FUTURE-PROOFING IN HEALTHCARE BUILDING DESIGN

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Abstract

Objective - The objective of the study is to explore how future-proofing (FP) in healthcare building design is approached by Swedish architects.

Background - Buildings are changing due to physical, economical, functional, technological, social and legal drivers. These changing circumstances results in new requirements on the buildings and drive change in healthcare building design projects. This results in a need to consider future-proofing (FP) approaches to manage this situation. Previous research on FP approaches has mostly focused on the importance of FP as such. There has been little attention on how the architectural practice actually worked with healthcare buildings related to FP, or their interpretations of related concepts to FP, such as flexibility.

Research question - How do Swedish architects approach and address FP and what design strategies have they applied in healthcare projects?

Methods - The paper is an explorative, qualitative, multi-case study of planned and/or built Swedish healthcare buildings. Data has been collected from presentations of healthcare building design projects encompassing FP approaches and through semi-structured interviews with architects designing healthcare buildings. The interviews were transcribed and analysed through content analysis focussing on the architects view and interpretation of FP in their projects.

Results - Sixteen different types of building design strategies addressing future changes were identified in the projects that were studied. The differences in the design strategies related to dissimilar contexts, budgets, stakeholders and design processes.

Conclusion - The view among the architects, that were included in the study, on FP approaches is found to be based on a narrow scope and include a vague terminology. While it is difficult, even impossible, to predict all future changes in a healthcare building design project, there is a need to develop design strategies that can address FP. However, and herein lies the challenge, an FP approach needs to be broad enough to allow for variations and defined enough to be justifiable from a project cost and delivery perspective as well as enabling a design supporting the healthcare activities.

Keywords: *flexibility* | *generality* | *elasticity* | *healthcare building* | *architecture*

Introduction

Future-proofing (FP) is a relatively new concept in design of hospitals. It encompasses such approaches as flexibility, generality, but also claims to be a somewhat more overarching approach. To address this, and which strategies Swedish architects use in health care building design, a study project was designed. This paper presents results from this project.

Buildings are affected by changes related to physical, economical, functional, technological, social and legal drivers [1]. Healthcare buildings in particular are exposed to changes, such as development of medical technology, delivery models of care, changing conditions for healthcare finance as well as organizing of the healthcare system and disease developments. Coupled with long planning processes of up to 10-20 years [7], it is also a challenge for healthcare buildings to be up-to-date in every aspect, even at the inauguration [4].

Whereas historical changes can be traced back in time, future developments are almost entirely unknown. By designing with the future in mind, design strategies encompassing FP approaches could reduce new construction, reactivate underused or vacant buildings and ease refurbishment processes (demount or replace components) [1].

It is argued that participants in design processes should address FP, or concepts related to FP, in longer and more complex design and construction projects [2, 3]. However, as identified in research, there is a vague FP terminology amongst stakeholders in design and construction processes in general [1, 5]. Furthermore, while closely related concepts to FP such as flexibility are commonly used in the design processes, they are rarely interpreted in the same way by the people involved in the projects [1, 6, 7]. This may cause unclear goals early in the design process and as a result; give rise to misunderstandings between the participants.

Studies of how participants in design and construction processes address, understand and use FP in Sweden has not been found. Nor has any studies been found covering FP of healthcare buildings in Sweden. As a consequence, this paper aims to shed light on FP approaches and how they can contribute to building design processes in a Swedish context. The study focus on a key actor in the design process, the architect, to study what strategies are used to address FP.

Background

Effects of FP approaches on buildings will vary depending on different priorities and focus during the design process [1]. As healthcare buildings vary depending on function, size and form they all require different design strategies. The challenge then in the design process is to have a clear approach to FP as well as a common understanding of how to deal with FP in the design team.

Few studies in healthcare care literature have analysed commonly used concepts and definitions to FP [6]. In those cases, when related concepts to FP – such as flexibility - has been studied, the definitions of concepts often varies. For instance in recent peer-reviewed healthcare design literature, flexibility is used as an umbrella-term defined as adaptability, convertibility and expandability [5, 6]. Adding research from the building research discourse, show that flexibility has also been used as equal to adaptability [1]. Additionally, flexibility has been used more generally as an umbrella-term including terms like; multifunctional, intelligent and universal. [8]

In Swedish architectural practice, there have been attempts in documents to define concepts linked to FP. An often-applied document is the *Locum Concept Program for Healthcare Buildings* published by Stockholm Region real estate organization, Locum [9]. Their concept program is commonly used by consultants, clients and users in design processes of new healthcare buildings. It focusses on open-building strategies (core/shell-building). Whereas generality and flexibility are described as follows:

Flexibility – *Possibility of adjustment in construction over time when new circumstances occur.*

Generality – *Possibility to be used diversely without changing construction when new circumstances occur.*

A recent published report by the organization of Swedish municipalities and counties; SKL, on FP is *Fully flexible – flexibility and generality in healthcare buildings* [10]. This report aims to provide a knowledge overview for those working with healthcare buildings in Sweden. The report includes four core concepts; flexibility, generality, elasticity and redundancy. Flexibility and generality are described as above, while elasticity and redundancy are described as:

Elasticity – *Possibility for buildings to meet organizational changes.*

Redundancy – *Double functions or overcapacity in building systems stabilizing service functioning and diminishing the risk for shut downs.*

Based upon the above findings, a study was prepared that took its outset in the descriptions above. Focus was on which FP design strategies were used by architects and how they related to the terms *flexibility, generality, elasticity* and *redundancy.*

Method

This paper explores the current situation of how Swedish architects designing healthcare buildings approach FP in relation to terms used in existing Swedish documents. This paper does not intend to evaluate design strategies focusing on uncertainty, nor asses certain design strategies over others for policy-making.

In this study architects have been asked to present and discuss FP in relation to the healthcare projects they worked with. Architects interpretations of closely related concepts to FP have been analysed. Moreover, design strategies linked to FP have been mapped and categorized according to the terms flexibility, generality, elasticity and redundancy.

The paper is based on an explorative, qualitative, multi-case study of architects descriptions of intentions related to FP in planned or built Swedish healthcare buildings (n=7). Data has been collected from 1) presentations (n=6) on FP building design and 2) semi-structured interviews (n=6) with architects designing FP in healthcare buildings.

Sample and setting

At the start of the project, five architectural offices that are regularly engaged in healthcare building design were asked to provide examples of what they considered to be the most relevant project considering flexibility and generality. Two architecture firms decided to present two projects each instead of one. In total, seven healthcare projects from different cities were presented:

Table 1. Healthcare projects discussed in this study

Project	Building type	Type of project	Sqm	Building phase during presentation date 150908
A	University hospital	Reconstruction and extension of existing healthcare building within existing hospital area.	25 650	Consecrated
B	Regional hospital building	New healthcare building within existing hospital area.	47 000	Under construction
C	Nearby hospital	New healthcare building in a new hospital area.	18 500	Under construction
D	Regional hospital building	Reconstruction and extension of existing healthcare building within existing hospital area.	30 000	Under construction
E	Psychiatric building	New healthcare building within existing hospital area.	33 000	Consecrated
F	University hospital	New healthcare building in a new hospital area.	300 000	Under construction
G	Regional hospital building	New healthcare building within existing hospital area.	20 000	Under construction

In addition to choosing and describing the projects, they were also presented at a conference, a thematic day on 'Flexibility and generality in healthcare buildings' organized by the Centre for Healthcare Architecture at Chalmers. This was done in September 2015.

Two years later the presenters were asked to participate in a semi-structured interview with questions focusing on FP approaches. This interview aimed at follow up on statements done during the presentations. In two cases the architect did not have the possibility to participate, in those two cases a second architect from the same architecture firm, working with the same healthcare project, did participate in the interview. It was considered a benefit that some time had passed between the first and second time. This enabled on the one hand the projects to be more completed and on the other hand that the architects could have experiences and reflections concerning the projects. In total eight architects participated in the study:

Table 2. Architects who participated in this study

	The architects role in the healthcare project	Date of presentation	Date of respondent in interview	Healthcare project
Architect 1	Senior project manager	150908	180212	A, B
Architect 2	Senior project manager	150908	170929	B
Architect 3	Project manager	150908	-	C, D
Architect 4	Senior project manager	-	180116	C, D
Architect 5	Project manager	150908	-	E, F
Architect 6	Responsible architect	-	171010	E, F
Architect 7	Facility planner (architect)	150908	171009	G
Architect 8	Responsible architect	150908	171009	G

Data collection

Data has been collected from presentations (n=6) addressing FP building design and semi-structured interviews (n=6) with architects utilizing FP approaches in healthcare buildings. The data collected from presentations and interviews focused on the narrative of the seven healthcare building projects. The character of a narrative can be described as *"how everything started", "how things developed"*, and *"how things ended up"*[11].

Data analysis

The recorded presentations and interviews were transcribed, and collected in one table. The transcriptions have been analysed through content analysis [12]. First the data was categorizing and test coded in relation to the framework used in Swedish practice; flexibility, generality, expandability and redundancy. After the test coding an evaluation was done, modifying sub categories for the coding structure. See below:

Table 3. Categories and subcategories used in coding

CATEGORIES (First coding)	SUB CATEGORIES (Second coding)
Flexibility	New openings in slabs Demountable walls
Generality	Facade pattern Floor heights Module grid Position of shafts Load bearing capacity General plan solutions General rooms Oversized shaft Flows/logistics and layout design
Elasticity	Building modules Building volume which can be expanded Building volume which can be divided Ward unit which can increase or decrease
Redundancy	Installations

Results

During presentations and interviews, when Swedish architects talked about how buildings should meet future circumstances, they repeatedly came back to two concepts: generality and flexibility. *The notions of generality and flexibility seemed hard to grasp for the architects in the study. Definitions of the concepts were either metaphorical or incomplete, for instance "Generality is like a box one can use for many purposes, you can either keep it to store things or use it as a table. Flexibility is when one has decided to use it as a box, but now one has the possibility to store different things in the box.".* Generality and flexibility were also described as *"…generality is the possibility to use the space without changing too much and flexibility is…eh…? I have it in my documents somewhere…".* The last quote shows a mixed use of both concepts; generality is defined as flexibility as it is described in Swedish literature; and despite the common use of flexibility the concept still lacks a clarity and definition.

The concept of elasticity was only used in one of the presentations and in one interview (same healthcare project). In this case, the architect described elasticity as *"…is about adding".* The concept of redundancy was not found to be used by the architects in the study at all.

The term FP was not used by any of the architects in their presentations. Later, during the interviews when FP was added in the questions, most of the interviewed architects were not sure how to interpret FP. One architect said *"…for me future-proofing is something more [than elasticity, flexibility, generality]. I would like to add the connection to the users of the building. I have experienced that users of the healthcare buildings have not fully understood their new building. I believe doing a user manual can be one way to FP."*

Even if the architects used concepts related to FP in different ways, many of the architects still claimed the importance of a common understanding of FP between all participants in a healthcare project. Furthermore, several architects in the study witnessed and noted, as result of unclear definitions and goals of FP in healthcare building projects, too high ambitions of FP early in the projects in relation to budgets. One of the architects stressed that unclear definitions in pre-studies generates high ambitions, or even demands, that could lock-in for a long time in the design process in unwanted, too costly, design strategies. In some situations, this could have consequences such as expanding time schedules due to retakes, or result in keeping certain characteristics of the building even if FP design strategies no longer are wanted.

In addition to the focus on understanding the concept and use of FP among architects, the aim of the study was also to identify how architects have worked with FP in their healthcare projects. From the text data analysed in this study, 16 different design strategies were identified. The design strategies were then sorted under the four categories identified from Swedish practice oriented literature; flexibility, generality, elasticity and redundancy. How the different design strategies are related to categories and the seven healthcare projects, is presented in the table below. Design strategies are marked as either discussed and implemented in the healthcare project, discussed but not implemented in the healthcare project or not discussed (during presentation or interviews). Additionally, the differences in the design strategies were shown to relate to dissimilar contexts, budgets, stakeholders and design processes.

Table 4. Identified design strategies for FP in presentations and interviews regarding 7 Swedish projects.

Categories and definitions found in Swedish literature describing how buildings can be prepared to meet future circumstances	Design strategies for FP architects discussed in presentations and interviews	Healthcare building (A-G)						
		A	B	C	D	E	F	G
Flexibility *"Possibility of adjustment in construction over time when new circumstances occur."*	New openings in slabs	-	-	-	-	X	-	-
	Demountable walls	X	X	-	X	X	-	X
Generality *"Possibility to be used diversely without changing construction when new circumstances occur."*	Façade pattern	-	-	-	X	X	X	X
	Floor heights	X	X	X	X	X	X	X
	Module grid	o	X	X	X	X	X	X
	Position of shafts	-	X	X	X	X	X	-
	Load bearing capacity	-	-	X	-	X	X	-
	General plan solutions	X	X	X	X	X	-	X
	General rooms	X	-	X	-	X	-	-
	Oversized shaft	-	-	-	X	-	X	-
	Flows/logistics and layout design	X	X	X	X	X	X	X
Elasticity *"Possibility for buildings to meet organizational changes."*	Building modules	-	-	-	-	-	-	o
	Building volume can be expanded	o	o	X	X	o	o	o
	Building volume can be divided	X	-	-	-	-	X	-
	Ward unit can increase or decrease	-	-	X	-	X	X	-
Redundancy *"Double functions or overcapacity in buildings systems stabilizing service functioning and diminishing the risk for shut downs."*	Installations	X	-	-	-	-	X	-

(-) Not discussed by the architects in the presentations/interviews, (X) Discussed by the architects in the presentations/interviews and implemented in the project, (o) Discussed by the architect in the presentation/interviews, but not implemented in the project.

Table 4, *Identified design strategies for FP in presentations and interviews regarding 7 Swedish healthcare projects,* shows that three of the design strategies (module grid, floor heights and flows/logistics and layout design) were discussed in all the seven healthcare projects. The purpose of a module grid was to ease future rearrangement of rooms. The size of a module grid varied between projects and in some cases between functions, such as in-patient wards (low-tech) and Intensive Care Units (high-tech). Floor heights was described as facilitating future addition of building systems. Both higher floor height and module grid have in common that it eases changes during the design process as well as changes of the building after inauguration. The idea of flows/logistics and layout design were described differently by the architects in the study. Some architects talked about double escape corridors in case of emergency, one discussed flow as a possibility to reach patient rooms directly from exterior corridors to decrease the risk of contamination and one added open-ended corridor as a possibility for future flow to work when expanding the building.

General plan solutions and position of technical shafts were other commonly used design strategies. Identically designed floorplans that could accommodate both in-patient and out-patient wards is one example of a general plan solution. The position of technical installations and vertical communications was described as highly relevant for FP. Placing vertical ducts close to staircases and elevators created *"free areas"* and higher freedom in case of change in the layout.

The possibility to expand the building volume was discussed by all architects in the study, on the other hand expansion of building volume was only implemented in two of the seven projects. Narrow sites (vertical expansions) and costly construction/advanced installations (horizontal expansions) was in five of the cases reasons to not expand. In the two projects who applied the possibility for the building to be added, the main reason was unclear programming during design process. Decision makers were not sure about the future catchment-area or future use within the building.

Only one architect discussed 3D building modules. The project, which was referred to, was initially planned as a temporary building. During the entire design process the client had asked for a building that could be disassembled and that a 3D module was therefore preferred. Both the buildings module grid and floor heights were a result from how big the 3D elements could be, considering it had to be transported on roads. But later, during procurement, the clients decided to go for the best price, and the company with best price was not delivering 3D modules but prefabricated concrete walls. At this stage the drawings were not redeveloped and many of the measurements were results of the maximum dimensions of the 3D modules. The architect described it as*: "If we would have had the possibility to change the design after the decision to not build it with modules, then we would have had a totally different project today. On the other hand, we wouldn't have been able to design the project during such short notice. Since we were limited by the modules the project goal was very clear."* Consequently, she argued, that in one way the project became much more flexible with concrete walls in the façade, since this allowed a pillar structure with plaster walls. *"Additionally, we would have lost the flexibility in the next step if we would have built modules, we would have much more difficulties to change, like adding doors within walls or move inner walls."*

Discussion

In the study presented, we have studied concepts related to design strategies focusing on how a building could meet future circumstances. As an umbrella term to those concepts, we have used the concept of FP. However, the architects in the study were either unfamiliar with FP or questioned the concept by thinking it should be used in a broader context. While it is difficult, even impossible, to predict all future changes in a healthcare building design project, there is a need to identify design strategies that approach the challenge of FP. Just as the architects in the study, we argue that FP should be considered in a much wider scope in comparison to what Swedish praxis has published until today. However, and herein lies the challenge, if an FP approach is to be developed, it needs to be both broad enough to include variations and narrow enough to be justifiable from a project cost and delivery perspective at the same time, as it creates a design that supports healthcare activities.

Results of this study show that different building design related concepts published up until today in Swedish practice, such as generality, flexibility, elasticity and redundancy, are too broadly and vaguely used amongst architects to be useful in a communication between actors in design processes. But on the contrary, even when the vocabulary is unprecise and vague, this study shows that actual design strategies aimed to meet future circumstances are many, with different focuses and precise definitions on project basis.

We ask ourselves, could a broader framework have given other results concerning how FP was interpreted? A possible interpretation of a broader framework is that architects use design strategies that they do not think of as being approaches for FP. Maybe, a broader and more open framework based on a clear definition of FP, a framework that includes other categories than flexibility, generality, elasticity and redundancy, can enable other results and insights.

Conclusion

The representatives from the architectural practices in this study had no clear view on FP and what it could include, nor was it evident that there was a common understanding of everyday terms like flexibility. However, compared to the research-based literature, the architects had an understanding closer to the practice-based literature where fewer terms are used, e.g., flexibility encompasses also terms like adaptability and convertibility, which in the research based literature represented clearly different aspects.

To sum up, as straightforward as the area of changes of built environment may seem, it does become quite complex when FP approaches shall be defined in relation to effectiveness and efficiency as there is a lack of such studies. There is a need to further study FP approaches for enabling them to become a practical basis for discussing options and testing design solutions.

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