Innovative sales concept and knowledge-platform for prefabricated building construction

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ABSTRACT
The market segment for prefabricated concrete elements in Switzerland has been examined and critical issues for companies in the precast concrete construction industry have been established. By analogous comparison with other construction segments and by transferral from international comparisons, basic potentials for this prefabrication market segment have been defined. On the basis of previous studies and of own empirical studies, options for action have been established that will lead to a greater sales volume for prefabricated concrete elements in Switzerland. A business model for a prefabrication knowledge-platform will be created on the level of the industrial sector, that ensures central functions for increased sales of prefabricated components. The business model for a knowledge-platform will actively provide technical and sales information about precast element for architects and engineers. It will eliminate factors impeding the sale of prefabricated components enhances aspects facilitating such sales. The creation of the knowledge-platform is based on experiences of other construction branches and of the interests of the respective stakeholders in the industrial institution to be founded.

KEYWORDS: Prefabrication, Precast Concrete Construction, Business Model, Cooperation

1. INTRODUCTION
The opening up of the Swiss construction market for foreign products and services is leading to a different range of products and services offered. This leads to new basic conditions for enterprises that are active in the Swiss construction market. Foreign prefabrication suppliers for building
components are pushing their way into the Swiss construction market with new or cheaper products, which leads to a tense competitive situation for domestic prefabrication enterprises (Swissbeton, 2006).

Prefabrication means the industrial production of a construction element at a place that is different from the final installation place of the element. Prefabrication provides the possibility to manufacture construction elements using industrial methods. With prefabrication, the impact of the weather, impediments due to the simultaneous work of several trades in a confined space, and extensive installations for producing the building elements on the construction site can be excluded to a large extent. The advantages of prefabrication can be characterized as follows:

- Manufacturing processes for construction elements are independent from each other, can be effected in parallel, and thus allow a reduction in construction time.
- Transparent planning and early decision-making will reveal dependencies between the individual trades at an early stage of construction, intersections can be clarified at an early stage.
- Prefabricating construction elements allows to take advantage of learning curve and economies of scale effects.
- Prefabrication allows easier implementation of quality management systems and thus for an increased product quality.
- Variance in quality or time delays as a result of the weather arising from fabricating the components on the construction site are ruled out in the case of prefabrication.
- Structures can be fully used immediately after assembly (dry construction).
- Only a small workforce is required on the construction site, i.e., large building projects can be implemented even with a small number of staff.
- Only small amounts of material (casings etc.) have to be stored on the construction site.
- The equipment of the construction site needs to be chosen only with a view to the requirements of assembling the prefabricated construction elements; extensive installations for on-site fabrication can be dispensed with.
- By repetitively using standard details, such details can be optimized at low costs per unit.

In general, the advantages of prefabrication can be summarized into the prevailing issues of costs, deadlines, and quality.

The following basic conditions have to be taken into consideration in connection with prefabrication:

- Corrections in the manufacturing and assembly phases are possible only at relatively great financial expenditure.
- Specific transport and assembly logistics including the necessary infrastructure must be ensured.
The range of products manufactured by the precast concrete factories can be roughly divided into two groups. On the one hand, these are supplier components such as staircases, balustrade elements, and supports that contractors build into otherwise conventionally erected buildings. With these products, the prefabrication companies get involved into the construction process only at a relatively late stage. On the other hand, precast concrete factories prefabricate entire buildings including the load-bearing structure and room-building elements. In this case, the manufacturers of prefabricated components or planning offices specializing in the relevant fields are involved early on at the planning stage.

2. ANALYSIS OF THE MARKET

2.1 INTERNATIONAL COMPARISON

The quantities of prefabricated concrete building components differs very much between the European countries. There are no overall statistics that would allow a direct conclusion as to the quantity of the prefabricated concrete elements used. Rather, such a key figure can only be deduced indirectly from various different statistics. Figure 1 shows for different European countries what proportion of the total cement consumption is used in each country for manufacturing concrete elements (BFBN, 2006). In the Netherlands, for example, about 42 % of the cement is used for prefabricating concrete elements, in Austria about 20%, and in Switzerland only about 8 %.

Provided that in the respective countries

- the total consumption of cement per inhabitant and
- the cement content in the prefabricated building components

are comparable, the quantity of concrete elements can be directly deduced from Figure 1.
It becomes apparent from Figure 2 that, in Switzerland, about twice as much cement is consumed per inhabitant as in Germany or in the Netherlands (BDZ, 2006). The consumption of cement in Switzerland is roughly comparable to that in Austria.

<table>
<thead>
<tr>
<th>country</th>
<th>cement consumption [kg, 2005] per inhabitant</th>
</tr>
</thead>
<tbody>
<tr>
<td>Spain</td>
<td>1,253</td>
</tr>
<tr>
<td>Portugal</td>
<td>823</td>
</tr>
<tr>
<td>Italy</td>
<td>789</td>
</tr>
<tr>
<td>Austria</td>
<td>649</td>
</tr>
<tr>
<td>Switzerland</td>
<td>601</td>
</tr>
<tr>
<td>Turkey</td>
<td>482</td>
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<tr>
<td>Norway</td>
<td>386</td>
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<tr>
<td>France</td>
<td>373</td>
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<tr>
<td>Germany</td>
<td>327</td>
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<tr>
<td>the Netherlands</td>
<td>319</td>
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<tr>
<td>Poland</td>
<td>306</td>
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<tr>
<td>Denmark</td>
<td>304</td>
</tr>
<tr>
<td>Sweden</td>
<td>210</td>
</tr>
</tbody>
</table>

If one relates the figures from Figure 1 to those from Figure 2, one can approximately deduce the absolute quantity of the prefabricated concrete elements per inhabitant of a country and the relation between these quantities, respectively. The comparison between Austria and Switzerland reveals that the quantity of prefabricated concrete elements in Austria is about three times as large as that in Switzerland. The comparison between Germany and Switzerland shows a relation of 1:2 and in the comparison of the Netherlands to Switzerland the relation is about 1:2.5.

Based on these comparisons the conclusion can be made, that currently only a small number of prefabricated concrete elements is used in Switzerland and therefore an additional sales potential for prefabricated concrete elements exists in Switzerland.

**2.2 Situation of the Market in SWITZERLAND**

As a result of opening up the Swiss construction market for European planners and construction companies, it can be expected and observed that, along with the companies, the corresponding construction methods will also spread in Switzerland. Consequently, the quantities of prefabricated concrete elements used are likely to approximate.

Figure 3 shows the quantity of the prefabricated concrete elements used in Switzerland (Swissbeton, 2006). The trend toward increasing use
of prefabricated concrete elements is clearly visible, which confirms the assumption of a market potential made in section 2.1. Also apparent is the fact that the proportion of imports is increasing and that the increase in the total quantity results from the increase in imports.

![Figure 3 Prefabricated concrete elements in Switzerland](image)

In summary, Swiss companies in the field of concrete prefabrication are faced with the following problems:

- Decreasing market share of domestic manufacturers
- Despite an upward trend, total sales are low when compared on an international level.

Apparently, customer contact or customer loyalty of Swiss companies is not optimal, leading to sales on a low level on the one hand and to the loss of market shares due to increasing imports on the other hand.

This impression is supported by empirical studies in which architects, construction engineers, and building contractors were surveyed with regard to their attitudes toward prefabricated concrete building units (ZHW, 1999).

As a result of this study, criteria were derived that will impede or promote an increased use of prefabricated concrete building units. Planners, developers, or building contractors named particularly the following impeding criteria:

- The decision for using prefabricated units is made too late.
- Architects presume that the deployment of prefabricated concrete elements is profitable only when large number of identical elements is purchased. This presumed requirement of large numbers restrains architects.
- The standard of knowledge of planners/architects regarding design, structural, and construction-physical aspects is low. To gain this basic knowledge is perceived as a difficult task.
Cooperation with concrete prefabrication companies is complicated and insufficient. Buildings made from precast concrete elements tend to have a bad image.

Another aspect is that final decisions have to be made at an early stage in the planning process and that intersections between various trades have to be clarified at an early stage in the planning process. This aspect requires sufficient attention in plannings that include prefabricated components. However, architects do not consider this aspect as a drawback but rather as a challenge.

Today, prefabricated concrete components are primarily used (ZHW 1999) because:

- prefabricated components have a better quality than elements produced on-site
- tight deadlines can be met thanks to parallel construction processes, and
- the progress of construction is largely independent of the weather conditions.

Close cooperation between companies prefabricating building elements and planners will strongly promote the deployment of precast concrete elements.

3 DERIVATION OF OPTIONS FOR ACTION

In classical project execution forms such as project execution involving individual service providers or project execution involving a general planner and a general contractor, execution using prefabricated units often comes into consideration as an option at a very late stage of execution. Tenders and working drawings are almost exclusively developed for conventional on-site production. The planning services for execution which is suitable for prefabricated units require the interfaces, e.g., with the building services, to be clarified as early as at the planning stage and not during the erection of the structure of the building. But traditionally planning services for the technical equipment of the building is normally performed only during the phase of erecting the structure. Therefore, tenders are commonly made for a structure of conventional construction, even if overall cost savings are possible in the case of an early clarification of interface issues.

Tenders for conventional on-site fabrication of the building units prevents the extensive use of prefabricated units. In traditional construction tender only staircases, balustrades (e.g.) are built in as prefabricated units.

In order to achieve the goal of an increased sale of prefabricated building units it is necessary to increase the number of tenders suitable for prefabricated units. Architects, construction engineers, and influential real estate developers must become aware that a tender suitable for prefabricated elements and, hence, for the erection of a building using prefabricated elements is altogether more advantageous than the
preparation of tender documents and, consequently, the erection of the building in a conventional construction manner.

In consideration of the impeding factors (cf. section 2.2) and, at the same time, of the development of the import proportion (cf. Figure3), the following solution can be postulated:

A national industrial institution as knowledge-platform is to be founded that guides planners and developers in such a way that

- knowledge gaps with regard to precast concrete construction are closed
- decision-making aids for decision-making in regard to prefabricated building construction or conventional construction are provided
- prejudices such as the strict requirement of large numbers are eliminated, and
- innovative performance parameters (quality of construction elements, functionality, sustainability, etc.) become known.

Such a national knowledge-platform would orientate Swiss customers toward Swiss enterprises in the field of concrete prefabrication. Furthermore, such a knowledge-platform operating as an interface between prefabrication companies and customers would also provide a industrial institution that ensures consulting and planning independently of manufacturers. Such independence from manufacturers is necessary for preparing tender documents in so far as several rules for tenders prohibit any simultaneous participation in both the preparation of tender documents and the tender itself.

4 EMPIRICAL STUDIES

4.1 Business forces of knowledge-platform

For the postulated solution to the business model for the knowledge-platform, the interests of relevant business forces/stakeholders must be determined. The model of competitive forces within an industrial branch (Porter, 1992)(Girmscheid, 2006) is used to define the relevant business-forces/stakeholders. Thus, the following influence groups can be identified whose competitive forces will influence the intended business model:

- customers
- competitors
- suppliers
- potential competitors
- substitute products

Adjusted for the knowledge-platform, the stakeholders shown in Figure 4 are revealed. The attitudes of the respective stakeholders toward the intended industrial institution are determined by empirical studies.
4.2 Research Methods

Empirical research methods can basically be divided into qualitative and quantitative research methods.

**Quantitative empirical methods** are used when the relevant criteria of an issue and fundamental correlations are already known or when hypotheses are to be confirmed. The advantage of quantitative methods is that the expenditure for analyzing the data does not increase in proportion to the size of a sample. Therefore, even larger samples can be readily processed. Furthermore, a systematic collection and analysis of the data is possible, eliminating to a large extent the subjective influence of the person processing the data. A disadvantage is that new criteria of a problem can be determined only indirectly or with difficulty from the results of quantitative research (Backhaus et al., 1996)(Girmscheid, 2004).

For the “customers of the industrial body” stakeholder group, criteria and correlations regarding prefabricated building construction are basically known from preliminary studies (cf. section 2.2); furthermore, a possibly large number of samples will be considered for the purpose of establishing reliable conclusions. For this reason, qualitative empirical studies will be carried out for the stakeholder group “customers”. These studies will be performed using an internet-based questionnaire.

**Qualitative methods** are primarily used when relevant criteria are to be determined in the first place by empirical research and when hypotheses on correlations are to be developed. Qualitative empirics are
thus suitable mainly for exploring issues about whose criteria only little is known prior to the study. The examined sample taken from the population should comprise, if possible, “best-practise” partners or companies in order to obtain high-quality and reliable data. One option for qualitative collection of data is to carry out problem-focused interviews with open, semi-structured questions. However, such data collection also has drawbacks. For example, a certain subjective influence during the collection of the data and their analysis cannot be ruled out (Mayring, 1999)(Girmscheid, 2004).

The other stakeholder groups, i.e., bodies relating to potential precast industrial institution suppliers or for substituting building materials, are of smaller size in terms of number. Further only little is known about the attitudes of the individual precast manufacture stakeholder groups prior to the study. This is the reason why qualitative research methods are used for these stakeholder groups. The form selected for this is that of the problem-focused interview with open, semi-structured questions (Mayring, 1999).

The process of gaining knowledge by means of both quantitative and qualitative empirical methods follows the sequence shown in Figure 5. After defining the particular desired contribution of empirical study to the goals of the research project, literature research is conducted and the respective study groups are selected. After explaining the choice of reasearch methods in each case, pilot studies are first conducted that allow for an adjustment of the respective method to the study group. After the main data collection and after data analysis, results can then be finally established.
Figure 5 General sequence of an empirical study

Goals dissertation/research project
Goals and desired contribution of empirics
Literature research
Definition of study groups
Determination of study methods
Quantitative knowledge extraction
Qualitative knowledge extraction
Pilot data collection Questionnaires
Pilot study Interviews/case study
Adjustment
Main data collection
Main study
Data analysis
Preliminary results
Final results, final report

Preparation and pilot phase
Data collection
Data editing
Analysis
Main phase
Knowledge extraction
4.3 Analysis

The analysis of the qualitative empirical study is effected by means of qualitative content analysis, as such analysis allows for systematic, theory-based processing of data material and for detecting fundamental structural and design criteria (Mayring, 1999).

The quantitative empirical data collected were analysed using the methods of descriptive statistics. As a correlation between the effects of several criteria can be presumed, a multi-variable method of analysis is used. In the present case, the data are collected on a metrical scale, such that multiple regression analysis is used for the analysis (Backhaus et al., 1996). This method of analysis allows to relate the independent variables (e.g., range of services offered by the industrial body, communication channels used, aspects of motivation, and cost structures) to the dependent variables (e.g., utilization of the respective range of services offered). From this information, the range of services offered by the industrial prefabrication knowledge-platform as well as the core competences derived from it can be determined.

5 BUSINESS MODEL FORMATION

The customers’ expectation towards the industrial knowledge-platform is known from the empirical study. From these expectations, the required range of services offered and the accordingly necessary core competences can be directly derived. Thus, potential suppliers who can contribute the expertise in the field to the industrial knowledge-platform have become identified as well. At the same time, the qualitative analyses conducted have revealed whether and on what basic conditions these suppliers (planners, research etc.) would be interested in participating in the work of the industrial knowledge-platform.

As prefabrication companies ultimately benefit most from the intended increase in the total turnover of prefabricated building units, it must be presumed on principle that these enterprises also have an interest in participating in the work of the industrial knowledge-platform.

It is possible that the knowledge-platform will offer services that have previously been part of the range of services offered by individual companies and, in this way, ensured a USP for these companies. In the event that such USP of the individual prefabrication enterprises be eliminated, these companies will be negatively disposed toward the activities of the knowledge-platform as these activities of the industrial association will eliminate existing competitive advantages. Hence, the formation of a horizontal cooperation (Girmscheid, 2006) in the shape of an industrial institution will probably not be supported by all prefabrication companies. In the course of the empirical studies, the interests of individual prefabrication companies with regard to the knowledge-platform have been determined.
In addition to forming a horizontal cooperation through participation of different prefabrication companies, the formation of diagonal cooperations (Girmscheid, 2006) has also been envisaged. This form of cooperation will incorporate marketing providers and external engineering offices depending on the necessary core competences of the knowledge-platform.

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