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## Evaluation methods for hospital facilities

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### ABSTRACT

**Initial position & background:** There are various methods and tools for evaluating facilities. The focus is usually on the technical building performance, function/usability or form/beauty. Examples are: Post-Occupancy Evaluation (POE) and Usability Appraisal. Nevertheless, evaluations of buildings in use are seldom. They are considered a long and expensive part of the final phase of a building project. Therefore the experiences of finished building projects are not collected and mistakes are repeated.

**Problem & task description:** This paper lists different types of evaluation methods ordered according to focus areas and proposes which evaluation methods to use in different building phases of healthcare facilities. Hospital evaluations with experts and users are also considered; their subjective view on space, function, technology, usability and aesthetics.

**Results & solutions:** This paper presents the different methods for evaluating buildings in use in a new model, the Evaluation Focus Flower, and proposes which evaluation methods are suitable for various aims and building phases, i.e. which is giving best input for the initial briefing process of new hospital facilities with ambition of creating buildings with enhanced usability. Additionally various evaluation methods used in hospital cases in Denmark and Norway are presented. Involvement of users is proposed, not just in defining requirements but also in co-creation/design and evaluation of solutions. The theories and preliminary research results have relevance to researchers and practitioners planning new complex facilities, of any kind, not only hospitals.

### Keywords

Evaluation methods, Hospitals, Briefing process, POE, Usability Appraisal

## 1 INTRODUCTION

There are various methods and tools for evaluating facilities. The focus is usually on one of the three: the technical building performance, function/usability or form/beauty. Nevertheless, evaluations of buildings in use are seldom. They are considered a long and expensive part of the final phase of a building project. Therefore the experiences of finished building projects are not collected and mistakes are repeated.

My focus is on planning usable complex facilities, like hospitals with multiple challenges of healthcare sector. In Denmark there are currently 28 (16 new) hospital building projects that will shape the future for a long time ahead. They can probably be planned more optimally, resulting in better usability, if the building process, especially the briefing stage is enhanced with evaluations to support decisions.

This paper proposes a way to organise evaluation methods according to focus area and how to choose the right evaluation method for different buildings phases of new healthcare facilities. A new model, the Evaluation Focus Flower, for sorting methods according to focus area is presented. An additional model proposes evaluation methods that can be used at different phases of a hospital building project, specially focusing on early stages and briefing process.

The article is structured as follows. Section 2 presents a literature review on POE, a detailed overview of various methods and the new models structuring various evaluation methods. Section 3 describes three hospital cases in Denmark and Norway. Section 4 covers analysis of how the methods could be used in hospital projects at different phases. Finally section 5 presents the conclusion.

## 2 EXPLORATION OF EVALUATION METHODS

### 2.1 Reasons for evaluation

Several reasons exist for making evaluations. Cold (2012) divides them under 3 groups:

- Recognition - To understand the place and yourself, experience, understanding, development of theories
- Control - To see others' experience and use of place, control and get abilities/ knowledge
- Professional information - To know expert evaluations, discuss and inform

The British Council for Offices (BCO) suggests two main purposes for a Post Occupancy Evaluation (POE). The main aim is to gain feedback on how successful the workplace is in supporting the occupying organisation and individual end-users. The other purpose is to use POE to assess if a project brief – the programme of requirements, was met.

Researchers recently presented additional aims of making a POE - to gain knowledge from own and other sites and *feed forward* for new briefing processes (Jensen, 2010, Preiser, 2010, Lindahl, Hansen, Alexander, 2012). This use of POE methods for new building projects is called Pre Design Evaluation (PDE) (Ornstein and Andrade, 2012, Preiser and Vischer, 2005).

I recommend combining POE / PDE with user involvement and co-learning, making a common understanding in the participant group (Fronczek-Munter, 2012).

A model combining those aspects is presented in Figure 1 and shows various reasons for evaluations of buildings. The model has two axes.

The horizontal axis is inspired by innovation thinking and shows the amount of action and innovation level in the building.

The vertical axis adds the context:

- Existing building, (either testing current existing conditions, or knowledge applied for improvements or radical innovation in same facility)
- New building, (testing if requirements are met, learning from other existing facilities and feed forward for briefing and innovation in a new building, part of user involvement and co-learning process)

- Develop generic knowledge (documentation of best practice case in specific type of building or geographical area, inspiration to innovation – many cases)

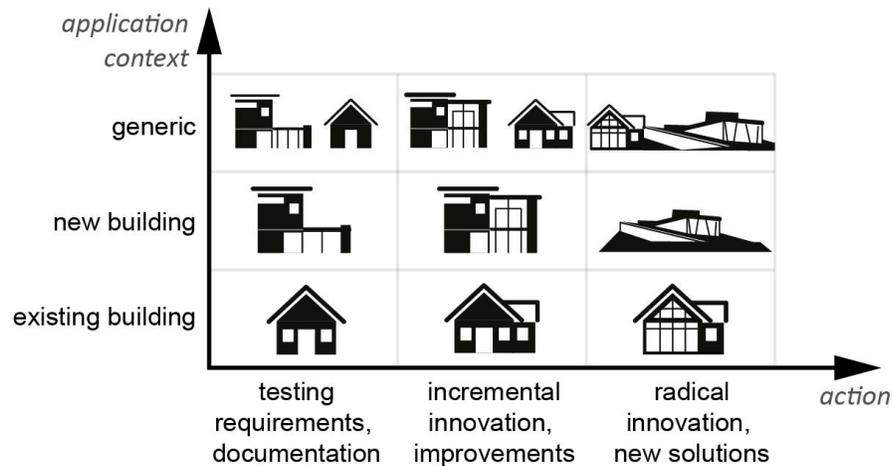


Figure 1 Model of the various reasons for evaluations of buildings

Comparable to the methods of user involvement, which I recommend to choose carefully to fit the expected focus and type of result (Fronczek-Munter, 2011), I also recommend to be aware of an organisation's motivation for doing evaluations and in advance choose the focus areas and methods to support the aims.

## 2.2 Methods of evaluation

Once the goals of the evaluation are clear, a suitable method can be chosen. In order to assist that process I have organised the different methods from literature review in Table 1. Additionally, I have developed a new Evaluation Focus Flower model, see Figure 2, for an easy overview of methods and their main focus. The POE method is described in two understandings: the traditional common practice and a broader "umbrella" understanding, in which all the further methods can be used.

### 2.2.1 POE

The most known evaluation method for buildings is Post Occupancy Evaluation (POE) (Preiser, 1988, 1995, 2003, 2005). 'Post occupancy' refers to the fact that the building is already taken to use at the point of evaluation. The origins of the method are in the USA and it has been used since the 1960s. According to the definition of Preiser et al. (1988, 2005), POE is "the process of evaluating buildings in a systematic and rigorous manner after they have been built and occupied for some time".

There are 3 levels of detail in POE, (Preiser, 1995, 1988, 2003, Blackstad, 2008):

- *indicative* - quick, walk-through evaluations, involving structured interviews with key personnel, group meetings with end-users, inspections. Result is a quick overview of positive and negative aspects of building performance, gained with limited use of resources

- *investigative* - in-depth evaluations, interviews and survey questionnaires, photographic/video recordings, physical measurements, benchmarking with literature and state of the art facilities. Result is in depth evaluation of the facility
- *diagnostic* - longitudinal and cross-sectional evaluation studies of performance aspects, comprehensive, many variables, research approach. The result is knowledge from state of the art descriptions from cases.

The POE approaches have evolved from case studies of stand-alone building projects, to structured studies of varied building forms with valid, cross functional results for benchmarking (National Research Council, 1987). The critique of traditional POE was that it usually focuses on technical building performance. Nowadays the term for such technical focused assessments is commissioning. Jensen (2010) proposes, that evaluation of usability complements commissioning activities in a combined validation of both the technical and the user oriented performance of buildings, and that the processes could run continuously, like the continuous briefing (Jensen et al., 2009), but with different peak times. Riley et al. (2003) present the historical development of POE, also previous resistance to POE by construction professionals. Preiser (2010) recently states that POE /PDE is a proactive process which feeds into the next building cycle through strategic planning/ needs analysis and programming/briefing. The broad understanding of POE, is that it evaluates the performance of the building based on user experiences, but also considers a more holistic, process-oriented evaluation (Preiser and Vischer, 2005). The clients are interested in POE to improve their facilities and occupants' performance (Bordass and Leaman, 2005).

POE practitioners are usually architects, but according to Preiser (2010) they will be trained in several other disciplines in the future, also in social sciences/management. Nevertheless other kinds of participants can run POE or PDE: managers and design team with user groups, personnel and end-users.

### 2.2.2 Overview of evaluation methods

There are over 150 POE techniques available worldwide (McDougall et al., 2002, Leaman, 2003, Bruhns, Bordass, Leaman, 2005, Blakstad, Hansen, Knudsen, 2008, Riley et al. 2009, Haron, Hamid, 2011). Some are well established: Mental Map (Lynch, 1960), Save (1990) others are more recent: USEtool (Hansen, Blakstad, Knudsen, 2009). Some of the different methods of evaluation are presented in Table 1 and Figure 2 with typical focus areas.

Figure 2 provides an overview of the methods, grouped and placed on the Evaluation Focus Flower model in order to easily find the right evaluation method fitting the focus area to study. The many focus areas are represented by flower petals with overlaps. The model background are three main areas, that are based on three qualities of architecture, that were defined in Ancient Rome by Vitruvius (80-15 BC) in his book *De architectura*, also known as *The Ten Books on Architecture*. The qualities are: *firmitas*, *utilitas* and *venustas*. Today most architecture students hear about the three elements in their first architecture history classes. Nevertheless the understanding of the words is not universal, but constantly changing throughout time and place. Venustas will be translated in this paper as Beauty / Form, Firmitas as Durability / Technology, and Utilitas as Utility / Usability.

### Evaluation focus flower

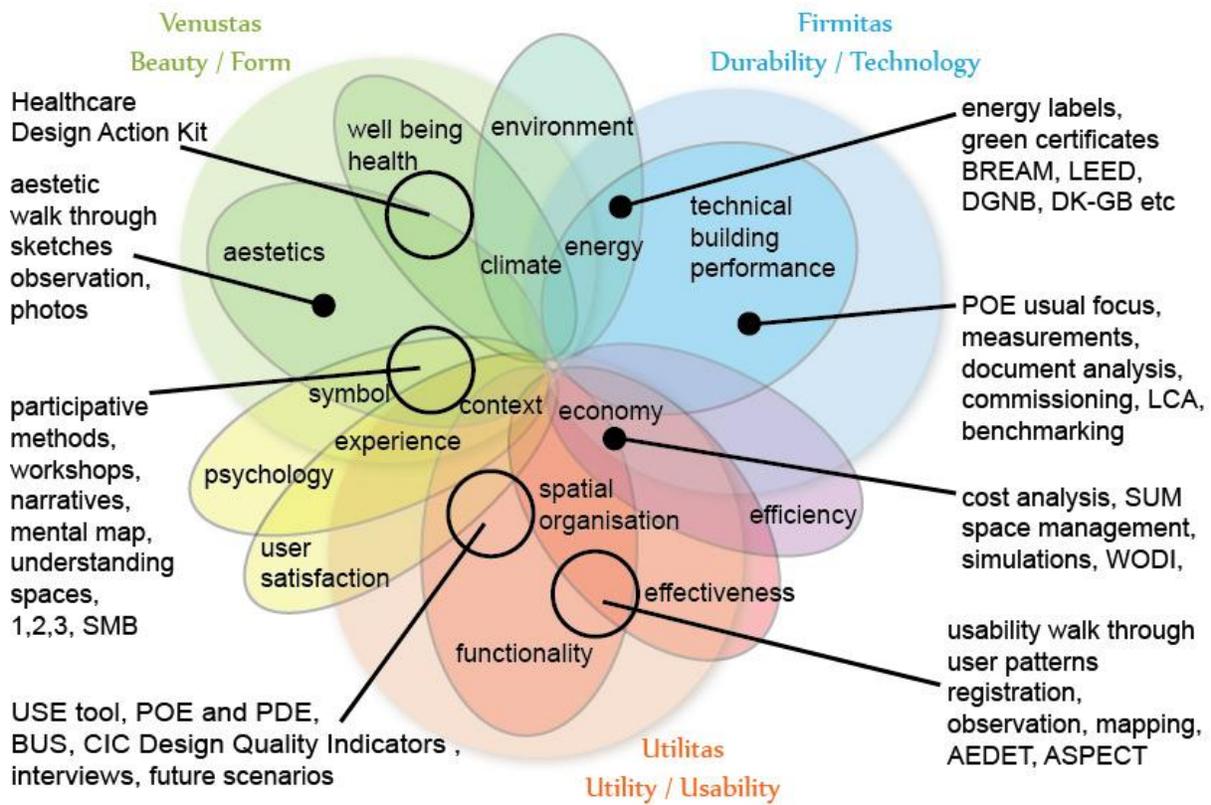


Figure 2 Evaluation Focus Flower model with a few evaluation methods placed accordingly to their main focus

In Table 1 the methods are grouped and explained, and generic methods that can be used in various focus areas are added.

Table 1 Different methods of building evaluation and their main focus. Numbers refer to references

Method	Tools used	Focus
<b>Generic methods</b>		
Benchmarking (23,26)	comparing standard data from own evaluation to others	Generic method, often energy, space utilisation
BRE Design Quality Method (DQM) (22)	Studies of architecture, interior, comfort, life cycle cost, user satisfaction - questionnaire	Architecture, interior, comfort, life cycle cost, user satisfaction
Document analysis (2,17)	Study of documents, drawings etc.	Generic method for various use
Interviews (2,17)	Individual or group interviews	Generic: current use of space, explore experiences of users, satisfaction, efficiency, existing work practice, context
Learning from experience (4,5,36)	- Facilitated group discussions or interviews	Team learning from its experience

Observation, documentation, photographs (2,17)	Observation of facilities, their use and focus topics, documentation, photographs, experience, test, learn	Generic method: beauty, usability, technology
Overall Liking Score (22,36)	Questionnaire (Hardcopy/web based) 7 point scale	Occupant survey. Diagnostic tool
Participatory methods (2,17)	workshops, narratives (story telling), pictures, personas, future scenarios, simulations	Generic method, get various inputs from stakeholders, co-learning
POE broad understanding, PDE (pre-design evaluation) (4,5,18,26,36)	Questionnaire, space measurement, walk-through, survey, focus groups, forum, facilitated group discussions, interviews, workshops	Generic method: Functionality, building quality/impact, user satisfaction, productivity, added value of FM, sustainability, workplace management, aims: testing, monitoring, co-learning, input to decisions, beauty, usability, technology
Survey/ questionnaire (2,4,5,17)	Questionnaire	Generic method: usability, work style and pattern, culture, efficiency, satisfaction
Walk-through, excursion (2,17) A walk around the block (9,25) Observing physical traces- Behaviour vs. Design	Walk-through – structured route and focus areas, positive and negative aspects, walk with everyday users and visitors excursion – free route	Generic method: usability, aesthetics, technology, functional design, behaviour and appearance
<b>Beauty</b>		
Mental map (9,25)	Drawing important places on a map, comparison, discussion	Remembered and used physical spaces of the city, our different relations to them
Place understanding (9,28, 29)	Understand : the causal - intentions, the formal /configurative – the form, the semantic - symbolic	aesthetical expression of a place or architecture, intentions, form and symbolic value
Townscape, Serial vision (9,12)	Systematic sketches and notes	Experience the city space through movement, systematic visual, perception, position, form, changing experiences in continuous movement
Place identity and role (7, 9)	Interviews, workshops: assessment of interaction of physical environment, activities and people's perceptions, culture, cognitive ecology	Identity of a place as interaction of physical environment, activities and people's perceptions, dynamic and will change when factors change
Semantic differential scheme (9,19,21)	Scheme with 8 parameters, i.e.: complexity, originality, pleasantness, people's immediate experience and evaluation of places, comparisons	Comparing people's immediate experiences, beauty, psychology
SAVE (1990) Survey for Architectural Values in the Environment (9,27)	Mapping architectural values of cities, municipality atlas. topographic, historic, architectonic analysis	City's dominating features, structures, character of topographic, historic, architectonic value
1,2,3 method (9)	1- <i>immediate impressions</i> - sketches and notes. 2- <i>analysis</i> , 3- <i>consolidated place assessment</i>	Place and architecture evaluation, preliminary impressions and feelings about space confronted with scientific analysis

<b>Usability</b>		
AEDET, ASPECT, QIND, CIC DQI (18,22)	Study by designers, not users	Help in design process, functionality
BUS Occupant survey (Building USE Studies), OBU Healthcare POE Method (4,5,22,23,26,36)	- Building walk-throughs - Questionnaire backed up by focus groups	Occupant satisfaction productivity, comfort
CIC Design Quality Indicators (4,5)	Questionnaire	Functionality, building quality/impact
De Montfort method	forum, walk-through	Broadly covers the process review and functional performance
Healthcare Design Action Kit (22)	Checklist for managers, architects and a patient inquiry about building in use	Hospital supporting patients and relatives
Healthcare Design Quality Assessment Method (22)	Many qualitative tools i.e. questionnaire with open questions	Design , architectural solutions, effect on users
Interaction model for the emotional process (Küller, 1986, 1991)	Observations of the physical environment and users/ patients behaviour, mood, social behaviour, activities, resources, eating patterns, etc.	Users relations to physical environment, functionality, psychology. Studies show i.e: homey interior affects wellbeing
Mapping, analysis of space and relations (2)	Analysis of space and relations between them, observations, interviews, organisation, mapping	Space utilisation, functionality, organisation
Overall Liking Score (4,5)	User survey on comfort and well-being	Comfort , well-being of users, how important are various conditions
PROBE, (4,5,22,23,26,31,36)	Questionnaire/- Focus groups/- Visual surveys, energy assessment, evaluation Performance of systems	User satisfaction / occupant survey Systems performance, building engineering benchmarks developed
Quality of city space and 3 types of activities (15)	Systematic assessment of quality through observation of necessary, optional and supplementary (also social) activities in city spaces	City spaces of good quality will have many of optional and supplementary activities
ST&M, ASTM standards (22,26)	measuring if requirements are met	functional requirements test
USE tool (1,2,16,17)	Usability walk-through, user survey, process guideline - the organisation can make it without experts, 5 phases: defining, mapping, walk-through, workshop, action plan.	Usability of the facility, functionality, user satisfaction, productivity
User patterns, time/activity/space studies example: SUM space utilization monitor (CfPB) (2)	self reported and registered study of time/activity/space	Space utilisation
<b>Technology</b>		
BRE Design Quality Method (DQM)	Questionnaire	Architecture, indoor climate, Life Cycle Cost (LCC), user satisfaction
Commissioning (20)	Testing technical installations, measurements, calculations	Validation of performance, interplay of technical installations, life cycle

Energy Assessment and Reporting Methodology (4,5,23,36)	Energy use survey, data collection e.g. from energy bills	Energy use and potential savings
LEED, BREAM, DGNB, DK-GB (26)	Energy measurements, levels	Energy labels, green certificates, high goals, proving excellence
POE traditionally, BPE (Building Performance Evaluation) (4,5,22,23,26,31-35,36)	Questionnaire, Energy assessment, environmental monitoring, space measurement, cost analysis, data collection e.g. from energy bills, interviews etc.	Testing if aims are achieved, systems performance, benchmarks, energy use
WODI, WODI Light (CfPB)	Web based questionnaire	KPIs database, employee satisfaction, productivity

### 3 HOSPITAL CASE STUDIES

To show a sample of the varied use of evaluation methods used currently in hospital projects I present three recent cases.

#### 3.1 Healthcare Innovation Lab (HIL), Herlev Hospital, Denmark.

The case study was conducted at the Gynaecologic Department at Herlev Hospital in 2010-2011 as part of Healthcare Innovation Lab, which was a public-private collaboration project testing the use of simulations and user-driven innovation between users and companies at Hospitals in the Danish Capital Region.

I participated as one of the researchers in a number of design and simulation workshops with a user group from the outpatient clinic. One evaluation method was a scenario-based table-top simulation, a series of evaluations of possible new spatial arrangements and working organisation. The simulations have proven to be both time efficient, easy to understand and use for all participants and very innovative in both process and results. The user group succeeded in developing an innovative concept of the future outpatient clinic in terms of spatial layout, work organization, knowledge sharing and technology.

This case has proven that evaluations can be one of the activities for involvement of users at workshops for developing new clinic facilities, but also that evaluation can lead to innovation.

The workshops took place while the architectural competition for new design of the hospital was running. I would suggest using the simulation method either in the *briefing stage* to evaluate alternatives for the future or in the *design stage* to evaluate the preliminary sketch design solutions.

#### 3.2 St Olavs Hospital, Norway.

I have conducted a test of parts of Use tool at Laboratoriesenteret at St. Olavs Hospital, Trondheim, Norway as part of a PhD course "Evaluation of architecture" in November 2012. I guided a few co-students from the course for a walk-through at Laboratory Centre. The route had 4 stops where we observed the focus points Aesthetics and Usability, made notes and discussed our analysis. To finalise I made a pilot test of USE tool survey at 2 locations. The results of USE tool were: broad overview of the facility, structured observations and group summary, but also surprising additional information about usability from user questionnaire. It can be concluded, that for a full overview the observations must be followed up by questionnaire filled at site by employees. The evaluation was not part of the hospital project. It must be noted that the process

was not a full USE tool test, but only parts of it, but it gave valuable inputs, that could be used for *briefing* of other hospitals.

### 3.3 Bispebjerg Hospital, Denmark

This case study took place in Bispebjerg Hospital, Capital Region in Denmark in 2010-2013, where I observed the processes of briefing and user involvement for a major redevelopment of the whole hospital at its site. One of the evaluation methods used was Study trips/excursions – a less structured walk-through process, where the managers and client project group visited other sites for inspiration. The focus was often one specific area ie. logistics, and the location was chosen as the best case within exactly that theme. Interesting cases were not only hospitals, but also other buildings: hotels, airports, to observe the best systems running smoothly. Another evaluation method was User patterns and space utilization, time/activity/space studies. These were run as preliminary studies of used and empty rooms, done by an external party and served as basis for area calculations. Both methods were used in *briefing stage* of the project.

## 4 HOSPITAL BUILDING PHASES AND SUGGESTED EVALUATION METHODS:

As building performance and usability assessments are complex, they require multi-method strategies using a triangulation of methods and evaluations with multiple perspectives (Lindahl, Hansen, Alexander, 2012). Case studies have shown that hospital projects use various evaluation methods for different reasons. I present a generic example model of evaluation methods with different aims, suggested to use at different phases of hospital projects, in Figure 3.

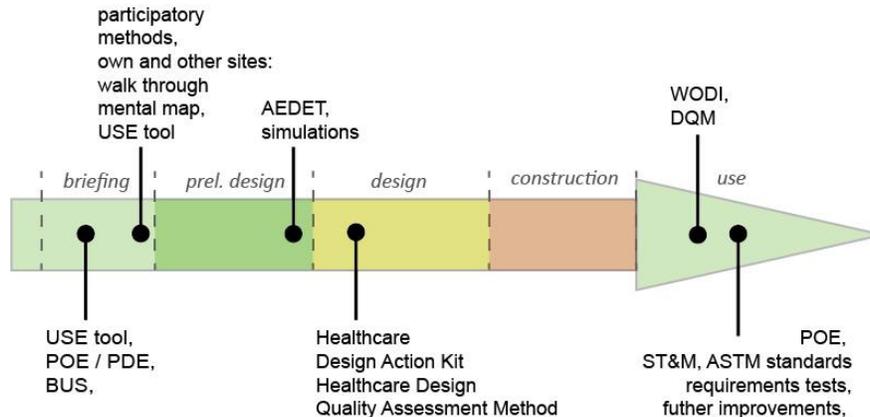


Figure 3 Example model of evaluation methods used at different phases of hospital projects

In the *briefing phase* for new healthcare facilities I propose running usability evaluations of buildings, like POE or PDE (Pre-Design Evaluation) also evaluating alternative scenarios (Ornstein, Andrade, 2012), USE tool, mental map and participatory methods. I suggest that “users can and perhaps should be involved in much earlier stages of project development and in a much broader extent than traditionally in the building sector. One of the possible ways is to make *Usability evaluations* at early design stages, in cooperation of the design team and users of buildings, which are similar to the planned one. In that way co-learning can occur and there can be achieved a deeper understanding of users needs and potential possibilities. The claim is that would result in a better usability of the built environment” (Fronczek-Munter, 2011). Some of the evaluation methods can be run on own existing facilities for future comparison, and for

learning which areas need improvement and which are ideal and need to be kept. There should also be walk-through evaluations of best cases, both for inspiration in terms of beauty, usability and technology, but also to provide a common base for the project participants.

In the *preliminary design stage*, I suggest evaluation methods that help the architects in the early process, methods such as User patterns and Learning from experience. The team can get valuable and structured information about space utilisation and uncover the previous experiences, in order to rethink and innovate from the current situation and together with the client choose the right scenarios for the future.

The following *design phase* is where main decisions have already been taken, but there are still lots of complex design solutions that need to be chosen. In order to optimise that process some evaluation methods can be used to learn from other locations and experiences, methods like Adet and especially for hospital projects the Healthcare Design Action Kit to help the functionality issues. Another possibility is running simulations of the preliminary design solutions, which can possibly find improvements in how the architecture and layout can support the future organisation.

The *construction phase* has legally specified procedures for evaluations.

In the *use phase* I suggest running evaluations for testing if requirements are met and possibly make improvements, but also to teach the users how to operate the building and check the satisfaction of different users and productivity levels in the organisation. Examples are WODI, POE, ST&M.

## 5 CONCLUSION

Various evaluation methods for buildings are available. I present a new model, the Evaluation Focus Flower, in which the different methods for evaluating buildings are grouped and ordered on the background of the three Vitruvian qualities of Architecture, in order to easily find the right evaluation method fitting the focus area to study. In this paper I give an example of methods that can be applied at different phases of a hospital building project, and propose which evaluation methods can give best input for the initial briefing process of new hospital facilities with ambition of creating buildings with enhanced usability. Additional information about current use of various evaluation methods is provided from three hospital cases in Denmark and Norway.

The models from this paper can structure thinking about types of evaluations, the reasons for doing evaluation, expected process, focus and results and use of the right tools at the various stages of hospital projects. In that way you can secure both meaningful process and results, but also user involvement, providing a common understanding, inspirations, co-creation and innovation for the future hospital facility.

This paper is part of an ongoing PhD study on Hospital Usability Briefing, therefore the interest and further research will continue in optimising methods that can be used in briefing stages for healthcare facilities. The findings have relevance to researchers and practitioners planning new complex facilities of any kind, not only hospitals.

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