Potentials and Barriers for Implementing BIM in the German AEC Market

Results of a current market analysis

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Abstract. *The research project „BIM – Potentials and Barriers" aims to analyse the existing practice concerning BIM and the barriers for the implementation of this approach in Germany. Accompanied by an ‚advisory board' with nameable representatives from practice, the public authorities and AEC associations, a set of hypotheses has been elaborated that could be evaluated by a detailed survey. Based on the detection of relevant stakeholders, the survey first tries to disclose the real situation of how BIM is currently used in practice. Furthermore the potentials of the application of BIM in the different processes and target groups are determined as well as the barriers and constraints. Thereby the enhancement of the considered thematic areas is an important solution approach of the project: besides technological aspects, the analysis is also focusing on contracting, norms and processes as well as education, knowledge and role perception.*
Keywords. *BIM; survey; collaborative engineering; virtual engineering; product modelling.*

MOTIVATION

Despite of approaches made toward enhancing efficiency, the construction sector has not been able to improve productivity effectively.

An American study of the National Institute of Building Science (see figure 1) compares the productivity of the construction sector with other industrial sectors and attests an even negative development within the last 40 years. This indicates the necessity for the application of innovative means and methods (Teicholz, 2004).

The implementation of the BIM method in Germany is still at very early stages. In comparison to the USA and the Nordic European countries, the German AEC sector still doesn't internalise the potentials of this method and technology. Although the software vendors are already offering BIM solutions adapted to the German processes (like the German-standard-complient quantity takeoff), with exception of a few general contractors and pilot projects of the public authorities, their worth generating application is still missing.

It seems that the fine granular organisational structure of the German AEC market is one of the facts that obstruct the integrated adaption of the

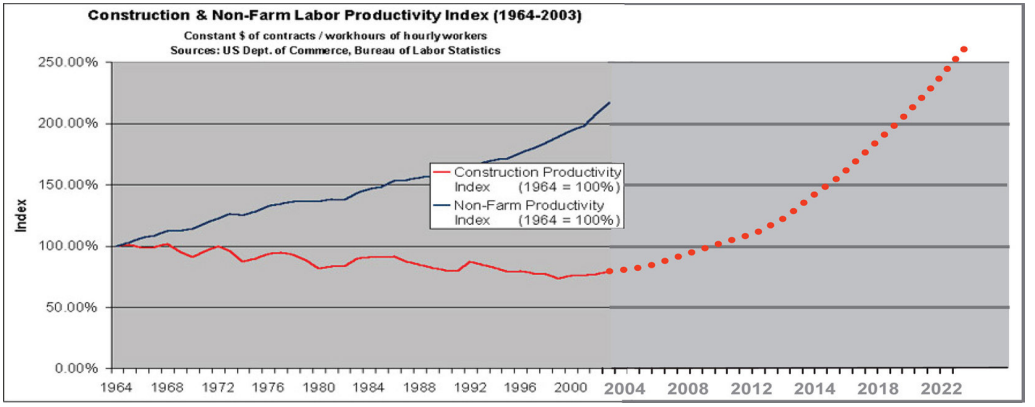


Figure 1
Labor productivity index for US construction industry and all non-farm industries from 1964 through 2003, National Institute of Building Science (NIBS) 2007.

BIM method. Besides a strong functional segmentation of the processes in separate companies, also the size of the companies involved are critical for generating a global added value: over 92 percent of the construction companies are smaller than 20 persons (German Federal Statistical Office, 2010) and the average size of architects and engineers offices is between three and five employees (Hommerich and Ebers, 2006).

In this context, special attention has to be paid to the bad economic situation of architects and other planers in Germany: only about 50% of the architects and engineers are calculating their project oriented work and about 30% of the design offices generate not more than 15.000 € profit per year (Hommerich and Ebers, 2006).

Concerning their working methods they mostly adhere to antiquated principles of operation. They do not exploit the benefits of their bought software in the slightest – even modern model-based CAD-Systems are used as a pure "digital 2D drawing board". Thus, a possible added value by a high density and quality of information in the planning and the following lifecycle phases is not exploited.

The elaboration of a specific action plan to ameliorate this situation seems difficult because reliable analyses concerning the state of the application of BIM in Germany are still missing.

METHODICAL APPROACH

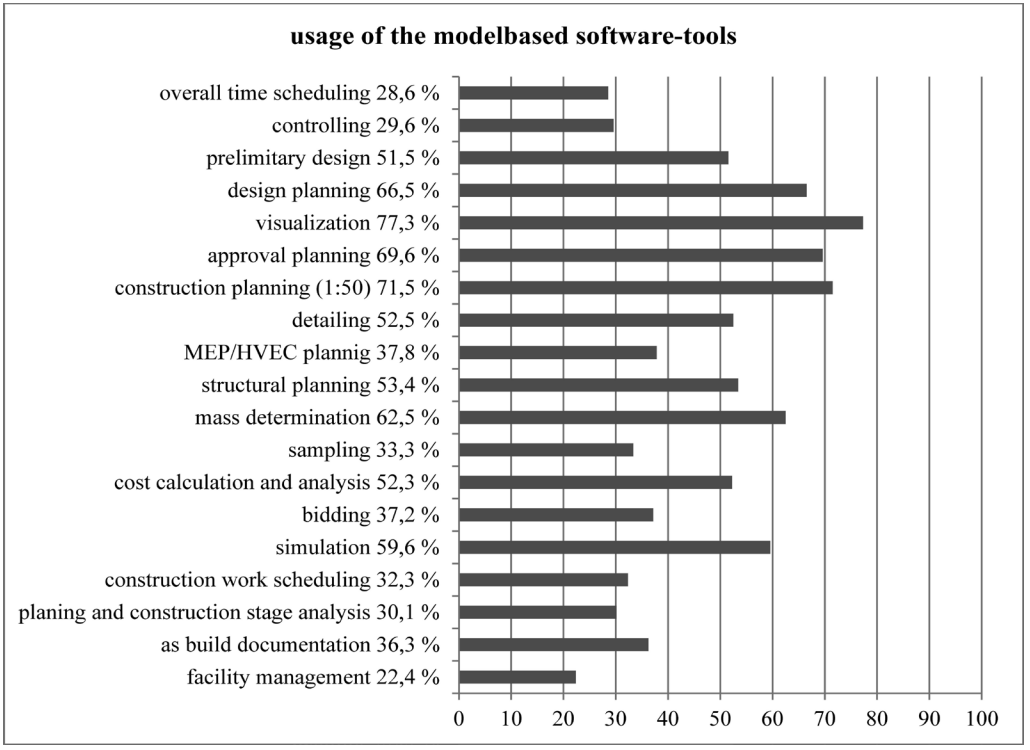
The research project „BIM – Potentials and Barriers" that started in May 2010 aims to analyse the existing practice concerning BIM and the existing barriers for the penetration of this approach.

Accompanied by an `advisory board' with nameable representatives from practice, the public authorities, AEC associations and the buildingSMART initiative, a set of hypotheses has been elaborated that could be evaluated by a online survey.

The enhancement of the considered thematic areas is an important solution approach of the project: beside technological aspects, the analysis is also focusing on contracting, norms and processes.

Speaking of the generation of added value, the current discussion doesn't make a difference between the project context and the company context – but one of the problems of the missing success of BIM seems to be the disparity between the ones who generate the value and the ones who earn the value in later lifecycle phases. Thus, especially in the first project phases, where in the most cases the architect models the first building representation and builds the structural base for the whole BIM life cycle, there is a gap between the created value for the project and the direct company-internal benefit for the architect's office – investing more effort than normally demanded in projects.

Figure 2
Usage of model-based software tools in different AEC processes.



Also the assurance of the model quality and its integration in the contract management has been considered. There is still no answer concerning a reliable specification with quality criteria for BIM models that can serve as a mandatory guideline.

Related to the hypotheses outlined above a questionnaire including four parts has been elaborated. First a classification of the participants allows disclosing their functions, their roles in the project, the size of their company, the size of the project volume and so on. Here different target groups are associated to the specific questions addressed: Planners and designer, construction firms, investors/ building owner and facilities managers as well as the public authorities.

Then the survey tries to disclose the real current situation of how BIM is currently used in the German AEC market. Here the different applied levels of the 'BIM evolution' are detected – from 2D drawing to pure geometric 3D modelling up to object oriented modelling. Then the integration of process data (4D) as well as cost and quantity information (5D) is conducted. By asking for specific processes and activities a detailed overview can be expected.

After the state of the art, the potentials of the application of BIM in the different processes and target groups are analysed: The expectation of the inexperienced people as well as the experiences of the ones already using BIM. Here the survey tries to collect estimations of the possible (future) benefit and the willingness of implementing BIM in the companies.

Besides the potentials, the survey also tries to highlight the barriers and constraints of the BIM

approach – on technological and also on organisational level.

RESULTS OF THE SURVEY

The following chapter describes several of the most noticeable results.

Participants and target groups

The survey was addressed to planners, construction companies, investors and project developers, facility managers as well as the public sector. Contacting these target groups was accomplished with the help of the respective German confederations and associations. It also has been possible to use information channels of the AEC software vendors to communicate the survey. Thus a high response could be realized.

The main part of the participants are planners (architects and engineers: 57%), followed by building owners (21%) and construction companies (11%).

Status quo

As the survey showed, the general level of the application of the BIM method is already quite high. However, BIM is only one method among others and is applied as explusive strategie only in the exceptional case. So on average two to three different methods are applied in projects or companies in parallel. Here it showed that still up to date 2D Planning is used the most.

Especially planners are still using their sophisticated software in more than 60% of their overall usage for pure 2D Planning - construction companies even more than 70%. Thus, it seems interesting to disclose in which processes the model-based method is applied how much. The following diagram shows the intensity of BIM usage in different AEC processes:

Especially in the early design phases BIM is already a favourite method. So it is used for visualisation over 77% and for design planning over 66%. In the following processes like detailing (52%) sampling (33%) preparation for awarding (37%) and construction work scheduling the frequency recedes. Astonishing is the very low usage of the model-based method in the area of facilities management (22,4%).

Also concerning the exchange of data a similar picture can be drawn: the dominating exchange formats, independent of the target group, are still paper, PDF and DWG. Model-based formats are used - also by BIM-users – very rarely yet. This can be seen as an indicator for missing model-based working cooperation partners and also unsufficient technical interfaces.

Relating to the projects size, the use of BIM rises especially in projects over 2 million €. A similar correlation exists concerning the size of the enterprise: in enterprises up to 10 employees more than average Non-BIM-users are represented. On the contrary, BIM-users mostly work in medium sized enterprises from 3 up to 300 employees. Companies over 300 employees are more than average not using BIM at the moment but are willing to do it in the nearer future.

Also the question of how the switch toward BIM has been analysed by the participants. It is noticeable that in most of the cases these changes have been made individually for each project and not for the whole company. That shows that on the one hand side the motivation for the change often comes from the project partners and that a project based change minimises the risk as well as the required educated people.

The thematic widening of the survey towards economic topics allowed the detection of very interesting correlations: BIM is currently used especially by stakeholders who attach great importance to an efficient corporate management. The biggest correlation could be disclosed concerning quality management, project management as well as process orientation. Thus, 34% of the BIM-users are DIN-ISO 9001 certified but only 9% of the Non-BIM-users.

Also regarding to project manuals resp. project protocols with defined standards, processes and responsibilities the BIM-users have the highest application with 47%. The usage of webbased collabo-

ration plattforms by BIM-users is also twice as high (42%) as by Non-BIM-users.

Concerning process orientation, the construction firms operate highly process oriented. The feedback from the public sector and the planners – especially the architects - points to an only marginal process orientation of these groups. The specification of decission processes, tasks and responsibilities seems also to be a unique feature of the BIM-users.

Experience and benefit by the BIM Method

In summary, all target groups declared an increased benefit by the BIM method (see figure 3). Three groups attract attention here: on the one hand side investors and building owner have the most benefit over all aspects, on the other hand side the public sector and the building services engineers have the lowest named benefit.

A detailed query provided feedback to different aspects: in the area of resource management for the project and effort for coordination among the pro-

Figure 3
Assessment of the benefits of the BIM method for experienced user groups.

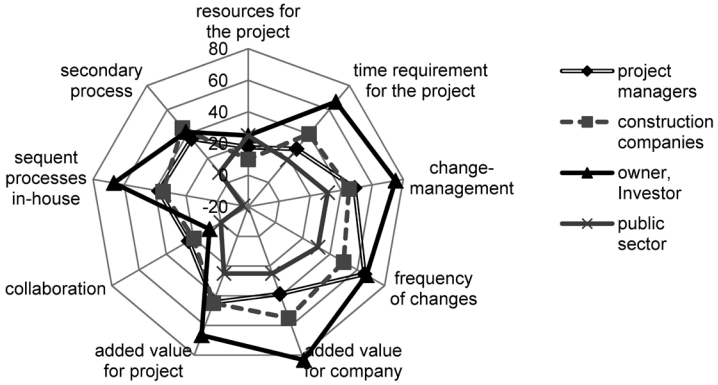
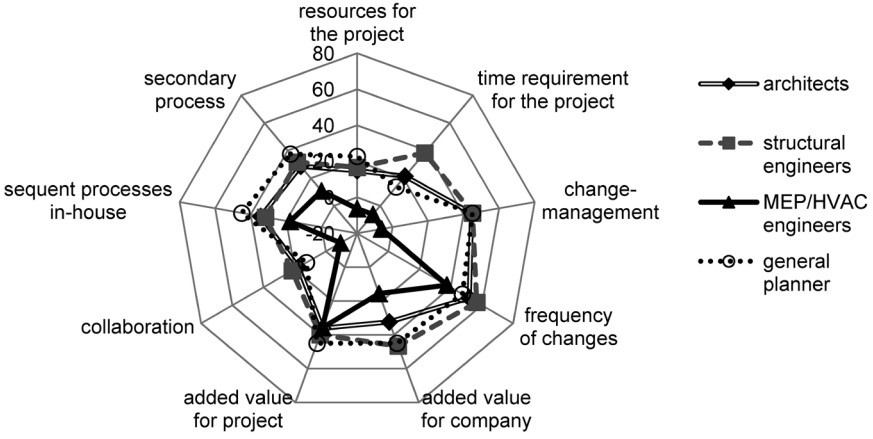


Figure 4
Assessment of the benefits of the BIM method for experienced users (planners).



ject partners only marginal benefits could be made in all target groups.

In the public sector the effort for coordination has not changed, whereas the support of internal sequent processes on average has declined. The building service engineers even state an increased effort for change management in the project whereas the benefit by the reduction of multiple entries could be improved.

The resource allocation for the project as well as the expenditure of time have almost remained on the same level with a tendency to the negative. But despite the neutral to slightly negative assessment in these areas, the company's internal added value as well as the project oriented added value could in average be enhanced.

In the other target groups (project manager, controller, architects, structural engineers and construction companies) the enhancements lie in similar dimensions (see fig. 4). Only the architects and general contractors remark fewer benefits in the expenditure of time for the project.

Technological barriers for the implementation of BIM

By the evaluation of the hypotheses concerning the technological aspects remarkable differences became obvious: BIM-user and Non-BIM-user differ about the questions regarding hardware requirements and the complexity of model-based software. Whereas BIM-user described the hardware requirements as not problematical, this point seems to be a barrier for Non-BIM-user. Similar the statements concerning the complexity of BIM software differ: The Non-BIM-user agreed on the thesis 'the complexity of BIM software is too high', whereas the experienced BIM-user couldn't see that as a problem.

Interestingly there is an analogy in the agreement of the statement that model-based BIM software has functional limitations. Especially the topic interoperability seems to be one of the main problems. While BIM-user assessed the effort for importing data into the model-based software as medial problematic, this point seems to be a high barrier for the Non-BIM-user (see fig.5).

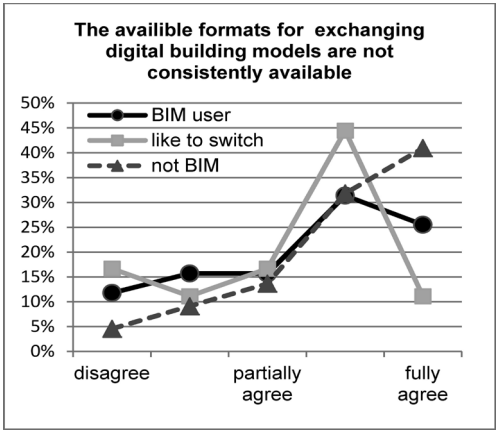


Figure 5
Agreement to the thesis 'the existing exchange formats for digital building models are not consistently available.

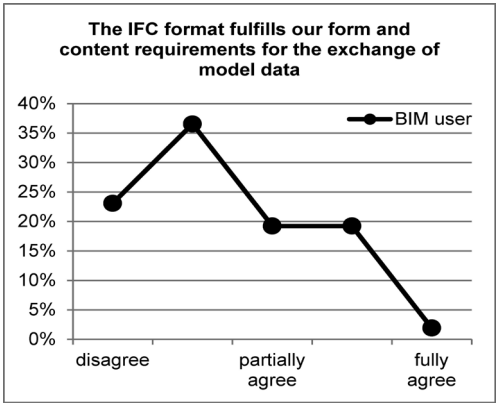


Figure 6
Assessment of the capability of the IFC format.

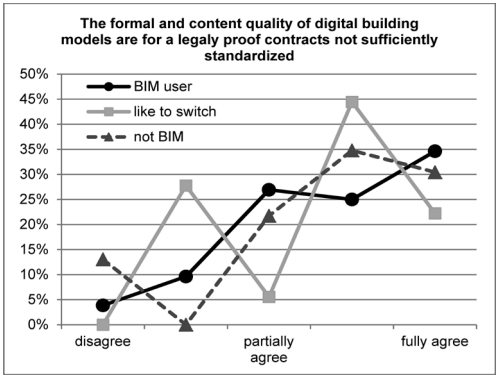


Figure 7. Agreement to the statement that the quality of digital building models in form and content is not adequate standardised yet

Asked about the data exchange standards, all groups agreed in the statement that the existing exchange formats for digital building models are not continuously usable. Especially the IFC format respectively its implementation in the software interfaces still cannot fulfil the requirements of the target groups (see figure 6).

Economic barriers

A high barrier for the Non-BIM-users seems to be the available capital for investment. For the actors already using BIM software the financial aspect is not a barrier or problem. The Non-BIM-users agreed indeed in not having enough financial resources for BIM related investments.

Also as a general barrier the phase-oriented award of contracts has been detected. Thereby the involved actors are not able to enhance their added value as it would be possible by a phase overarching integrated work. On the other hand side the model-based method is not being applied continuously.

Normative barriers

Standardisation is an important auxiliary mean for a simplified and secure contracting: By referring to normative descriptions contracts can be concluded very efficiently and securely between client and planner respectively contractor as well as among the planers themselves. This becomes very important when the contract partners – like in Germany – are composed newly for each project.

Applying the BIM method, the project partners are exchanging models, not blueprints or drawings. This allows an integrated process without media interruption. Especially in cases of model changes it is beneficial to extract the data directly out of the model. This demands a consistent model but also clearly specified exchange parameter and quality criteria. But how does it look in practice? The participants of the survey highly agreed (65%) to the statement that the quality of digital building models in form and content is not adequate standardised yet (see fig. 7).

Educational barriers

The abilities of entrants in the BIM relevant areas – only with exception of the qualification in CAD - are rated collectively as under average and not sufficient.

Especially the constant negative assessments – by Non-BIM-users as well as BIM-users – of the methodical abilities, inter- and transdisciplinary thinking, process orientation and the comprehension of superordinated interdependencies and also business economics can bee seen as indicators for an urgent need for action.

A concluding and detailed statement of the educational situation in Germany is surely outside the scope of this project. Hence, the questions on educational barriers discussed in this survey rather serve to complete the holistic examination of the general situation and to identify possible arrestive factors for the impelementation of BIM.

CONCLUSIONS

In summary the project discloses a strong correlation between an efficient and structured corporate management and the application of BIM.

The survey also shows that in general noticeable benefits can be reached by implementing the BIM method - but not as high as communicated by BIM lobbyists as buildingSMART or the BIM software vendors. But interestingly it became obvious that BIM does not seem to be able to increase the benefits concerning the cooperation among the different project partners in the existing German process structures considerably. Presently the BIM method is applied mostly to increase in-house-efficiency – not collaborative company superordinated processes. Here seems to be an important future sphere of activity.

An improvement of the situation is only possible by eliminating the detected barriers: On technical level this means better technical interfaces, especially the implementation of the neutral IFC-Standard has been rated as not supported sufficiently. A general economic challenge in Germany is also the amelioration of the economic situation of planners. Here

a commission of German AEC organisations is currently working on new concepts for fee structures.

The BIM method also demands changes in the existing conceptions of roles in the AEC processes – here new services and role models are to be elaborated and evaluated. An important part has to be played by the universities and AEC associations with new concepts of education and training – here the target should not only focus on a technical level but integrate technological and methodical aspects – especially to enhance the understanding of economic issues. Also there is a deficiency in reliable samples of contracts for BIM related services and processes, especially to assure a sufficient quality and content of BIM models.

The conspicuous differences in the assessment of the BIM barriers between BIM-users and Non-BIM-users shows the high necessity of education and information by AEC associations and chambers.

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