
Standardization and Industrialized Construction of Special Purpose Buildings

Standardization
and
Industrialized
Construction

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Abstract

Purpose – The aim of the present study is to look into the potential of standardization of special purpose buildings, with the example of the Norwegian Directorate of Public Construction and Property Management (Statsbygg).

Design/Methodology/Approach – The present study uses results from a group workshop on the topic of standardization, suggesting building types suitable for standardization or modular construction. In addition, data from Statsbygg's project database is used.

Findings – There is a broad specter of special purpose buildings with potential for standardization, such as customs facilities, courthouses, university buildings and buildings with a high share of office functions. Even buildings with an individualized character, such as museums or government buildings, have a certain potential for standardization of functional or constructional elements. Modular construction can be used where and when appropriate.

Research Limitations/Implications – Being on a brainstorming level and limited to Statsbygg, the study provides a starting point for further research looking at other building commissioners working with special purpose buildings, or quantifying the potential for cost reduction.

Practical Implications – On the basis of the findings from this study, Statsbygg considers further standardization of their special purpose buildings, not only within building types but also across the portfolio or within a project, for example rooms or functional elements.

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Originality/Value – Research on standardization of special purpose buildings is limited. The article presents the results of a workshop with project managers, contributing to the topic based on their experience from the construction of special purpose buildings. Although on a brainstorming level, the research is a starting point for further research into this topic.

Keywords Standardization, Standards, Industrialized construction, Prefabrication, Modularization, Special purpose buildings, Public sector, Construction projects, Cost reduction

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1. Introduction

Statsbygg, the Directorate of Public Construction and Property Management, is responsible for building special purpose buildings for the Norwegian state. A special purpose building is a “type of property [with a] unique design or layout, [...] or other features that limit the property's utility for purposes other than the one for which it was built.” (US Legal, 2018). This includes e.g. university buildings, governmental buildings, customs facilities, courthouses, police stations, prisons and museums. Planning and construction of special purpose buildings differs from constructing houses or office buildings because every building's unique function and character needs to be addressed individually.

Despite this paradigm, Statsbygg and the Directorate of Norwegian Correctional Service (KDI) developed a standardized set of functional requirements for Norwegian prisons to meet the urgent need for extended prison capacity in Norway (Statsbygg, 2018). The standard facilitates planning and construction by proposing a standard prison concept with possible partial modular construction. Statsbygg has used the standard in four prison projects (two finished and two under construction). Positive effects on project performance, regarding both time and cost (Økland *et al.*, 2017), have inspired Statsbygg to look into further standardization, assuming potential savings through economies of scale and learning effects between projects. Standardization within construction projects is not a new topic, but for special purpose buildings built by Statsbygg, the unique character has been in focus rather than standardization.

This paper investigates the potential for further standardization of special purpose building along the following research questions:

- (1) *Which types of special purpose buildings have a high potential for standardization?*
- (2) *How can also buildings with a highly individual character benefit from standardization?*
- (3) *What are the constraints when standardizing special purpose buildings?*

We will start by outlining the research method and the theoretical reference for the topic of standardization of special purpose buildings before presenting the results from a group workshop and drawing conclusions for the potential for standardization of special purpose buildings.

2. Method

This research is conducted at the beginning of a PhD-project on cost reduction in public construction projects. Further standardization of special purpose buildings can be one of the starting points for cost reduction. A qualitative case-study approach was taken, allowing for collection of in-depth information on a specific topic (Neuman, 2006) for a limited research object (Halvorsen, 2008) – in this case, Statsbygg.

As part of a seminar for Statsbygg's building commissioning department in March 2018, a group work on the cost-reduction in Statsbygg's construction projects was conducted. "Group discussion is a means of collecting data in one go from several people (who usually share common experiences) and which concentrates on their shared meanings" (Payne and Payne, 2004, p. 103), allowing ideas to develop through interaction among group members. The group work followed a presentation on the standardization of prisons. The approximately 120 group members were mainly project managers and other project staff members. They were split into 15 equally sized groups with different levels of experience from construction projects represented in each group. Staff from the department facilitated the group work, and the first author of this paper was a regular participant in one group. The response rate was 73 per cent; 11 of 15 groups reported results through a quest back form. The groups were asked to discuss the topic of standardization and suggest other types of projects for standardization and/or modular construction. The varied outcome reflects the open discussion question and the fact that the author did not direct groups into a certain direction. Answers also included suggestions for standardization of specific building elements and room types as well as comments on challenges with standardization (cf. Chapter 4.2).

Transferability to other building commissioners has to be verified, but it is assumed that results can be reproduced for other special purpose buildings. High internal validity (Johannessen *et al.*, 2011) is achieved as almost all employees in the building commissioning department contributed.

3. Theoretical reference

3.1. *Standardization and industrialized building of special purpose buildings*

Standardization is a concept including "the extensive use of components, methods or processes with regularity, repetition and a successful history" (Pasquire and Gibb, 2002, p. 3). Standardization is often also associated with processes, suggesting "not necessarily functionally or aesthetically distinct products from more conventional construction, but more routes toward the attainment of stated goals" (Craig *et al.*, 2000, p. 3). Subsequent similar projects can profit by re-using the same processes, functionalities, design or plans from previous projects. Standardization is often a prerequisite for a high degree of industrialized building, where parts or modules are produced in factories and being assembled on site (Berg, 2005; Berg, 2008). Buildings with many repetitive units, such as hotels, student housing, hospitals and prisons are considered as suitable for modular building (Kamali and Hewage, 2016; Grant, 2013). As mentioned in Chapter 1, special purpose buildings are properties with unique features appropriate for one type of use (US Legal, 2018). Research on the standardization of special purpose buildings is limited, as standardization is perceived as incompatible with the unique character of special purpose buildings, where every construction project has to be addressed in an individual way (Moum *et al.*, 2016). Nevertheless, standardization of processes and technical solutions, as well as reduction of variation is possible without compromising the individuality of each building (*ibid.*).

3.2. *The effects of standardization*

Standards make the technical state of the art accessible for the broad market (Blind *et al.*, 2011), reduce variation in product quality (Jones and Hudson, 1996), ensure safety, environmental and social standards, and allow collaboration by different suppliers (Viardot *et al.*, 2016). Technological standards lead to innovative efficiency and productivity in knowledge creation (Spulber, 2013). In the construction industry, standardization can contribute to improved performance (Pasquire and Gibb, 2002). Among positive effects

arising from standardization and pre-assembly are better planning and control, improved quality, an improved health and safety environment, higher predictability and the possibility for increased profitability through reduced costs, shorter lead times, less defects and higher productivity (Pasquire and Gibb, 2002). Dullness, lack of innovativeness (*ibid.*), failure to meet individual needs of the users and a lack of flexibility (Craig *et al.*, 2000) are downsides. When the standard is optimized through positive and negative experiences, standardization presents an opportunity for increased learning for future projects (Berg, 2008), e.g. by developing better tendering documentation based on the log of change request from previous projects.

Recent research by Økland *et al.* (2017) found mainly positive effects of standardization and modular construction of Norwegian prisons, including significantly reduced planning time through re-use of design and facilitated client/user participation. Parallelization of groundwork and module production shortens construction time. The standard facilitates learning from one project to the other (*ibid.*). Research also points toward a positive effect of modular building on project cost but somewhat limited by a shallow pool of contractors with experience of modular construction (*ibid.*).

4. Findings and discussion

4.1. Results from the group work

In the group sessions, the participants were given the instruction: “Discuss the topic of standardization and suggest other types of projects where standardization and/or modular construction can be of relevance.” Engaging discussions led to extensive answers to the topic and to interesting side results beyond the original question.

Nine groups named educational buildings having high potential for standardization, followed by office and administration buildings (mentioned by seven groups) and court houses (mentioned by six groups). Five groups each reported traffic control facilities, customs facilities and children’s homes. Other building types mentioned were governmental buildings, police stations, student accommodation and museums.

In addition, most of the groups also listed building elements with a potential for standardization. This is an interesting finding as it allows standardization of special purpose buildings on a more general level with standardized solutions for the whole portfolio. Figure 1 shows a full overview of the answers.

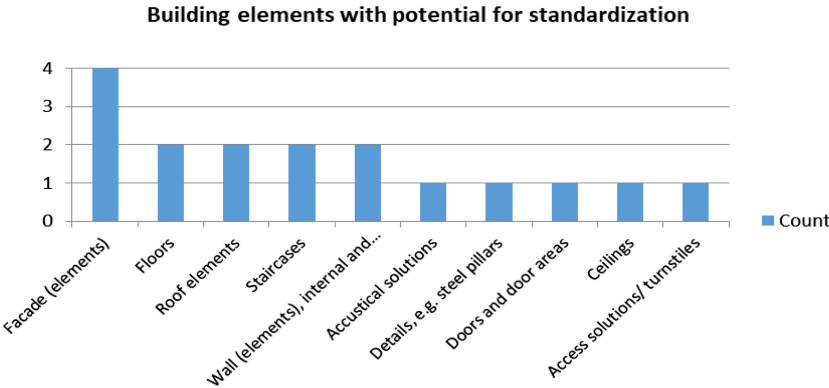


Figure 1.
Summary of Results:
Building Elements
with Potential for
Standardization

Most of the groups also suggested room types to be standardized. Figure 2 shows room types mentioned by more than one group. In addition, one group each mentioned treatment rooms, parking lots, special rooms (of repetitive type), dog stables (e.g. at police stations), traffic control halls, weight control functions, emergency control rooms, court rooms, dormitories, shooting ranges, bicycle parking and vestibules.

The results show that the project managers see potential for standardization and modular construction for a broad specter of special purpose buildings. They even mentioned highly individual building types, such as museums, which on first sight do not seem to be suitable for standardization. Suggestions include a high degree of standardization of more common building elements.

Statsbygg has completed two standardized prison projects by now, with shortened project time, achieving cost savings of around 20 per cent through standardization and industrial building, compared to the last prison project completed before standardization. Considering that Statsbygg manages buildings with an area of 2.9 million m² worth 22 billion NOK and has 120 ongoing construction projects, with a total expected investment volume of 7 billion NOK for 2018, even a more tentative saving of 10 per cent through standardization on a portfolio level would mean reduction of 700 million NOK per year.

Suggestions for standardization of buildings, building elements and room types show that project managers see potential for standardization of special purpose buildings, although with limitations (cf. Chapter 4.2). This is in accordance with the literature, and going beyond it by suggesting that even construction projects without many repetitive units can be standardized to a certain degree. The results from the workshop are used internally to prioritize building types where a process toward further standardization will be initiated.

4.2. Additional results from the group sessions

As an additional result from the group sessions, participants state several challenges with standardization:

- A. *Architectural challenges:* Standardization should not limit the possibilities of the architect to develop a unique architecture of every building. Standardizing functions

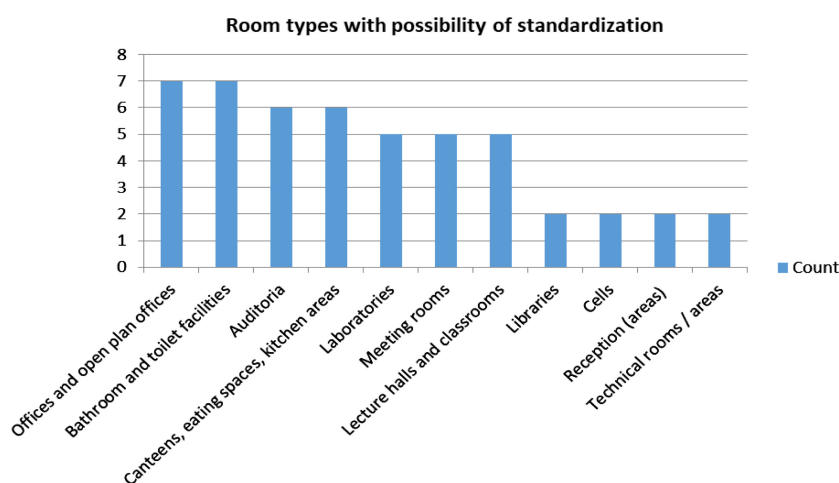


Figure 2.
Summary of Results:
Room Types With
Potential for
Standardization
(Room Types
Mentioned by One
Group Not Included)

or parts of the building should not compromise the architectural expression of each building.

- B. *Acceptance challenges*: Users of special-purpose buildings tend to consider their building as unique. Thus, a challenge is to make them accept that less unique parts can be standardized or built with modules. A good and accepted standard is developed in collaboration with the client and the user of the building.
- C. *Challenges toward the extent of the standard*: Complete standardization can be difficult, but it might be broken down into appropriate levels. A standard has to take into account adaptation to real estate differences, which are setting prerequisites for the geometry of the building on site.

Other suggestions included standardization across sectors, the standardization of user equipment to allow for standardized interfaces, the establishment of a standard with built-in flexibility, and further standardization of processes. Group members also mentioned the reduction of variation within a building (e.g. concerning wall thickness), the collection of a “drop-down menu” for standard room types or the adaption of room sizes to standard module size.

5. Conclusion and suggestions for further research

The findings from the group sessions indicate that further standardization of special purpose buildings is possible. On the basis of the present research, building types with the highest potential for standardization are customs facilities, courthouses, university buildings and buildings with a high share of office functions. Standardization even of buildings with a highly individualized character is possible when it comes to certain rooms and to constructional elements. Standardized solutions for building elements can be developed for the whole portfolio. Standardizing common features of the buildings allows focusing on unique elements for the present special purpose building. In this manner, standardization can contribute to faster project delivery and to more cost-efficient construction projects without compromising on the architectural expression and the individuality of special purpose buildings. Both literature and experience from projects suggests that standardization contributes to cost-effective construction projects, but it remains to quantify more exactly the potential for cost savings through standardization.

The present study provides a starting point. Results are on a brainstorming level, though from qualified and experienced participants. Further research might look at other building commissioners working with special purpose buildings, or focus on the extent, practicability and cost reduction potential of standardization, which is possible for the different types of buildings, and on approaches for implementation of a higher degree of standardization in the construction of special purpose buildings.

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