BUILDING INFORMATION STANDARDS: BIG DATA TECHNOLOGIES PREVENTED FROM BECOMING BIG IN BUILDING

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The increased use of BIM in the building sector have led certain actors to commence riding on the big data hype. Big data techniques allow the use of unstructured data alongside structured data to an extent that was previously impossible. Science and technology studies (STS) approaches are used to examine information standards as a technology to organise big data applications in building. Crucially, opportunities are strongly guided by the data that is collected about buildings, and thus by the understanding of what a building is. Building information standards are viewed as performative and their becoming as a process of power, understanding and emerging interests. The empirical material stems from a study on the shaping of a Danish classification standard and its implementation in a Danish hospital project. The analysis shows several performative aspects and particular ways in which a building can be understood: First, there is a focus on the internal structure of a building as a product and less on the process that leads to making a product. Second, a systems theory approach to building structure understands building components as having functions in a way that aligns well with the installation part of the building. Third, delimitations within which information standards propose to collect data implies a focus on building components as material over components being economical entities. Performativity struggles during the shaping of the standard are expected to continue also during its implementation phase in an environment where multiple standards co-exist. On this background we discuss whether the building information standard, meant to be a big data technology enabler, might become a barrier for big data.

Keywords: big data, classification, performativity, standardisation, STS

INTRODUCTION

Building projects are increasingly guided by building information models that generate data on building products and processes providing big data opportunities. The increased use of information models in building is accompanied with a need to standardise the collection and structuring of the data in those models. Such focus on standardisation contrasts with voices in the big data discourse that promise a more heterogeneous reassembling of a variety of structured and unstructured data to create value (Mayer-Schönberger and Cukier 2013, Simon 2013: 29-47). Instead, it seems to be in line with historical developments in building where standards traditionally play an important role (Carassus 2002).

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Standardisation serves an instrumental purpose in building by promoting similarity across time and space. The consistency of a standard allows people to coordinate their actions and aim for more complex achievements, while at a time standards built on knowledge structures in practice and therefore usually encompasses ambiguity in their ordering attempt (Bowker and Star 1999, Busch 2011, Timmermans and Epstein 2010). In building information models, a common standard allows information about building components to be gathered and used in a more systematic way across different parts of building design and the production site. It centres on a need for a more common terminology and structure concerning products and processes that are intended to help identify to different actors what components are or will be used in a building (Koch and Jacobsen 2014). In this way, information standards provide a solution to interoperability problems between actors using different classification systems.

However, the solution to interoperability problems proposed in a standard is not straightforward. Science and technology studies (STS) based approaches problematise seemingly neutral technical solutions such as standardisation to show that they can and should be viewed as deeply normative. Standards are developed by professionals with a certain understanding of appropriate ways to organise building, or more cynically, representing certain interests within the building sector. These normative understandings shape the standard through strategic and everyday decisions that have to be made when developing standards. Over time, as a standard stabilises, the normativity engrained in a standard has a tendency to become viewed as neutral or even natural (Bowker and Star 1999, Timmermans and Epstein 2010). However it may look, a standard is not neutral or natural at all and can therefore at any time be questioned and opened up if sufficient strength is mobilised.

In this paper we use STS approaches to critically examine the standardisation of building information systems. The human work involved in creating and maintaining standards for data structuring and those mechanisms that makes the outcome invisible or appear neutral have been explored previously in the seminal work of Bowker and Star (1999), and to some extent in related works on standardisation (Brunsson and Jacobsson 2000, Timmermans and Epstein 2010). Opening up the shaping and structuring of data in building is relevant to us because of the material effects of data on the development of buildings. Standards on data collection and structuring influence not only the knowledge that is being generated but also have an impact on the buildings being built. Callon's (2007) notion of performativity is used to show the struggle between different socio-technical networks in standardisation of building information systems. This paper will show that such struggle leads to certain understandings of a building to be favoured. Furthermore and in line with Callon, this paper will also argue that any stabilisation of meaning is a temporary outcome, and show that there are multiple sites for a performativity struggle.

Empirically, this paper builds mainly on a case study of a building information classification system – the Cuneco Classification System (CCS). The CCS is a Danish standard for handling building information that contains rules on classification of building information, the number of information levels and the measurement of building components. The CCS promises to provide automated identification and classification, which should allow a smooth transfer of data between actors using different software packages in building (Koch and Jacobsen 2014). This paper is part of a longitudinal study in which the CCS standard is followed during its formation and subsequent implementation in the design and building of a Danish hospital. The empirical material will show that the shaping of a standard stabilises on particular ways that a building can be understood. The implementation phase in the hospital buildings shows that after a certain understanding is stabilised in a standard there is still room for multiple understandings captured in multiple standards. The stabilisation of the CCS standard around certain understandings and stakeholders during the shaping of the standard is therefore challenged again on a different site, for example during the implementation of the standard.

METHOD

Theoretically, this study is mainly based on STS literature on classification, standardisation and information technology, and on performativity. The central methodological approach follows Bowker & Star's fourth methodological theme for studying information infrastructure, namely uncovering the practical politics of classification and standardisation as they are designed (1999: 44-6). We use a longitudinal case study that follows the design of standards as they emerge. Callon's (2007) concept of performativity further legitimises scrutinising standard creation and implementation, and opens up space for multiple struggles between statements and reality. Furthermore, a brief review was done on standard creation and implementation which shows some cases of multiplicity and interaction within and between standards.

Empirically, this paper follows a mixed method. Most weight is on the qualitative study of the shaping of the Cuneco Classification System (CCS) in a Danish community of Architects, Engineer and Construction (AEC), and the implementation of the CCS in a Danish hospital design. The empirical material was gathered in connection to an intensive longitudinal study and included interviews (57), participant observation of events (18) and a document analysis. Second, this qualitative in depth material is complemented with a quantitative study on the existence of other building information standards in Denmark. The large amounts of data and information collected in the course of the study have made us decide to be selective of the information that will be presented in this paper. The empirical material will be used to show different aspects of performativity and multiplicity among standards.

THEORETICAL FRAMEWORK

Similarity and performativity in standardising

Classification systems are described as segmentations of the world that do work in the world (Bowker and Star 1999: 10). Ideal classification systems are consistent, have mutually exclusive categories and cover all that is intended to describe (Bowker and Star 1999: 10-1, Busch 2011). Classification may be done ad hoc, but tends to be standardised to varying degrees. As mentioned, standards create similarity and homogeneity across time and space. Consistency of form or understanding allows people to coordinate their actions, and subsequently the consistency and increased coordination allow for higher complexity in the things people may achieve in a society (Bowker and Star 1999, Busch 2011, Furusten 2000, Timmermans and Epstein 2010). The Cuneco Classification System (CCS) is an example of a standardised classification system that provides a systematic ordering of building information.

As a mechanism of coordination standards have a rule like character (Brunsson and Jacobsson 2000). The power that become embedded in standards makes it an interesting area of political manoeuvring. After all, a standard corresponding to one professional group's understanding and goals requires less adjustment and can be used as an instrument to move others. It is in this light we follow Bowker and Star's methodological invitation to study and uncover " the practical politics of classifying and standardizing"

(1999: 44). Following the process of shaping a standard, it can be shown which perspectives on building are embedded in the outcomes.

That standards have an impact on the building being build is perhaps evident for conventional standards, but also applies to information and classification standards. The idea that information does not merely represents reality but actively helps shape is captured in the concept of performativity (Callon 2007, Mackenzie, Muniesa and Siu 2007). As pointed out by Gond *et al*., (2015), this STS inspired understanding of performativity has found its way into organisation and management theory. Callon's (2007) performativity guides this study in at least three different ways. Firstly, performativity further legitimises to study the process of standard creation and implementation as the ideas stabilised in standards help shape reality. Second, Callon presents theoretical frame to study performativity in the making: i.e. the assemblages of actors and statements that collaborate and compete in a struggle for survival in a mutual adjustment between statement and practice. Thirdly, the understanding that the process of struggle and mutual adjustment happens time and again can be read as an invitation to look at multiplicity in both creation and implementation phases of a standard.

Opening up for multiplicity within and between standards

Despite ideals of homogeneity - a standard is after all a mechanism for coordination through making things similar - there several domains where multiplicity persists. Starting with relatively limited forms of multiplicity in standards, the text will discuss increasingly radical forms of multiplicity occurring in standardisation literature. Following a distinction between standard creation and standard implementation (see also Botzem and Dobusch 2012), there are cases showing multiplicity in both phases.

A study of the development of the JAVA programming standard shows that struggles between different understandings of the standard may persist when a single standard is being developed and alternatives have been excluded already. In the JAVA case, initial exclusion is challenged during standard maintenance and development by threatening to develop an alternative standard (Garud, Jain and Kumaraswamy 2002),

A discussion on multiplicity between standards may start with the well-known technological standard battle between VHS and Betamax videocassette recorder technology (Cusumano, Mylonadis and Rosenbloom 1992). Multiplicity is here initially present but is strongly reduced as one standard becomes dominant. In other cases, dynamics between standards have led to co-existing standards. Such outcomes have been observed in sectors such as international coffee certification (Reinecke, Manning and Von Hagen 2012), local fast food markets (Berman 2013) and telecommunication (Genschel 1997, Shen *et al*., 2013). Multiplicity may conceptually be taken a step further when multiple standards do not compete or co-exist but co-evolve into hybrid standards. A case of co-evolution into a hybrid standard is observed in the development and diffusion of the Chinese 3G network (Shen *et al*., 2013). An extreme case of multiplicity is presented as reflexive modernisation in a study of an Electronic patient record at a Norwegian hospital (Hanseth *et al*., 2006). Here multiple outcomes of standardisation are considered unavoidable due to side-effects of the effort to standardise.

Summing up

The performativity of standards and differences in understandings that guide its shaping and implementation may serve to expect the persistence of multiplicity. This multiplicity is found in the literature on standards. During the shaping of the standards we see processes that can be characterised as political: as collaboration and competition, but even co-evolution. In the next sections, shaping the CCS standard will be described and discussed.

THE SHAPING OF THE CUNECO CLASSIFICATION SYSTEM

Development of the CCS standard

Prior to the establishment of the Cuneco development centre in 2010-2011, industrial players made some important moves that paved the way. An organised alliance of the largest engineering and contracting companies, operating on a multi-national level, carried out an investigation of classification and published a report advocating a Danish classification for construction. This gave extensive and somewhat external help and support to the core classification advocates. The government authority also generated a funding possibility by positioning an EU program in support of classification in the building industry.

BIPS, an industry association took charge of formulating an application, and a positioning process commenced in which some community players with their understanding of classification were included, while others were excluded. The Danish CEN/ISO organisation became involved and so did the building clients association. However, the constellation did not allow inclusion of Technological Institute or Aalborg University, two important institutional players in the AEC sector. Aalborg University was profiled with an alternative technology, and also with outspoken criticism of the very idea of making a classification that the Danish Building Classification, DBK, had already attempted. BIPS managed to collect a winning coalition and received the funding.

In this process, the basic ideas of the previous attempt were incorporated to begin with, but shortly after obtaining funding. The centre took the name of Cuneco, inspired by the Esperanto word for community “kuneco” (Cuneco 2014). The organisation of Cuneco involves a centre manager, a secretariat, a steering group, a partnership and a project organisation. Projects cover the four main areas named hereafter and also test the developed elements of infrastructure. The Cuneco classification system consist of mainly four elements (Cuneco 2014): Classification, Property data, Information levels, and Rules for measuring.

The classification developed here build on a conceptual systematic ordering of information about a building using a basic process model linking resources, processes and results (Ekholm and Häggström 2011). The single building is broken down into elements. The data related to the properties of these elements is to be given a decoupled structure where information levels refer to the gradual levels of detailing in the process of designing, building and operating a building. The rules for measuring the elements (metrics) are to be standardised as well, so that elements are assigned well defined volumes, lengths, weights etc. All these elements are to be stored as basic digital data on a server that is available for users in a cloud-based solution. Cuneco’s vision also encompasses forming a business model for the long-term maintenance and further development of the classification and especially the accumulation of property data for building elements.

When funding was obtained in 2010, the centre initiated and gradually finalised a series of development projects covering the vision for the entire program. Elements of the classification thus began to materialise. When initialising the project, much of the basic thinking and results obtained from the previous development program (DiCon) were adopted again. This provoked criticism from some players, as they meant that these concepts had proved unusable in practice (including ISO 12006-3, IFC, and DBK 2006);

however, leading players from Cuneco insisted that this basis was fundamentally solid even though it needed updating and further development.

An early analysis focused on user needs and value creation for users. This analysis took more the shape of a stakeholder analysis, conceiving of users as large interest groups, such as architects and building clients. An important result of this exercise was however to generally ask all the development projects initiated to conceptualise user scenarios, making it explicit how the classification and the other developed standards should be used in practical situations.

One design issue is how to create rules for identifying building components. Here the central designer drew on electrical and installations standards based on systems theory, claiming that all building components have a basic function that can be neatly separated and ordered.

> Building component: a delimited part of a building, which in itself or in combination with other building components have a characteristic function in the building. (Cuneco 2012)

The delimitation of such an understanding became more broadly known in the spring of 2012, where a proposal for the Cuneco classification system (CCS) of building parts was launched – first, a system for classification on a relatively aggregate level, and later a set of tables for six structural aspects: type, product, composed product, place, function, and supplementary aspects. It is proposed to separate classification and property data, keeping classification as one property among others for objects. This is also seen as preparation for future use of other classifications. It has had a reputation for being biased towards installation components:

> I don’t understand why they don’t let me reorganise their building component classification, it is rather impacted by an electrical installations view, and it should be different. (Consultant and expert in building data structuring, interview Jan 2016)

Another design issue is the relation between classification and property data. Ekholm (2010) who proposes a reference system for property data, argues for the need for a theory for structuring property data (see also Ekholm and Häggström 2011). The 2012 proposal for property data was a rather independent development of property data with a systematic structure and relation to classification, but it did not have a theoretical foundation. Furthermore, the proposals for classification continue to have an unclear theoretical basis.

Implementing the CCS standard in a Danish hospital project

By the summer off 2012, the first major test project commenced, which involved a large Danish hospital project. The first prototypes and testing activities were developed during the autumn. In this context, the building client became allied with six software suppliers. Together, their six systems cover parts of the information flow from early conceptual design of a building (one system), over detailed design (two CAD-systems and a BIM system), cost and budget calculation (one system), and space management (one system). According to the project manager, the systems are able to identify building components, classify them and sort them. This also involves data flows supported by the chain of the six systems:

> At [the hospital] we are now at classification of rooms and about to classify building components. The six participating IT companies can actually all, almost all, classify. We have made an internal demo of an information flow...: [lists the six systems]. The programs are capable of doing that. With CCS we can classify, sort, identify. The programs are further than I thought. (Project manager, interview Nov 2012)

By January 2013, it became clear however that classification of rooms had been a very rocky process, which led it to be abandoned. The client organisation later communicated that the handling of building components in the tendering process for the earth and foundation works had enabled considerable savings.

During late 2012 and early 2013, the centre experienced serious delays and obtained new funding for implementation. The funding authority also accepted a new prolonged schedule. Recruitment of project managers and project members, as well as living up to internal quality procedures, are frequently cited as the reasons behind delays (interviews).

By January 2013, the information level structure proposal was launched and sent to a hearing. This was the first processual element of standards Cuneco produced, the other elements being focused on the product. The proposal operates with six levels of information, and proposes user 'views' as part of the user interface tackling the envisaged growth of building information along the process of designing and operating a building. These proposals received a number of comments from the broader community, which led to a revision carried out in the spring of 2013. By early autumn, the development of a classification of resources was well under way, and the centre was actively planning and initiating testing projects.

During 2014-2015 a portfolio of test projects were carried out. The central server was implemented and a portfolio of roughly twenty standards was launched. However, the resource classification supported production processes remained very general.

Multiple standards in the Danish building industry

In December 2014 the BIPS industry association carried out a study on the use of building information standards in different stages of the building process. The study was conducted among some of the members of the association, which are architect firms, consulting engineering firms, building clients, contractors and other building actors (Bips 2015: 20). The results show that the CCS operates in a standard landscape where a number of different information classification standards are used. First the Revit software represent 65% of the BIM software in use. Second, proprietary standards score the highest. Then, the Standard for Buildings (SfB) is used about twice as often as the CCS classification which corresponds to a top coverage of 54% in drawing and 27% in operations. The Danish Building Classification (DBK) is used by a roughly equal amounts of people as the CCS classification. Adding to the diversity in the standard landscape, about a third of all respondents claim to use an own system (Bips 2015: 20). Notwithstanding the fact that these numbers will change over time, they give weight to the importance of understanding multiplicity among standards as a current reality in the Danish building sector.

DISCUSSION

The shaping of the CCS system shows three particular ways in which actors define how a building should be understood. The first performative aspect focusses on the internal structure of the building as a product and less on the process that leads to making the product. The focus on internal product features can in a power politics perspective be interpreted through the reconstitution of architect and engineering firm regime in the Danish building industry. The contractors are relatively weaker. They represent the interest in standards for the data on the process and did not manage to establish this as equally important in the standard development process.

Second, the systems theory approach to the internal structure reflects an understanding of building components as having "functions" derived from electrical installations. This performative aspect applies strongly to the installation part of the building, but does not always apply easily to types of building components that have more than one function in a building. Take the example of concrete and wood which in this case have both façade and structure bearing functions and may thus be more difficult to classify. Also it does not support a more compositional shaping understanding as needed by architects. Again, here the very narrowly organised development organisation assured that just a core group had influence on the design of the standard. This group assigned the standard development to a consultant strongly schooled in the installations standards with its functional systems theory approach.

The third performative aspect, the delimitations of the standard, views the process and the product, 'a building' as its cores, and largely disregarding design of agglomerations of buildings, the design of roads and infrastructure. But also important, it structures data with a focus on building components as materiality over components being economical entities or components being something that need to be delivered and in need to be transported.

There are some interesting observations on multiplicity to make as well from this study. First, in the building sector the fragmentation of data leads actors to appeal for a common mediated system. The common standard the designers of CCS aspired to create turned out less of a common and mediated systems as intended. At the same time the BIM software Revit represents a strong market driven standardisation within design. Standardisation is perceived as a solution to fragmentation but may be of limited use as multiple classification systems persist to co-exist. The persistence of multiple standards for building information standards in Denmark caution any aims for a grand homogeneity. When dealing with the politics of shaping of information classification standards, it may be important to recognise that there are different legitimate and relevant structures to collect and save data. What is considered relevant and legitimate will vary depending on the context, and is influenced by different understandings and interests of what a building is or should be. Following Callon (2007), this multiplicity carries on through the implementation phase where again different standards-user networks compete and co-exist. Multiplicity extends beyond the struggle/intersections between different understandings of building, into multiple struggles/intersections. Different understandings of buildings compete and co-exist in multiple locations time over again.

CONCLUSION

We set out to investigate standardisation of data structures using Bowker and Star's (1999) ideas on uncovering the politics of classifying and standardising and Callon's (2007) notion of performativity. Ideas about freely combining unstructured data neglect the hard work and politics involved in data structuring practices. Opening up the shaping and structuring of data is relevant to us because of the material performative effects of data on the development of buildings. Standard shaping can be explained to be about competition and collaboration between professionals, understandings and interests about what data is needed and appropriate to build. In a single standard this has been shown to create certain biases depending on how data and building are perceived. The shaping of the CCS standard has reflected a designer actor alliance with prevalence for the building as a physical entity, physical building properties and structures, and a functional building component definition. Such stabilisation of the understanding of a building comes necessarily at a cost of disregarding other interpretations such as process-based view of building, components with multiple functions, economic and transport features of components.

After stabilisation in a standard, multiplicity persist during the implementation or diffusion phase of a standard. The CCS standard has to work in an environment where several other standards are in use, each reflecting their particular assemblage of actors, interests and understanding on building. Multiple understandings collaborate and compete during the shaping of a standard and in later stages of the standardisation process. Thus, not only are there multiple understandings, there are also multiple locations for such understandings to perform. In conclusion, this paper underlines that visions of homogeneity in data structures to be created through standardisation technology are unreflective of the conditions observed in our case. Here, multiplicity persists as a temporary stabilisation of understanding in a single standard, is followed up by new places for contestation during standard implementation. Holding on to ideals of homogeneity may under these circumstances prevent data use from becoming big in building.

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