BIM QUICKSCAN: BENCHMARK OF BIM PERFORMANCE IN THE NETHERLANDS

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ABSTRACT

In 2009 a "BIM QuickScan" for benchmarking BIM performance was created in the Netherlands (Sebastian, Berlo 2010). This instrument aims to provide insight into the current BIM performance of a company. The benchmarking instrument combines quantitative and qualitative assessments of the 'hard' and 'soft' aspects of BIM. The use of this instrument by BIM consultants in the Netherlands has taken place since early 2010. Since then, 130 scans were done within companies in different sectors that use BIM. 682 self-scans were also completed on the website. All the data of the scans, and the results were stored in a database.

The overall conclusion that is drawn from the data is that the average level of BIM in The Netherlands is fairly high. On an organizational level, as well as in the mentality and culture of companies, a high BIM level is reached. However, the BIM level in the chapter *Tools and applications* falls behind in comparison to the maximum potential.

In order to facilitate the release of the full potential of BIM in The Netherlands, further research needs to be conducted. The BIM QuickScan will continue to be used in the future in order to monitor the state of art of BIM in The Netherlands.

Keywords: BIM, benchmark, QuickScan, process analyses, level, maturity

1. INTRODUCTION

In 2009 the "BIM QuickScan" was created in the Netherlands (Sebastian, Berlo 2010). It consists of an online questionnaire with almost 50 questions in 4 chapters (also called 'categories'): *Organisation and Management; Mentality and Culture; Information structure and Information flow; Tools and Applications*. All questions are multiple choice. After filling out the complete questionnaire, the respondents receive a result that states their level of BIM. Depending on the given answers more or less points can be earned. Not all questions influence the final result in the same amount. Some questions are purely for benchmarking purposes and do not influence the resulting BIM level at all. Examples of this type of questions are '*What is your core-business?*' and '*What software do you use?*'.

Goal of the BIM QuickScan is to give insight into the strengths (and thereby also the 'weaknesses') of the company regarding BIM aspects.

2. DATA SOURCES

In this research, data is collected in two fundamentally different ways. One set of data is collected by certified consultants. We refer to this dataset as 'the QuickScan'. Another set of data is collected and stored in a database by inviting a large number of companies to fill out an online survey on the perceived situation in their company. This is called 'the self-scan'.

2.1 Certified consultants data

After development of the 'BIM QuickScan' a number of BIM consultants were instructed in the proper use of the instrument. After having successfully passed an exam on BIM knowledge in general and the use of the instrument, they were certified to use the official BIM QuickScan. They received a special login to the online BIM QuickScan system and where allowed to charge the company for their services (with an imposed maximum). In a period of 15 months, from November 2010 to June 2012, a total of 130 BIM QuickScans were performed by 13 certified consultants.

The report produced from a QuickScan performed by a certified consultant gives a complete overview of the BIM level in the company. The consultant knows, from the instruction, how to interpret the results of the BIM QuickScan and can give advice on future improvements of the company's BIM level. The report from a QuickScan taken by a certified consultants is much more comprehensive than a report from the self-scan.

2.2 Self-scan data

The self-scan is an online survey that is freely available (TNO, 2010). The questions are the same as the questions in the instrument used by certified consultants. In a period of 25 months, from May 2010 to May 2012, a total of 682 self-scans were completed and the results were stored in a database. The algorithm that calculated the result is the same as the official QuickScan. The presented results from the self-scan were less extensive, only showing one graph of results per chapter. The goal of the self-scan is to show users that the term BIM is more than they expect. It should convince them to think broader about BIM and take a scan from a certified consultant.

2.3 Output structure

The output of the QuickScans is structured in two different ways. The first way of structuring the output, is by using the four chapters or categories: *Organisation and Management; Mentality and Culture; Information structure and Information flow; Tools and Applications*. The result per chapter is a score on an open scale. The result of a BIM QuickScan will remain the same in time, but the maximum score may rise in time, since the state of the art of BIM advances. Therefore the potential, or the performance gap to be bridged, can grow larger in time when the BIM level of a certain company remains the same.

The other way of structuring the output is by aspect. All questions in the QuickScan are categorized under at least one aspect. These are not restricted to individual chapters, although some relations between chapters and aspects are unavoidable. The aspects that are distinguished are: *Strategic; Organisation; Resources; Partners; Mentality; Culture; Education; Information flow; Open standards ;Tools*. The score of the aspects is displayed in a radar diagram where each score is displayed as a percentage of the maximum score. This gives an overview of the strong and weak points in the BIM performance of a company.

3. DATA RESULT ANALYSES

The data from both the QuickScans and the self-scans was examined. It was found that in the consultant scan data, some corrupt data was present. 4 out of 134 data sets in the database were identical to 4 other data sets. The only difference was the name of the consultant. In all cases it is suspected that the data was

stored, twice by different employees from the same consultant company. This corrupt data was deleted, the result being that in fact 130 unique QuickScans by 12 certified consultants were performed.

From the cleaned up data, graphs and tables were plotted. Through analysis of these graphs and tables, conclusions on the average BIM level and the BIM level per sector are drawn.

3.1 Data per chapter

On an organizational level, as well as on a level of mentality and culture, the assessed companies score considerably higher than on the operational level [Figure 1a]. Companies appear to lack access to specific tools and applications, or the tools and applications that are present are not used in an optimal way. On the maximum BIM level to be achieved, it is important to note that in the chapter *Information structure and information flow* a score of 5,0 was indicated as the maximum, whereas in the other chapters 4,0 is the maximum score. Sebastian and Berlo [2010] explain that this chapter is considered to be of higher relevance to the BIM level than other chapters. In this paper we won't go into detail about this decision, but it is important to take notice of it while interpreting the graphs and results.

Average BIM level per chapter
from scans (n=130) by certified consultants

	Organisation and Management	Mentality and Culture	Information structure and Information flow	Tools and Applications
Potential	1,85	1,67	3,00	3,25
Level	2,15	2,33	2,00	0,75

Average BIM level per chapter in detail
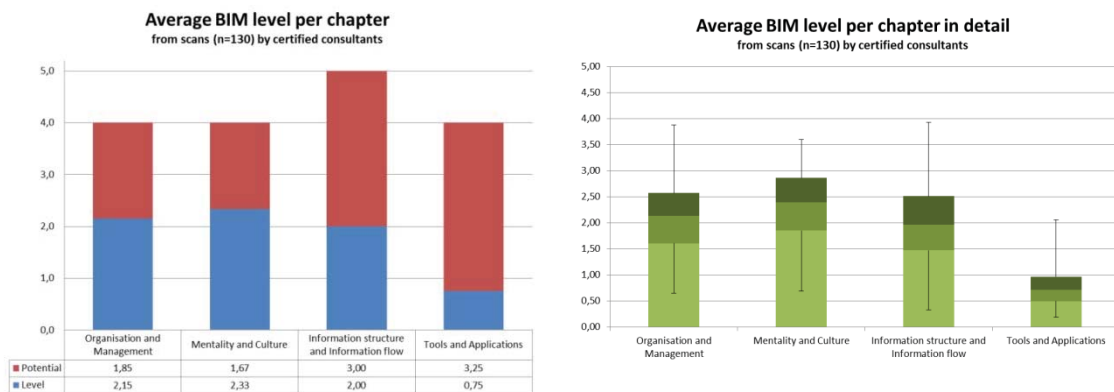from scans (n=130) by certified consultants

Figure 1a+b: BIM level per chapter from scans by certified consultants.

The spread in average results is very high [Figure 1b]. This indicates a wide range of results from the different scans. The different levels of the bars represent the values from the 1st quartile, the median and the 3rd quartile. The lines indicate the minimum and maximum values. Because of this spread, the average score is not applicable as an average score to the industry. The conclusion that has to be drawn is that companies operate on a wide range of BIM levels.

Average BIM level per chapter
from self-scans (n=682)

	Organisation and Management	Mentality and Culture	Information structure and Information flow	Tools and Applications
Potential	1,99	1,66	2,87	2,89
Level	2,01	2,34	2,13	1,11

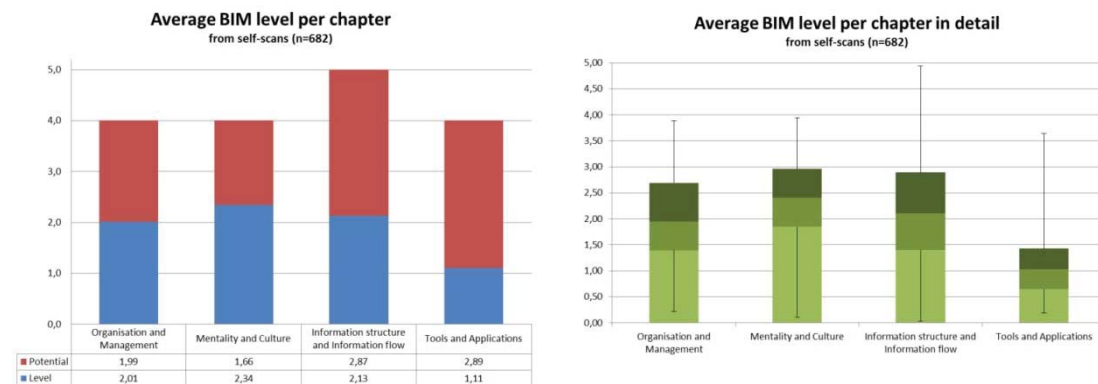**Average BIM level per chapter in detail**
from self-scans (n=682)

Figure 2a+b: BIM level per chapter from scans from self-scans

The same conclusion is drawn from the results from the self-scan [Figure 2]. Although the average result is comparable to the average results from the QuickScan, an even wider range of results is found in this data set. A positive conclusion from this observation is that the QuickScan generates very different

outcome levels based on the input. This makes it a robust tool for actually measuring the BIM level in a company. The fact that the overall average of the self-scans from companies regarding their BIM level appears to be in line with the average from the assessments by certified consultants [Figure 3], is an expected result.
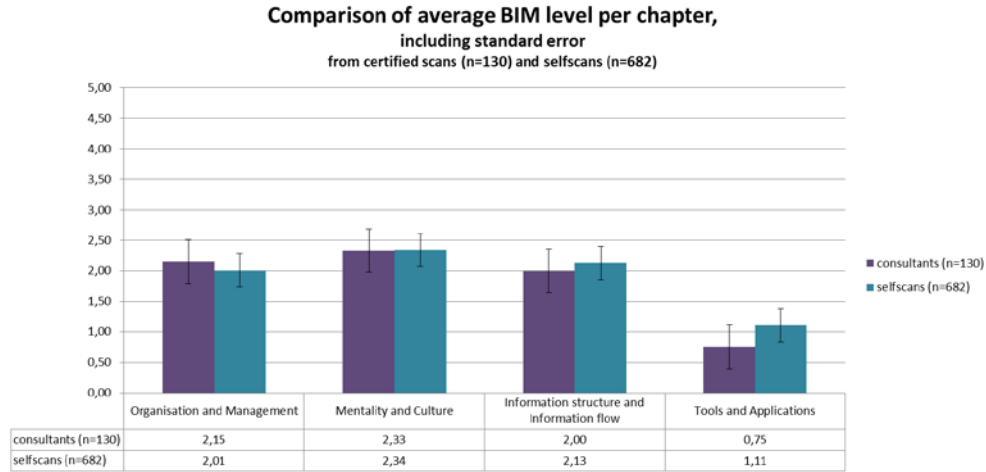

Comparison of average BIM level per chapter,
including standard error
from certified scans (n=130) and selfscans (n=682)

	Organisation and Management	Mentality and Culture	Information structure and Information flow	Tools and Applications
consultants (n=130)	2,15	2,33	2,00	0,75
selfscans (n=682)	2,01	2,34	2,13	1,11

Figure 3: Comparison BIM level per chapter self-scan vs. scan by certified consultant

Experience learns that some questions are too difficult for people that perform the self-scan. They tend to give the answer that seems highest in rating, just because they don't understand the question and want to move on to the next. This behavior might explain the slightly higher average result in the self-scans compared to the scans performed by certified consultants.

Looking more into detail at the results, the data is subdivided into several different sectors in the construction industry. The data from scans by certified consultants is shown in [Table 1] and the data from the self-scans in [Table 2]. For some sectors there is very little data available from scans by certified consultants. At the same time a large amount of companies is categorized in the sector "Other". A further subdivision into sectors, or a clearer instruction on how to categorize certain companies, may be required.

Besides the scores, a ranking of the sectors per chapter is indicated in the table between brackets. And despite the rather small number of scans performed in certain sectors, the ranking of the BIM level per chapter per sector from the self-scans corresponds rather well with the scans performed by certified consultants.

Table 1: BIM level per chapter per sector by certified consultants; score (ranking).

#	Sector	Organisation and Management	Mentality and Culture	Information structure and Information flow	Tools and Applications
56	Architect	2,01 (8)	2,37 (4)	1,81 (7)	0,61 (8)
9	Contractor / Developer	2,22 (4)	2,52 (3)	2,40 (3)	0,82 (6)
8	Builder	2,19 (6)	2,11 (8)	2,22 (4)	0,67 (7)
1	Client / Property Owner	1,41 (9)	2,19 (6)	1,15 (9)	1,56 (1)
13	Supplier	2,05 (7)	2,35 (5)	1,86 (6)	0,86 (4)
5	Construction Engineer	2,88 (1)	2,88 (1)	2,57 (2)	1,00 (3)
2	Fitter - Installer	2,39 (3)	2,08 (9)	1,30 (8)	0,50 (9)
6	MEP Engineer	2,74 (2)	2,63 (2)	2,68 (1)	1,12 (2)
30	Other	2,21 (5)	2,14 (7)	2,09 (5)	0,86 (5)
	Average	**2,15**	**2,33**	**2,00**	**0,75**

Table 2: BIM level per chapter per sector from self-scans; score (ranking).

#	Sector	Organisation and Management	Mentality and Culture	Information structure and Information flow	Tools and Applications
299	Architect	2,10 (3)	2,49 (3)	2,26 (3)	1,11 (4)
144	Contractor / Developer	1,80 (6)	2,06 (6)	1,87 (8)	1,05 (6)
37	Builder	1,99 (5)	2,29 (5)	2,09 (5)	1,25 (2)
13	Client / Property Owner	1,56 (9)	1,80 (9)	1,89 (6)	1,00 (8)
11	Supplier	1,70 (8)	1,94 (8)	1,75 (9)	0,64 (9)
42	Construction Engineer	2,37 (1)	2,71 (1)	2,48 (2)	1,07 (5)
44	Fitter - Installer	1,76 (7)	2,04 (7)	1,87 (7)	1,01 (7)
26	MEP Engineer	2,33 (2)	2,58 (2)	2,51 (1)	1,42 (1)
66	Other	2,05 (4)	2,39 (4)	2,12 (4)	1,21 (3)
	Average	**2,01**	**2,34**	**2,13**	**1,11**

Looking at the graphs, we observe that the results from the self-scans per chapter per sector [Figure 4b] show a more coherent image than the results from the scans by certified consultants [Figure 4a]. This can be ascribed to the low number of scans performed by consultants in certain sectors. It is expected that with more available data, the average result will become more coherent. An indication for this is the fact that the sectors where more data is available from certified consultants give similar results for both types of data collection.
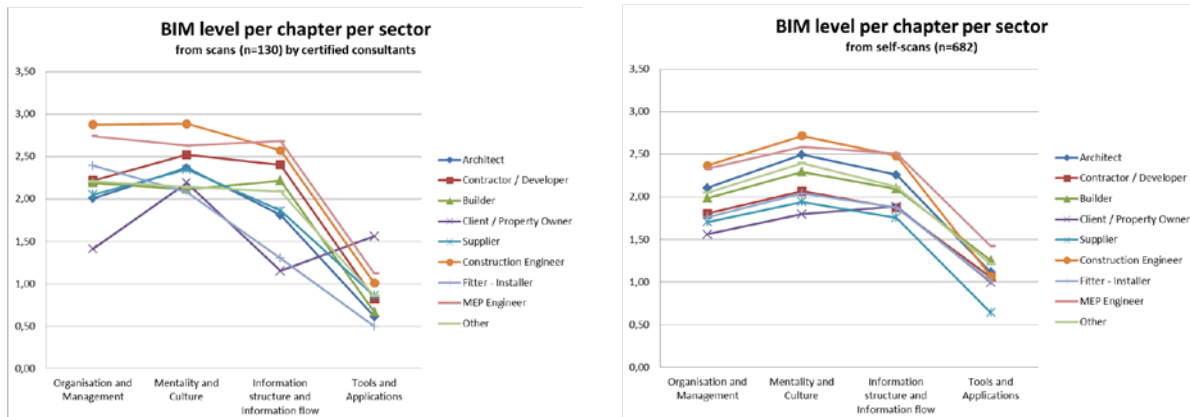

Figure 4a+b: BIM level per chapter per sector from scans by consultants (left: a) and self-scans (right: b)

From the data available, the construction engineer and MEP engineer are on the highest BIM level. This can be explained from the fact that these parties often have a passive role in the collaboration in building teams. Because their influence is limited, they might have been forced to think about effectively using BIM.

3.2 Comparison of certified consultants

Although the BIM QuickScan was never intended to be used to evaluate the certified consultants, it is interesting to plot a graph with the average found result pre chapter from each certified consultant [Figure 5]. There is a clear consensus between most of the consultants' results. This is an indication that they use the QuickScan instrument in a consistent way leaving no possibility for companies to get a higher 'score' by asking another consultant.
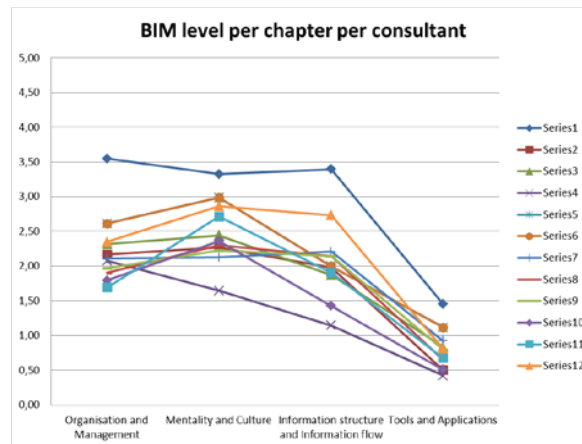
Figure 5: BIM level per chapter per certified consultant (anonymous)

A striking low average found level from the consultant represented as 'series4' can be explained. This consultant is part of a company together with the consultant represented in 'series6'. They distribute their scans between each other, letting the consultant from 'series4' scan companies that just started using BIM, while the consultant represented in 'series6' scans the companies with a longer BIM experience. Leveling out these two consultants puts them right in the middle between the other consultants. Only the consultant represented in 'series1' stands out from the rest of the group. This might indicate that this consultant is striving towards a high result from the scan. Deeper analyses learns that this consultant only scanned 3 companies that had long experience with BIM. More scans have to be taken by this consultant to get a reliable average level.

3.3 Development of results over time

In order to study the development of the average BIM level in time we used the data from the self-scans. The 130 regular QuickScans were not enough to provide a solid indication. The results from the self-scans were grouped chronologically in groups of 100 results. The development of the average results of these groups (per chapter) are displayed in [Figure 6].
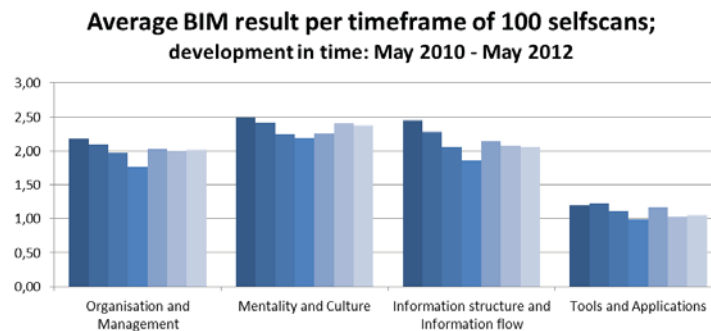

Figure 6: Average BIM level per 100 self-scans; development in time

The overall average result appears to decrease in time until half of the data sets, this is also just about halfway the assessed period. From that moment in time the resulting average BIM level rises again. It looks like the BIM level is decreasing. But we believe this is not necessarily the case. The interesting results may also be caused by the fact that the "leaders" in the field of BIM are also the first companies to perform the self-scan. Since they are keeping a close eye on developments in BIM, they will have heard first about the BIM QuickScan. In time, the "followers" will also have gotten word about the BIM QuickScan, which may explain the decline in the average BIM level. As time progresses and the BIM

QuickScan becomes an accepted tool, this possible division between "leaders" and "followers" is expected to die out. Making future results a more reliable display of the level of BIM in The Netherlands, while providing a more reliable insight into the development in time.

3.4 Data per aspect

Companies that fill out the self-scan only get a result (the bar chart) on the chapters. They don't get results on the 10 aspects because this is, for now, an added value that is exclusive to the certified consultants. Therefore, data about aspects is only available from the scans by certified consultants.

Table 3: BIM level per aspect per sector from scans by certified consultants; result in %.

#	Sector	Strategic	Organisation	Resources	Partners	Mentality	Culture	Education	Information flow	Open standards	Tools
56	Architect	64	40	77	40	56	53	42	44	40	23
9	Contractor/	66	49	73	52	61	60	49	51	46	31
8	Builder	65	47	79	51	52	54	41	49	56	16
1	Client/Property	53	14	60	39	54	57	47	13	33	50
13	Supplier	56	40	70	38	57	57	45	42	37	36
5	Construction	87	46	76	51	71	76	56	54	26	30
2	Fitter - Installer	73	36	73	32	52	49	45	36	20	27
6	MEP Engineer	77	65	81	52	67	69	57	63	48	38
30	Other	69	46	79	45	52	54	45	49	44	30
	Average	**66**	**44**	**77**	**44**	**57**	**56**	**45**	**47**	**41**	**27**

When the BIM level is considered by the various aspects per sector from this data [Table 3], the construction- and MEP engineer are dominant in most aspects. They particularly stand out in the aspects *Strategic, Organisation, Mentality, Culture, Education* and *Information flow* as displayed in the radar graph [Figure b]. There are a number of interesting observations that can be made from these graphs. For instance, the fitter-installer (n=2) falls behind on the aspects *Organisation, Information flow* and *Partners*. However, drawing conclusions from this data is a little premature, due to the limited amount of samples. Another observation is the fact that the construction engineer (as well as fitter-installer) scores very low on *Open standards*. Especially since construction engineer scores (very) high on most other aspects. An explanation for this observation may the very specific nature of the tools and applications used by construction engineers. Builders score highest on the aspect *Open standards*, this may be ascribed to the fact that the builder needs to integrate all the information, often from different software tools, into one integrated view to actually build the building.
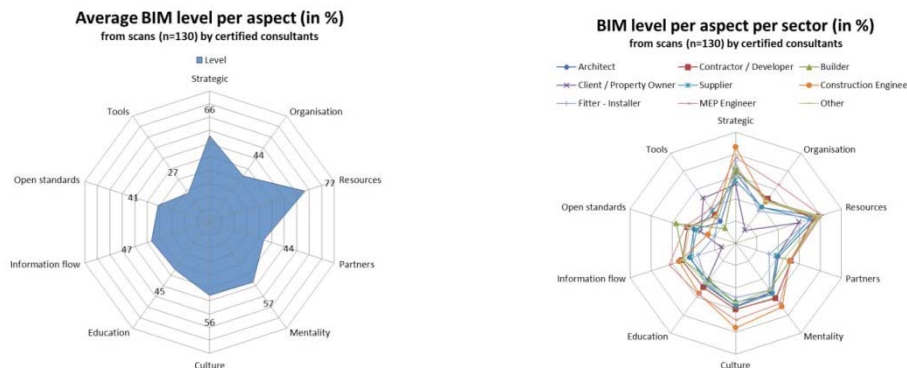

Figure 7a+b: Average BIM level per aspect in % (left: a) and BIM level per aspect per sector (right: b)

3.5 Conclusion

The overall conclusion that we draw from the data is that the average level of BIM in The Netherlands is fairly high. In general, companies in the Dutch construction industry acknowledge the added value of BIM in the building process. This is derived from the high scores the chapters *Organization and Management* and *Mentality and Culture* as well as high scores on the aspects *Strategic* and *Resources*. However, the spread of results is also very high, so the average high level does not apply to all of the companies in the database.

Significant improvement can be made in the field of tools and applications. Without exception, the scores are lowest in this chapter. In order to facilitate the release of the full potential of BIM in The Netherlands, further research will need to be conducted on whether the necessary tools and applications are not known in the market or the available tools and applications are not used effectively.

4. DATA ANSWER ANALYSES

Besides the analyses of the result from the QuickScan, it is also possible to analyse the answers to the questions as they were given. In this analyses we look at the data from the certified consultants, because we cannot guarantee that the given self-scan answers are trustworthy.

4.1 Typical answers

Without performing any deep statistical analyses, it is interesting to look at the different responses that are given to some of the questions. For most questions we have found a quite normal distribution of the responses. For example on the question '*Is the term BIM part of your company's strategy?*' 58% answered '*yes, roughly*', 20% answered '*yes, in detail*' and 22% answered '*no*'. For a BIM QuickScan this is not an unexpected result and most of the questions showed these kind of explainable results.

However, some results were surprising. For example the question '*Is there someone within your company that is responsible for effective and efficient use of BIM?*' 43% of the responses were '*no*', another 44% answered '*yes, but as an extra task on top of his/her normal work*' and only 5% answered '*yes*'. The remaining 8% answered that everybody in the company was responsible for this.

Another surprising result came from the question '*Are quality checks taking place on the BIM model?*'. A staggering 75% answered '*no*', against a 13% '*yes, but not when deadlines come closer*' and 12% '*yes, always*'. This result is in line with the responses on the question '*Do you use rules/rulesets to check to quality of your BIM data*'. On this question 92% answered '*no*'.

Furthermore 55% of the companies stated that none or only a few employers know the disadvantages of BIM (in addition to the advantages). Almost 80% of the employers of the scanned companies are happy to work with BIM. Surprisingly, the information from project partners is never re-used (34%) or only in a limited way (50%); meaning that only 16% of the scanned companies claims to never create redundant BIM data.

The use of BIM was mainly on design (55%), generating 2D drawings (44%), engineering (43%), visualization & animation (41%), construction (22%) and 'other' (22%). These numbers are influenced by the type of companies that had a QuickScan conducted. The large number of architectural firms that were scanned, influences these aspects positively. For the same reason 'Facility Management' (6%) is not popular because only a few property owners have had a QuickScan conducted so far.

A very promising result is that 88% of the respondents sees future BIM potential and is actively pursuing it.

4.2 Relations between answers

It would be interesting to find likelihood ratios between given answers in the BIM QuickScan. When performing a McNemar or Chi-Square test on the data, some interesting associations can be found. For

example in [Figure 8] we find that all companies that use open standards, have thought about what they want to achieve (global and explicit) with BIM (likelihood ratio of 71%).
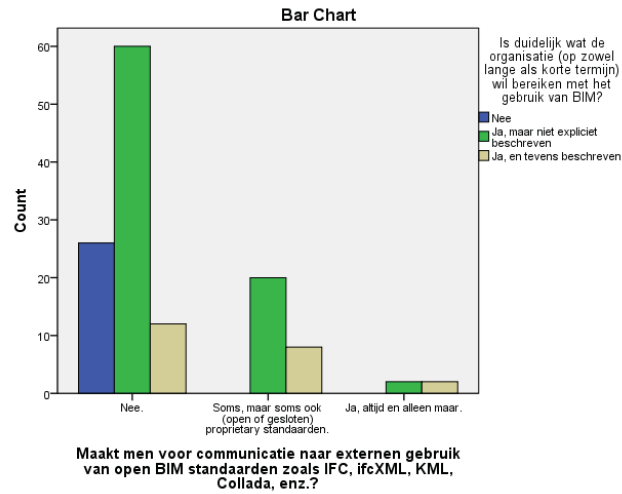

Figure 8: likelihood test between '*do you use open standards?*' and '*do you have a clear goal for BIM?*'

Of course, no causal relation can be stated from this result. It is not known in what direction the association between the two questions is (companies that use open standards thought about their BIM goals, versus companies that thought about their BIM goals use open standards).

Unfortunately the sample size and cell count are too small to perform valid tests. When more data are collected in the future, these kinds of tests may create added value for BIM research and promotion. We also intend to use these analyses to improve the BIM QuickScan instrument. When some questions have a strong relation, these questions could be merged. But if apparent contradictions are found between responses to certain questions, adding a new question could provide more insight into the nature of this ambiguity. Thus resulting in a clearer insight into the difficulties that companies are facing with regard to BIM.

5. CONCLUSIONS

Given the results from this research, it can be concluded that the BIM QuickScan is (a) providing insight in the level of BIM within a company and (b) has proven to be a valid instrument to collect benchmark data on BIM usage. Although it is very difficult to draw firm conclusions from the data, it has provided some new insights described in the previous chapter.

The collected datasets are very diverse, indicating a very wide range of BIM levels from the respondents. A conclusion that might be drawn from this is that companies stating they can 'work with BIM' still have very different definitions about the term.

After this first operational period of the BIM QuickScan, the certified consultants shared their experiences among each other. Anonymously they were very satisfied with the concept of 'scanning' a company before advising them in a follow up. For them the BIM QuickScan was a way to structurally start the conversation. The results generated by the QuickScan always corresponded with their gut feeling (trained by years of BIM consultancy experience).

6. REFLECTION

As described in this paper, the amount of data collected in different sectors in the building industry varies greatly. Prominent results will affect the outcome of the average results increasingly less when more data is collected. This issue emerged in the analysis of the data collected by certified consultants: one

consultant collected extremely high values of BIM performance. This particular consultant collected two out of six data sets for MEP engineers, influencing the average outcome of that sector.

Therefore collection of data will continue in the future. The results from this research should explicitly be considered as a benchmark. It is an impression of BIM performance in The Netherlands. Although the resulting score on the chapter '*Tools and Applications*' is structurally lower that the other chapters, we have to take into account that the algorithm providing this result could be too harsh.

7. FUTURE RESEARCH

Although the self-scan has a different goal than the scan by certified consultants, the writers hoped to draw conclusions from the comparison between the data collected from the two. The average results from the self-scan data and data from certified consultants do not differ significantly [figure 3]. However, because the datasets are very diverse [figures 1b and 2b], no conclusions can be drawn based on average comparison. A reliable conclusion could be drawn by analyzing self-scans from companies that later requested a scan from a certified consultant.

The results of the BIM QuickScan in its current state provide a benchmark for BIM performance in The Netherlands. The aim is to continue the collection of data in the future. In this way, a better insight into the development of BIM performance in The Netherlands can be achieved in the future.

We hope that international BIM research institutes are willing to collaborate in the BIM QuickScan initiative. Making this instrument international, even more insight in BIM usage can be gained. Comparison between the level of BIM in different countries (or regions) would be an interesting addition to the research field.

To stimulate further research on this dataset, we provide a downloadable file. The data is anonymised and in different formats (excel, SPSS, text) available. Feel free to download it on http://www.bimquickscan.nl/data/2012/

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