Visualisation tools in hospital real estate

Fieke Noordam
MSc thesis - June 21st 2021
Visualisation tools in hospital real estate

Exploring how the use of visualisation tools enhance stakeholder involvement in hospital (re)construction projects
Content

Introduction  Methodology  Findings  Conclusion  Recommendations
Content

- Introduction
- Methodology
- Findings
- Conclusion
- Recommendations
Why?

The (re)construction of hospitals...

Complex processes  Different users  Different demands

2D floorplans fall short in facilitating...

- Design understanding
- Design communication
Visualisation tools

Physical mock-up

Virtual visualisation
Visualisation tools

Physical mock-up

- Tape
- Wood/ Cardboard
- Genuine materials
Introduction

(GAF, 2021B)

(MMEK Designers, n.d.)

Amsterdam UMC, 2020)
Visualisation tools

Virtual visualisation

- Non-immersive
- Semi-immersive
- Immersive
Introduction

(MMEK Designers, n.d.)

(Heijmans, n.d.)

(GAF, 2021A)

(GAF, 2021A)
There is little known on how visualisation tools are used best to involve stakeholders within hospital (re)construction projects.
Goal

'Give hospital (re)construction projects and managers insights into how visualisation tools can be used to involve hospital stakeholders and provide them with advice to make this complex task more manageable.'
Knowledge gap

Gap: N=6

(1) Bayramzadeh et al. (2018)
(2) Harty and Tryggestad (2012)
(3) Huang et al. (2017)
(4) Lin et al. (2018)
(5) Roupé et al. (2020)
(6) Tutt and Harty (2013)
Research question

RQ: How can visualization tools contribute to the involvement of stakeholders in hospital (re)construction projects?
Research question

How can visualisation tools contribute to the involvement of stakeholders in hospital (re)construction project?
Research question

How can visualisation tools contribute to the involvement of stakeholders in hospital (re)construction project?
Research question

*Question 1: Which stakeholders are involved in hospital (re)construction projects, and how?*
Research question

Question 2: Which visualisation tools are used in hospital (re)construction projects, and how?

![Diagram showing visualization tools and stakeholder involvement]
Research question

**Question 3:** When in the design process of hospital (re)construction projects are the visualisation tools used?
Research question

Question 4: How do visualisation tools impact stakeholder involvement in hospital (re)construction projects?
Literature study

- Bayramzadeh et al. (2018)
- Harty and Tryggestad (2012)
- Huang et al. (2017)
- Lin et al. (2018)
- Roupé et al. (2020)
- Tutt and Harty (2013)
Case study

Case 1. Amsterdam UMC

Case 2. Noordwest Ziekenhuisgroep

Case 3. Rijnstate
Interviews

Case 1.
- Project manager
- Architect
- Doctor
- Nurse
- Accommodation manager

Case 2.
- Project manager
- Architect
- Doctor
- Nurse
- Accommodation manager

Case 3.
- Project manager
- Architect
- Doctor
- Nurse
- Accommodation manager
Case study

Methodology
Validation

Expert panel

<table>
<thead>
<tr>
<th>Expert</th>
<th>Company</th>
<th>Role</th>
</tr>
</thead>
<tbody>
<tr>
<td>1.</td>
<td>AT Osborne</td>
<td>Senior Consultant Accommodation &amp; Real Estate (Education and Research)</td>
</tr>
<tr>
<td>2.</td>
<td>AT Osborne</td>
<td>Consultant Accommodation &amp; Real Estate (Healthcare)</td>
</tr>
<tr>
<td>3.</td>
<td>GAF</td>
<td>Architect (Healthcare)</td>
</tr>
</tbody>
</table>
Findings
Findings

Which and how are stakeholders involved?

D  C  B  A  E

Which and how are visualisation tools used?
- Virtual visuals
  - 3D
  - VR
- Physical mock-up

When in design process?

How do visualisation tools impact stakeholder involvement?

VR

Feedback
Q1. Which stakeholders are involved in hospital (re)construction projects, and how?

Many different hospital stakeholders

Patients are little involved

Ones involved represent their department

‘Multidisciplinary groups work very well because the different stakeholders start discussing with each other and come to a solution together.’ (B1, 2021)
Q2. Which visualisation tools are used in hospital (re)construction projects, and how?

Mock-ups enable effective testing of a room

Mock-ups for ‘typicals’ and ‘criticals’

Virtual visualisations create design support and enthusiasm

Virtual visualisations can not test physical user processes

Both tools complement each other: best used together

‘A mock-up shows; this is the way you are standing in it, does it fit, can I resuscitate a patient in that room? Can I stand here with a nurse and another doctor?’ (B3, 2021)
Q3. When in the design process of hospital (re)construction projects are the visualisation tools used?

Case 1.

Case 2.

Case 3.
Q3. When in the design process of hospital (re)construction projects are the visualisation tools used?

Several visualisation tools throughout the design process

Physical mock-ups can be used best in an early design stage when design changes can still easily be made

Virtual visualisations can be used best at a later design stage to show a more elaborated version of the design

‘When the mock-up was finished, we realised that if you went into the bathroom and left the door open, you couldn't enter the main room if someone became unwell. Well, that was important to note, otherwise, you'd have to adjust that in all the rooms afterwards’ (A3, 2021)
Q4. How do visualisation tools impact stakeholder involvement in hospital (re)construction projects?

- Improve communication
- Improve Understanding
- Virtual visualisations can be misleading
- Physical mock-ups
- Improve collection of feedback
- Facilitate discussions and compromises

‘The saying ‘a picture says more than a thousand words' is sometimes really true [...] what you cannot imagine, you cannot ask questions about’ (C6, 2021)
Conclusion

How can visualisation tools contribute to the involvement of stakeholders in hospital (re)construction projects?

- Physical mock-ups
- Virtual visualisations
Conclusion

How can visualisation tools contribute to the involvement of stakeholders in hospital (re)construction projects?
Conclusion

How can visualisation tools contribute to the involvement of stakeholders in hospital (re)construction projects?

Physical mock-up

Virtual visualisation
Conclusion

How can visualisation tools contribute to the involvement of stakeholders in hospital (re)construction projects?
Recommendations

For future research

- Other (real estate) sectors
- Other project phases
- More in depth research
- Influence on cost and time
- The psychological effect
- Possibilities to involve patients
Recommendations

For practice

- Use tools, work from sketch to detail
- Face complexity be explicit
- Mock-ups for typicals and criticals
- Keep developing
- Keep using the tools after completion
- Use the rule of thumb
Rule of thumb

Which purpose do we want to serve?

Support/enthusiasm
- Virtual Reality (immersive approach)
- Final physical mock-up
- 360° images and movies (semi-immersive approach)
- 3D images en movies (non-immersive approach)
- Physical mock-ups of wood/cardboard
- Physical mock-ups of tape

Discussion/compromises

Design input/feedback
- 2D floorplan with Lego figures

Program of Requirements
Draft design
Preliminary design
Final design
In which design phase are we?
The future of virtual visualisation tools

(RageofMars, 2020)

(The B1M, 2017)

(BBC, 2019)

(Rijndam Revalidatie, 2016)

(de Nijs, 2021)

(Ministerie van Volksgezondheid, Welzijn en Sport, 2020)
The future of virtual visualisation tools
Visualisation tools in hospital real estate

Fieke Noordam
MSc thesis - June 21st 2021
References

Images
- Amsterdam UMC. (2020, 1 oktober). Patiëntenkamers beddentorens Amsterdam UMC locatie AMC [Video]. YouTube. https://www.youtube.com/watch?v=OXJzBI23w6E&t=127s
- BBC. (2019, 26 september). Trying On Virtual Clothes - BBC Click [Video]. YouTube. https://www.youtube.com/watch?v=e8Wt2JlS1_M
- GAF. (2021A). Personal communication about NoordWest Alkmaar.
- GAF. (2021B). Personal communication about Rijnstate hospital in Elst.
Extra slides
Discussion

Opportunities of stakeholder involvement
A. Create shared understanding [2,3]
B. Enable collaboration [2,2]
C. Use of local/ expert knowledge [10]
D. Create support for design [4,1]
E. Stakeholders feel appreciated [4]
F. Prevents cost increase [11]
G. Reduce project delays [11]

Risks of stakeholder involvement
F. False expectations [1,2,3,7]
E. Late involvement [10]
D. Emergence of conflicts [1,10]
C. Lack of mutual language/context [3,1,10]
B. Abuse of power [1,2]
A. Unsatisfactory compromise [11]

Advantages of visualisation tools during involvement
3D representation of a design contributes to obtaining more informed design feedback [5].
Enables to better understand a design compared to 2D drawings, pictures or videos [5,20]
Enhances the ability to examine the design [5,6,11]
Reinforces communication, cogitation and integration [5,4,11]
Contributes to aligning design with the stakeholder’s expectations [11]
Allows design evaluation during the earliest phases when modifications to the design are still possible at low cost [11]

Disadvantages of visualisation tools during involvement
Ample time, and cost commitment for implementation [5,2,6]
Need for technical awareness [5,7,9]
Poor usability for inexperienced users [5,7,8]
Cause sense of isolation [5,9]
Experiences are not easily shared [5,6,9]
Unwillingness to accept a virtual environment [14,7,8]

‘Involvement’
A. Communication
B. Understanding
C. Design feedback
D. Discussion/ compromises
E. Support/ enthusiasm

Visualisation tools
M/V

Enrich
Positive impact on
False expectations

Negative impact on

(1) (Delgado et al., 2020)
(2) (Grudzewski et al., 2018)
(3) (Ibrahim & Pour Rahimian, 2010)
(5) (Soemardi Benco, 2012)
(7) (Wang et al., 2014)
(8) (Yung & Kho, Lattimore, 2019)
Limitations

- Limited number of cases
- Case selection
- Language interviews
- Certain personal backgrounds are unexplored
- Comprehensive summaries instead of all-encompassing transcripts
- Validation within AT Osborne and GAF
# (Dis)advantages of visualisation tools

<table>
<thead>
<tr>
<th>Advantages of visualisation tools</th>
<th>Disadvantages of visualisation tools</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>2D floorplan</strong></td>
<td><strong>Disadvantages of visualisation tools</strong></td>
</tr>
<tr>
<td>- It gives an overview of the building as a whole (A4, B1, B2, B5, C6, C8).</td>
<td>- It is hard for hospital stakeholders to understand and to give feedback on (A1, A2, A3, A5, A7, A8, B1, B2, B3, B4, B5, C1, C3, C4, C6, C8).</td>
</tr>
<tr>
<td>- It allows stakeholders to physically test user processes (A1, A2, A3, A4, A5, A6, A7, A8, B1, B2, B3, B4, B5, C1, C2, C3, C4, C6, C7, C8).</td>
<td>- It does not look beautiful, not inspiring because there are no colours nor actual materials (A4, A6, B3, B4).</td>
</tr>
<tr>
<td>- It is hard for hospital stakeholders to understand and to give feedback on (A1, A2, A3, A5, A7, A8, B1, B2, B3, B4, B5, C1, C3, C4, C6, C7, C8).</td>
<td>- It requires ample space (A1, A7, B4, B5, C1, C6).</td>
</tr>
<tr>
<td><strong>Physical mock-up</strong></td>
<td></td>
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<tr>
<td>- It allows a good and fast collection of feedback from involved stakeholders (A1, A2, A3, A4, A6, A7, B1, B2, B3, B4, B5, C1, C3, C4, C7, C8).</td>
<td></td>
</tr>
<tr>
<td>- It makes it possible for stakeholders to adjust the design on the spot by moving things around (B1, B4, B5).</td>
<td></td>
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<tr>
<td>- It enables all involved stakeholders to experience and discuss the design simultaneously (B2, B4, C1, C6, C8).</td>
<td></td>
</tr>
<tr>
<td>- It is handy to test typical and critical spaces (A1, A3, A5, B4, B5, C1, C2, C3, C8).</td>
<td></td>
</tr>
<tr>
<td>- It can convince stakeholders the design is sufficient (A7, A8, B3, B4, B5, C1, C4, C8).</td>
<td></td>
</tr>
<tr>
<td><strong>Virtual visualisation tool</strong></td>
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<tr>
<td>- It enthuses the user and creates design support (A1, A2, A4, A5, A6, A7, B1, B2, B3, B4, B5, C1, C2, C3, C4, C5, C6, C8).</td>
<td>- It can assess physical processes (A1, A3, A6, A7, B1, B2, B3, B4, B5, C6, C7, C8).</td>
</tr>
<tr>
<td>- It gives the user an idea of routing and the spatial relation of rooms (A1, A3, A6, A7, B1, B2, B3, B4, C1, C2, C3, C4, C5, C6).</td>
<td>- It does not easily collect feedback from involved stakeholders (A2, A3, A6, A7, A8, B1, B2, C6).</td>
</tr>
<tr>
<td>- It is relatively easy for the architect to make design changes (A1, B2, C2, C6).</td>
<td>- It shows specific details which can be misleading (A1, A4, A6, A7, A8, B3, B5, C2, C5, C6, C7, C8).</td>
</tr>
<tr>
<td>- It can convince stakeholders the design is sufficient (B3, C2, C3, C6).</td>
<td>- VR can only be used by one stakeholder at a time (A1, A4, B2, B4, C1, C2).</td>
</tr>
<tr>
<td>- VR can create digital motion sickness for users (A1, A4, A6, B3, C1, C2).</td>
<td>- VR can create digital motion sickness for users (A1, A4, A6, B3, C1, C2).</td>
</tr>
</tbody>
</table>
## Context of the 3 hospital projects

<table>
<thead>
<tr>
<th>Location</th>
<th>Project Timing</th>
<th>New construction or reconstruction</th>
<th>New location or current location</th>
</tr>
</thead>
<tbody>
<tr>
<td>Case 1: UMC-A</td>
<td>Amsterdam 2015 -&gt; ongoing (now constructing)</td>
<td>Reconstruction</td>
<td>Current location</td>
</tr>
<tr>
<td>Case 2: NoordWest</td>
<td>Alkmaar 2016 -&gt; ongoing (now constructing)</td>
<td>New construction</td>
<td>Current location</td>
</tr>
<tr>
<td>Case 3: Rijnstate</td>
<td>Elst 2020 -&gt; ongoing (now finalising design)</td>
<td>New construction</td>
<td>New location</td>
</tr>
</tbody>
</table>
Findings

- Bayramzadeh et al. (2018)
- Harty and Tryggestad (2012)
- Huang et al. (2017)
- Lin et al. (2018)
- Roupé et al. (2020)
- Tutt and Harty (2013)

1. Case 1
   Amsterdam UMC

2. Case 2
   NoordWest ziekenhuisgroep

3. Case 3
   Ziekenhuis Rijnstate

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**Who are the stakeholders involved?**

- Medical staff
- Design team
- Project manager
- FM
- Patient

**Which and how are visualisation tools used?**

- Virtual tool
- Mock-up

**When are the visualisation tools used during the design process?**

- Program of requirements
- Draft design
- Preliminary design
- Final design

---

**How do visualisation tools impact stakeholder involvement?**

1. Implement in design
2. Demands/feedback

- Case shows this
- Case does not show this
- Paper shows this
- Paper does not show this
- Case partly shows this
- No final design established yet
Findings

2. Harty and Tryggestad (2012)
3. Huang et al. (2017)
4. Lin et al. (2018)
5. Roupé et al. (2020)

1. Case 1
   Amsterdam UMC
2. Case 2
   NoordWest ziekenhuisgroep
3. Case 3
   Ziekenhuis Rijnstate

<table>
<thead>
<tr>
<th>Stakeholders Involved</th>
<th>Visualisation Tools Used</th>
<th>Visualisation Tools Impact Stakeholder Involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>Medicst</td>
<td>Virtual tool</td>
<td>Implement in design</td>
</tr>
<tr>
<td>Design team</td>
<td>Mock-up</td>
<td></td>
</tr>
<tr>
<td>Project manager</td>
<td></td>
<td></td>
</tr>
<tr>
<td>FM</td>
<td></td>
<td></td>
</tr>
<tr>
<td>Patient</td>
<td></td>
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</tr>
</tbody>
</table>

How do visualisation tools impact stakeholder involvement?

- Implement in design
- Demands/feedback
Interview protocol

Open question:

A. Kun u uzelf introduceren en uw rol in het ziekenhuis verbouwing toelichten?

B. Kun u mij vertellen wie er nog meer betrokken waren bij de bouw van Rijnstate ziekenhuis? (De ziekenhuis gebruikers, contextuele belanghebbenden; patiënten, zorgverzekeraar, gemeente, etc.)

C. Kun u mij vertellen hoe de communicatie van dit bouwproject is verlopen? (flyers, afbeeldingen, vergaderingen, website)

D. Wat vond u van de communicatie?

E. Kun u mij vertellen wat voor visualisatie tools (VR/ Mock-up) er zijn gebruikt?

F. Kun u mij iets vertellen over op wiens initiatief de visualisatie tools zijn gebruikt? Was diegene ook verantwoordelijk voor de visualisatie tools?

G. Wat is het verschil in ervaring bij de VR ten opzichte van de Mock-up ten opzichte van een 2D tekening?

H. Wat is het verschil in ervaring bij de VR ten opzichte van de Mock-up tijdens het verbouwingsproject?

I. Kun u mij vertellen wat het effect van de visualisatietools (mock-up/VR) was op de projectcommunicatie was?

J. Kun u mij vertellen wat de visualisatietools (mock-up/VR) hebben gedaan voor de betrokkenheid van de ziekenhuis stakeholders?

K. Hoe denkt u dat de betrokkenheid van een ziekenhuisstakeholder bij het ontwerpproces nog meer vergroot kan worden?

Specific questions on the risks of stakeholder engagement:

L. Kun u mij vertellen of de VR/Mock-up de ziekenhuis stakeholders hebben ondersteund om juiste verwachtingen te vormen van het voorgestelde ontwerp?

M. Kun u mij vertellen wanneer in het ontwerpproces de stakeholders van het ziekenhuis betrokken waren?

N. Is hun feedback vervolgens meegenomen in het ontwerp?

O. Kun u mij vertellen of de belanghebbenden in het ziekenhuis voldoende achtergrondkennis hadden om de visualisatie tool te begrijpen en te gebruiken?

P. Kun u mij vertellen of er conflicten/discussies zijn ontstaan terwijl de stakeholders de tool gebruikten?

Q. Kun u mij vertellen of er een verschil in macht was tussen de betrokken belanghebbenden in dit besluitvormingsproces? Wat was de invloed van de visualisatietool hierop?

R. Zijn er in dit besluitvormingsproces onbevredigende compromissen gemaakt? Wat was de invloed van de visualisatietool hierop?

S. Welke ziekenhuis stakeholders heeft u betrokken bij het gebruik van de visualisatietool? Denkt u dat andere belanghebbenden zich hiervan buiten gesloten voelden?

T. Sprak u namens een groep, en zo ja, hoe betrok u uw jouw achterban daarbij? / Spraken de betrokken stakeholders uit het ziekenhuis namens een groep, en zo ja, hoe betrokken zij hun achterban daarbij?
Literature study method

- Stakeholder involvement and visualisation tools in hospital real estate

<table>
<thead>
<tr>
<th>Visualisation tools</th>
<th>Stakeholder involvement</th>
<th>Hospital real estate</th>
</tr>
</thead>
<tbody>
<tr>
<td>VR</td>
<td>Stakeholder involv*</td>
<td>Hospital</td>
</tr>
<tr>
<td>Virtual reality</td>
<td>Stakeholder engag*</td>
<td>Healthcare real estate</td>
</tr>
<tr>
<td>Mock-up</td>
<td>Stakeholder manage*</td>
<td>Healthcare</td>
</tr>
<tr>
<td></td>
<td>Stakeholder integrat*</td>
<td></td>
</tr>
</tbody>
</table>
Inclusion and exclusion criteria were used

<table>
<thead>
<tr>
<th>Inclusion criteria</th>
<th>Exclusion criteria</th>
</tr>
</thead>
<tbody>
<tr>
<td>Setting: Hospital real estate</td>
<td>Setting: other (healthcare) real estate such as small care practices</td>
</tr>
<tr>
<td>Study focuses on the involvement of stakeholders</td>
<td>Study does not mention the involvement of stakeholders</td>
</tr>
<tr>
<td>Study makes use of mock-up of a virtual visualisation</td>
<td>Study makes use of other communication tools, such as discussion groups</td>
</tr>
<tr>
<td>Purpose of the study is related to the real estate usage</td>
<td>Purpose of the study is related to other areas, such as educational practice</td>
</tr>
<tr>
<td>Method of the study is hospital case studies</td>
<td>The study uses theoretical papers, systematic reviews, position papers, statistical studies, etc.</td>
</tr>
<tr>
<td>Clear description of methods and results</td>
<td>Data collection process is unclear</td>
</tr>
</tbody>
</table>

Literature study method

- Literature study N = 6

2. Harty and Tryggestad (2012)
3. Huang et al. (2017)
4. Lin et al. (2018)
5. Roupé et al. (2020)
Opportunities and risks of stakeholder involvement

<table>
<thead>
<tr>
<th>Opportunities of stakeholder involvement</th>
<th>Risks of stakeholder involvement</th>
</tr>
</thead>
<tbody>
<tr>
<td>I. Create shared understanding</td>
<td>I. False expectations</td>
</tr>
<tr>
<td>II. Enable collaboration</td>
<td>II. Late involvement</td>
</tr>
<tr>
<td>III. Use of local/ expert knowledge</td>
<td>III. Emergence of conflicts</td>
</tr>
<tr>
<td>IV. Create support for design</td>
<td>IV. Lack of mutual language/context</td>
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<tr>
<td>V. Stakeholders feel appreciated</td>
<td>V. Abuse of power</td>
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<tr>
<td>VI. Prevents cost increase</td>
<td>VI. Unsatisfactory compromise</td>
</tr>
<tr>
<td>VII. Reduce project delays</td>
<td>VII. Undesired exclusion of stakeholders</td>
</tr>
</tbody>
</table>

References:
(1) Arias et al., 2000
(2) Fischer et al., 2005
(3) Van Bueren, 2020
(4) Van Bueren & ten Heuvelhof, 2005
(5) Keys et al., 2017
(6) Bakker et al., 2017
(7) Roupé et al., 2020
(8) Bosch-Rekveldt et al., 2011
(9) Bakker et al., 2017
(10) McManus, 2002
(11) Sutter et al., 2009
(12) Hordijk et al., 2015
(13) De Bruijn & Ten Heuvelhof, 2008
(14) Hartman, 2000
(15) Mäcker & Pipek, 2000
Literature study findings

Stakeholder involvement in hospitals (A)

Role and power of stakeholders in the process

- **User group** (Stakeholders 1ab, 2ab, 3b, 4b)
  - Show demands/expectations for new design

- **Knowledge group** (Stakeholders 1cd, 5bc, 6bcd, 8,9,10,11,12)
  - Show specific details demands for new design

- **Steering group** (Stakeholders 2ab,3a,4a,5a,6a)
  - Decision-making, focus on time, quality and financial aspects

- **Management board** (Stakeholders 7)
  - The final decision; go/ not go

- Visualization tools
- Stakeholder involvement
- Hospital real estate

- Reconsideration of plan

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## Literature study findings

### Stakeholder involvement in hospitals (A)

<table>
<thead>
<tr>
<th>Organisation unit</th>
<th>1A</th>
<th>1B</th>
<th>1C</th>
<th>2A</th>
<th>2B</th>
<th>2C</th>
<th>3A</th>
<th>3B</th>
<th>3C</th>
<th>4A</th>
<th>4B</th>
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<th>5A</th>
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<th>6A</th>
<th>6B</th>
<th>6C</th>
<th>7</th>
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<tbody>
<tr>
<td><strong>Initiation</strong></td>
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<tr>
<td>Initiating the construction project</td>
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<td>Consider different concepts (room types)</td>
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<td>Adopt programme of requirements</td>
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<td>Realisation of the design (UO)</td>
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### Roles

- **R** (Responsible)
- **A** (Accountable)
- **C** (Consulted)
- **I** (Informed)
Literature study findings

Visualisation tools for stakeholder involvement (B)

- Visualisation tools facilitate involvement
Literature study findings

Visualisation tools in hospitals (C)

- Visualisation tools facilitate involvement

<table>
<thead>
<tr>
<th>Tools</th>
<th>Advantages</th>
<th>Disadvantages</th>
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<tbody>
<tr>
<td>Mock-up</td>
<td><em>(Full)scale model enables stakeholders to experience the proposed design jointly</em></td>
<td><em>Made at the end of the design process, after essential design decisions are already made</em></td>
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<td>VR</td>
<td>-Excludes misrepresentations since it leaves no room for self-interpretation</td>
<td>-Irrelevant design details cannot be left out; this can cause unnecessary discussions about details</td>
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<td>AR</td>
<td>-Functions well for renovation projects since it can overlay a current situation with a filter</td>
<td>-Less useful for a new design, if nothing is there, a lay-over-design cannot be made</td>
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<td>Immersive approach</td>
<td>-Makes it possible to experience design in a complete 3D environment</td>
<td>-The HMD disables face-to-face communication, which makes it less suitable for a collaborative design process</td>
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<tr>
<td>Semi-immersive approach</td>
<td>-Makes it possible to experience design in a progressed 3D environment</td>
<td>-Users can experience digital motion sickness by using a HMD</td>
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<tr>
<td>Non-immersive approach</td>
<td>-All stakeholders see the same environment by looking at a screen</td>
<td>-Does not allow the stakeholder to visualise a complete 3D environment</td>
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</table>
Q3. When in the design process of hospital (re)construction projects are the visualisation tools used?

Who made use of the tools: The involved hospital stakeholders
Q3. When in the design process of hospital (re)construction projects are the visualisation tools used?
Q3. When in the design process of hospital (re)construction projects are the visualisation tools used?

Who made use of the tools: The involved hospital stakeholders