EXPECTATIONS CONCERNING THE IMPLEMENTATION OF BIG DATA TO SUPPORT THE DEVELOPMENT OF REGULATIONS[1]

Eilif Hjelseth, Oslo and Akershus University College of Applied Sciences, Eilif.Hjelseth@hioa.no

Abstract

Implementation of Big Data in organisations is often connected to high expectations and investment in advanced technology and methods for analysis. This case study explores expectations for and perspectives on the implementation of Big Data in the Norwegian Building Authority (DiBK), to support the development and interpretation of regulations. The study is based on semi-structured interviews with stakeholders in DiBK and an exploration of a pilot study by an external consultancy company. The theoretical framework for analysis is based on Integrated Design and Delivery Solution (IDDS), which focuses on: 1) integrated processes, 2) collaboration with people, and 3) interoperable technologies. The outcome shows variations in the interpretation of Big Data. This understanding is significant in relation to support in reuse of existing analyse, participation new projects and trust in outcome of Big Data based analyses. The expectations to outcome of Big Data analysis should be related to improved understanding of the complex mechanisms between the design of regulations and experiences with various technical building solutions, rather than trying to answer detailed questions on the relation between a single type of building damage and a specific paragraph in the regulations. The development of a road map for the continuous implementation and involvement of Big Data should be preferred, instead of the traditional master project implementation strategy. Increased use of Building Information Modelling (BIM) and sensors based on the Internet of things (IoT) can enable the increased and continuous capture of data into a joint fact based foundation. The use of Big Data has the potential to support changes to the processes of how regulations are drafted and how public regulations can interact with marked-driven aspects that have influence on quality of buildings and building products.

1 INTRODUCTION

The Norwegian Building Authority (DiBK) has high expectations to use Big Data to support the drafting of regulations (acts, codes and guidelines) and to enable analyses between building codes and building damages. DiBK has taken initiative to conduct a pilot study dedicated to Big Data. The drafting of regulations for the built environment is of high importance, where the input comes from many stakeholders (private, public, and commercial actors and organisations), in addition to political influences. The use of documented facts from multiple sources has large variation. Use of Big Data to enable documented facts should therefore be relevant to support the drafting of regulations. The Vivento (2015) report to the Ministry of Local Government and Modernisation says: 'Big Data has long been 'hyped' up to be the release of data - the new oil. Many commercial companies have long used advanced analysis based on Big Data technology to adapt the marketing of products and services to businesses and the individual consumer. However, what about the public sector? To what extent have public-sector activities adopted the possibilities inherent in this technology? Which challenges will the public sector experience when large volumes of data from many different data sources are used in real time?' (Vivento 2015, p. 1, translation by author)

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This study will explore the understanding and expectations of Big Data based on literature reviews and semi-structured interviews with stakeholders in DiBK. Even though this study is based on DiBK as a case study, issues surrounding the implementation of Big Data should be relevant for other organisations. The research question is: '*Which type of expectations with respect to Big Data are useful to focus on to support the development of regulations?'*

2 RELATED RESEARCH

Big Data is a 'hot' topic and numerous publications, both scientific and commercial, have been produced on this topic. Developers of software and consultants have numerous examples where clients have achieved significant improvements after starting to use Big Data. The technology has been available for many years. Davenport and Harris (2007) and Davenport et al. (2010) have confirmed that analysts and managers today have access to a powerful set of data analysis, data mining and data visualisation software tools. Much attention is currently being paid, in both the academic and practitioner literature, to the value that organisations could create through the use of Big Data (Gillon et al, 2012; Mithas et al., 2013). Current technologies make available to analysts and managers a vast amount of structured and unstructured data from a variety of sources. However, despite the hopes of many, insights do not emerge automatically out of mechanically applying analytical tools to data (Sharma et al, 2014). Chen et al. (2012) have suggested that business analytics and related technologies can help organisations to 'better understand its business and markets' and 'leverage opportunities presented by abundant data and domain-specific analytics' (p. 1166–1168). Scientific based research gives a more nuanced picture of Big Data, where the outcome is related to a specific understanding and usage of Big Data related to particular organisational needs and challenges. It is therefore no guarantee that just introducing Big Data in itself will yield a positive result.

According to Gartner (2015a), the realism behind Big Data can be questioned. Gartner says that through 2015, 85% of Fortune 500 organisations have been unable to exploit Big Data for competitive advantages. Another aspect is the sharing of data; according to research by Capgemini (2013), only 22% of all countries share comprehensive data that includes both breadth and granularity. 'Big data' and 'analytics' are recent buzzwords in both the management and information sciences (IS) literatures (Sharma et al, 2014).

The Internet of Things (IoT) is by the Gartner IT Glossary (2015a) defined as a network of physical objects that contains embedded technology to communicate and sense or interact with their internal states or the external environment, and can by this be regarded as a significant source for facts. In 2014 Big Data was at the top of the Peak of Inflated Expectations (Gartner 2014). In 2012 and 2013, Gartner's analysts postulated that the IoT had more than 10 years to reach the 'plateau of productivity', but in 2015, they gave it 5 to 10 years to reach the final stage of maturity (Press 2015). In 2015 Big Data was removed from the Hype Cycle for Emerging Technologies (Gartner 2015a) and replaced by the IoT (Gartner 2015b, Press 2015). Elsevier started in 2014 with a special journal called *Big Data Research* (Ooi and Wu 2015), which indicates there is high research activity in general with respect to this issue.

The situation in the Architects, Engineers, Contractors, Operators and Owners (AECOO) construction industry is different, and it has been hard to identify Big Data as an established research domain. The outcome of a search for 'Big Data' in the widely used journals in the AECOO industry is: *Automation in Construction* (Skibniewski 2015), *Information Technology in Construction* (Amor 2015), and *Facilities Management* (Pitt 2015) did not return any positive results. In many respects, the concept of Big Data is not new in the AECOO domain, even though the term has not been mentioned. In *Capturing and Reuse of Project Knowledge in Construction* by Tan et al. (2010) and in the primer *BIM Handbook* by Eastman et al. (2011), the term 'Big Data' is not mentioned at all, even if building information modelling (BIM) is directly related to the processing of a large amount of data. In the *BIM Management Handbook* by David Shepherd (2015), Big Data is mentioned with references to Digital Built Britain (2015). Even if Big Data as a term is not directly used, the use of terms like BIM, data capture, and information delivery can be regarded as an indication to include Big Data as part of the digitalisation effort in the AECOO industry.

An inclusive interpretation or understanding can enable the reuse of previous work to support the implementation of Big Data. With inclusive-perspective initiatives, surveys, studies and reports by the

DiBK and other public agencies will be relevant to include as related research. An overview of selected studies is listed below. Most of these were also mentioned by DiBK interviewees as examples of what would support the Big Data concept. DiBK has developed a strategy called 'ByggNett' (2014), (which can be translated as BuildingNetwork), for the digitalisation of the Norwegian construction industry. This strategy can be regarded as supportive of the Big Data approach, even though the term 'Big Data' is not explicitly mentioned. The UK has a similar, but more ambitious strategy. In the Digital Built Britain (2015) framework, IoT is part the development strategy. On the other hand, the Rethinking Construction (2016) report from the UK Construction Task Force did not mention Big Data or the Internet of Things.

The Norwegian State Housing Bank, in collaboration with the DiBK, took initiative to conduct a survey (Multiconsult 2014) about the status of accessibility in existing properties. The project focused on concepts of sharing information. This survey included interviews with 15 public authorities, which were involved in processing building-permit applications. Discussions about whether legal authorities should use legal force, or not, to obtain information on accessibility was an important element in the report. The conclusion was that the focus should be on the sharing of information and the use of existing registries. The term 'Big Data' was not used in the report. This approach was supported by the KPMG report (2015) presented in the case study part of this paper, and was now named Big Data. DiBK took the initiative to conduct a survey identifying the sharing of data among the 15 authorities listed as consultative bodies in the Building Application Regulations (SAK10 2010). Over 70% of the registries from these 15 authorities were open or partly open. However, they were not prepared for digital sharing (Horvati 2015). The Norwegian Mapping Authority has published a report on strategies for building a section of a cadastre (Matrikkelen 2015). Even though the term 'Big Data' is not explicitly mentioned, the strategy recommended preparing for an open-data community. A survey initiated by DiBK examined the preference to facility mangers related to chare of observed data from own buildings. They recommended that facility management software should include functions for sharing of information, as long as these where anonymised. Benchmarking with similar buildings was the main motivation for this openness (Ipsos 2015). IK-Bygg is a net-based service solution managed by the Norwegian Association of Municipal Engineers. The registry is currently collecting data from 250 municipalities regarding the technical status and performance of public properties in each municipality. Facility managers send in information about their property and receive aggregated and anonymized information about similar properties to support benchmarking and sharing experiences (IK-Bygg 2015). Continuous updating makes IK-Bygg a good candidate for Big Data analysis. Big Data has also reached the ministry level, and the Ministry of Local Government and Modernisation has taken the initiative to study the feasibility of the identification and assessment of large data in the public sector. 'Smart buildings' and the automatic capturing of data were presented as one of three cases. The report presented challenges and actions for future development. It recommended the development of a Big Data policy for the public sector (Vivento 2015). The 'Data.norge.no' registry of the Agency for Public Management and eGovernment currently holds 548 open data sets in 22 themes (Data Norge 2015). There is no theme related to the AECOO industry, and identifying relevant data sets can be a challenge. Sources for Big Data is limited and are often based on manual inputs in registries, due to the fact that the buildings 'do not talk'. The contribution from the IoT could be an enabler.

3 INFORMATION ABOUT DiBK AND NORWEGIAN REGULATIONS

The Norwegian Building Authority (DiBK) is a national resource centre for regulations for the built environment and the central authority in several areas within the building part of the Planning and Building Act. DiBK is an instrument for realising building policy. DiBK intend to develop building regulations which meet the future needs and that will motivate simplification and innovation in the housing and building sector (DiBK 2015).

The Norwegian Building Act consists of two parts – planning and building (until 2014, each was managed by two different ministries) – and is 66 pages long. This act is supported by three codes: one for the building-permit application process (34 pages), one for technical solutions (42 pages), and one for the documentation of building products (7 pages). The codes are supported with annually updated guidelines of 224, 290, and 88 pages, respectively. The public regulations section adds up to 751 pages (referencing

a large number of standards). The Building Acts have direct references to 15 other authorities, each with its own set of regulations (DiBK-PBL 2010). This defragmentation illustrates that data about the built environment, especially on the public side, are distributed throughout a large number of sources, each with its own perspective of what constitutes relevant data.

The regulations mostly focus on the planning and erection of the building and the process of obtaining permission to build. Facility Management is described in rather limited terms. Handover information is mentioned, but the requirements are not formulated as detailed specification applicable for practical use. The Norwegian codes are function-based regulations (Hjelseth 2015). Because of this, according to TEK10, a building owner must require relevant documentation. The main part of the code only says as follows: '…Responsible designers and responsible contractors shall, within their areas of responsibility, provide responsible applicants with the documentation necessary to satisfactorily carry out the start-up, management, operation and maintenance of the structure, technical installations and systems…' (TEK10 2010, p. 16). Responsible designers and responsible contractors have dedicated roles in the application system for obtaining permission to build. Even though the guidance includes more details, buildings vary, and how it can be done in practice is not specified in the regulations. The reason for these extended requirements has its origin in solving imperfections in the market by use of regulations. However, the market did not respond to the updated requirements in the guidance. Instead, the regulations sparked discussions about what is required and what is considered relevant information. In this respect, Big Data could be an enabler in identifying relevant information related to practical use and experience.

Building regulations continuously change. The Norwegian Building Act is updated every 3–7 years, the codes are updated every year and major changes occur in the codes every 3–5 years. The guidelines are updated twice a year. Big Data monitoring can identify the need for updates on most relevant criteria. This indicates a need for Big Data support. Continually monitoring the impact of regulations is therefore highly relevant to identifying the relationship between regulations and damages to buildings/the quality of built environments.

The current government have high ambitions for the building sector and have begun to focus on 'Simplification, Renewal and Improvement' (in Norwegian: 'Forenkling, Fornying and Forbedring') in response to the need for more buildings using fewer resources (Amundsen 2014). An impact of this perspective is that the market will have a more active role in establishment of 'best practices', while public authorities will be responsible for assuring minimum requirements are met. In this perspective, Big Data will be an applicable approach to monitoring, which supports the role of fact-based decisions-making and regulations.

4 THEORETICAL FRAMEWORK

Figure 1 illustrates Integrated Design and Delivery Solutions (Owen, et al. 2013) as the integration of collaborative people, integrated processes, and interoperable technology. Big Data can be regarded as a variant of IDDS, but with knowledge as the delivered 'product', not buildings. IDDS can also be regarded as a simplification of the sociotechnical theory of Bostrom and Heinen (1977) adapted to the AECOO industry.

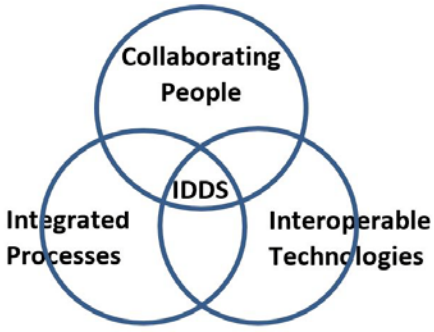

Figure 1. The three perspectives of Owen, et al. (2013); figure simplified by the author

Big Data can be regarded as integrated deliverables. The three imperatives can be reformulated with a Big Data perspective in the following ways:

- 1) Integrated Processes – focus on the value chain of processes for multiple sources
- 2) Collaboration with People – focus on multidisciplinary collaboration
- 3) Interoperable Technology – focus on the capturing, processing, and presenting by users of multiple hard- and software tools

IDDS was developed in 2009 as a special theme by the International Council for Research and Innovation in Building and Construction (CIB 2015). At the CIB 2016 World Conference IDDS was considered as one of the three themes, in addition to 'Resilient Urbanisation' and 'Sustainable Construction' (WBC16 2015). This indicates that IDDS is a relevant framework for an analysis of AECOO related problems.

The interpretation of Big Data is also a part of the theoretical framework of this study. Understanding what Big Data is, or is not, influences if the analysis is regarded as a part of Big Data initiatives and projects in the organisation. The Gartner Group uses the following definition: '"Big data" is high-volume, -velocity and -variety information assets that demand cost-effective, innovative forms of information processing for enhanced insight and decision making' (Gartner IT Glossary, 2015b). This study uses the Gartner definition as its foundation but will stress that this definition has three perspectives: in addition to the Vs, this definition also focuses on net value (compared to other solutions) and on supporting increased understanding of the problems to be solved.

5 METHOD

This case study consists of a semi-structured survey with stakeholders in DiBK and review of a consultancy company's report that was ordered by DiBK. The semi-structured survey was conducted with five stakeholders in the Building and building process department at DiBK. DiBK is a competency organisation, where the average education is above master's level; two of the five interviewees had PhD degrees. The interviews were conducted individually and lasted about 30–60 minutes.

All interviewees received an e-mail as preparation for the interview. This e-mail informed that the interview would be discussion based and would aim to identify their personal expectations and opinions regarding Big Data in DiBK. The aim of the interview was not to look for exact answers or comparing answers by use of statistics. To indicate the structure of the interview was following themes listed with a short description:

1) Status (past time)
   What are your expectations for Big Data, in general and in DiBK?
2) Reports (present)
   What was interesting about the results of the KPMG report?
3) Implementation (future)
   How can think Big Data can be implemented/How will this influence development of regulations?
4) Open theme
   Is there something else you would like to discuss? Open for proposals from each interviewee.

There was some variation in how much focus the interviewees devoted to each of the proposed themes. The discussion had the three perspectives of IDDS as its framework for analysis. The feedback from the interviewees was anonymized and organised in sections according to the IDDS framework. The second part explored the dedicated report (KPMG 2015) of the Big Data pilot study performed by the consultancy company KPMG. This study does not assess the quality of the KPMG report or the pilot study due to constraints from DiBK related to time and financial considerations that influenced the consultancy work.

This study has some limitations related to the methods used. The limited number of interviewees and the qualitative approach makes it difficult to determine how representative the opinions from the interviewees are in relation to the entire organisation. They are all from the same department in the organisation. The interpretation of the KPMG report has only been performed by the author and consequently is only

representing his interpretation. This study focuses on illustrating significant differences in perspective, but it is not precise on the size of each individual perspective.

6 ANALYSIS

The analysis covers both internal and external viewpoints. The internal analysis is based on interviews with stakeholders in DiBK and focuses on the expectations concerning Big Data and how Big Data can be implemented for practical use in the development of regulations. The external viewpoint is based on a consultancy company report and examines a pilot study on using Big Data for the early detection of building damage. The missing part, about IoT, is covered in the discussion section.

6.1 Interview with stakeholders in DiBK

Even though Big Data should be a familiar term, all the interviewees voiced questions like: '*What do you mean by Big Data?'*. Another variant that the interviewees included was: '*Answering this question depends on how one defines Big Data'*. The understanding of the concept of Big Data was an aspect that was mentioned by all interviewees in several contexts. Thus, the discussion section of this paper looks into interpretations, understandings, and definitions regarding Big Data.

The analysis is divided according to the three perspectives of IDDS:

1) Integrated Processes
Discussions with the interviewees focused on the potential of Big Data processing data from multiple sources to generate advanced analyses. One of the interviewees expressed their expectations in the following way: *'Big Data has the potential to solve our entire problems with the development of regulations'*.

Another had the following to say about the transition to Big Data: *'Big Data is going from still pictures to moving pictures'*.

Regarding the use of Big Data, marketing was the most commonly expressed purpose for which it was used. No other public authorities were mentioned as Big Data users by the interviewees.

An important element here was that the data had to be from a digital source; so access to digital sources is critical. If one has to do additional, manual registrations of a questionnaire, then the study is not Big Data was a general interpretation. Traditional surveys of building damage involve manual registrations by skilled people, and this is not Big Data. It was a joint understanding that more updated information was necessary to determine the consequences and impacts of regulations. DiBK employees have for a long time used digital registries as sources for analyses. With reference to the KPMG report (2015), one interviewee said the following; *'We have been working with 'Big Data' ideas for a long time, but we have not labelled it Big Data – maybe old projects can get a new life'*.

This comment is also good example on how the understanding of Big Data influences whether initiatives are assessed in an inclusive or exclusive way. The general expectations of Big Data among the interviewees varied due to their varied understanding of Big Data and how and what could be done in relation to the investment in Big Data projects. Knowledge of other authorities working with legislation was limited. The perspective of using Big Data in the design of legislation is quite different from using Big Data in the surveillance of legislation. This has been done regarding tax issues, in addition to crime-related issues. As one interviewee explained: *'Big Data has similarities to BIM, someone is hyping up the technology to contribute to unrealistic expectations. When improvement is shown, these often get negative comments because they are compared to the "hyped" expectations, and not to the effort and outcome of the traditional way of doing things.'*

The interviewees said that the 'future is digital' and the implementation of Big Data in the AECOO industry will be an important factor in what DiBK should and must do. Digitalisation, including Big Data, will also have a significant impact on both the drafting of regulations and how regulations are applied in practice. One of the interviewees expressed this in the following way: *'Future regulations must be*

prepared for digitalisation. This includes both the interpretation of the regulations and the information flow that is required to assess compliance with regulations.'

The feedback showed that Big Data should be regarded as an integrated way of drafting regulations and monitoring their impacts.

2) Collaboration with People

It was a joint understanding that Big Data could, in various degrees, influence how we work and collaborate. The KPMG report was therefore an obvious reference. The implementation of Big Data will influence how people at DiBK will work and collaborate. The impression was that this type of pilot study is useful for learning and providing experience, but that it can be too positive. One interviewee said as follows: *'It is not the professional content and outcome or the tests performed in the study that is most interesting; it the "way" of working. The most important is that we shift focus from "taking still pictures" after problems have been identified to having a continuous monitoring of the impact of regulations'.*

Two of the interviewees were involved with KPMG in development of the report. Those interviewees had a more positive interpretation of the outcome of the report. They regarded the findings from the cases in the KPMG report as examples for use, and not as final results of analysis. Their feedback was more related to the fact that KPMG had started a Big Data process; based on this, the outcome was positive, as expected.

An important aspect is that regulations are just one of many ways to secure the quality of the built environment. No one wants damages or bad solutions if they can be avoided in advance. Big Data can therefore play an important role in disseminating knowledge and experiences. One of the interviewees expressed this in the following way: *'Big Data can contribute to more relevant knowledge about good solutions in the market and by doing this, reduce focus on regulations to maintain the quality of the built environme*nt.'

Three of the interviewees were concerned about the lack of reusing previous studies and solving solved problems. This topic is included in the discussion section. As one interviewee expressed the point: *'We have actually been working with Big Data, Agile, Scrum and whatever you call these new things for over 10 years, but we have not called it by the new names.'*

There was a concern among the interviewees that Big Data could be too much driven by consultants. One of the interviewees suggested the development of a 'road map' as an alternative approach to a master project. The outcome of this approach was greater focus on long-term effects like increased competency. A better understanding of the problem can often be more important than getting a fixed solution from a consultancy company.

3) Interoperable Technology

All interviewees gave the clear impressions that technology related to Big Data was applicable. This understanding was based on general presentations, and the weakness in some of the analyses in the KPMG report was interpreted as just a consequence of limited use and adaption of software. One reason for this was that all the interviewees worked with digitalisation and were familiar with Big Data related technology, even though they had not used this type of dedicated software themselves. There was also a joint understanding, that even though Big Data did not work as hyped, it would still be beneficial. One of the interviewees expressed this as follows: *'This is not something new; we have worked with these types of questions for a long time, and the practical outcome of the KPMG report was not impressive: too many incorrect results. If this is Big Data, it is hard to see how this can be helpful in our current job situations.'*

All said that they hoped the KPMG report could provide good examples and show to others in DiBK that Big Data is useful and allows for a practical way of working. The general impression was that the pilot study itself did not provide complete Big Data solutions, and more effort in further adaption is needed to get applicable solutions.

6.2 Pilot study about Big Data for early detection of building damages

By ordering this feasibility report, DiBK wanted to have relevant examples, proof-of-concepts, of how Big Data can be utilized in DiBK. The report was put together between April and September 2015 by the consulting company KPMG. The final 68-page report was published 18 November 2015 (KPMG 2015). This part of the analysis explores selected sections from the KPMG report. This study does not assess the quality of the report due to constraints in the project that can influence the outcome. The aim of the KPMG report was to show how Big Data could contribute to early monitoring of building damage related to the requirements in the regulations. KPMG performed their study according to the mandate from DiBK, and this study must therefore not be interpreted as a critique of the work by the KPMG consultants.

Test 1. Visualisation of text:
KPMG's report states that visualisation is one of the characteristics of Big Data. The data source was the Finance Norway registry of approximately 1,000 water-related damages. SAS Visual Analytics from SAS Institute was used for visualisation. Finance Norway (2015) is the industry representing savings banks, commercial banks, life-insurance companies, general-insurance companies, and financial groups. This test examined the type of inquiries that were related to a block of flats. The outcome was presented as a word cloud, as shown in Figure 2.

Figure 2. Word cloud of text from the inquiries related to a block of flats (KPMG, 2015)

The smell of cooking from the ventilation system ('*Matlukt fra ventilasjonsanlegget*') was the most highlighted text element. As a comment, in the KPMG report, the building regulations do not include specific requirements about the 'smell of cooking'. The impact of this test could be that this issue should be followed up on and should be included in future regulations.

This word cloud is a new way of visualisation that gives an overview of the most frequently used words. Word clouds are not unique to Big Data and could alternately be done by copying the terms from the database into a word processor and then using a separate word-cloud generator (Smitty 2013). KPMG also illustrated the outcome from another test by using a bar diagram based on an identical source. Examples from the word cloud do not distinguish between 'Smell of cooking from *the* ventilation system' and 'Smell of cooking from ventilation system'. Another example where content can be similar but is written differently is as follows: ventilation system does not work properly/kitchen ventilator evacuates poorly/poor evacuation from kitchen ventilator. Another example is as follows: noise from kitchen ventilator/noise from ventilation system. Some support of semantic rules would have improved this type of test and illustrated that Big Data contributes to higher-quality analysis, not only to the capacity of processing more data. On the other hand, this 'proof of concept' can illustrate that Big Data does not have to be so big.

Test 2. Concept linking:
This test illustrates concept linking of phrases. The data source is the same as in the previous test but with SAS Text Miner from SAS Institute as the software. The outcome is presented in Figure 3.

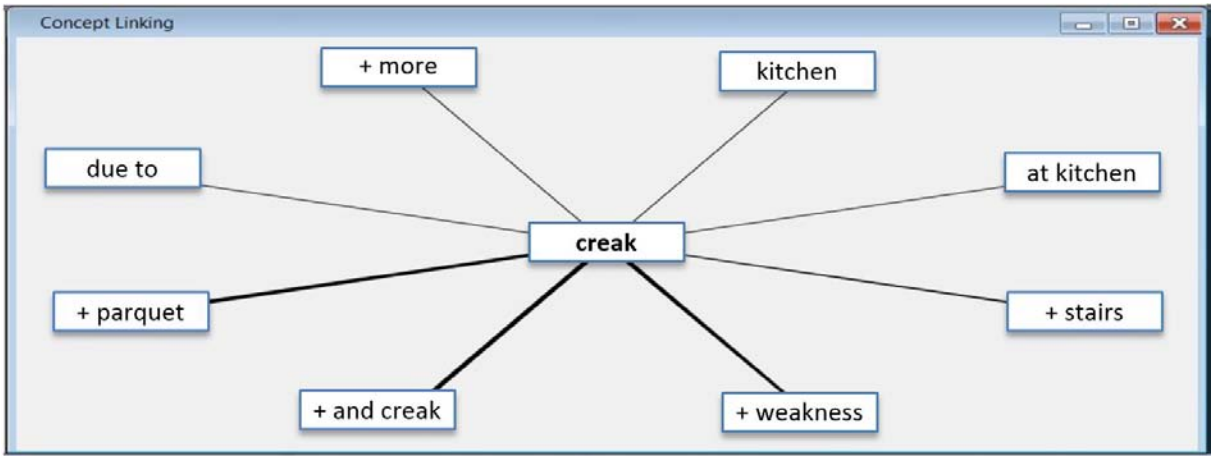

Figure 3. Graphical illustration of concept linking (KPMG, 2015)

The diagram shows an interesting way of illustrating results; however, the content in the graph does not give useful information about the linking of concepts. The outcome of the example is hard to interpret, and appears as a mix of 'concepts'. When 'creak' (as a concept) is related to 'creak' (also as a concept), there is an obvious misconnection. 'Due to' appears to be a concept. The professional outcome of this type of analysis is hard to be regarded as useful. The duplication of 'kitchen' and 'on kitchen' is commented on in the report, which states that adaptations for this can be included. How this improvement can be solved is not explained. The concepts seem to be missing relevant rules for linking. However, the interviewees said that support from professionals in the AECOO-industry could contribute to more precise expressions of the rules for linking concepts. This indicate need procession competency in the domain to support and quality assure the analyses. The general comments are similar to those from the previous test.

Test 3. Use of automatic classification:
This is an interesting example of the use of Big Data in analyses. KPMG used a text-mining tool and advanced text-mining techniques. This tool helps partly to filter out certain parts of speech, suggests the interpretation of words in different inflected forms as similar phrases and filters out words that occur as often or seldom that they can provide value to the ruleset/model.

The precision level was identified as a percentage with two decimals. This can give the impression that the measurement is more precise than it actually is and that the use of 5% or 10% intervals will be more relevant to indicate the precision level. The rule precision varied from 21.28% to 100.00%, with 50% as the average. Because the report does not include detailed information about the rule, it is hard to assess the real quality of this solution. This test illustrates a challenge of statistical analyses in general and Big Data in this case. Even if one finds a high degree of correlation, this does not necessary indicate that there is causality. The quality of automatic classification and the test can indicate that Big Data are more about large amounts of data than better-quality data. Therefore, the outcome of this test can be interpreted as saying that building regulations are too hard to automate. Studies by Hjelseth (2015) show that regulations can be digitally interpreted. A central aspect in this is that naturally controlled language processing is used instead of the more general natural language processing. It can therefore be expected that the outcome of automatic classification can be improved with more development.

Test 4 Internet-based capture of data:

The aim of the test was to see whether DiBK could gain insight into the industry and people's familiarity with and interpretation of relevant regulations through an analysis of information from the Internet.

--- *Twitter*: The analysis was based on Twitter messages, but due to the low number of messages with relevant hash tags (i.e. #) their study was unable to draw conclusions based on this source. KPMG used SAS Visual Analytics and IBM Watson Analytics in the test.

--- *Discussion groups*: This test focussed on posted comments in a discussion group on a selected website called www.byggebolig.no (byggebolig in Norwegian can be translated to' building a house'). The test showed that the Web crawler's functionality was insufficient for analysing the extracted text from the discussions in an appropriate manner. The KPMG report proposed more specialised tools that retrieve text from predefined areas on a webpage using 'web scrapers'. Alternatively, one must retrieve data directly from the database of those who operate the message board. However, manual exploration of the posts on byggebolig.no shows that there are a number of discussions concerning knowledge, interpretation and opinions on legislation.

Proposal for master plan:

The KPMG report suggested a master plan as a continuation of their pilot study. The current study does not assume or assess whether this is a good plan. However, it is hard to confirm that the outcome of the 'proof of concepts' explored in the KPMG report is at a level that indicates enough maturity to be scaled up to a full-scale project with more parallel workflows. Big Data can, or should, be regarded as an organisational change, even a change of culture. It is very hard to see that this is the case in the proposed KPMG project plan.

Related to the IDDS is the proof of concept focussed on interoperable technology by the use of advanced software from the SAS Institute. The procurement of analytical tools is placed at the start of the master project. Integrated processes had low priority. Collaborating with people was covered by a transfer of competency and handover to DiBK, which began when most workflows were finalised. The implementation of the system was the last started workflow. However, an important aspect of the plan was the recommendation that DiBK should continue to develop Big Data.

7 DISCUSSION

This study focused on how Big Data can support the development of regulations. The outcome from the analyses of the findings from both the interviews and the literature did not give a joint and simple answer. This discussion explores perspectives that give a better understanding of the findings and analysis. A very relevant factor is the understanding of what Big Data really is. This interpretation influences whether digitally supported activities are interpreted as Big Data or not is critical for what and whom will be included.

There are no joint definition or understanding of Big Data, and all interviewees wanted to discuss this issue. The Big Data concept gained momentum in the early 2000s, when the industry analyst Doug Laney articulated the now-mainstream definition of Big Data as the three Vs: *volume, velocity* and *variety*. Rijmenan (2014) expanded on this definition by including *veracity, variability, visualisation* and *value* while SAS (2015) also included *variability* and *complexity*. However, no joint understanding of Big Data has been established; the term is often hyped up and other elements are than the expansions above are included in various definitions. Even though this study has used the Gartner Group definition (Gartner IT Glossary, 2015b), the interviewees did of course not use this definition.

Different understandings of what Big Data is or is not can result in two different answers:

1) DiBK is an organisation that uses advanced analytics tools and through this has implemented Big Data, or,

2) DiBK has not invested in Big Data analytics tools, and consequently has not implemented Big Data (even though is uses multiple sources and skilled professionals for its analyses).

Exploring different viewpoints is a challenge without a fixed reference. The use of IDDS enables a framework for identifying and comparing viewpoints. The interviewees from DiBK regarded Big Data technology as solved or solvable. Their main interpretation was that Big Data represented a new fact-based process, but where they do not have full control over all the input. The Big Data approach stands in contrast to traditional processes where they make dedicated surveys and physical observations of buildings / building products. KPMG was very focussed on providing a proof-of-concept through the use of dedicated tests and by utilizing technology to show practical solutions to answering detailed questions. KPMG performed their study according to the mandate from DiBK, and this study must therefore not be interpreted as a critique of the work by the KPMG consultants. The outcome of the tests included results

whose validity can be questioned by adherents of DiBK's point of view. This indicates that Big Data analysis is far more than the use of advanced technology and large amounts of data. The data must come from relevant sources and be analysed in a way that identifies professional causality, not only correlations. The professional design of queries is often more important than advanced analysis. A summary of the different perspectives between the DiBK interviewees and the pilot study in the KPMG report is illustrated in Figure 4.

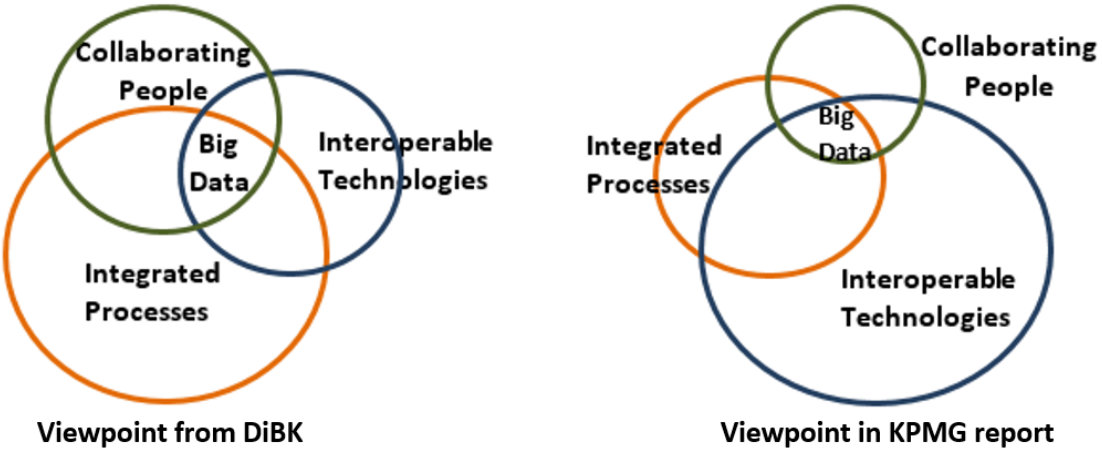

Figure 4. The differences in perspectives between DiBK interviewees and the KPMG report

The best solution is a combination that solves the problem with acceptable quality and optimal use of resources; time, economy, competency, accessible data sources, etc. Answering this question should be done with reference to experiential learning (Kolb 1984) in order to focus on the problem and solution and the double-loop learning (Argyris 2015) process in order to include the organisational aspect. In this way, the use of the IDDS framework can contribute to increased insight without having a predefined picture or best or correct answer.

Sharma et al. (2014) identify three perspectives on Big Data: Data to insight, Insight to decision, and Decision to value. Regarding data to insight, Sharma et al. express this as:

…insights emerge out of an active process of engagement between analysts and business managers using the data and analytic tools to uncover new knowledge. More importantly, those engagements take place within existing structures and processes for decision making. A better understanding of the insight generation process is important for understanding how the use of business analytics leads to improved performance. (p. 435)

The fist perspective is most relevant for DiBK. Regulations are not descried in historical facts, and the insight to decision and decision to value perspectives are therefore no relevant.

The importance of an increased focus on collecting and analysing facts is supported by LaValle et al. (2011, p. 22) who report that top-performing organisations 'make decisions based on rigorous analysis at more than double the rate of lower performing organisations'. These kinds of organisations use analytic insight to 'guide both future strategies and day-to-day operations'.

Frisk et al. (2013) propose that decision-making is less about choosing between alternatives and more about a creative process through which alternatives are discovered. Transferred to DiBK, this perspective be can Big Data support the drafting process of regulations by analysis of alternative solutions, while the decision related to approval of regulations is based on the established legal and political processes.

The Big Data way of thinking can perhaps be expressed through the following quote by Albert Einstein: 'If I had an hour to solve a problem, I'd spend 55 minutes thinking about the problem and 5 minutes thinking about solutions.'

IoT can be regarding as the 'missing link ' to increasing data about buildings. The closest to an official definition comes from the Internet of Things Global Standards Initiative: 'The IoT is the network of physical objects or things embedded with electronics, software, sensors, and network connectivity, which enables these objects to collect and exchange data' (Mann, 2015, p.2). Levy (2016) explains by practical

examples that IoT can transform every facet of buildings – how we inhabit them, how we manage them, and even how we build them. She proposes four ways that IoT is radically transforming building design and construction: 'Building information modelling (BIM) / Green building / Intelligent prefabrication with Radio-frequency identification (RFID) / Construction management' (op.cit.).

According to McHale, J. (2016), the good news is that things are changing and the introduction of Building Information Modelling (BIM) is helping to promote a holistic design approach, because it forces each design and engineering discipline to co-ordinate their designs, which will hopefully make the Building Internet of Things (BIoT) a practical proposition. Saran (2015) says that building regulations are likely to drive adoption. For instance, the UK's building information modelling (BIM) mandate requires that all public sector constructions commencing in 2016 comply with BIM Level 2. However, this is an ambitious strategy where public agencies support the AECOO industry to include BIM as mandatory deliverable in design of building projects. The Norwegian government does not want to force digitalisation as a mandatory requirement for all, but wants instead to stimulate the AECOO industry to demand digital and BIM based solutions and the software industry to develop new tools (ByggNett, 2014). The state-of-the-art study by Refvik (2012) confirmed that Norway has a high maturity in the utilisation of BIM. This indicates that the use of BIM and IoT can yield digital advantages.

Regarding further research. Big Data is a domain with high research activity and DiBK should therefore focus on utilizing existing and on-going research results, rather than initiating own research activities, or ordering consultancy reports. Regarding Internet of Thing appear research in solutions to monitor traditional building structures, walls, roofs, and windows seem to be a limited or missing topic.

8 CONCLUSION

In general, DiBK has high expectations for the use of Big Data as an enabling approach, both as support for drafting regulations and for monitoring the quality of buildings, with special focus on damages in buildings. Big Data should be understood as an inclusive concept. This imply that Big Data projects do not have to be projects where everything is new, advanced and big. This approach can stimulate the organisation to reuse a large number of outcomes from previous activities, reports and projects as contributions to a fact based and analytical way of working.

Implementations on Big Data based analysis as a preferred working method should have a limited focus on technology and a high awareness of the importance of reusing outcomes from previous and existing activities or projects. Implementing a long-term approach using a road map can have more stimulating effect on including the practitioners' competency, that initiating of a master project with high influence by external consultants.

There were significant differences in viewpoints between the stakeholders of DiBK and the KPMG consultancy report. IDDS was a useful framework for identifying different viewpoints. Understanding what Big Data activities are (and are not) is most critical for implementation and positive outcomes in relation to invested resources. The use of Big Data has the potential to support changes to the processes of how regulations are drafted and how public regulations can interact with marked-driven aspects that have influence on quality of buildings and building products.

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