LEAN CONTRIBUTIONS TO BIM PROCESSES: THE CASE OF CLASH MANAGEMENT IN HIGHWAYS DESIGN

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AGENDA

- **Introduction**
- **Synergies of Lean and BIM**
- **Clash Management**
- **Research Method**
- **Case Study on Clash Management**
- **Final considerations**

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INTRODUCTION

- Managing design is still a challenge and few design and construction companies apply Lean and BIM in an integrated manner to support it

- BIM-related processes are still fragmented and wasteful (practical justification of the research)

- There are not enough investigations on Lean's contributions to BIM processes in the literature and practice

The aim of the paper is **to investigate Lean contributions to BIM processes,** over an illustrating **case about clash management in highways design**.

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SYNERGIES OF LEAN AND BIM

The interactions of Lean and BIM have been explored for more than 10 years and numerous synergies have been pointed out (Dave et al. 2013; Sacks et al. 2010; Tzortzopoulos et al. 2020)

Most of the practical and theoretical discussions have focused on BIM capabilities' and features' contributions to Lean goals and techniques.

BIM contributes to achieving Lean goals, and enables Lean processes, auxiliary information systems, enabled by BIM, contribute to Lean (Dave et al. 2013)

BIM

synergies

Lean

Lean processes facilitate the introduction of BIM (Dave et al. 2013)

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CLASH MANAGEMENT

- Coordination and clash detection improvements are among the key reasons for BIM implementations (Akponeware and Adamu 2017)

There is still a gap in the **formalisation of the clash detection and resolution process**, as most investigations focus on **software tools instead of the process elements** to support coordination.

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RESEARCH METHOD

- Initial findings of an ongoing research project on exploring Lean and BIM synergies in the UK are presented (Knowledge Transfer Partnership - KTP).
- The investigation adopts **case study as its research strategy.**

- The study was conducted in **three stages**:

1 Understanding of the problem and the company's design processes.

2 Development and analysis of the clash detection and resolution process map.
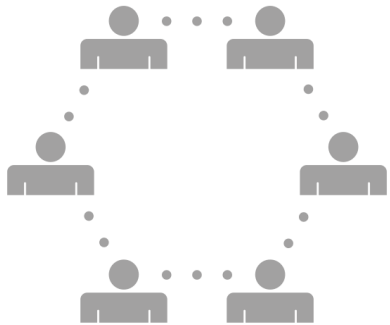
3 Analysis and reflection on the Lean contributions to the BIM processes.

RESEARCH METHOD

The scope of the analysis is restricted to one highway design project (generalisability of the conclusions is limited).

Main sources of evidences:

Workshops

- to **refine and develop processes**
- to **support discussions** regarding improvement opportunities

Document analysis

- to **support the examination and evaluation** of the current state
- to **trigger suggestions** for future state

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CASE STUDY ON CLASH MANAGEMENT:
Description of the current state

Figure 1. Company design process with different levels.

Starting point of this investigation: understanding of the company's design process, focusing on the BIM sub-processes, i.e. clash detection and resolution.
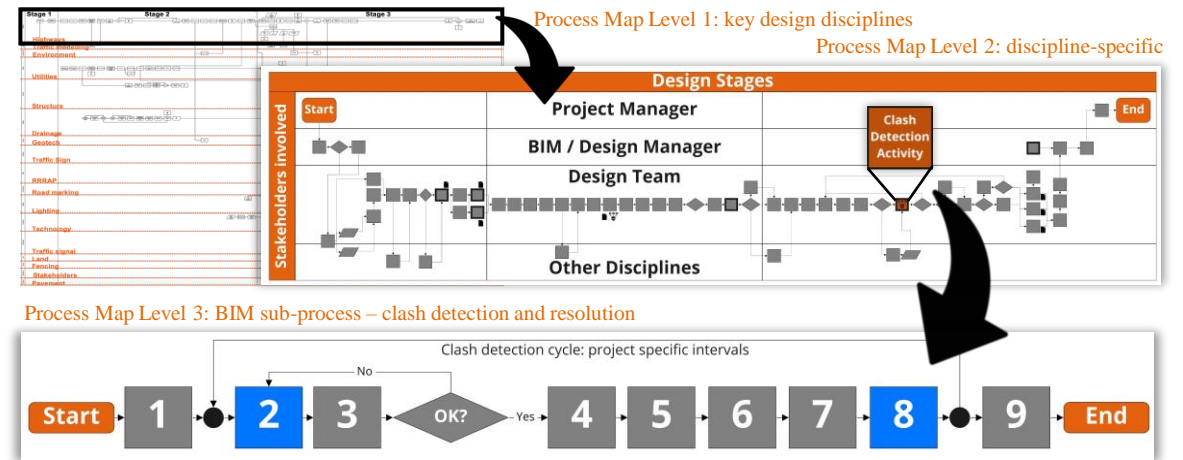
(1) define and communicate the federation strategy
(2) generate models and prepare the disciplines for federation
(3) prepare the federated model and federate the discipline models
(4) perform clash detection
(5) report the clashes and analyse issues detected
(6) publish the federated model
(7) organise and undertake regular design coordination meetings
(8) resolve issues, update and share the updated models
(9) update the clash register and issue a report (if required).

CASE STUDY ON CLASH MANAGEMENT:
Description of the current state

Huge inventory of clashes at the beginning of the process (in detail design stage):

- Silo-based approach to develop the discipline models (before any federation and coordination)
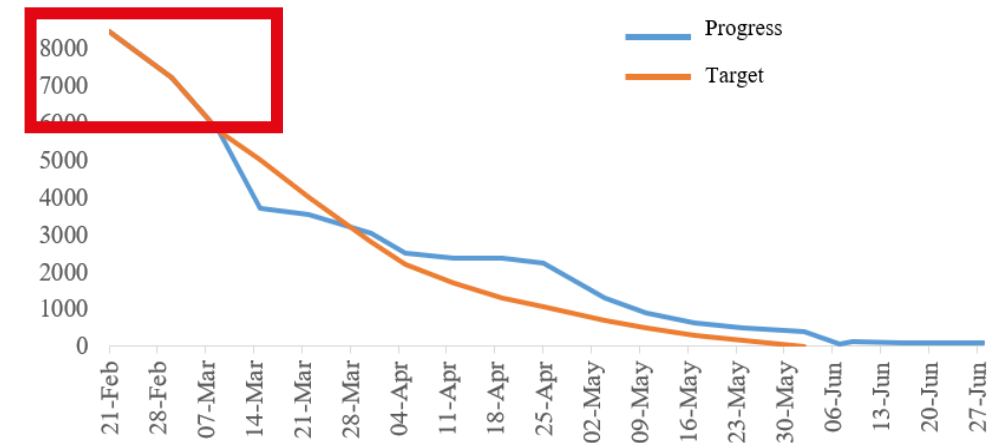- Relatively new software used to undertake the design

Figure 2: Evolution of the number of clashes

CASE STUDY ON CLASH MANAGEMENT:
Analysis and evaluation of the current state

The clash management activities were considered as:

- **necessary non-value adding activities** to coordinate disciplines and eliminate conflicts,
- **waste in the design process**, when the activities relied on manual and time-consuming activities.

The workload related to BIM works had been **underestimated due to lack of previous experience**

BIM process enabled **collaborative decision-making** among a multi-disciplinary design team

CASE STUDY ON CLASH MANAGEMENT:
Analysis and evaluation of the current state

Key root causes for the inventory:
(i) expected or intentional clashes, which can be resolved on site with minimal impact
(ii) design modelling errors
(iii) minor errors of coordination between different disciplines
(iv) similar clashes that had not been grouped according to the disciplines at the beginning of the process

- Root causes were **not analysed through a structured** approach

- The high number of clashes **did not provide a realistic picture** of the design maturity.

- There were **technical issues**

CASE STUDY ON CLASH MANAGEMENT:
Suggestions for the future state

The **formalisation** through the process mapping exercise and **analysis** of the current process **highlighted opportunities for improvements**.

The key improvement opportunities:
- **the process itself,**
- **the structure and transfer of information,**
- **the standardisation and automation of time-consuming activities.**

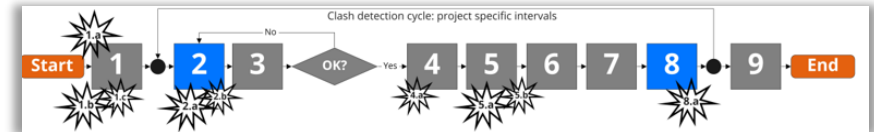**Figure 4.** Improvement opportunities identified.

Table 1. Key clash detection and resolution activities and potential improvement opportunities.

Key activities	Potential improvement opportunities
1. Define and communicate the federation strategy (defined by the BIM execution plan)	**1.a Early identification of client requirements** within a clear definition of the BIM Execution Plan (BEP) at the start of the project. **1.b Develop standards**, e.g. templates and guides, to support the definition of clash detection prerequisites, tolerances, and methods. **1.c Use process mapping technique** to increase transparency, defining clearly how the information moves from one stage to another, also clearly defining the clash detection and resolution frequency and cycles.
2. Generate models and prepare disciplines for federation *(design team)*	**2.a One-piece flow** to handle the clashes one-by-one as they are detected. **2.b Mistake proofing** to support BIM models' compliance, consistency and accuracy, avoiding element omission or duplication.
3. Prepare federated model and federate discipline models	-
4. Perform clash detection on federated model	**4.a Improved process standardisation** and **automated approach** for manual and repetitive clash detection activities, e.g. grouping or filtering the clashes.
5. Report the clashes and analyse issues detected	**5.a Flow management and control approach, digital visual management and A3 reporting** can be adopted to improve clash management through automated systems, defining an interactive way to find, report and analyse the clashes and to improve transparency. **5.b Systematic waste analysis** through root cause analysis and clear definition of a clash classification criteria, identifying and reporting issues instead of clashes.
6. Publish the federated model	-
7. Organise and undertake regular design coordination meetings	-
8. Resolve issues detected by clash detection, update and share updated models *(design team)*	**8.a Continuous improvement** to facilitate the exchange of lessons learnt between projects, using **Lean problem-solving techniques.**
9. Update clash register and issue a report (if required)	-

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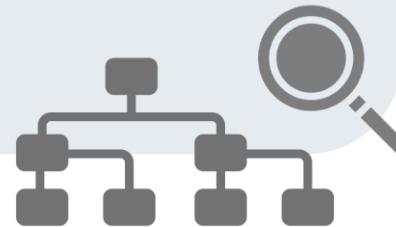- **Final considerations**

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FINAL CONSIDERATIONS

The paper contributes to knowledge by determining **how Lean could reduce waste and increase value** of a clash detection and resolution process.

BIM ← **Lean**

The formalisation and standardisation of BIM processes **can increase the transparency** of the process (Klotz et al. 2008)

Clash detection and resolution is an **important and justified process** in a Lean project delivery (Tommelein and Gholami 2012)

FINAL CONSIDERATIONS

The results indicate that **Lean can contribute to the BIM processes**, **beyond the BIM capabilities and features**, to support BIM process improvements.
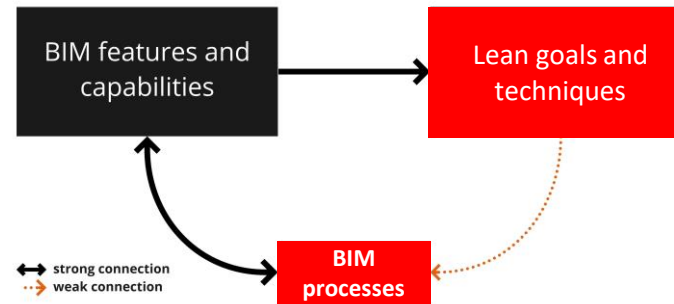

Figure 5: Lean goals and techniques contributions to BIM processes

The wide range of intervention opportunities in BIM processes from a Lean perspective **needs further investigation for Lean to have a firmer place in BIM discussions**.

THANK YOU!

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