# PROCURING BUILDING INFORMATION: DEVELOPING A FRAMEWORK FOR HIGH LEVEL INFORMATION PURPOSES IN EMPLOYER INFORMATION REQUIREMENTS

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Building Information Modelling (BIM) is becoming increasingly popular across the Architecture, Engineering, Construction and Operations (AECO) industries to manage and deliver built and digital information assets. A key component of BIM is the effective elicitation and translation of client needs into information requirements that can be readily used by AECO professionals. In the UK, the Employer Information Requirement (EIR) is a key document for procurement in BIM-enabled construction projects which specifies such information requirements. However, the literature indicates significant opportunities for the production of more effective, client focused EIR documents that explicitly link high-level organisational requirements with data systems. This paper is part of an ongoing study that investigates information procurement by clients in the Higher Education and social housing sectors in the UK, using a critical realist approach. A preliminary grounded thematic analysis of eight EIR documents reveals a lack of high-level, performative information purpose. To support a greater level of information purpose in future EIRs, the documents are then analysed deductively based on Beynon-Davies' (2010) information theory, leading to the development of a much-needed conceptual framework. Our framework comprises four main dimensions: information purpose, information relationships, information structure, and informative acts. Together, the conceptual categories both enable and encourage systematic and systemic consideration of information purposes. We conclude with recommendations for more purposeful EIRs that reflect client needs from the outset of BIM adoption in construction projects.

Keywords: BIM, information procurement, organisation information requirements

## INTRODUCTION

The digitisation of the built environment through Building Information Modelling (BIM) is growing worldwide, and notably across Europe (Panteli *et al.,* 2020). Arguably the most critical success factor for the integration of client information needs in BIM processes is the early engagement of clients at the pre-design stages (Bolpagni and Ciribini, 2016). In the UK, information requirements are termed "Employer Information Requirements" under PAS 1192, which was replaced in 2019

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by "Exchange Information Requirements" under ISO 19650. Likewise, "employer" is now termed "appointing party" under ISO 19650, although both terms can also denote a "client". This paper adopts the older terminology, as the EIR reports analysed here pre-date ISO 19650. As a key pre-tender document, the EIR is intended to ensure delivered information assets match the targeted deliverables and thereby meet client requirements as closely as possible (Ashworth *et al.,* 2016; Cavka *et al.,* 2017). However, the effective determination and expression of client needs in EIRs and their integration in subsequent stages faces severe challenges. Obstacles seem mostly organisational and sociological rather than technical (Cavka *et al.,* 2017). As highlighted by the BS EN ISO 19650 standard, "[the] absence of clearly defined information requirements may increase the likelihood that delivery teams will not be able to provide complete and correct information to support decision-making and project progression" (UK BIM Alliance, 2019, p. 22). Critical success factors include adequate education, training and experience of BIM processes and EIRs among clients in the FM industry, and the capacity for all stakeholders to collaborate in delivering the right information at the right time, from design to delivery of physical and/or digital assets (Tucker and Masuri, 2018).

This working paper proposes a much-needed conceptual framework based on the information theory by Beynon-Davies (2010) to help bridge performative, high-level information needs with data systems for information procurement in construction. Following initial, grounded thematic analysis of 8 EIRs conducted in the UK, the preliminary findings reveal that, except for one document, the EIRs do not explicitly state the strategic (or high-level) purposes of the information requirements. This paper then adopts the theory by Beynon-Davies (2010) to perform a deductive thematic analysis of the 8 EIRs. The paper contributes valuable conceptual insight to help bridge organisational needs with BIM applications by way of EIRs that are more purposeful in their specification of information requirements. Clarity of purpose in information requirements is primordial to ensure that EIRs achieve their full potential of helping to translate client needs into practical information needs usable by professionals in the construction and FM industries.

## LITERATURE REVIEW

### Classifying client information requirements

The primary role of information in construction processes is to enable strategic and operational decision-making during the full life cycle of built assets (Kamara *et al.,* 2002). Client information requirements essentially relate to clients' needs and purpose in procuring information related to built assets. Information requirements in construction elude simplistic definitions, as client needs depend on multiple context-specific factors. The Employer Information Requirements (EIR), now termed 'Exchange Information Requirements' in the BS EN ISO 19650 standard (UK BIM Alliance, 2019) which replaced PAS 1192-2:2013 in 2019, are a key pre-tender document that can help to ensure client needs are met at all stages of a built asset's life cycle by specifying the information deliverables required. ISO 19650-1 Clause 5.1 stipulates that "the appointing party [e.g. client] should understand what information is required concerning their asset(s) or project(s) to support organisational or project objectives" (UK BIM Alliance, 2019). Information requirements should relate to project, asset and organisational objectives and thereby consider both Organisational Information Requirements (OIR) and Asset Information Requirements (AIR), two key documents which are intended to inform the content of EIRs. According to the

standard for asset management systems BS ISO 55001:2014, overarching information requirements comprise: A) roles and responsibilities for information management; b) processes, procedures and activities for information management; c) risks, including the impact of quality, availability and management of information on organisational decision making; and d) the exchange of information with stakeholders, including information quality, information attributes, method of exchange and the timing of information exchange (BSI, 2014, p. ix). EIR templates commonly classify requirements as technical, management and commercial, which complement the client requirements specified in the Organisational Information Requirements (OIR), Asset Information Requirements (AIR), and Project Information Requirements (PIR) (UK BIM Alliance, 2019). Notwithstanding existing standards, protocols and guidance, EIRs do not seem to fully capture clients' information needs, which severely hinders the purposeful procurement of information in BIM (Cavka *et al.,* 2017).

**Bridging organisational and technical requirements**

Current practices in EIR elicitation and prioritisation signal significant challenges for the integration of client needs throughout the life cycle of assets (Dwairi *et al.,* 2016). Clients in FM often do not know which requirements to specify in BIM or how to express them, and often lack experience and training concerning BIM processes, including for operations and maintenance (O&A) (Ashworth *et al.,* 2018; Cavka *et al.,* 2017). Furthermore, requirements elicitation and validation methods need to be flexible and iterative (Patacas, Dawood, Greenwood, and Kassem, 2016). The most significant pitfalls to effective EIRs relate to organisational, management, strategic and sociological issues (Ashworth *et al.,* 2018; Cavka *et al.,* 2017). Adequate involvement of clients at the pre-design stage is also key to ensuring their needs can be integrated in BIM systems and processes (Tucker and Masuri, 2018).

A number of technical terms are used to facilitate a standardised delivery and quality of information in BIM, as detailed within EIR documents. For example, the Royal Institute of British Architects' (RIBA) Plan of Work (PoW) 2013 timeline comprises eight reference stages for the construction and delivery of built assets in UK (i.e. Stages 0-7). Within BIM, the PoW is widely used in conjunction with Levels of Definition (LOD) to indicate when and in what level of detail different information should be delivered (a process also known as 'data drops'). The LOD defines the level of granularity or intensity required for a type of information "described in terms of geometry (levels of detail) or information requirements (levels of information)" (Kell and Mordue, 2015). In general, the closer a delivery stage is to the final built asset, the greater the Level of Detail to be expected for information. However, the term 'LOD' is ambiguous, as it can both denote the Level of Detail and Level of Definition, which provide different scales with which to specify the required intensity of information (Tolmer *et al.,* 2017). Finally, Plain Language Questions (PLQs) are questions within EIR documents that avoid jargon to enable clients to translate organisational needs into technical information requirements that can then be used by AEC professionals during the project (Dwairi *et al.,* 2016).

Methods inspired from Requirements Engineering (RE) can enable the exploration, elicitation, analysis and validation of client requirements in a more flexible, simple and contextually adapted manner than many standardised, generic EIR templates (Cavka *et al.,* 2017; Dwairi *et al.,* 2016). Requirements Engineering can be described as: "the subset of systems engineering concerned with discovering, developing, tracing, analysing, qualifying, communicating, and managing requirements that define

the system at successive levels of abstraction" (Hull *et al.,* p. 8). Goal-oriented RE can successively break down high level organisational goals into choices about specific technical requirements (Davis, 1982), provided the use of consistent methodologies (Lamsweerde, 2001). In BIM, Plain Language Questions similarly help to translate high-level needs into specific information requirements (Dwairi *et al.,* 2016). Although the literature indicates a significant potential for EIR elicitation to draw on RE methods, the fields of software engineering and information systems development where RE originates differ significantly from the construction industry because they can be more linear and predictable. Particularly, construction processes can feature a greater number of stakeholders and diversity of goals, contrasting organisational workflows, as well as potential conflicts in information requirements between project clients and the different AEC professionals (Cavka *et al.,* 2017; Tucker *et al.,* 2017). Notwithstanding, we use the information theory by Beynon-Davies (2010) as it compellingly highlights the importance of a clear purpose for information requirements and describes how effective information systems bridge performative, high-level information needs and data systems. This point is further elaborated into a conceptual framework at the end of the working paper.

## METHODOLOGY

This paper is part of an ongoing research project that explores the purpose and procurement of information in BIM. For this research a critical realist methodological stance (Bhaskar, 2008) is taken to distinguish the real world from the observable world. In this viewpoint, the observable and social world such as the one that comes from documents, events and practices are caused by underlying theoretical mechanisms and structures. Through theory building, we seek to provide a better understanding of these unobservable structures. With this methodological viewpoint, EIR documents have been analysed to explore whether and how the performative, high-level information needs of the project clients were formulated. Data analysis was carried out through a desktop study of EIRs and information delivery schedules from 8 projects in the UK. These documents were prepared by consultants and only used for project delivery purposes. Unlike publicly available EIR documents that were published as best practice case documents, the collected data contained sensitive and commercial information together with inherent gaps and errors. Therefore, client and project related information is anonymised for ethical reasons. Table 1 provides a summary of the presented data for this study.

*Table 1: Reviewed Employer Information Requirements*

| Client | Sector | Project and the year of preparation |
|---|---|---|
| C1 | Education sector | P1 - 2016 |
| | | P2 - 2017 |
| C2 | Social housing | P3 - 2019 |
| C3 | Education sector | P4 – 2018 |
| | | P5 - 2018 |
| C4 | Education sector | P6 - 2015 |
| | | P7 – 2018 |
| | | P8 - 2018 |

This research investigates how the information within the documents was structured and assesses the degree to which the purpose of the information requirements was clearly stated. The EIR documents were first analysed by inductive thematic analysis following Braun and Clarke (2006). The initial codes consisted of the sub-headings in

the EIR and their content was extracted verbatim as they appear in the EIR documents (example of one code: 'EIR technical requirements') following a flexible grounded theory approach (Charmaz, 2006). The preliminary coding revealed the absence of a clear purpose for the information requirements across nearly all EIRs. The information theory by Beynon-Davies (2010) explores ways to bridge performative information with data systems, and provides the basis for the deductive analysis, as presented in the next section. The next steps in data collection will collect the views of clients and BIM managers through semi-structured interviews to shed additional light on the real practical processes behind the production of the EIRs.

## FINDINGS AND DISCUSSION

*Deductive analytical categories*

The findings concerning the 8 reviewed EIRs are structured thematically into four sections: i) information purpose; ii) information relationships; iii) information structure; and iv) informative acts. All four analytical themes are inspired by the information theory by Beynon-Davies (2010). The first three sections are primarily empirical. The initial coding of EIRs revealed a lack of high-level purpose for information requirements, justifying the need to explicitly consider this shortcoming. 'Information relationships' denotes the fact that sets of meaningful, purposeful information are related to each other rather than purely discrete. Preliminary analysis revealed that the information requirements were structured based on function (i.e. technical, management or commercial, as standard in EIR templates in the UK) rather than relational purpose. Thirdly, the structure of the EIRs is largely determined by the need for specific data systems. This data-driven approach to information requirement procurement makes the EIRs highly technical documents where information purposes are overlooked or get lost in the technical details. The last section explores how information requirements can gain their significance through integration in information systems, a process referred to as 'informative acts', based on Beynon-Davies (2010). Reconceptualising information requirements in EIRs as informative acts enables translation of high-level performative requirements for stakeholders at each stage of construction and into FM. The observed lack of performative information purpose in the EIRs calls for a conceptual framework to ensure a more purposeful procurement of information requirements.

*Information purpose*

The investigated EIRs feature two main levels of information purpose: i) high-level, organisational and project-related objectives, termed 'client strategic purpose', 'client objectives' or 'project scope' across the different EIRs; and ii) specific functional or technical objectives. First, project descriptions of the expected built asset encapsulate higher-level organisational objectives. Overall, however, the EIRs specify generic strategic information needs that lack contextuality and do not provide an explicit purpose for the required information in terms of client needs. P3 and P6 are more detailed in terms of asset use, referring specifically to end user needs and intended use of the expected facilities. In contrast, the other 6 EIRs articulate client strategic purposes more narrowly in terms of benefits of BIM systems that are commonly expressed in standards and guidance documents (e.g. PAS 1192-3, NBS BIM Toolkit). It may be that specific user needs and other requirements of the built asset are expressed elsewhere, but no explicit relationship is made to this in the EIRs. Among others, recurrent strategic objectives across all 8 EIRs include: meeting BIM Level 2 maturity, more rapid design appraisal and coordination, reduced building costs, optimisation of the asset's life cycle, relevant construction simulation at each stage, or

providing a data source for asset management, among others. Following ISO 19650, the specified objectives can be thematically re-categorised as project-related (e.g. better design, coordination, resource efficiency), organisational (e.g. improved decision-making and communication for project delivery), and asset-related (e.g. marketing purposes, ensuring client and user acceptance and usability), as would apply for P3. RIBA PoW provides the basis for the information delivery schedule for all EIRs, yet only P3 lists relevant Levels of Definition (LODs) and Plain Language Questions (PLQs) for each PoW stage.

Second, specific functional objectives relate to technical and management information requirements, as well as information exchange requirements. These are more thorough and project specific in P3. The purpose of the functional information in all other EIRs is typically succinct. In the latter, choice and responsibility are often left to the supplier. For example, Clients 1 and 3 state the following requirement for client model viewing: "The contractor should define how they are going to share the model with the client in order for them to view the design. The client is happy to use a recommended free viewing platform." In turn, the amount of description about functional objectives appears to relate to the degree of customisation of EIR templates, which varied across the projects. P3 demonstrates the highest level of customisation to suit the individual client organisation, project and sector. The EIRs mention the clients' desire or potential desire to review the BIM models during construction, but do not provide details of reviewing compliance to clients' organisational needs. Compliance focuses instead on information exchange and other technical and management standards (Zadeh *et al.,* 2017).

In all, analysis of the EIRs reveals opportunities for a more explicitly purposeful requirement and procurement of information. P3 attempts to explicitly articulate client information needs consistently and systematically to guide all project-related, organisational and asset-related requirements, as recommended in the literature (Dwairi *et al.,* 2016), but as noted above these focus primarily on project delivery and BIM related processes rather than wider, long-term organisational needs. Although it remains unclear whether the functional information requirements are project-specific or template-specific, P3 provides a more explicit link between organisational needs and technical operations, which is a key capability for successful requirements determination (Davis, 1982; Kamara *et al.,* 2002). The link to the OIR and AIR is not explicit in the EIRs, likely because standards do not seem to require it. In the absence of a clearer purpose, there is a risk that EIRs may feature incomplete or unnecessary information, both of which can several hinder the effectiveness of EIRs as key documents for information procurement in BIM (Ashworth *et al.,* 2016, p. 11).

*Information relationships*

Technical, management and commercial requirements in the investigated EIRs relate to organisational, project and asset objectives. Overall, the most extensive set of information relationships is laid out in the delivery schedule for maintainable assets (C1, C3 and C4), or model production and delivery table (C2). Examples of specific information relationships include the specified Level of Detail/Definition/Development (LOD) and Level of Information (LOI) at each RIBA PoW stage, compliance to BIM protocols and standards for information exchange (e.g. COBie), interoperability and BIM processes (e.g. PAS 1192-3), the required Common Data Environment (CDE), the Asset Information Model at handover, and information integration with the client's existing Computer-Aided Facilities Management (CAFM) software and data. All of these function as important components for sharing and

interlinking information and datasets with each other at different stages of the design, construction and delivery process. However, the strategic purpose of the specific information requirements was seldom explicitly expressed as they remained highly technical.

For example, LOD is a key information relationship that helps to determine the amount and depth of information about a particular object (e.g a space, system or product) to be delivered at a particular stage during the construction and delivery process. These should relate to the PLQs by specifying the information required to answer the client's questions at each stage. The terminologies used for LOD and their specification varied across the EIRs. The relational purpose of the information gets lost in the technical details in all the EIRs but P3. Specified LODs were associated with all RIBA PoW stages in P3, but only for stage 6 (i.e. handover) in the other EIRs. Importantly, all EIRs used multiple LOD denominations, such as Level of Detail, Level of Definition and Level of Development, sometimes all within the same EIR document. P1-2, P4-5, and P7-8 refer to Level of Definition as both Level of Detail and Level of Information as described in NBS BIM Toolkit. P3 and P6 adopt the Level of Development classification of the American Institute of Architects, which distinguishes between Level of Detail as an input element, and Level of Development as 'reliable output'. The expected relationship between the BIM system at handover and the client's CAFM was also specified. Clients 1, 2 and 4 specified their existing platform, while C3 stated: "The clients CAFM system is to be determined, therefore it is crucial that the supplier aims to deliver asset information in a standard format."

*Information structure*

The reviewed EIRs structure information requirements differently. 6 EIR documents structure requirements as technical, management and commercial requirements. In P6, 'information management' equates to both technical and management requirements. P3 structures information requirements more specifically as related to project, management, technical, Asset Information Requirements and Information Exchange. The difference in structure is likely due to variations in the use of different EIR templates. Although the overall structure varies, the EIRs cover all essential information requirements prescribed in standards (e.g. PAS 1192-3). P3 provides more detailed client objectives and descriptions of expected deliverable assets. P3 includes separate appendices for model production and delivery table, COBie information exchange requirements, the maintainable asset list (including whether COBie is required for each asset), and a copy of the BIM Forum Level of Development Specification. The other EIRs provide appendices for the information delivery schedule for maintainable assets (with asset type descriptions), and assessment form templates concerning BIM, IT and resource suppliers. In the absence of high-level information purposes in all reviewed EIRs (except perhaps P3), our analysis indicates that information structure constitutes the primary purpose for information. In other words, the EIRs appear as highly technical documents that do not explain the purpose of the procured information beyond that of technical project requirements. The EIRs also do not mention any OIR, from which the EIR would be expected to derive its high-level information purposes. This excessive focus on structure also obscures the salience of the relationships between the different types of information.

*Informative acts*

Altogether, effective information purpose, relationships and structure underpin successful EIRs (Cavka *et al.,* 2017). However, the reviewed EIRs concealed the

approach to adopted requirements in a methodological black box. Reconsidering information requirements as informative acts enables to redeem a more purposeful procurement of information in EIRs. Beynon-Davies (2010, p. 393) defines informative acts as "acts of communication involving message-making and interpretation". He demonstrates that a successful information management system simultaneously enables deriving significance from and structuring of relevant data systems. Currently, elicitation methods and prioritisation of client requirements are not prescribed in existing industry standards and protocols, although the creation of PLQs can help elicit and communicate client information requirements. Providing connections to performative information within EIR documents could foster the integration of clients' needs in BIM systems, and encourage clients to make more sense of BIM processes in relation to their organisational needs and objectives. In effect, well-integrated and articulated information systems enable the alignment of organisational objectives in terms of an activity system with relevant data systems. Moreover, informative acts are dynamic and fluid: by enacting the significance of information, well-functioning information systems blur the boundaries between data and activity systems. Beynon-Davies' (2010) information theory provides the basis for our proposed conceptual framework for the purposeful procurement of information through EIRs (Figure 1). He describes 'activity system' as "the performance of coordinated action within human groups" (2010, p. 393). In BIM, this can refer to organisational objectives in terms of desired assets and designed to optimise the processes of design, construction and operation. High-level information needs are performative in considering all stakeholders and stages. The information system technology and documents are structured by organisational objectives and help structure the required data system. In turn, the data system is meaningful, or valuable, only insofar as it is purposeful. The key challenge of EIRs (and all requirements determination strategies) is to translate high-level organisational objectives into relevant information and data systems.

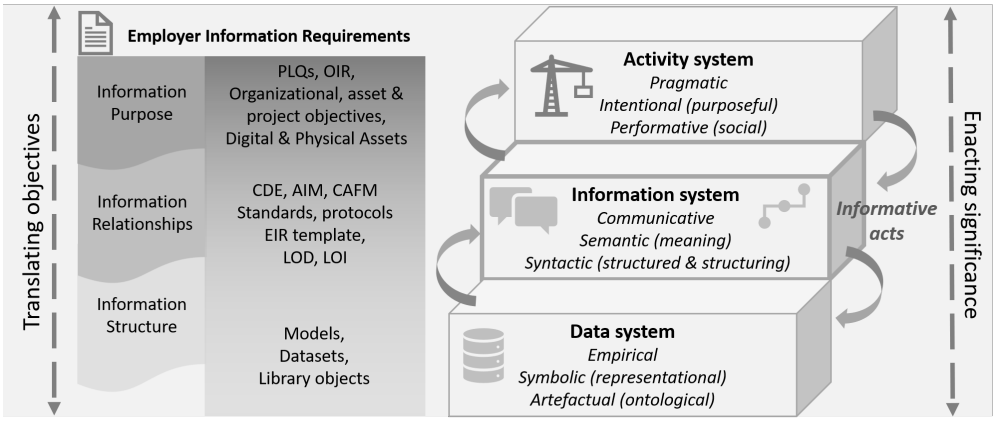


*Figure 1: Conceptual framework for a more purposeful procurement of information in EIRs inspired by Beynon-Davies (2010)*

In the proposed framework, the common EIR structure (i.e. technical, management, and commercial) is distributed rather than discrete: Although tempting, the various technical, management and commercial information requirements cannot be simply mapped onto the respective data, information and activity systems. Therefore, the framework's analytical value is conceptual/heuristic rather than functional/technical, although future research may explore the value of developing EIRs that explicitly adopt such 'activity, information, and data systems' structure. The framework enables

linking of each information requirement to overarching organisational objectives so as to systematically ensure, or 'enact', the significance of both data and information in relation to specified purposes, and to each other through information relationships. Furthermore, the translation of client objectives is depicted as a gradient: information purpose, relationships and structure operate as porous, overlapping categories rather than bounded or siloed domains. Such conceptual framework facilitates a more dynamic, relational and purposeful approach to the procurement of information in construction. EIR documents thereby have the potential to function as an information 'common good' from the outset of otherwise highly technical BIM processes.

## CONCLUSIONS

A thematic desktop analysis of 8 Employer Information Requirement (EIR) documents in the UK reveals significant opportunities for a more purposeful specification of information requirements. This paper proposes a much-needed conceptual framework to bridge performative information with data systems to help leverage 'common good' in procuring information for digital built assets. A key challenge for effective EIRs remains the ability to translate high-level organisational needs into relevant information systems and datasets. The research attributes significant agency to the Organisational Information Requirements (OIR) and Asset Information Requirements (AIR) and Plain Language Questions (PLQs) in formulating client focused EIRs. Indeed, the EIRs reveal room for a better translation of client needs into functional information applications and data requirements, and for a more explicit reference to the OIR. The developed framework enables and systematically 'enacts', the significance of both data and information in relation to specified purposes, and to each other through information relationships. This indicates that an 'activity, information, and data systems' structure for EIR documents may lead to a better procurement of purposeful information in digital built assets. This is important in reconciling the differing purposes of practitioners and stakeholders and deserves future investigation.

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