision-making.
	A3.	De spagaat 	*The splits* Shrinkage causes a lack of capacity opposite to the high ambition and knowledge. Instable. Sometimes the reverse: a small, specialized firm suddenly gets nationwide demand.	• Experience with complex projects • Large clients	• Little regular clients	• Meet firm shrinkage by BIM • Collaboration through BIM when hiring specialists for missing disciplines.	• Too complex projects as first BIM-project. • Lack of support among employees
Professional bureaucracy	B3.	De betrouwbare partner 	*The reliable partner* Emphasis on a reliable process, functionality and a satisfying product. Clear process and quality guidelines. Different specializations within the firm.	• Emphasis on process • Emphasis on a sound product • Stable environment • Clear guidelines	• Larger firm	• Improve advise to the client by BIM • Meet BIM-requirements of architect selections	• Variety of employees
	B4.	De gevestigde prijswinnaar 	*The established prizewinner* One central, charismatic leader. Clear guidelines and marked roles. Emphasis on architectonic quality and iconic value. Risky projects. International operating.	• Clear guidelines	• One overall leader • Possibility for projects/competitions to stop	• International collaboration	• Difficulty with complexity of the designs in BIM • Clients aim at the signature, not at the process
Adhocracy	C2.	De jonge honden 	*Young boys* Young, small firm. Little formal behavior, high educational level. Innovative entrepreneurship with high ambition opening new horizons.	• Small firm • High ambition • Direct coordination • Decision-making on all levels	• Low standardization level • Small network	• Select partners on BIM-quality • Characterize the firm using BIM	• Little investment possibilities
	C4.	De starchitect & de hype 	*The starchitect & the hype* Strong name and an individual 'star-architect' being the charismatic leader. Specialized employees, small projectteams. Strong signature, risky projects.	• Investment possibilities	• Possibility for projects/competitions to stop • Large turnover of staff	• Young ambitious employees • International collaboration	• Variety of employees • Decision-making in different project teams

Table III - SWOT-analysis of architectural firms concerning BIM implementation
Copyright icons: Archipunt (van Apeldoorn 2011)

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