PRODUCTIVITY MEASUREMENT - THE SOCIAL CONSTRUCTION OF REDUCTION THROUGH EXPANSION

Christian Koch[1]

[1] *Construction Management, Architectural and Civil Engineering, Chalmers University of Technology, Gothenburg*

A recent large-scale measurement of productivity in Swedish construction involved some 880 respondents and around 500 projects. It covers construction costs, lead time, use of manpower and management in the building of office buildings, public institutions, and civil engineering. Measurements were done through questionnaires and telephone interviews, aspects of productivity such as project start and end, project costs, use of manpower, major disturbances in the process. The results showed a remarkable variety of almost all parameters including cost levels per square-meter building and meters infrastructure (roads, bridges). The aim here is to critically scrutinize the construct of such an investigation. What kind of inclusions and exclusions of concepts and devices are made to stabilize the result? What kind of value does it represent for stakeholders? Drawing on Science Technology and Society concepts, such as qualculative practices and sociology of calculation, it is argued that the social construction of this investigation actually merely represents an everyday event in a society completely penetrated by auditing regimes. Building up the social network of the investigation, involves negotiation of relevance and rigor. Methodologically the scrutiny builds on self-reflection of the main author of the productivity investigation and interactions with researchers and key stakeholders. There is no more need to be modest about productivity measures, than many other big data bombardments of everyday life. Actually, most productivity measures are built on respondent's interpretation. This goes for national statistical bureaus, but it also goes for most productivity research. "Reduction" is and recurrent in the calculation process. It occurs when reducing the value of a building to square-meters, or the initiation and finalization of a building into two dates. "Expansion" is also in play following rules of large volumes of respondents, but performing in a surprising manner as it produces a representation of large variation in building projects.

Keywords: productivity, qualculation, quantitative research, reduction, expansion

INTRODUCTION

Productivity is a central business concept and it receives continual attention in construct management research (Lowe 1987, Chia *et al*., 2012, Nasir *et al*., 2014). Some even celebrate it as a holy grail of construction management. It can be defined as the ratio of what is produced to what is required to produce it, the output divided by the input (Slack *et al*., 2004). However, literature vary widely on how to understand

[1] christian.koch@chalmers.se

Koch, C (2018) Productivity Measurement - The Social Construction of Reduction through Expansion *In:* Gorse, C and Neilson, C J (Eds) *Proceeding of the 34th Annual ARCOM Conference,* 3-5 September 2018, Belfast, UK, Association of Researchers in Construction Management, 677-686.

and measure productivity (Bernold and Abourizk 2010, Lowe 1987). To measure productivity can be described as a piece of business research (Bryman and Bell 2011). This also means recognizing that the research involves measuring people (Bryman and Bell 2011, Doria 2013, Power 2004). Productivity research moreover borrows concepts and thinking from engineering approaches of operation management (Bernold and Abourizk 2010, Slack *et al*., 2004). Doing a productivity investigation implies mobilizing business concepts from the field of productivity (Power 2004) and research concepts for quantitative research such as mean value, variance, validity, reliability etc. (Bryman and Bell 2011).

The aim here is to critically scrutinize the construct of such an investigation. What kind of inclusions and exclusions of concepts and devices are made to stabilize the result? What kind of value does it represent for stakeholders? What kind of negotiations has been carried out? Drawing on Science Technology and Society concepts, such as the concept of qualculative practices, i.e. to enlarge the notion of calculation to include judgment. (Callon and Law 2005) and sociology of quantification and calculation (Doria 2013, Johnson 2012, Power 2004), it is studied how constructs and devices are mobilized, and why some are included and other excluded. It is argued that the social construction of the investigation actually merely represents an everyday event in a society where all aspects of human activity are covered by auditing regimes. Building up the social network backing the investigation, involves negotiation of relevance and rigor, but also means drawing on the wider context of the measuring. Methodologically the scrutiny builds on self-reflection of the main author of the productivity investigation and interviews with key stakeholders. The investigation process has been very long and the focus here is mostly on the calculation process during analysis and reporting, carried out from September 2017 to March 2018. Two strongly interrelated and synchronized investigations were made, following the same investigation model and research design. They were analysed and reported at the same time. In total 880 respondents and 505 unique building projects. The building and infrastructure investigation obtained answers from 369 projects from clients and site managers. The HVAC investigation got answers from 210 project managers. The contribution of this paper is, that it is one of a few construction management research accounts of the actual process of researching a quantitative investigation. It is a journey into the "soft belly" of science, i.e. into the processes where apparently unambiguous research results are socially shaped (Latour and Woolgar 1986).

METHOD

The study draws on a freshly finished quantitative survey in the Swedish construction industry. The study was carried out by the authors in collaboration with others, but the present analysis builds on an autoethnography approach in the sense of being an autobiographical account (Chang 2008, Johnson 2012). The autoethnography was carried out by constructing a narrative of the research calculation process, supported by document analysis (numerous draft of the central documents; the two manuals, the two analyses and the two reports). Moreover, an ex post mapping of the process from commencing the analysis to finalizing the report, week by week activities was carried out using an excel spreadsheet to organize the different experienced activities. There is a focus on the closest stakeholders: project group members, and the principals, which are two employers' associations and an industry/university center for management in construction. The analysis was carried out drawing on several levels of hermeneutics (Alvesson and Skoldberg 2009). In an autoethnographic context the critical reflection of

one's own frame of thinking comes to the fore and it has been attempted to link this into broader contexts of research and reflective thinking (Alvesson and Skoldberg 2009, Chang 2008).

It is a limitation that the author was not part of the initialization of the research, but merely the last phase (from October 2017). The report is by April 2018 still to be launched in the broader public and the broader interaction with stakeholders has not occurred yet.

Framework of Understanding

The framework of understanding assembles some of the constructs, devices and processes that are supposed to characterize a quantitative piece of research. The understanding is processual rather than static, drawing on arguments from new sociology of economy, where calculation is performed. Initially a state of the art method book; Bryman and Bell (2011) is used to identify the constructs and devices that characterize the ideal quantitative investigation. Then Michel Callon and colleagues are used to present some of the new sociology of economics concepts usable on the quantitative research process. Finally, we draw on two studies of performance Powell (2004) and Doria (2013).

The ideal quantitative investigation

It quickly surfaces that Bryman and Bell (2011) is not describing one ideal process of quantitative research, but many. Moreover, there is far more concepts and devices offered that an average quantitative investigation would adopt. Bryman and Bell (2011: 168) is themselves explicit about this limitation using Cicourel s concept of 'measurement by fiat', meaning that most measures use assumptions of validity and reliability rather than systematic test. The research method of a quantitative investigation is presented as 11 steps (Bryman and Bell 2011: 155)

Table 1: The process of quantitative research (Bryman and Bell 2011)

Step no.	Activity
1	Theory
2	Hypothesis
3	Research Design
4	Devise measures of concepts
5	Select research sites
6	Select research respondents
7	Collect data
8	Process data
9	Analyze data
10	Findings/conclusions
11	Write up findings/conclusions

During step 5 and 6 the issue of sampling is important. How does it correspond to the selected field? Is it representative? It is usually assumed that the size of sampling relates to its validity. As Bryman and Bell (2011: 194) note "it is the absolute size of a sample which is important, not the relative….Increasing the size of a sample increases the likely precision of a sample". One can talk about the law of large numbers, i.e. the belief that the validity of a quantitative investigation is levered with a higher number of respondents, making research designers inclined to expand their scope of investigation and strive for high numbers of respondents (Bryman and Bell 2011).

During step 7 and 8 the issue of response rate surface. Bryman and Bell (2011) suggests that the response rate should reflect not only the distribution answering/ non-answering, but rather usable answers.

During step 9 this issue of validity and reliability has to be elaborated. Bryman and Bell (2011) point to five types of validity. Here face validity is important, meaning checking whether the measure reflects the content of the concept in question. But also, internal validity that checks whether claimed causality holds, and external validity, which evaluates whether findings can be generalized beyond the specific research context. Finally, Bryman and Bell (2011) mentions ecological validity reflecting whether a study is able to be applied to everyday life. While ecological validity is possibly rarely used, it raises important questions of abstraction and reduction when it comes to productivity studies.

Reliability evaluates the consistence of a measure of a concept (Bryman and Bell 2011). Two main aspect are important here; stability and internal reliability. Stability evaluates whether the measure is stable over time and internal reliability values whether indicators, scales and indices are consistent. A possible risk is the occurrence of outliers, extreme data that might be occurring because of measurement mistake or because they belong to another phenomenon altogether (Rousseeuw, and Leroy, 1996),

Also in step 9 choices of form of analysis is made. Bryman and Bell (2011:357) discuss univariate and bivariate analysis. Univariate analysis takes one variable at a time, where bivariate investigates the relation between two variables, interested in uncovering whether there is causal relationship between them. Bryman and Bell (2011) underlines the risks related to confounding relationship and causality.

Sociology of calculations

The new sociology of economy is a research program with many aspects. However here it is the critical sociological examination of calculation processes that are of interest. Callon and Law (2005) discuss calculation as being "qualculative", meaning that every calculation is tainted with and inseparable from judgements. Calculative practices according to Callon is a range of practices that must be understood as being constitutively open, and which also incorporate practices that are neither rigid nor rigidly predetermined. 'Quantitative methods, qualitative procedures, professional judgments, or the tinkering of daily practice, all of these are qualculative' (Callon and Law 2005: 731).

Qualculative processes can develop in indefinitely many ways and their boarders are fluid. Calculative processes also feature valuation; social practices where the value or values of something are established, assessed, negotiated, provoked, maintained, constructed and/or contested (Doganova *et al*., 2014).

Power (2004) discusses the foundations of measurement in counting practices, and their inherent reductionism. Measuring is made possible through an abstraction from many specific qualities of the phenomenon measured, it is rendered measurable through classification and calibration of quanta of data which reduces/transforms the phenomenon into parameters.

Power argues (2004: 769) that measurement distinguishes itself from judgment or guessing by being independent of who is doing it. Measurements are in principle replicable, impersonal and objective.

Power (2004) also introduce the idea of first- and second-order measurement (meta-measurement). Second order measurement consists of particular institutions of counting and data production, and as related dense networks of calculating experts operating on these numbers within specific cultures of objectivity. In other word calculation processes does not occur in a vacuum, they are embedded in broader societal phenomena. Similarly Johnson (2012) point to the entanglement between identity building of researcher and calculation. Synthesising, when applying the notion of qualculative practices on the research process of quantitative investigation, it is viewed as an entangling and mobilizing of actors and a series of concepts and devices meant to stabilize the results. Some of the more important concepts and devices are replication, reduction, expansion, validity, reliability, uni- and bivariate analysis. In the research calculation practice there is an urge for expansion yet doing it by reducing and abstracting. Moreover, calculation research practices also involve selecting and deselecting devices and concepts. The non-adoption of devices is recurrent and the second order measurement of productivity characterized by the absence, non-adoption of many of the "ideal research process" best practices. One can point to the neglect of resource limitation of the research as a key explanatory factor of the many non-adoptions.

The Counting and Calculating Process of Productivity Measurement

The research design built on an investigation model, made in a previous study (Josephson 2013). It orders a set of features of productivity in construction projects. In a positivist understanding these are factors or parameters. A main property of the model is an ambition to measure productivity as more than cost per square meter. Processual and soft aspects are entered, looking at disturbances during the process and performance of the project organisation members, i.e. the client, the consultants, the contractor, and the suppliers.

The design of the questionnaire led to a set of questions, where most had pre-given categories for answers. However, there were also a series of questions where facts and figures was demanded, as well as some open questions, relating to stated definitions, such as on client costs, and partnering. Finally, a few questions were open without definition, including questions on disturbances and learnings. The design and operation of data collection was done in autumn 2014. Arriving at the preparation of analysis, the project budget had resources for 1000 man hours distributed as 550 hours for an analyst and 450 for a combined project manager, analyst and report writer. On this basis it was decided to focus on the calculation of basis correlation and to not adopt more advanced statistics. Once the data collection was finalized it was possible to establish the response rate. For the building and investigation, the number of respondents compared to the number addresses was at 66%, whereas in HVAC it was 42%. However, these overall figures gloss over a far more differentiated response rate, differing down to the single question. This was tackled by entering the number of responses for each calculation. This practice was used throughout the report. A central decision was to follow a previous investigation to enable comparison. This implies a high level of fixation of calculation and analysis, possibly around 90 %. Given the type of calculations and analysis needed it was decided to do the analysis using Excel and not statistical software packages such as SPSS 4 or SAS. The design of planned calculations followed the previous investigation, but modified it where the research group evaluated that other calculations was needed. The planned calculation was understood as "descriptive statistics", thus mainly attempting to map simple relations characterizing the field. It was planned to carry out roughly 70 main

calculations, uni- and bivariate and around half of them presented as diagrams with columns in bar charts, and half as tables. A manual was elaborated describing step by step what analysis to do, for example specifying which parameter from each project should be entered in a bar chart or which 1 by 1 parameter relation should be calculated and depicted. The planned number of correlations to be analysed by October was the same for the Building and infrastructure investigation and the HVAC investigation: 32 tables and 35 figures/diagrams, and 30 more were expected. An early control issue was the number of respondents versus number of projects as well as overlaps of respondents and projects. There were thus cases with more than four respondents from one building projects. Most of the control of validity became an issue of "face validity", going through the data material and evaluating their likeness of being correct. However, the early calculations revealed extreme cases and this triggered further evaluation of validity see below. During calculations a work mode emerged: One analyst did proposals for the various univariate and bivariate analysis and the other validated the calculation and occasionally proposed changes and follow up analysis. Also at this time a third analyst was included in the project team to carry out the HVAC analyses. This was done due to the experience of delay and overrun vis a vis the scheduled deadline. Early in the calculation it was decided to split the calculation according to four types of building; institutional space, groups of villas, offices and infrastructure. Moreover, the manual of planned calculation became an emergent document adjusted and enlarged as the calculation went on. Two main surprises occurred when doing the calculation of a relationship was done. First the occurrence of variance almost any uni- or bivariate analysis came out with large variation in figures. It was maintained to calculate mean and median values even if these appeared less relevant. Second a few projects exhibited extreme responses, i.e. far more man hours spent per square meters and more than 3 hours management time per employee hour on site. An emerging analysis document became a solidifier for the process and gradually transferred into draft reports. Analyzing also challenged the analysts' assumption and common sense when it came to cost of the client, and cost of (processual) disturbances. While cost of disturbance was reinterpreted a factor 100 because of the questionnaire row of questions inferring a wrong metric of the answee, client costs were excluded as responses in many cases were the same or higher than the building sum. The reporting helped establishing overview and triggered further calculations. The report went through around 15 versions. While a large number of methodological insecurity has surfaced during the calculation processes relatively short method sections was elaborated, which however serve as important solidifying devices. At this point the number of total number of univariate calculation and correlation calculations/bivariate analysis in the shape of diagrams has arrived at 59 and the number of tables at 66 in the building infrastructure analysis. The HVAC analysis arrived at 41 diagrams and 43 tables (February 2018). Perhaps not surprisingly, the project organisation experienced a budget overrun at around 400 hours for analysis and reporting. In March and April 2018, first preliminary results and then the final results were communicated. Stakeholders where presented with main results at four occasions. These events established certain claims of the investigations, getting them closer to "facts" and also involves production of face validation when stakeholders questioned or confirmed findings.

ANALYSIS

The analysis does not systematically go through the series of counting control and calculations carried out (Power 2004). Instead a few main points are made. Focusing on replication, reduction, expansion and the wider context of productivity measure.

Replication

It is completely central for the process that it was designed and also carried out as a replication of a previous study. A long set of designs and analysis, i.e. was rendered calculative and concerns of possible inclusion or exclusion could simply be answered by "do it as it was done last time". But the effect of replication does not burn down to efficiency. Rather the replication works as an expansion mechanism as well as stabilizer. Where the investigation does not live up to "stability" in a Bryman and Bell (2004) fashion it certainly does in a Callon and Law (2005) fashion. Where traditional quantitative research claims stability, Callon and Law (2005) expects this to be a process and an answer to open questions about where the qualculation negotiations might take the stabilization process. Apart from processual stabilization, the replication even performs other effects. Especially during the planning and processing of the analysis, there were an inclination by actors to follow the previous investigations proposals as presented and communicated. A mechanism that can be labelled the power of default (author reference). Even if the adoption led to a number of worried questions as to whether to do the same, it was frequently done so.

Reductions

Throughout the process a number of reductions were carried out, reducing the value of a building to cost per square-meter, the value of a road into cost per kilometres, the initiation and finalizing of a building into two dates, And reduction through transformations such as to transform support from a headquarter to a construction project by measuring the number of man-hours spent in the contractors headquarter on a given project. And to transform the performance of the project organisation into measuring selected project participants understanding of each other's performance

However less reductive measures were also employed. The questionnaire used, also had open questions, such as "mention your largest disturbance in the building process" or "what was your main learnings of the project? Asking open question like that opens for a plethora of types of experiences, providing several surprises compares to implicit hypothesis in the research. However, it should be noted that the very situation of participating in a telephone interview and filling out a questionnaire is abstracting from the lived practices of the respondents (Bryman and Bell 2011). The reduction mechanism also relates to as to whether a respondent is fully articulate of his/her lived experience. The exercised reductions point to however, that it is not reduction per se which is problematic but rather the trustworthiness of the reduction, related to ecological validity (Bryman and Bell 2011), i.e. does the reduction appear plausible, which links into the second order of calculation (Power 2004) see below. One can bear in mind the anecdote of the Chinese map makers, which decided that the best map would be at 1:1 scale. It is this important to distinguish reduction from reductionism. The question about internal validity, i.e. whether claimed causality holds, confronted the research with the dilemma/ challenge of replicating a previously done research model. This model contains a series of implicit hypothesis about how productivity is produced and what factors influence it. These were reflected upon one by one, but most calculations were reproduced, and doubts and deviances articulated in the written interpretations that accompanies the calculations in the report. It was

not attempted to evaluate the external validity which qualifies whether findings can be generalized beyond the specific research context. And this is only one example of a series of non-adoption of devices: explicit hypothesis, confidence level, calculated variance, instruments for bivariate causality analysis etc. This actually illustrated a Callonian fluidity, i.e. a plasticity of concepts, as it appeared as a choice to be made, whether or not to adopt the devices. However, Power (2004) would probably claim that the second order of calculation; institutionalized ways of calculating productivity was performing here. Indeed, other productivity research internationally (Bernold and Abourizk 2010, Bröchner and Olofsson 2006, Chia *et al*., 2012, Crawford and Vogel 2006, Nasir *et al*., 2014) does not represent a remarkably different exercise or level of rigorous methods of research. Indeed, the adopted level of use of these concepts are probably aligned with the international productivity research and measurement community, or more important; the authors of this investigations assumes this is case, and thereby stabilize their own analysis with this assumption, which in turn tend to stabilize over time if not challenged. By neither choosing a standard tool for the e-mailed data collection, like survey monkey nor for the calculations like SPSS 4 or SAS, the calculation process became more open and deliberate constructing. The software packages represent strong devices in a calculation, as the software provide strong proposals for the calculations as default. The calculation process thus cancelled this form of power of default (Koch 2010), i.e. power of pre-set parameters.

Expansion lead to "performing" variance

Paradoxically by enlarging the number of respondents a landscape of enormous variance of building processes was produced. An example is the building and infrastructure types. Roughly speaking the 500 projects needed to be grouped in 20 piece groups when it comes to types such as schools, villas, bridges, pipelines etc. Variation in the calculation of costs showed differences between highest and lowest measure higher than 50%. So while it was expected to underpin one type of ecological validity, about productivity figures what turned out was another ecological validity; a representation of near-uniqueness of the building projects. So, while the research design assumed that by expanding to the 500 largest projects in Sweden in 2014 would imply stability in the data, this did not perform. It can be discussed whether the outliers, the extremes should have been let out. Outliers can be defined as data that deviates significantly from the rest, as if it were generated by a different mechanism (Rousseeuw and Leroy 1996). The outliers did get extra attention and the validation did lead to deleting some of them. However, cases of extreme cost are not seen as belonging to another phenomenon as suggested by Rousseeuw and Leroy (1996). Rather in some cases it was interpreted and stabilized as confirming a pattern of a few extreme project in the field of Swedish building projects.

Productivity in a wider context

Along with Power (2004) we would claim that the analysis calculation process is not carried out in isolation. Quite the contrary; it interacts and entangles not only with other participating project members also working on the investigation, but with a research community nationally and internationally, the societal institution commissioning the productivity measure etc. In what Power (2004) calls second order calculation. Particular institutions of counting and data production, operating in dense networks of calculating experts on these numbers within specific cultures of objectivity (Jones 2012). Construction Excellence in an UK context is an example of such an institution, but the institutional presence of productivity measures in a sense merely represent an everyday event in a society completely penetrated by auditing

regimes, i.e. measuring cuts across almost all spheres of contemporary life (Doria 2013). Not only so, they all represent reduction of qualities of social life and many involve limited rigour viewed from a research point of view. What kind of value does it represent for stakeholders? So far relatively few interactions have been done. On this limited basis it appears that the investigation will trigger debate and dissent as much as consent and alignment. The "variation" point and the occurrence of extreme projects appears to generate resonance among stakeholders. This even alludes to another aspect of qualculative practices, namely the "symbolic" and aesthetic strength of visualized figures (D'Adderio and Pollock 2012). Here the visualisation of variance and extreme projects occur in coloured diagrams. This stabilization phenomenon has not been possibly to study systematically yet. Nevertheless, there is no more need to be modest about productivity measures, than many other big data bombardments of everyday life. Actually, most productivity measures are built on respondent's interpretation. Of course, this goes for national statistical bureaus, but it also goes for most productivity research. Therefore, criticism of this method and speculation on that respondents have misunderstood, misinterpreted etc., are prone to occur by this investigation as well. Thereby the likely entanglement with stakeholders is possibly more ceremonial as a celebration of the importance of productivity.

CONCLUSIONS

The aim of this contribution was to critically scrutinize the construct of a quantitative investigation, viewing it as a process of calculation and stabilization. The framework of understanding drew on quantitative research method and new economic sociology. A series of reductions was made in the investigation process, making the researchers and the stakeholders uneasy. However, it was claimed that it is not reduction per se, but rather the trustworthiness of the reductions made that are important. In other words, reductions are a necessary research tool and reductions is not reductionism. The device of "expansion", including more data in the investigation targeting the 500 largest projects performed in at surprising manner. It was expected to underpin an ecological validity, but turned out as a manifestation of near-uniqueness of the building projects. So, while the research design assumed that by expanding to the 500 largest projects in Sweden in 2014 would imply stability in the data, this did not perform. Rather another representation of the Swedish building sector occurred, namely the narrative of the unique building project with remarkable outliers. The analysis reveals the generation of data, the control of data, the calculation done upon them and their communication in "stabilized" report form as a pretty recurrent qualculative practice. The processes exhibit fluidity as predicted by Callon and Law, even if stabilization devices such as replication, reduction, validity, univariate and bivariate analysis were enrolled into the calculation processes. Measuring productivity is indeed about human and non-human interaction, and cannot as operation management want to think it, be reduced to measuring systems of building processes.

REFERENCES

Alvesson, M and Skoldberg, K (2009) *Reflexive Methodology New Vistas for Qualitative Research Second Edition*. London: Sage.

Bassioni, H, Price, A and Hassan, T (2004) Performance measurement in construction. *Journal of Management in Engineering*, 20(**2**) 42-40.

Beatham, S, Anumba, C, Thorpe, T and Hedges, I (2004) KPIs: A critical appraisal of their use in construction. *Benchmarking: An International Journal*, 11(**1**) 93-117.

Bernold, L E and AbouRizk S M (2010) *Managing Performance in Construction*. Hoboken, NJ: John Wiley and Sons.

Bryman, A and Bell, E (2011) *Business Research Methods*. Oxford: Oxford University Press.

Bröchner, J and Olofsson, T (2012) Construction productivity measures for innovation projects. *Journal of Construction Engineering and Management*, 138(**5**), 670-677.

Crawford, P and Vogel, B (2006) Measuring productivity in the construction industry, *Building Research and Information*, 34(**3**), 208-219.

Chia, F C, Skitmore, M, Runeson, G and Bridge, A (2012) An analysis of construction productivity in Malaysia, *Construction Management and Economics*, 30(**12**), 1055-1069.

Callon, M and J Law (2005) On qualculation, agency and otherness. *Environment and Planning D: Society and Space*, 23,717-733.

Chang, H (2007) Autoethnography: Raising cultural consciousness of self and others. *Methodological Developments in Ethnography*, 12, 207-221.

Crawford, P and Vogel, B (2006) Measuring productivity in the construction industry. *Building Research and Information*, 34(**3**), 208-219.

Doganova, L, Giraudeau, M, Helgesson, C-F, Kjellberg, H, Lee, F, Mallard, A, Mennicken, A, Muniesa, F, Sjögren, E and Zuiderent-Jerak, T (2014) *Valuation studies and the critique of valuation*. *Valuation Studies* 2(**2**), 87-96.

Doria, L (2013) *Calculating the Human: Universal Calculability in the Age of Quality Assurance*. Palgrave Macmillan. Basingstoke.

Johnson, L (2012) An inquiry into inquiry: Learning to become a literacy researcher. *English Teaching: Practice and Critique*, 11(**2**), 81-93.

Josephson, P E (2013) *Produktivitetsläget I Svenskt Byggande 2013*. Göteborg: Sveriges Byggindustrier.

Koch, C (2010) *Decisions on Shaping Enterprise Resource Planning - from Picking a Hammer to Living a Community*. PhD Thesis. Tilburg University. Tilburg.

Latour, B and Woolgar, S (1986) *Laboratory Life: The Construction of Scientific Facts*. Princeton: Princeton University Press.

Lowe J G (1987) The measurement of productivity in the construction industry. *Construction Management and Economics*, 5(**2**), 101-113.

Nasir, H, Ahmed, H, Haas, C and Goodrum P M (2014) An analysis of construction productivity differences between Canada and the United States. *Construction Management and Economics*, 32(**6**), 595-607.

Pollock, N and D'Adderio, L (2012) Give me a two-by-two matrix and I will create the market. *Accounting, Organizations and Society*, 37, 565-586.

Power, M (2004) Counting, control and calculation: Reflections on measuring and management. *Human Relations*, 57(**6**), 765-783.

Rousseeuw, P and Leroy, A (1996) *Robust Regression and Outlier Detection 3rd Edition*. Chichester, West Sussex: Wiley.

Slack, N, Chambers, S and Johnston R (2004) *Operations Management*. London: Pearson.