BIM and Online Collaboration Platforms – An investigation into emerging requirements

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Abstract

It is widely documented that productivity in the AEC/FM industry has been hampered by fragmentation, low innovation, adversarial relationships and slow adoption of Information Communication Technologies. The rising recognition of the potential of Building Information Modelling (BIM), combined with online collaboration platforms, provides an opportunity for addressing those industry obstacles. This study reviews existing literature pertaining to how BIM and online collaboration platforms can facilitate the much desired integration within the industry. Subsequently, a scoping study for UK online collaboration platforms is carried out.

Despite the expected benefits of BIM technology, it has not been widely embedded within the UK AEC/FM industry. This is mainly attributed to the incompatibility of current practices with BIM. Current collaborative practices still result in some rework, suboptimal design decisions, constructability issues and waste. Factors relating to the introduction of collaborative BIM practices revolve around a shared vision, clear responsibilities and technology ease of use. The essential role of online collaboration platforms for construction organizations reaching full BIM maturity is not yet fully appreciated. Additionally, corporate BIM strategies lack a clear vision. The scoping study identifies some trends in the evolution of online collaboration platform functionalities and sets the ground for a gap analysis.

Keywords: BIM, cloud computing, collaboration, lifecycle, requirements

Introduction

A number of reports dating back to 1950 have addressed the chronic Architecture Engineering and Construction (AEC) industry traits in an effort to improve efficiency and effectiveness in construction processes which would ultimately lead to greater value for the client (Murray and Langford, 2003). These interconnected traits

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can be outlined as: low profit margins, no barriers to unskilled personnel, client focus on capital cost rather than value, inability to estimate life cycle costs (“short sightedness”), horizontal fragmentation, vertical fragmentation, adversarial contracts, low innovation and slow adoption of Information and Communication Technologies (ICT). One popularly reported account to these is the project led nature of the industry (Beach et al., 2011; Dubois and Gadde, 2002) where the transfer of innovation across projects is hindered (Harty, 2005; Koskela and Vrijhoe, 2001).

Having transformed many other industries, the Information Age might bring about the much desired integration within and between the AEC and Facilities Management (FM) industries. The rising recognition of Building Information Modelling (BIM), combined with online collaboration platforms, provides an opportunity for addressing the above problems. BIM is defined as “a digital representation of physical and functional characteristics of a facility creating a shared knowledge resource for information about it forming a reliable basis for decisions during its life cycle, from earliest conception to demolition” (CPIC, 2012). Online collaboration platforms (also referred to as Construction Project Extranets (CPEs) (Yeomans, 2005) or Online Construction Project Management (OCPM) (Becerik, 2006)) are the main manifestation of cloud computing within the AEC/FM industry. Their functionalities have been under continuous development in the last decade (Wilkinson, 2005; Wilkinson, 2012).

Vision driven by technology

Long term vision

Figure 1 presents how six different sources envision how ICT can transform the industry. There is congruence that we ought to walk the path towards greater integration enabled by interoperability

The co-evolution of business process and technology

Across all industries, technology and business processes could be understood as existing in a symbiotic relationship through which they co-evolve, influencing one another (Figure 2). In the last decade, through componentization and service orientation, technology vendors are increasingly becoming an “on-demand business” (Cherbakov et al., 2005). Solutions are now more flexible, modular and hence more able to be tailored around an existing business process. Nevertheless, as the dimensions in the Figure 1 suggest, business processes cannot remain unchanged for the AEC/FM industry to reach the long-term vision. Instead, it is argued that there has to be a shift of both technology and business processes (Figure 2).

Short term vision, focus of this study

The scope of this investigation pertains to the slight shift of technology towards existing business processes and not the long term vision (Figure 2*). Even though the recommendations will not require significant process change, this investigation will indirectly expose issues related to the re-engineering of the industry.

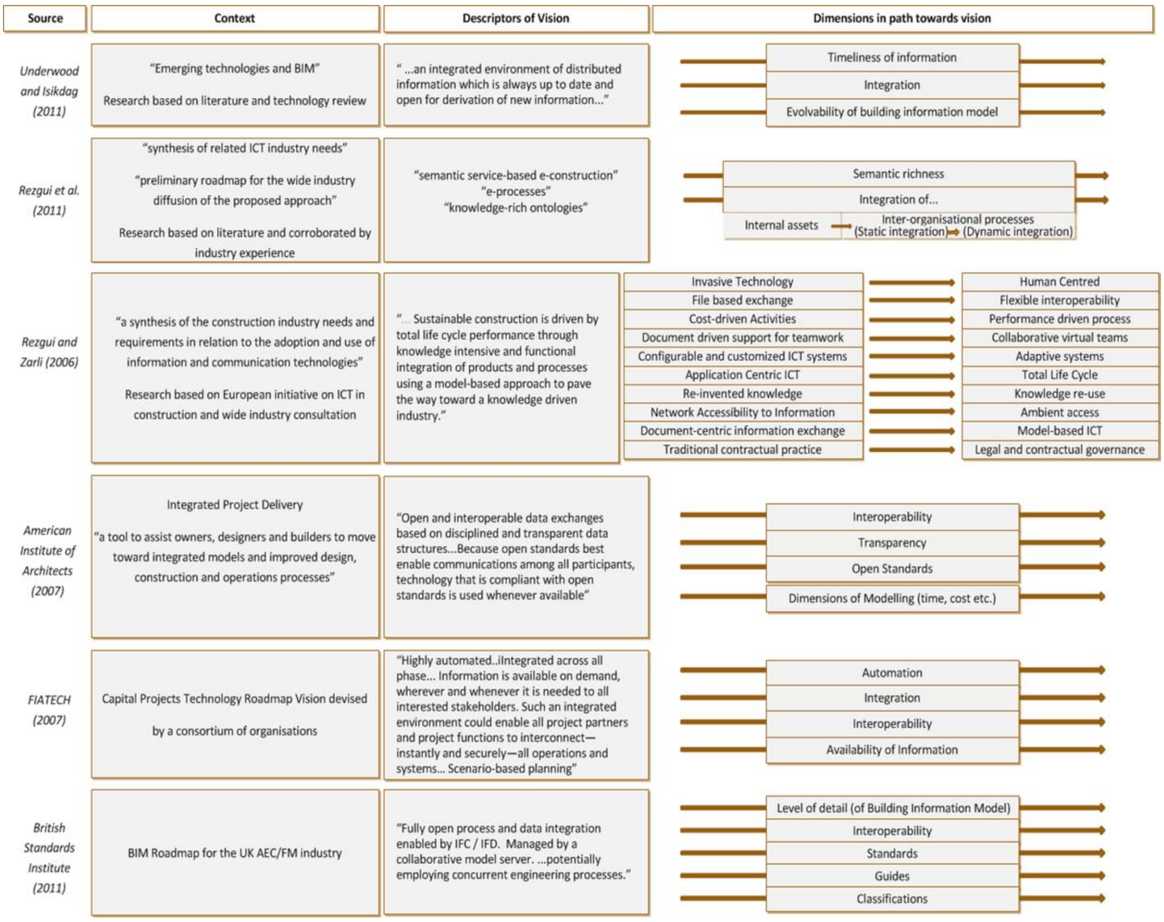

Figure 1. Long term vision driven by technology

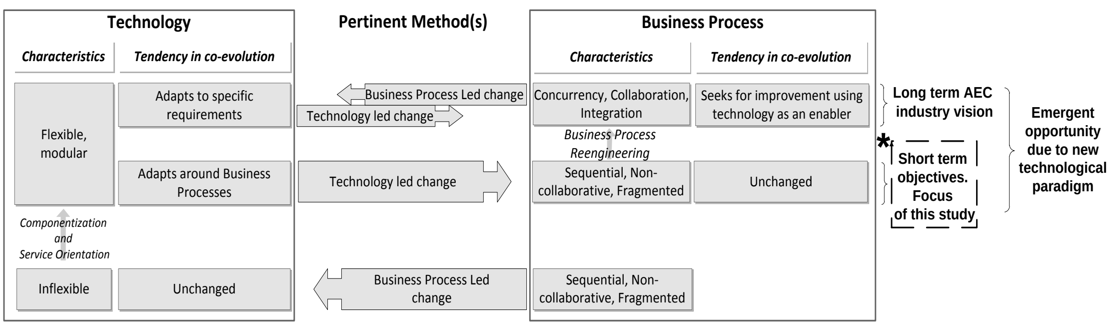

Figure 2. The co-evolution of technology and business process

Aim and objectives

The aim of this study is to identify opportunities for UK online collaboration platforms to offer greater value to clients under existing working practices. The specific objectives are to: 1.Identify the role of Online Collaboration Platforms (OCP) within BIM processes; 2.Identify the circumstantial developments relating the evolution of the functionalities and the relevant barriers to the adoption of OCPs; 3.Identify possible areas of improvement in OCP functionality and make recommendations; 4.Examine the applicability of the recommendations by comparing against user requirements and feasibility of development.

Methodology

The method and techniques used for meeting the objectives are shown in Figure 3. This paper reports on the progress up to the identification of areas for improvement.

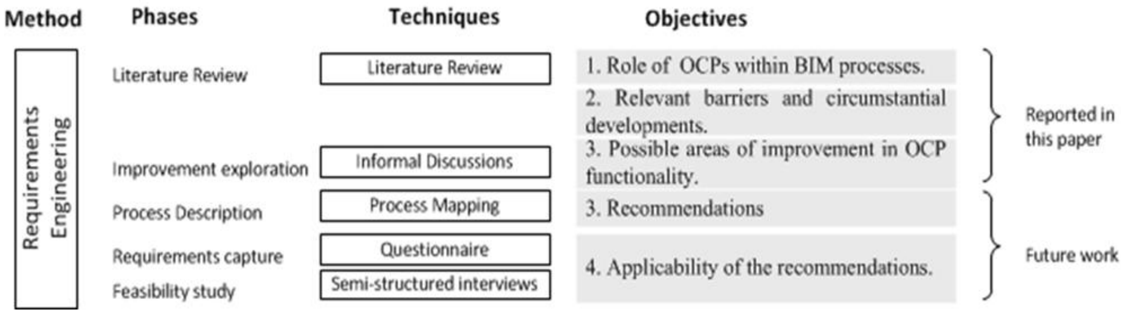

Figure 3. The techniques applied to achieve the project objectives

Literature Review

Context

Following the recommendations by the BIM Industry Working Group (BIS, 2011) the Government has decided to mandate the use of "fully collaborative 3D BIM (with all project and asset information, documentation and data being electronic)" for its projects by 2016. The number of people "aware and currently using BIM" rose from 13% to 31% from 2010 to 2011 (NBS, 2012). Furthermore, 68% share the view that "BIM is all about real-time collaboration". Similarly, the UK online collaboration vendor market has been growing steadily over the last decade (Wilkinson, 2012). The NCCTP (2006) survey revealed that 96% of users of collaboration technology were satisfied with its service and half of them were committed to it. Six years later, however, we are far from widespread utilization with the majority of BIM users utilizing only the "little BIM" (Jernigan, 2008). Despite the obvious mobilization, the industry is not exploiting all the potential benefits.

Collaboration, BIM and OCPs

Collaboration "assumes that participants have common objectives…" hence "share resources and knowledge" and "seek more benefits… than by working alone" (Son et al., 2011). As indicated by Isikdag and Underwood (2010) "…effective collaboration can only be achieved through effective coordination and communication."
The categorization of collaboration models by Anumba (2002) is helpful in understanding the implications of each model and its corresponding medium of communication on the effectiveness of collaboration and its appropriateness to the desired project phase. Despite the complexity of the construction process (Bertelsen,

2002; Froese, 2010; Dubois and Gadde, 2002) owed largely to the interrelatedness of contributions from different agents, the UK AEC industry adopts a fairly simple generic scheme which is outlined by the RIBA Plan of Work (RIBA, 2007). It is widely argued, both from the industry and academia that the lack of contribution from several disciplines in early design decisions leads to design rework, constructability issues and non-optimal design decisions. Additionally, this non-collaborative method of working reinforces the fragmentation of the industry and vice versa.

ICT has served as a facilitator for collaborative practices in the last decade. BIM technology offers solutions for the problems identified above. This is mainly achieved by opening channels of communication and, at the same time, "instigating" early contribution from agents of different disciplines (Succar 2009) resulting to a better informed design from the early phases. BIM, complemented by OCPs automatically change communication patterns as it acts as a central building information repository hence introducing order and centrality in information exchanges.

Shelbourne (2007) explains that "good collaboration does not result from the implementation of information technology solutions alone, the organisational and people issues, which are not readily solved by pure technical systems, need also to be resolved". A review of different studies on collaboration in AEC by Shelbourn et al.(2006a), Lee and Eastman (2008), Son (2011), Simatupung (2005), Isikdag and Underwood (2010), Shelbourn et al. (2006 b) reveals the common themes of common vision/incentive alignment, clarity on responsibilities/decision synchronisation, and intuitiveness and interoperability of software as prerequisites for effective collaboration.

Lifecycle approach, BIM and OCPs

The lag in adoption of lifecycle management approaches in AEC/FM is attributed to discipline fragmentation, client focus on capital asset value rather than life cycle costs and the use of design-bid-build contracts and delivery methods. The adoption of BIM can address the above issues by: 1. Enabling communication between disciplines; 2. Allowing for the early approximation of lifecycle costs and their elucidation to the client; 3. Drawing/demanding contracts and delivery methods of the form of Design and Build or Integrated Project Delivery (Sebastian, 2011).The biggest "upside potential" by the adoption of BIM is at "use" phase even though, to date, its measured benefit in real projects is low (Building Smart International, 2010).

A building information model should therefore act as: 1 A facilitator and reminder/motivator/instigator of early design decisions to account for lifecycle costs. As explained by Succar (2009), an indicator of BIM maturity is the level by which information flows from the construction and operations phase to the design phase; 2.A central data repository for facility management during the operations phase.

Interoperability: the major enabler

The importance of interoperability is indicated by a study of the US National Institute of Standards and Technology which estimated the cost of inadequate interoperability in the US Capital Facilities Industry in 2002 to be $15.8billion (NIST, 2004). The study defined interoperability as "the ability to manage and communicate electronic product and project data between collaborating firms' and within individual companies' design, construction, maintenance, and business process systems". Within the BIM community "interoperability" is normally used to denote data (technical) interoperability however, business interoperability has yet to receive the analogous consideration.

Data (technical) interoperability is the ability of different software to use common data formats. This definition expounds the central role of interoperability to BIM processes as it enables users of different platforms to seamlessly offer an input into a common model. The global AEC/FM industry has been striving to achieve data interoperability for the last 15 years (Laakso and Kiviniemi, 2011). The two major interoperability standards are the Industry Foundation Classes (IFC), a common data scheme that allows interoperability across software packages (Building Smart, 2012) and the Construction Operations Building Information Exchange (COBie) (East, 2007) which denotes how "how information may be captured during design and construction and provided to facility operators"

As explained by Grilo et al. (2011) the collaborative, multi-organisational BIM environments do not only require interoperability across software platforms but across "social, procedural, legal and strategic aspects of collaborations." Cerovsek's (2011) "BIM cube framework for technological development" suggests that technology intelligence is achieved from technical interoperability while collective intelligence is only achieved when organisational interoperability is present.

It is argued that the provision of all levels of interoperability is central to the service of an OCP. This service, in turn, is much reliant on the efficacy of interoperability standards.

The significance of OCPs in BIM maturity

By enabling distributed collaboration, both synchronous and asynchronous (Anumba, 2002), online collaboration platforms play central (or "neural") role in BIM processes. Underwood and Isikdag (2010) point out that "cloud computing will enable the next generation of (full state) BIMs" (or BIM 2.0) where the "digital building model will evolve through the lifecycle of the building". In this integrated environment (BIM 2.0) the internet will act as the medium through which the BIModel will be continuously updated and open for new information.

Grilo and Goncalves (2011) explain how cloud computing in combination with BIM will transform e-procurement by enabling the mapping of "traditional unstructured information into structured objects" hence generating interoperability. Beach et al. (2011) argue that online collaboration platforms address the universal BIM adoption issues of "data sharing, access, and processing requirements".

Barriers and weaknesses

Figure 4 maps some reported barriers to BIM and OCPs according to their specificity to OCPs and their pertinence to business led change or technology led change.

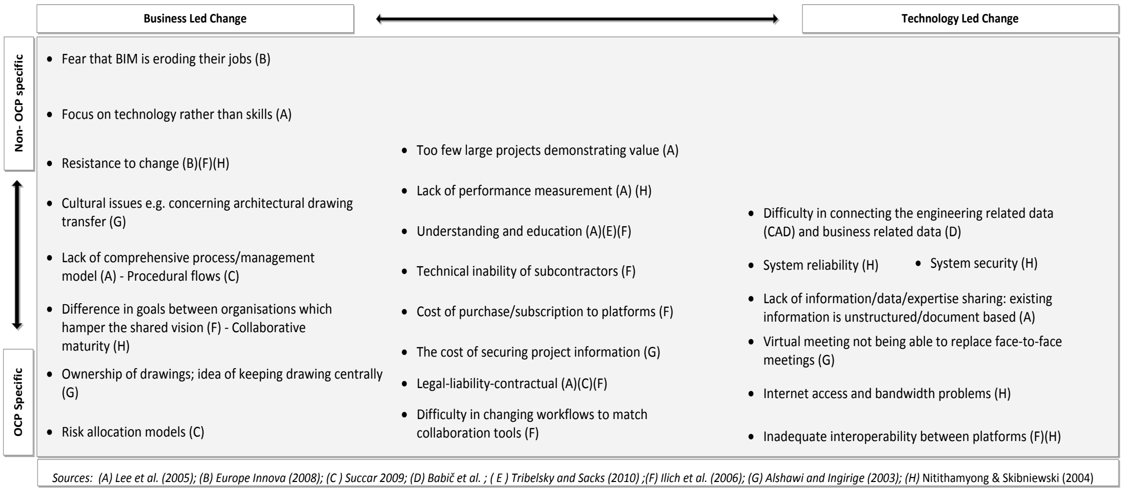

Figure 4. Barriers to BIM and OCPs

Functionalities of OCPs

Appendix A takes a closer look into the functionalities of OCPs with the aim of identifying opportunities for improvement. The list is based on five studies which have explored OCP functionalities (Becerik, 2006; Kim et al.,2011; Kagioglou et al., 2011; Nitithamyong and Skibniewski, 2004; Wilkinson, 2005)

Conclusion

This paper has explained how BIM offers the opportunity to overcome the chronic AEC/FM traits and reach the technologically driven vision. The role of OCPs within BIM processes has been explored and the importance of interoperability in BIM processes has been described. Additionally, some reported barriers to BIM and OCPs have been suitably categorized. Finally, the paper provided a basic examination of the trends in the development of OCP functionalities and identified some possible areas for improvement.

The following steps will be to: 1.Design and disseminate a questionnaire in order to capture the requirements of OCP users; 2.Relate the results to the identified areas of improvement and put forward specific recommendations for added functionality; 3.Conduct three semi-structured interviews to evaluate the feasibility of the recommendations.

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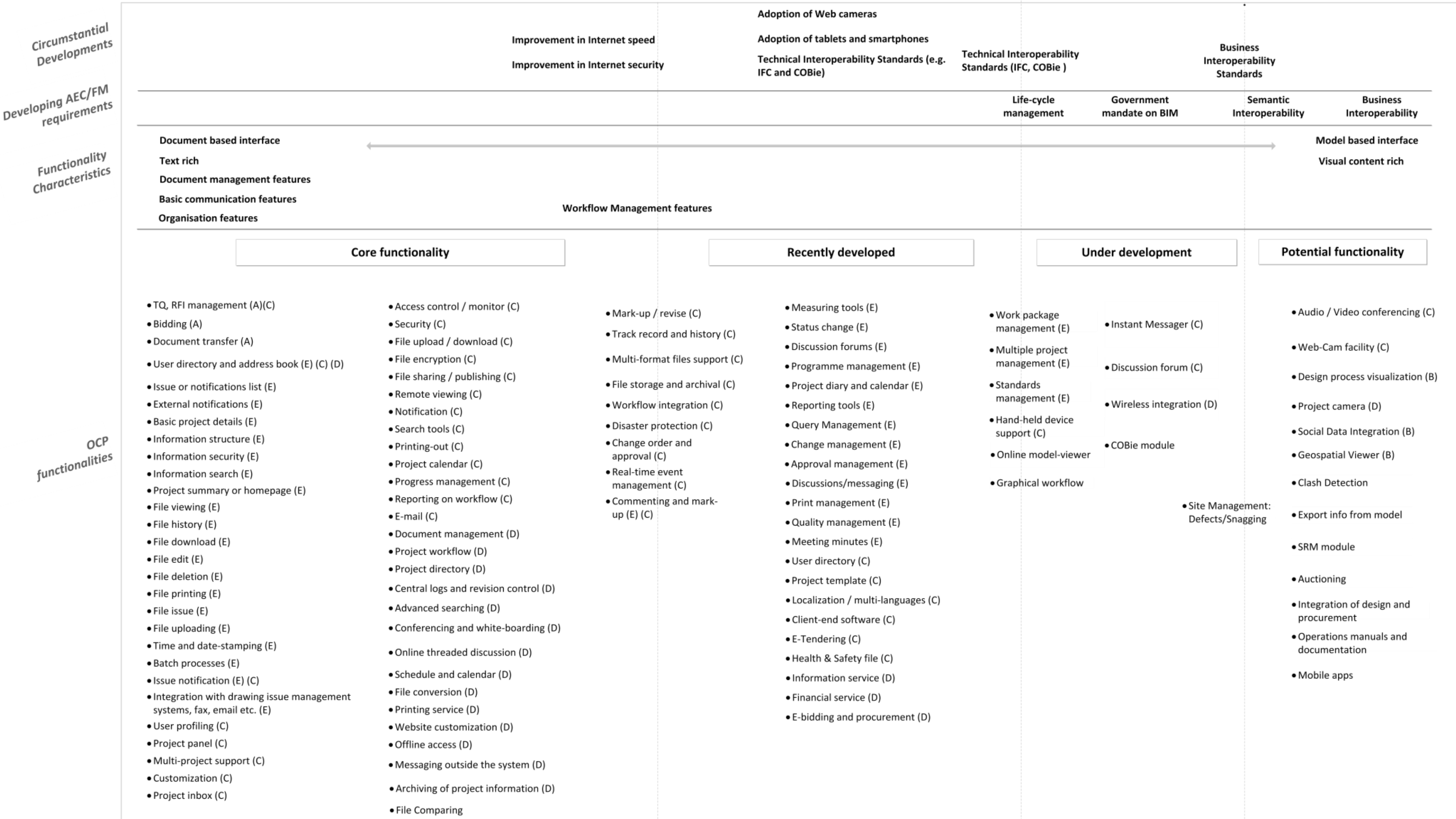

Sources: (A) Becerik (2006) , (B) Kim et al. (2011) , (C) Kagioglou et al. (2011) , (D) Nitithamyong and Skibniewski (2004) , (E) Wilkinson (2005)

Appendix A. Development of OCP functionalities