Promoting Early Collaboration, Communication and Leveraging the Use of BIM between Project Stakeholders for the Generation of Effective Knowledge in Information Protocols

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Barriers to Knowledge Management (KM) in construction projects

Challenges exist in terms of capturing and sharing knowledge of best practices and lessons learnt within and across projects

- **Multi-organisational, and temporary nature of construction projects which cause valuable knowledge to remain with individuals and/or become lost with time;**
- **Specifically, project teams are regrettably disbanded after each project without adequately capturing and storing important data of the project for future use;**
- **Due to the fragmentary and transient nature of construction projects makes it difficult for information to be communicated among project members.**

- **The problems associated with the information management of construction projects reveal that the principal sources of confusion and disagreements between project teams are communication breakdown and information bottlenecks between the client and the contractor, misunderstandings between engineers and architects due to the lack of collaboration and poor communication;**
- **A lack of consistency in the information flow of the project as it progresses;**
- **Another problematic issue within the construction project is that an effective and practical system for capturing, storing, compiling, representing and retrieving important data may be absent, which does not achieve collaborative working practices among key project actors.**

Research Aim: to explore how early collaboration and communication through BIM adoption early can contribute to the KM lifecycle in construction projects

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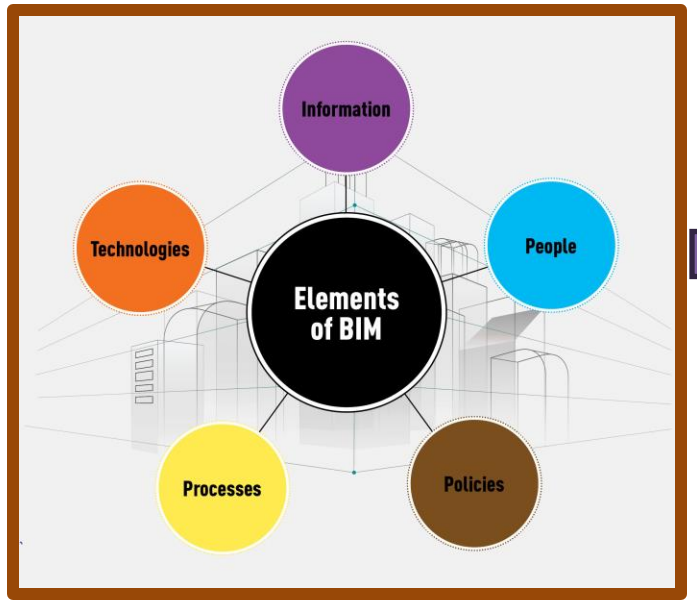
Building Information Management/Modelling & BIM Models Management in construction projects



- ✓ BIM acts as an **innovative and centralised database** that contains intelligent input information related to building models.
- ✓ BIM enables project teams to easily access their required knowledge and information, thus reducing **information asymmetry** between project members, as well as reducing project uncertainty and risk.
- ✓ BIM is a process for creating and managing information on a construction project across the project lifecycle and the key output of this process is the **Building Information Models** (BIMs). These BIMs should be **managed coordinatively** at the early phase of the construction project where early collaboration, communication and the potential of building information models (BIMs) management at the project phases between project stakeholders are essential to generate effective knowledge in information protocols (i.e. the building information/ information models) via smooth information flows and data coordination.

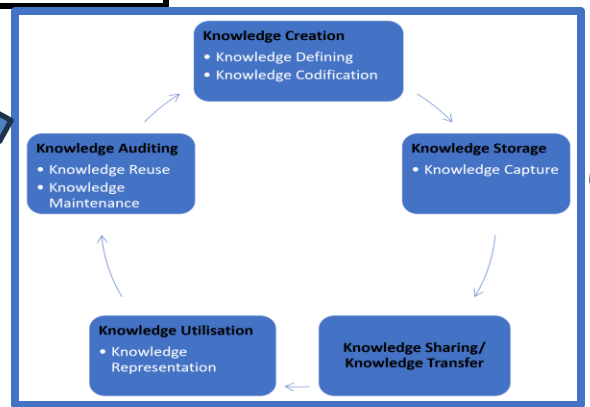
- ➢ **It is also focused on the BIM Models management based on the context of design process of construction projects as knowledgeis an understanding of some pieces of information given by design consultants for the design contents.**
- ➢ **Moreover, knowledge is valuable intellectual asset generally possessed by humans, which is the key understanding of how to use data and information and why to use them in a particular way.**
- ➢ **In this article, it is concentrated on the designers' knowledge that is based on designers' experiences, design concepts, design's beliefs and as a result, these information from designers' knowledge are defined and codified as data in which ways of working that can be captured, stored, shared and communicated for the design information requirements using BIM technologies.**

Importance of Knowledge Management Lifecycle in construction projects

Table 1: Relations between the Six Main Knowledge Management Processes (Robinson et al., 2005)

Generating Knowledge Process Lifecycle Relations					
Knowledge Defining ⟺	Knowledge Codification ⟺	Knowledge Capture ⟺	Knowledge Sharing/ Knowledge Transfer ⟺	Knowledge Representation ⟺	Knowledge Reuse/ Knowledge Maintenance
• Acquiring • Creating • Describing • Discovering • Identifying • Planning • Specifying	• Accessing • Locating • Organising • Setting	• Detaining • Gathering • Keeping • Placing • Recording • Storing • Seizing	• Collaborating • Distributing • Exchanging • Merging • Sharing • Transferring	• Acting • Applying • Presenting	• Archiving • Adjusting • Auditing • Assessing • Integrating • Modifying • Reapplying • Readapting • Removing • Validating

- KM can help improve communication and collaboration among project members in relation to the capturing, storing, representation and sharing/transfer of data, as well as the auditing of such data for reused information in construction projects.
- KM is seen as a fundamental process for organisations because it constitutes a systematic process of generating, gathering, capturing, sharing and analysing knowledge in terms of resources, documents, and people skills within and across an organisation.
- KM has been defined as 'the identification, optimization, and active management of intellectual assets to create value, increase productivity and gain and sustain competitive advantage'.
- The KM process consists of six main stages: defining, codification, capturing, sharing/transfer, representation, and reuse of knowledge, which are summarised in Table 1. Based on these processes, the KM Lifecycle has been developed (see Figure 1).



The KM lifecycle can assist in focusing on the generation, collection, capturing, storing, representation, and retrieval of data to support problem-solving, dynamic learning, strategic planning, decision-making, and the smooth flow of communication between project stakeholders.

Figure 1: Generating Knowledge Lifecycle (Dutt et al., 2011)

Information Management Processes based on ISO 19650-1

Table 2: Scope of Information Management Responsibilities among Project Parties (Beste, 2023)

Information Requirements/ Models	ISO 19650 Term related to Project Parties	Different Project Stakeholders	Responsibilities
• Organisational information requirements (OIRs): to clarify organisational needs, requirements, and objectives • Project information requirements (PIRs): to agree on what asset information should be delivered for each project • Exchange information requirements (EIRs): to agree on how to transfer the information, in what format, what level of information, and establishing a clear agreement among project stakeholders on how and with what characteristics they need to exchange their digital information • Asset information requirements (AIRs): to clarify the asset's requirements, their management, and operation and maintenance (O&M) procedures Scope of Work Contract • Project Information Model (PIM): the single source of digital information related to a project or projects, developed during the design and construction phase of a project and created for the construction of a new asset or the modification of an existing asset; PIM is an information model developed during the design and construction phase of a project. The requirements for the PIM are set out in EIR. • Asset Information Model (AIM): the single source of digital information related to an asset or assets, which must be at a level required to support an organisation's asset management system during the O&M, including existing asset information systems, new information, or information on PIMs. AIM is a model that compiles the data and information necessary to support asset management required for the O&M phase of an asset.	Appointing Party	Employer, Client, Asset Owner, Operator, End-user	- Creating the PIRs and Project Standards - Establishing procedures for creation and delivery of information - Preparing correct information to the Delivery Team at handover - Establishing Common Data Environment for the project - Capturing lesson learnt with the lead appointed party.
	Lead Appointed Party (Delivery Team)	General Contractor (directly assigned by the client, and takes the role of a coordinator)	- Establishing BIM Execution Plan (BEP) - Creating Master Information Delivery Plan - Preparing and assigning resources 'people, process and technology' within the Delivery Team - Creating contract documents for each appointed party - Adding its own information requirements for the Delivery Team into EIRs set by the appointed party.
	Appointed Party (Task Team)	Suppliers and Vendors (responsible for creating and providing information according to the appointment by the Lead Appointed Party)	- Helping the Lead Appointed Party in BEP creation - Establishing a task information delivery plan across the task team - Collaborative creation of information according to the information standard and requirements - Participating in the review of the information model.

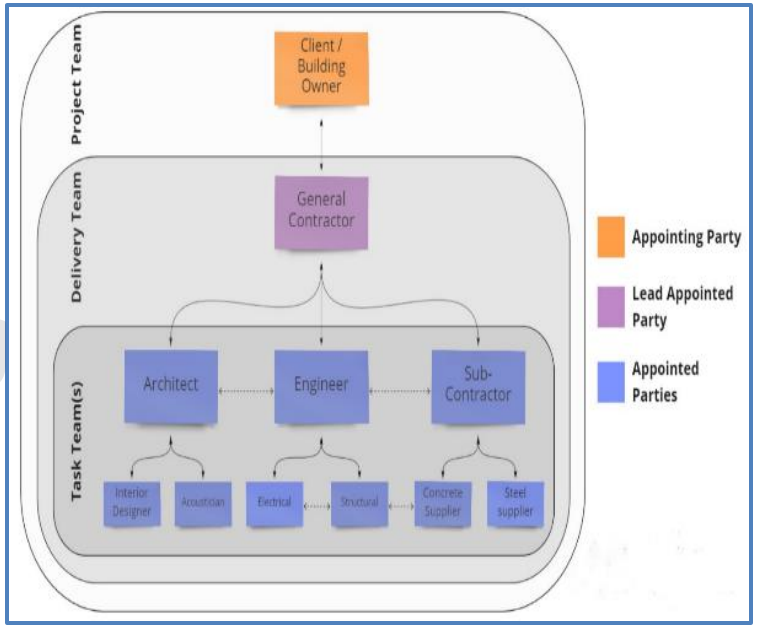


Figure 2: Different Project Stakeholders involved from the appointing party to the lead appointed party of the delivery team and appointed parties from the task team (Winfield, 2020)

There are different steps within the IM in BIM, but **a research gap** is identified due to the current disruption of information flows in the project/asset's lifecycle in BIM.

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Research Methodology

AN INTEGRATIVE LITERATURE REVIEW

- An **integrative literature review** based on the archival research is a research strategy that involves reviewing and synthesising the representative literature on an integrated topic.
- To gather a sufficient basis for the secondary data, an **exploratory research study** was conducted of the state of the art in existing literature, standards, and websites.
- The exploratory phase was a three-step process: **identify, collect and gather the literature; standards; and commentary websites**. Focusing the literatures, BS & PAS Standards and UKBIM Framework series upon the UK guides are comprehensively reviewed, **not considered upon the guides outside of the UK**. As the UK Government encouraged the building industry to implement BIM Level 2 in all projects as part of its Digital Built Britain drive which seeks to improve data management process and smooth information flows make the enhanced KM in BIM more efficient.
- Next, valuable standards and accompanying guidance associated with **ISO 19650 standard series and UKBIM Framework Guidance** were searched; these were sorted separately, as well as being collected from the UKBIM Alliance and BSI Group Standards websites.
- Secondly, **academic papers** containing a combination of the above terms focusing on the process for improving knowledge management practice through BIM were looking into the **Web of Science and Scopus**.
- Thirdly, after reviewing the papers, relevant papers were added into references, and standards and guidance were selected and gathered in order to **build the inclusion criteria for the generation of the new workflow**.
- By using the search databases (Web of Science & Scopus focusing on journal articles from **2018 to 2022**, the **37 articles**, and 3 ISO BIM series and 3 BS/PAS BIM standards are reviewed from among BIM framework and BS Standard Series.

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Research Methodology

Integrative literature review was conducted of the state of the art in existing literature, standards, and websites:

Phase 1: Define Search Keywords and Phrases

(“ the use of building information management in building information models of construction projects ”) AND (“ knowledge management problems ”) OR (“ the potential of BIM benefits in information management of construction projects ”) AND (“ improving knowledge management processes ”)

Phase 2: Identify Search Databases focusing on the potential of BIM for improving KM practice and the KM lifecycle

SCOPUS

WEB OF SCIENCE

Total Output: **318** papers

Phase 3: Total 159 papers are relevant to include (focusing on the journal articles from 2018 to 2022)

Phase 3: Screen Articles

Only 85 papers were collected (articles limited to construction management and English, papers for only “open access”, not concerned to the Information management in BIM construction projects)

Phase 4: Remove Duplication

48 papers were removed (articles not fully focused on KM processes or KM lifecycle, not associated with “ISO 19650” or “BIM standard” acting as the strict inclusion criteria)

37 papers were critically reviewed for data extraction

Introducing Research Gap

- **Imprecise information/data documentation for asset owners, deficiencies in sharing Project Information Requirements, an absence of information related to employer's information requirements, and poor software protocols and standards that result in poorly organised project data.**

- **To minimise rework by reducing information waste through an integrated approach, suggesting this new knowledge generation workflow can adopt in BIM (based on ISO 19650-1 standard) effectively to achieve a smooth flow in information protocols.**

- **BIM-enabled Knowledge Management workflow** helps the realisation of data coordination and information quality in project delivery;
- It can facilitate the ability of project teams to generate, capture and share the data that is vital to the project and integrate these as project/asset information models;
- This process is inscribed under the KM lifecycle and can collaborate with BIM models management so that project members can exploit this knowledge generation workflow effectively to add value to information protocols, business practices and decision-making for the overall benefit of the organisation.

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Research Outcome

Difficulties in BIM and Knowledge Management Process

- Disruption of information flows in the project/asset's life cycle in BIM due to non-consistent terminologies and taxonomies,
- Inadequate specification of information requirements,
- Confusion over the information needs in the information protocols,
- Lack of standard work processes,
- Time and money constraints,
- Poor information technology infrastructure,
- Limitations on oral and paper communication modes,
- Complicated information flows among increasingly diversified stakeholders,
- A lack of standard workflow to communicate information and knowledge.

✓ The importance of KM in BIM enables a core repository to be established that restores project data and helps to project parties in order to collaboratively conduct BIM-enabled project tasks (e.g. reduce information waste, clash detection, design optimisation and cost estimation).

✓ Although BIM has the capability of managing multidisciplinary information, **collaboration and effective communication** between project members acts as a critical strategy that can improve the KM process in BIM and deliver competitive advantages for project information management.

❖ **The introduction of collaborative knowledge management can ease data coordination processes, provide more efficient information and reduce conflict among project teams.**

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Research Outcome

Introducing New Knowledge Generation Workflow

Steps should be adopted to build a new workflow for generating effective knowledge in information protocols:

1) **Data Generating: Defining Knowledge for key decisions and codification of knowledge in terms of Organisational Information Requirements (OIRs)**
2) **Data Collecting: Setting knowledge for Project Information Requirements (PIRs) based on OIRs**
3) **Data Storing: Capturing knowledge for Asset Information Requirements (AIRs)**
4) **Data Exchange: Sharing knowledge/knowledge transfer for Exchange Information Requirements (EIRs)**
5) **Data Representation: Representation of Knowledge in AIM for Asset Information Products and PIM for Project Information Standards**
6) **Data Retrieval: Following knowledge auditing, knowledge reuse for PIM and knowledge of AIM that are maintained in a long-term archive.**

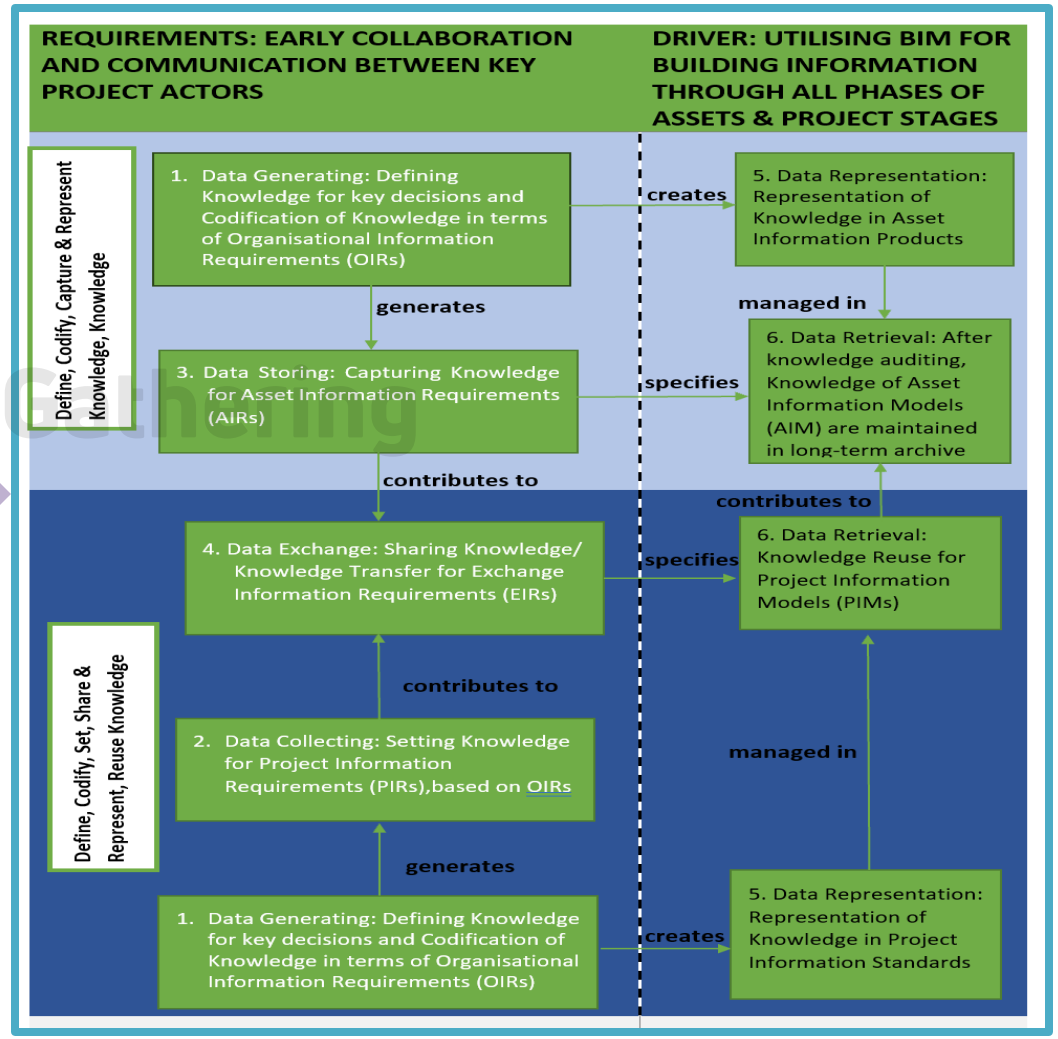


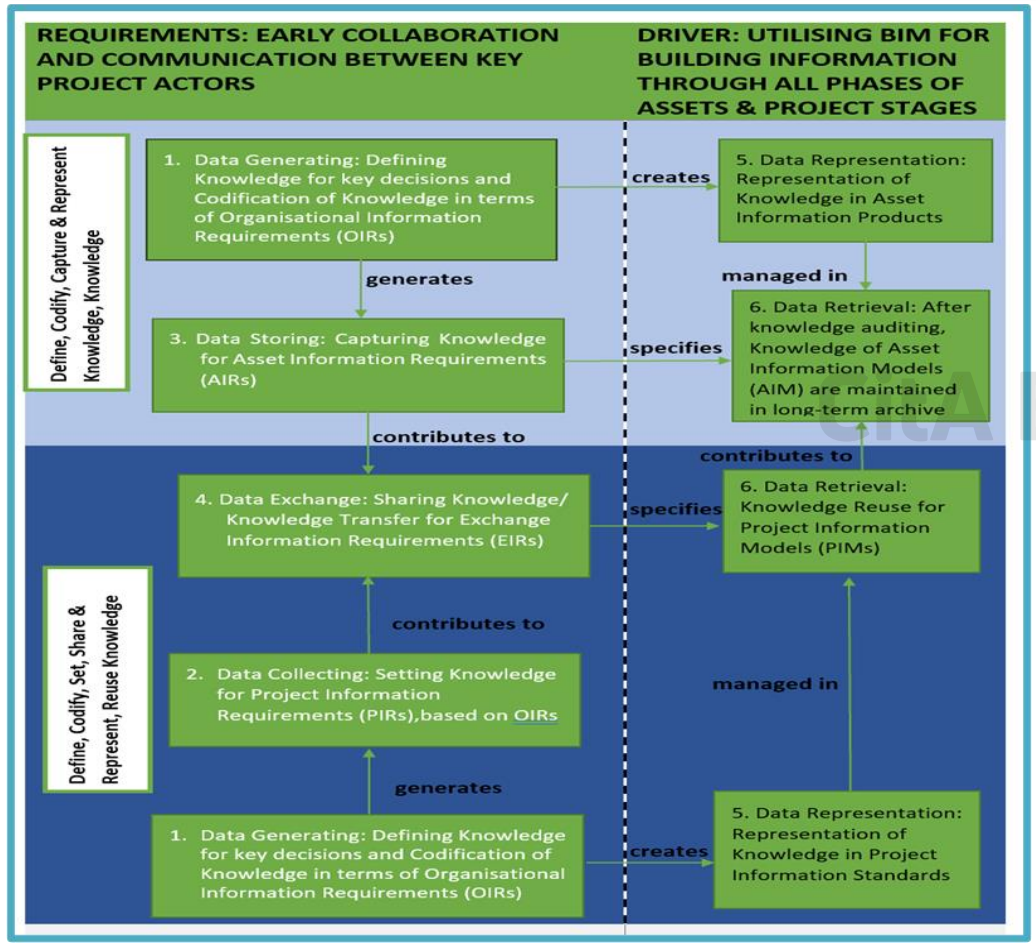
Figure 3: Information Flows in the Knowledge Generation Management (Source: Authors' own)

Research Outcome Discussion

- This paper presented insights into the **status of current KM problems in construction projects** and leveraging the use of BIM in knowledge represented building models management.
- It has reflected on **the importance of early collaboration, communication, and leveraging the use of BIM in KM processes** to facilitate the smooth delivery of information protocols in building information/models.
- It is identified that the **capability of KM is enhanced by early collaboration, communication, and leveraging the use of BIM** at the early project phases as this provides an interactive information flow in the knowledge generation management (i.e. research outcome) that is transparently accessible and workable in a collaborative environment for multi-disciplinary project members.
- The findings revealed that **early collaboration and communication** between the major project stakeholders of the appointing party is the key driver for defining knowledge in terms of identifying and setting effective information requirements (i.e. knowledge in OIR) that focus on client demands, providing vital support with regard to planning for project requirements.

- **The ability of BIM potentially enables a collaborative platform for the KM process to be initiated, and that focuses on capturing of AIR effectively, systematic sharing/transfer for EIR, clear knowledge representation of AIM and PIM, and reuse for PIM.**
- **This research identified that the capability of KM should be enhanced by early collaboration, communication, and leveraging the use of BIM as this can offer an interacting knowledge workflow (i.e., Research Outcome) that is transparently accessible and workable in a collaborative environment for multidisciplinary project members.**
- **The proposed knowledge generating workflow, which is the main contribution of the paper, consists of six steps and is based on the adoption of a BIM-enabled KM life-cycle approach.**
- **This workflow can benefit all project stakeholders from the appointing, lead appointed, and appointed parties by introducing collaborative KM process throughout the project lifecycle under a BIM environment.**

Conclusions



- Improvements in KM from early collaboration and communication through BIM adoption enable project stakeholders to collaboratively work on knowledge-intensive models, subsequently increasing project performance at the early procurement phases.
- More importantly, this knowledge generating flow ensures that effective KM (i.e. data generating, collecting, storing, exchanging, representation, and retrieval) helps in data coordination and information exchange for data documentation throughout the project phases of the asset lifecycle.
- Developing a knowledge generation workflow can benefit project stakeholders, including asset owners, consultants, project members of the appointing, lead appointed, and appointed parties, as well as end-users, in the following ways: 1) Ensuring the right information is delivered at the right time; 2) Facilitating greater collaboration and data coordination in the IM system, as well as ensuring information quality among project team members; 3) Reducing information wastage and rework through clearly specified information requirements; 4) Progressively generating knowledge through a managed process, improving the accuracy and validity of information; 5) Capturing an audit trail of information development and information exchange across the delivery and operation of a built asset.

Figure 3: Information Flows in the Knowledge Generation Management (Source: Authors' own)

References

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END OF PRESENTATION !

Open for Questions ...

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Gathering23
Accelerating BIM adoption
CitA
THANK YOU