CIVIL ENGINEERING DRIVERS AND INDICATORS

Eero Nippala
Tampere University of Applied Sciences (TAMK), Tampere, Finland
eero.nippala@tamk.fi

Once a closed market, civil engineering is now genuinely opening up. In the past, forecasting the industry has consisted mainly of assessing the public sector’s budget realisation, but now there is a gradual move towards a market-based model, introducing an opportunity to assess the construction market by means of market research. The opening and globalisation of the market also presents additional information needs and needs to identify the pieces of information that best predict future development.

The research question has been to define future development of the civil engineering markets. The key indicators have been chosen for several reasons, the main reason being that despite the availability of some longitudinal data statistics remain, on the whole, inadequate. The used method on analysing the change is contextualism, in other words, studying long-term process in their context.

In a closed market, activities are planned according to the available resources. In an open market, demand depends on the needs of customer industries and on financial considerations. The most important indicators for forecasting civil engineering construction are public sector budget, private sector outsize projects and GDP change.

Keywords: key indicators, civil engineering, market change, forecast

INTRODUCTION

Infrastructure construction has undergone a transition from a largely closed market to an open one resulted from EEA Agreement (1994). In a closed market, activities are planned according to the available resources. In an open market, demand depends on the needs of customer industries and on financial considerations; as a result, the significance of reliable business information has increased. Market information is needed both for short-term operational planning and for long-term strategic planning.

The migration of customer and production sectors to a market open both nationally and internationally has created discontinuities on many different levels. Customers no longer need to content themselves with the local or national service selection. Instead, they have the chance to look for suppliers from an international market. Suppliers in turn can specialise in this regard and seek customers from a broader geographical area.

The rate of change in the open market is accelerating. The impact of changes in the international economy, international contracts, the marginal terms of the customer industry’s economics, etc., on civil engineering are stronger and more direct (Nippala & Petäjä, 2004). It has been an objective of this project to produce key indicators for the infra-construction market that can be used to evaluate the current status and future development of the market.
The remaining part of the paper is organised in the following way. Firstly, I introduce some literary foundations for the research area. Secondly, I describe the methodology of the study. Thirdly, I report my empirical case on how the forecasting of civil engineering works has had to change along with market structure changes, and how it must continue to change. The focus is on the period of time before 1990 and the two decades 1990–2010, and on suggestions for how things should be after 2010. Finally, I draw conclusions and propose further research.

LITERATURE

No theoretical foundation exists in the economic theory for the construction industry for estimating and forecasting the demand for civil engineering in a closed market. There is an unquestionable need for channels and networks, but it cannot be made to fit the supply-demand theory of business economics. One possible way to approach the demand for civil engineering is to comply with set standards or meet a recognised need. Examples of standards that must be complied with are clean water quality standards or threshold values for processing waste water. One example of meeting a recognised need is when the amount of renewable energy used increases or when congestion is reduced in population centres. In this way, the desired outcome or state can be forecast, along with the need for civil engineering it creates, but not the actual demand. Many different sectors compete for public funding. It is not possible for any one sector to increase its volume, even when the need to do so is recognized. (Hillebrandt, 2000)

A study of construction carried out in Germany showed that the development of civil engineering should be estimated by using information from micro-sectors (Ottnad & Hefele, 2006). However, this is a challenging task as statistics are often incomplete or inadequate. Political decisions affect investments significantly, so that the total may not equal the sum of its parts. One end product substituting for another may greatly affect the investment; a rail network can be used to replace a highway network, for example, or locally produced energy to avoid building an energy network. On one hand, growth of traffic volumes demands investment in the traffic infrastructure; on the other, reduction in energy consumption, the amount of waste and water consumption reduce the need for investment. However, in this case there was a need to modernise and make local-level investments for the replacements of all of these systems. Part of the infrastructure is owned by private companies. For these companies, the amount of production is clearly defined by the demand and the financial conditions for meeting it.

Fluctuation in the level of economic activity is quite common in developed countries. These movements are known as business cycles. A business cycle usually has four distinct phases: the upswing or recovery phase, the peak, the downswing phase and the trough. As most forecasters know, establishing one’s current position in the business cycle is not that straightforward. Better results appear to be achieved, therefore, when combining quantitative and qualitative data in the economic forecasting models (Snyman, 2009).
RESEARCH METHOD

According Pettigrew (1990) contextualism as a the research method on change is proposed initially by the philosopher Stephen Pepper in his book “World hypotheses” (1942). The research on change includes context, content and process of change together with their interconnections through time. The focus is on changing, catching reality in flight; and studying long-term process in their context, a return to embeddedness as a principal of method. Context refers to the outer and inner context of the organisation. Outer context includes the economic, social, political, and sectoral environment in which the firm is located. Inner context refers to features of the structural, cultural, and political environment through which ideas for change proceed. (Pettigrew, 1990)

A contextual analysis of a process such as change draws on phenomena at vertical and horizontal levels of analysis and the interconnections between those levels through time (see figure 1). The vertical level refers to the interdependences between higher or lower levels of analysis upon phenomena to be explained at some further level; for example, the impact of a changing socioeconomic context on features of intraorganisational context and interest-group behaviour. The horizontal level refers to the sequential interconnectedness among phenomena in historical, present and future time. (Pettigrew, 1990)

Figure 1. In this paper the past is time before 1990, the present is time 1991-2010 and future is time after 2010. Higher level changing is for example political changes and lower level changes take places inside civil engineering sector.

RESEARCH QUESTION

The research question has been to define future development of the civil engineering markets. The key indicators have been chosen for several reasons, the main reason being that despite the availability of some longitudinal data statistics remain, on the whole, inadequate. The variables produced by the official statistical body are supplemented by tailored time series, collected either by the researchers themselves or by industry entities.

The Finnish civil engineering market has been divided into three periods: before 1990, 1991–2010 and after 2010. In the 1990 the state outsourced the first civil engineering department
(Civil Aviation Administration) and in the 2010 the last one (Navigation Administration). Each time period requires its own indicators. The first period consists of the time when state organisations and municipalities had their own planning and contracting units, and private industries were alone in contracting out to private contractors. A prime example of this type was the building contractor (see figure 2). The other indicators for the first period were forecasted public sector civil engineering investment and gross domestic product (GDP). GDP growth explained the possibility for state investment in the civil engineering sector.

During the time period 1991–2010 a change occurred in civil engineering construction, with the public sector outsourcing its contracting units and motivated market research. Technical Research Centre of Finland (VTT) began researching investors’ (state, municipalities and industry) investment intentions and following up outsize projects.

Today new indicators must be found to describe further more open civil engineering market because the old indicators fail to describe the future market. The research frame have to be renewed, for example more economic indicators are needed.

Figure 2. The transformation of the Finnish civil engineering market.
PHENOMENON PAST, PRESENT AND FUTURE

Time period before 1990, market structure
Civil engineering has always been closely tied to the development of society and business life. Civil engineering is needed when suburban areas and communities are constructed. The needs of industries and societies affect the traffic, energy and communication networks (Karjalainen, 1985). In addition to specific needs, the civil engineering industry was used as a tool in labour and regional politics up until the 1980s. The labour political dimension was discarded due to technological development and unemployment benefits, while the regional political dimension remained until the 1990s.

Forecasting indicators before 1990
Public sector budgets. VTT has been carrying out civil engineering market forecasts since the 1980s. The first forecasts were made mainly with state and municipal civil engineering investment plans in mind (Karjalainen, 1985). There was no advance information concerning additional state budgets even if a plan were known, which is one reason why forecasts went wrong. At that time the majority of civil engineering work was in the form of road building contracted by the state’s own contracting unit. If extra money were available, more work (subcontracting) could be ordered during the year.

Railway, street, water supply, sewerage and many other civil engineering sector constructions were also carried out by state or local municipal organisations, all with budgets and investment plans for the following year (Karjalainen, 1985).

GDP forecast. Even before 1990 GDP was one important indicator for forecasting future development of the civil engineering market. The GDP growth explains other sectors’ need. If during the last 50 years GDP growth has been less than +2 per cent annually, construction has grown negatively. If GDP has grown more than +2 per cent, construction has grown more than 2 per cent. If GDP has grown about +2 per cent, the growth of construction has been zero.

Figure 3. If GDP growth remains under +2 per cent, construction growth will be negative.
**Time period 1991–2010, market structure**

Since the recession at the beginning of the 1990s civil engineering has also been guided by economic realities. Projects are given priority according to how they boost the economy. Part of the public infrastructure has become privately owned; in this respect, decisions are made on a purely economic basis.

In recent years, construction has been an outgrowth of the change in regional structures and by migration, which concentrates the population in attractive cities and their surrounding communities. The altered and increased traffic flows demand both mass transport solutions and highway investments. Construction in an existing urban area brings with it marginal terms: tampering with an existing built environment and taking part of the construction underground (Nippala & Petäjä, 2004).

Since the mid 1990s many of the formerly closed markets of infra construction has been opened up for competition. This has brought an expansion in the selection of end products and increased significance for the private sector as constructor. However, the public sector still dominates, with 80 per cent of all infrastructures (Nippala & Petäjä, 2004; Nippala & Vainio, 2008).

Investments in construction concentrate on the buildings, highways and networks of the existing built environment. While some investments are used for renovations, others are used to upgrade constructions to meet the requirements of society. The role of companies as implementers of investment work has grown to 70 percent and in infrastructure maintenance to 65 per cent (VTT).

Currently, the end products of civil engineering can be either private or public. Often, they are classified according to their role as transfer or distribution networks, but most commonly, their classification is based on their functionality. As an example, a function can be the transfer and distribution of electricity.

<table>
<thead>
<tr>
<th>Infrastructure</th>
<th>Public Private</th>
<th>Transfer Distribution</th>
<th>Transport Energy</th>
<th>Water</th>
<th>Telecommunication</th>
<th>Sport and recreation</th>
<th>....</th>
</tr>
</thead>
</table>

The examination framework of the national economy divides the end products (use) between the public and the private sectors. This use can be either investment or consumption. Based on this division, construction can be divided into public sector construction investments and consumption, i.e. upkeep and maintenance, and to the corresponding construction investments and consumption of the private sector.

In addition to the work of their trademark industry, companies in the civil engineering industry also carry out foundation work for residential buildings and property maintenance of outdoor areas. By this definition, civil engineering work in Finland in 2009 totalled around EUR 9.2 billion (figure 1). In recent years, the significant changes in the residential building industry have made a major impact on the civil engineering market (table 1) (VTT).
Table 1. The % change of civil engineering production volume in Finland compared to previous years

<table>
<thead>
<tr>
<th></th>
<th>2009 EUR Billion</th>
<th>2007%</th>
<th>2008%</th>
<th>2009%</th>
</tr>
</thead>
<tbody>
<tr>
<td>Total</td>
<td>5.5</td>
<td>0</td>
<td>+2</td>
<td>-2.5</td>
</tr>
<tr>
<td>Investments</td>
<td>3.9</td>
<td>0</td>
<td>+3</td>
<td>-4</td>
</tr>
<tr>
<td>Maintenance</td>
<td>1.6</td>
<td>-1</td>
<td>-1</td>
<td>+1</td>
</tr>
<tr>
<td>Foundation work</td>
<td>0.6</td>
<td>+14</td>
<td>0</td>
<td>-27</td>
</tr>
</tbody>
</table>

The statistical information is historical and can be used to analyse the market to a certain degree. Current information and forecasts for the future are nevertheless required for operational control purposes.

In the closed market, planning information gave a clear enough picture of the civil engineering situation. The same source of information is used when looking at the situation in the open market. The economic cycle of civil engineering is typically said to be synonymous with the figure describing the large single civil engineering investments in the government budget. If the paragraph outlines a major change due to an impending highway project, “civil engineering works are on the rise.” The end of the highway project means that the “civil engineering works are in decline.” This information is broadcast, being deemed reliable and easily accessible.

Companies and central government have often viewed the economic cycle of civil engineering somewhat differently. Central government sees the increase in its civil engineering funding, while companies see foundation and earth construction ending with the slump in residential construction (Raksu).

**Forecasting indicators 1990-2010**

*Surveys.* Several industry-specific economic surveys are used to evaluate the development of the economic cycle in the civil engineering market. The surveys are produced by actors such as building designers, earthworks contractors and machinery contractors. The Earth Construction Branch Advisory Committee publishes the traditional biannual economic survey that covers the outlook on the industry (VTT). The survey reports on the economic cycle of civil engineering owners (municipals, companies), designers and contractors, and provides economic forecasts, market observations, cost changes, and so on. The economic survey is also supplemented with calculated data to describe the changes in volume.

This report on the outlook of the civil engineering industry has been published since 1993. The same questions have been used from the beginning to gather survey data on the development of operations.

*Outsize projects.* Although the influence of outsize projects on the civil engineering market was realised as early as the 1980s, no system existed for collecting sufficient information. VTT began collecting information between 1991 and 2010 from all civil engineering construction sites where construction costs exceeded EUR 50 million. The collected information helps to forecast the construction volume for the following year. The total cost today of outsize projects (>EUR 50 million) is about EUR 500–1,000 million and of civil engineering EUR 6–7,000 million. Outsize projects have special influence on
certain sectors. In the aviation sector, for example, one outsize project may double or triple the construction work for the whole year.

**GDP growth.** In Finland the beginning of the 1990s was marked by a recession. The forecast for civil engineering was in error and nobody could see the depth of the coming recession in advance. Civil engineering companies were still buying new excavators in 1990.

**Public budget.** State and municipal ownership in the civil engineering market decreased during 1991–2010. Ownership changes in the Finnish civil engineering industry began at the onset of the 1990s. The first big change came in the aviation sector, with the transformation of a state-owned organisation into a commercial enterprise. In 1995 the Finnish State Railways separated into the Finnish Rail Administration, VR Track Ltd Contractor, VR Cargo Oy and VR Henkilöliikenne Oy (handling passenger traffic). This was followed by changes in the organisation of road and sea traffic.

Figure 4. Market share by order sector. The share (total market in euros) of the private sector is slowly growing.

![The civil engineering market share in Finland – order sector](image)

Period after 2010, market structure
The period after 2010 starts with an insecure financial situation. The world monetary crisis in 2008 and the subsequent rapid recovery keep the oil price high and have influence on the Finnish civil engineering sector. The European economic situation is also insecure because of the Greek and Irish economic difficulties.

The economic situation for the Finnish state is also worsening, with Finland having to pay back loans taken out for the 2008–2009 recession. For Finnish civil engineering this will mean a greater onus in future on the private sector.

The indicators are used to describe the interaction between civil engineering construction and its operating environment. The interaction is couched in specific terms, for example in the supply-demand situation and in the development of costs. The indicator system’s approximations are suitable for analysing international infra construction.
Forecasting indicators after 2010

Private sector investment. Investments in energy, district heating, water supply and airports are made by the private sector. These sectors, more or less dependent on the economic situation, decrease their investments very quickly if the economic situation gets worse, weighting GDP as an even more important indicator.

RAKSU group expert opinion. In Finland a group of experts meets four times a year to discuss market development of the civil engineering and the economic situation. The experts represent various sectors, such as contractors, scientists, ministries and associations. The group forecasts the civil engineering volume for the following year for publication on the web pages of the Ministry of Finance (Raksu).

Surveys of actors. VTT conducts biannual surveys among contractors and civil engineering investors (municipalities, state and private organisations).

Over recent years the survey of planning engineering offices has been reasonably successful in forecasting the changes in civil engineering. Contractors’ surveys are another good indicator for future development, with knowledge months in advance of the forthcoming market situation based on the number of calls for bids. A further useful indicator is the number of contracts, although with forecasting only four months ahead there are some limitations to the use of this information.

Outsize projects. The state budget finances a number of large-scale projects, as do private companies. The influence of outsize projects varies year by year (See Figure 5). Examination of years 1195–2015 reveals that the influence on the total civil engineering market in 2013 will be about 400 per cent greater than in 2005. While acknowledging that these are only planned figures, decisions have in any case been taken to finance all the projects. The private sector projects in Figure 5 all started before 2009, and incorporate the risk of some delay.

Figure 5. Total for public and private projects (over EUR 50 million) in Finland.
DISCUSSION

The most important indicators for forecasting civil engineering construction are:

- public sector budget
- private sector outsize projects
- GDP change.

The public sector finance still approximately 55 per cent of civil engineering in Finland. The remaining 45 per cent share of other sectors is growing. The most important single factor is the state budget. An annual additional budget supplemented the state budget during the 1990s as civil engineering construction was inadequately forecast in the main budget. A number of these also appeared during the 2000s. The main budget, published in September, covers nearly 100 per cent of yearly civil engineering investments.

The outsize projects over EUR 50 million (both public and private) make up about 5–10 per cent of the total construction volume in Finland. In some civil engineering sectors one single outsize project may represent 50 per cent of all investments. For example, the Vuosaari harbour project in the Helsinki Metropolitan Area constituted over 50 per cent of total waterway investment at that time.

GDP is a fairly accurate forecast of building construction. The foundation of new houses forms about 15–20 per cent of the work carried out by civil engineering contractors. This is also a key sector for companies operating outside growing city areas.

Experience of which data are relevant and which are not is derived from surveys for contractors carried out by the Confederation of Finnish Industries (EK) over 30 years and those for owners and civil engineering planners performed by VTT over a period of about 17 years. While the 17 owner surveys appear incapable of providing explanation, those for planners and contractors have proved more valuable, forecasting future civil engineering construction volume approximately 0.5–1 year ahead.

PHENOMENON IN EUROPEAN AND NATIONAL (FINLAND) LEVEL

The comparison between European level and national level civil engineering drivers are illustrated in table 2. The source of the European level drivers, including Finland, is Euroconstruct conferences held during 2000–2010. The conferences are focused to construction short-term forecasts in nineteen European countries.

At the General level nearly all European level drivers has some influence also over national level. But not vice versa, a small country doesn’t have influence in European level civil engineering markets.

A positive economic growth does not have direct positive influence in civil engineering investment because public sector tax income has some delay. In the long run, of course, it has positive influence in civil engineering investments. The negative economic growth has in many countries also positive influence in civil engineering investments. Stimulus packages activate civil engineering investments (table 3). At local level elections have positive influence in civil engineering investments.
Table 2. Examples of European level and national level civil engineering investment drivers mentioned during 2000 and 2010 in Euroconstruct reports.

<table>
<thead>
<tr>
<th>Driver</th>
<th>European level drivers</th>
<th>National level drivers, (case Finland)</th>
</tr>
</thead>
<tbody>
<tr>
<td>EU directive and legislation</td>
<td>Directive 2000/60/EC, secure of clean water</td>
<td>National legislation (National Building Code)</td>
</tr>
<tr>
<td>TEN Network</td>
<td>Investment in infrastructure in new member countries</td>
<td>State road and railway investment budget</td>
</tr>
<tr>
<td>Expansion of EU</td>
<td>Aid to new member countries infrastructure investment</td>
<td>Encourage companies to export civil engineering work to new member countries</td>
</tr>
<tr>
<td>Economic growth - depression</td>
<td>stimulus package</td>
<td>stimulus package</td>
</tr>
<tr>
<td>Budget deficit less than 3 percent and government debt less than 60% of GDP</td>
<td>Restrictions in finance (Greece, Ireland)</td>
<td>Future restrictions in Finland</td>
</tr>
<tr>
<td>Elections</td>
<td>--</td>
<td>Local elections accelerates civil engineering investments</td>
</tr>
</tbody>
</table>

Table 3. Examples of European level and national level indicators for short term forecasting mentioned during 2000 and 2010 in Euroconstruct reports.

<table>
<thead>
<tr>
<th>Indicators</th>
<th>European level indicator</th>
<th>National level indicator, (case Finland)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Expert opinion</td>
<td>Euroconstruct member group</td>
<td>Ministry of Finance Construction market Analyst group</td>
</tr>
<tr>
<td>Economic growth</td>
<td>Bank, IFO institute etc. forecast of GDP growth</td>
<td>Bank of Finland etc. forecast of GDP growth</td>
</tr>
<tr>
<td>Outsize project</td>
<td>Euroconstruct country level reports of big projects</td>
<td>Follow up of outsize projects in Finland (over million 50 euro)</td>
</tr>
<tr>
<td>Infrastructure owner</td>
<td>--</td>
<td>Opinion of different sector civil engineering owners</td>
</tr>
<tr>
<td>Demand of private sector</td>
<td>Industrial investment forecast, mining sector forecast, energy supply forecast</td>
<td>Industrial investment forecast, mining sector forecast, energy supply forecast</td>
</tr>
</tbody>
</table>
CONCLUSION

This paper explains the indicators for Finnish civil engineering construction in three different time periods: before 1990, 1991–2010 and after 2010. Indicators have changed because of structural changes in the Finnish civil engineering sector. The most important indicators before 1990 were the public sector’s investment plan (state) and regional investments (municipalities). The time period 1991–2010 required two further indicators, namely outsize projects and owners’, planners’ and contractors’ surveys. The new indicators brought a significant improvement to forecasting.

The official statistics consist of traditional civil engineering – road, railway, streets, waterways, airports, ports, energy sector networks (e.g. gas, electric and district heating), water supply, the telecommunication network and environmental structures, parks and leisure areas. The industry (civil engineering contractors) also operates in the building construction sector and the maintenance of buildings (outdoor area). These works are not included under civil engineering in the official statistics.

Two further indicators are necessary for the period after 2010. The first is the expert opinion of the RAKSU group (called up by the Ministry of Finance); the second is civil engineering investments of the private sector. The second indicator is more problematic because of the absence of statistics; use can only be made of weak anticipatory signals.

Development work on the indicators continues in 2011–2012. A new research (Vainio & Nippala, 2010) will possess a more scientific touch, including testing of the theory described in this paper.
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