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HOW THE INTERNET IS CHANGING THE ROLE OF CONSTRUCTION INFORMATION MIDDLEMEN: THE CASE OF CONSTRUCTION INFORMATION SERVICES

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SUMMARY: *The Internet has radically changed the border conditions for infomediaries in most industries. It has created new business opportunities in the new, networked value chains that have evolved, and threatened the existence of companies who fail to re-engineer their operations. The paper firstly deals with recent developments within e-business in general and among information middlemen in particular. They act as intermediaries between those who have information and those who need it. They also produce information by themselves. Information can be delivered digitally, and is thus eminently suited for electronic commerce. The central starting point of the analysis is in basic transaction cost theory, which explains how specialised information brokers add value to the construction and facilities industry. Despite all the hype about the "New Economy", this theory still holds. What has changed, however, is that new factors enter the equation, such as for instance an infomediary's ability to restructure information into such a form that their customers' computer applications can read it as well as humans. In the paper the stages of the design, construction and FM cycle are analysed and the role that information plays through these are discussed. After this the functions that construction information services have traditionally carried out are described. The paper aims at presenting proposals for a multi-tier architecture for how such services should structure their future information systems in order to meet the new demands they are facing. In particular an information middleman's services should cover the whole life-span of the CFM process, since the same information stored in databases can be provided in different combinations for different purposes throughout the process, thus offering significant economics of scale. Finally some preconditions for the conclusions are discussed.*

KEYWORDS: *Information middlemen, infomediaries, information brokers, building centres, the construction process*

1. INTRODUCTION

This paper is about Information Middlemen, in a networked Internet based business environment in the construction and Facility Management (CFM) Industry, where three things have happened almost simultaneously. The apprehension of New Economy has evolved from a belief of almost unlimited growth back to a comprehension that basic economic theories still do apply, but digitalisation has brought some fundamental changes. This has shaken the foundations of middlemen. In the CFM industry all players have taken information and communication technologies (ICT) into use. Information is largely produced, stored, and distributed digitally. The business processes of Information Middlemen have undergone similar changes. When these three trends are combined, a fundamental change in the CFM industry's information support is at hand.

From this viewpoint, the paper first deals with recent development within e-business, among information middlemen in general and in the CFM industry, and among the players in the CFM industry. It then proposes general conclusions / consequences for information middlemen in the CFM sector. Finally, it proposes some directions for future research.

The first parts are based on a literature review, and the parts about the CFM Industry and CFM information middlemen draw heavily on the author's present work as research director in The Building Information Foundation RTS. Other roots for the research can be found in the Finnish RATAS-projects in the late 1980-ies and early 90-ies, and in several large Technology programs funded by TEKES, the national technology agency of Finland

2. THE NEW ECONOMY AND E-BUSINESS

What started as euphoric descriptions of a new economy where old rules would be overturned, soon turned into more careful views. The turning point happened during 2000 when the value of in particular IT- and Internet-related companies diminished to only fractions of their highest value. (Coltman et al, 2002, Fingar and Aronica, 2001). About simultaneously the view in writings about the consequences of the Internet changed to a more everyday tone. There now seems to exist a widely shared opinion that although the very foundations of the economy didn't change after all, some changes occurred in the prerequisites for business, in particular for digital goods.

The view on the role of Internet in business has changed in business strategy literature, within only a few years. What started as plain "web-publishing", or "brochureware" has evolved through a series of evolutionary steps to re-engineering of internal processes and intricate ICT systems supporting networking with customers, as illustrated in Fig. 1. Jansson et al (2001) have presented similar trends.

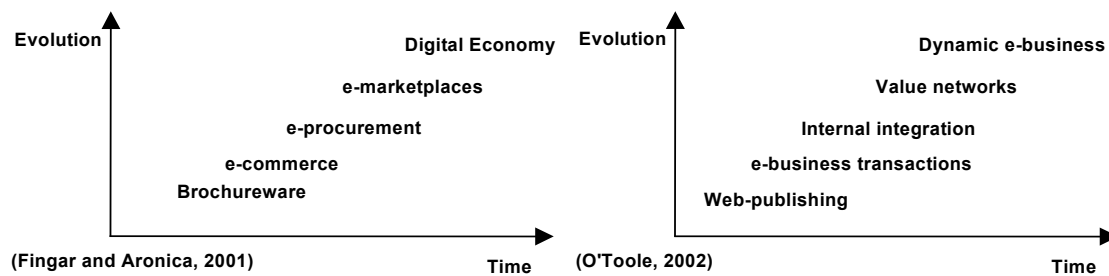


Figure 1: Internet-imposed changes in the prerequisites for business

According to Shapiro and Varian (1999a) "technology changes, economic laws do not". Accordingly, there is no New Economy, where the old laws of economy cease to exist. But there is something new. Information is becoming increasingly digital. And they point out that essentially, everything that can be digitised is information. Books, databases, magazines, Web pages are all information goods. They stress that focus should be on the value for the customers. Finally, the Internet offers a totally new infrastructure to form networks and use them for transferring (digital) information between people, firms, and software. When the three aspects, digital information, information networks and customer value, are combined with existing principles for the economy, new patterns, business models and strategies evolve.

2.1 Customer value and networks

Several recent studies show that e-business seems to be a useful tool only for some firms and some tasks. Among successful examples mentioned, are books, CDs, computer equipment and airline tickets. There has been little evidence for widespread transferability to other consumer markets. What started as a promising Business-to-Consumer effort, seems to be turning to Business-to-Business, where Electronic Data Interchange (EDI) and the standard EDIFACT, have prepared the ground for electronic business. In search for profitable customers, expectations have turned from consumer to business services. (Coltman et al, 2001, Ravindra, 2001, Fingar and Aronica, 2001)

Trying to define what customer value is, Porter's value chain and Coase's transaction cost theory provide a good foundation. (Ravindra, 2001, Fingar and Aronica, 2001, Porter, 1998, Coase, 1988) The general strategy for increasing customer value is differentiation. "The buyer's value chain is the key to understanding the underlying basis of differentiation - creating value for the buyer through lowering the buyer's cost or improving buyer performance. Differentiation results from both actual uniqueness in creating buyer value and from the ability to signal that value so that buyers perceive it." (Porter, 1998)

Coase's transaction cost theory (TCT) from 1937 originally emanates from the need to explain why firms exist. Although Coase originally discussed the price mechanism, and the costs of using it, the term has come to be known as transaction costs in economic literature. (Coase, 1988)

Sarkar et al (1995) use the TCT to argue against the notion that electronic commerce will lead to the disappearance of middlemen. They illustrate the TCT as shown in Fig. 2. A producer (or a middleman or firm or a service) is needed when $T_2+T_3 < T_1$. If $T_1 < T_2+T_3$, the consumer deals directly with the producer. Coase (1988)

stresses that transaction costs, or price, should be understood in the widest sense of the word, including not only money costs, but everything needed to carry out a market transaction: search and information costs, bargaining and decision costs, etc. In the following text this logic is applied to customer value.

Firms act together in value chains, or value systems for aggregating value for their customers, form value chains or value nets, or business webs, b-webs. (Tapscott et al, 2002, Parolini 1999, Luomala et al, 2001) In the value

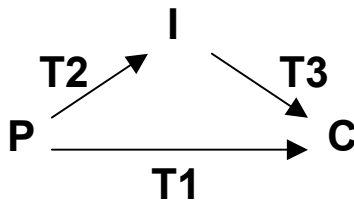


Figure 2: Possible transactions between intermediaries (I), Customer (C) and Producers (P). T1, T2 and T3 are transaction costs. Sarkar et al (1995)

chain formed by customers and suppliers, the customers are the customers of customers and so on, and the suppliers have suppliers who have suppliers and so on. This is illustrated in Fig. 3. (Fingar and Aronica, 2001)

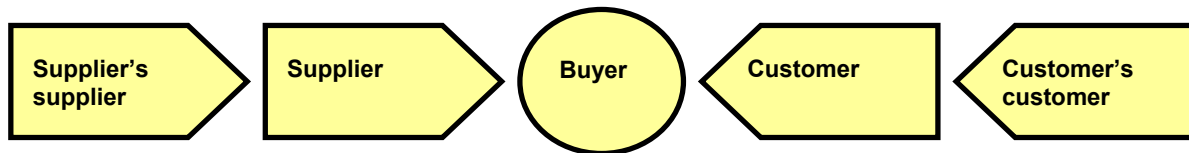


Figure 3: The value chain

If a firm is to be successful in a value net, it must not only exploit ICT to its full potential, it must also adjust its business processes accordingly. ICT is no longer a support function, separated from business, but at the very core of business itself. This, and a need for fast reactions to customer needs, has led to short term rolling plans and the need for flexible production systems. (Earl and Khan 2001)

Through a detailed analysis of case studies of some well-known companies Kalakota and Robinson, (1999) show that in companies who had successfully met these needs, a profound re-engineering of the company's strategies and processes had been undertaken, and a structure which integrates ICT tools for customer relationship management (CRM), resource planning (ERP), and product data management (PDM) had been implemented. According to Smith (2001) future trends for the technology is that the implementations will be based on Java and XML, and continuously integrated and standardized. Solutions will move from tightly coupled applications to loosely coupled Web services.

For services in a value net, using such a platform, Ravindra (2001) has identified five key factors. The site has to be promoted to the right customers, and their behaviour should be the basis for further enhancements. The site must provide good usability and functionality. There must be a functioning distribution and logistics chain in addition to the web experience. There is a need for customer assistance throughout the whole purchasing activities chain, from first contact, through purchase to after sales. The ICT infrastructure must provide such a support for fulfilment and functionality that enables the accumulation of revenue despite very small click-through margins.

2.2 Pricing in electronic business

Information products are costly to produce, and the costs are up-front. Once a product is produced, and in digital format, it can be digitally reproduced and distributed at almost no cost using networks. And once the product is produced, the costs are sunk costs. The price of the products can only be deduced from the value they have to their customers. It is important to analyse and understand how much can be invested in an information product.

(Shapiro and Varian, 1999a) The margins are very small if long-term profitability is to be gained. (Ravindra, 2001)

Several authors have shown that an initial supposition that the Internet inevitably will lead to cheaper prices for customers, might not materialize. Customers are unwilling to purchase from unknown web sources. Brands are a solution to this, as familiar brands make the web source familiar. The core idea of branding is differentiating. Differentiated products create difficulty in comparing products, and can facilitate premium pricing. (Coltman et al, 2001, Öörni and Klein, 2003, Smith and Brynjolfsson, 2001) Shapiro and Varian (1999a) demonstrate that bundling, personalized products and prices, versioning and lock-in, are additional ways to maintain profitable pricing, and show how the web is very suitable for doing this.

3. INFORMATION MIDDLEMEN AND THE INTERNET

It has been argued, that the Internet forms a severe threat to the business of middlemen in general. If customers start to deal directly with the producers the middlemen might disappear. (Sarkar et al, 1995, Benjamin and Wiggand, 1995, Schmitz, 2000) However, according to Sarkar et al (1995) this might not be the only case. As shown in section 2, using Coase's TCT it can be illustrated that an outcome just the opposite might be equally plausible. When $T1+T2 < T1$, the use of a middleman leads to lower costs for the customer. The outcome might be that the existing intermediary structure is enforced, and even that new network-based intermediaries emerge.

Other studies reach similar conclusions. Middlemen whose services go beyond simple matchmaking, and have value adding expertise, will remain viable. Their business opportunities coincide with the surplus they can generate, on activities they support. But simple matchmaking which merely brings together buyers and sellers, is predicted to be replaced by large databases and sophisticated search protocols. (Wimmer et al, 2000) A firm's, in this case a middleman's, services get competitive advantage, when they give their customer value, which is greater than the customer's costs for producing the same services themselves. (Porter, 1998)

Coltman et al (2001), Scott (2000), Schmitz (2000), Tapscott et al (2002), Wielemaker et al (2001) and Willcocks and Plant (2001) have all discussed strategies, which might give middlemen competitive advantage. The reduction of the amount of asymmetric information is one of them. Companies are reluctant to provide "negative" information about their products. A well-known example is that of a used car, where a middleman with a good reputation can charge a premium price for a good car, while a seller unknown to the customer cannot. (Schmitz, 2000) Secondly, in a network abundant with information, attention becomes a scarce commodity. (Tapscott et al, 2002) The amount, dispersion and trustworthiness of information, is another area where information middlemen can produce information of better quality and at lower cost. (Schmitz, 2000) A third one is proximity to the customers. A middleman can affect the decisions of the customers, and thus gain bargaining power against the producers. (Scott 2000) A fourth one is reputation, trustworthiness and attention, which can be achieved by building brands. Despite what has been predicted, brands seem to continue to have a significant role on the Internet. (Wimmer et al, 2000, Smith and Brynjolfsson, 2001, Coltman et al, 2001) The importance of brands might even be reinforced. A well-known brand is a tool for a customer to judge the quality and accuracy of information found on the net. Willcocks and Plant (2001) examined 58 Business-to-Consumer companies from three continents in order to learn how they had been able to take advantage of the Internet. Companies often started off with the idea of technology leadership. Those who migrated to a market strategy, i.e. concentrated on services and/or brands, were more successful than others. Willcocks and Plant offer four ways for using the brand as a part of a market strategy: Brand re-inforcement, brand repositioning, brand creation and brand followership. They also point out that "delivering on the brand" (the "promise to the customer," as it has been called) can be expensive and difficult. (Willcocks and Plant, 2001) Amazon.com, already an established brand, reinforce the trustworthiness of their auction site by providing certification services and guarantees of authenticity. (Wimmer et al, 2000)

Coltman et al. (2001) and Ravindra (2001) describe studies among business leaders, which show that when the Internet emerged as a promising platform for business, expectations emerged that slow movers, traditional middlemen and "brick and mortar" companies might be disintermediated by new Internet-based start-ups. However the studies indicate, that there seems to be at least as much potential for doing business over the Internet for traditional well-established companies, as there is for start-ups. The burst of the Internet bubble in 2000 has given them the time and perspective they needed. Many have now chosen an incremental strategy, and focus on certain areas, which exploit the Internet's special features, and are profitable. Firms that have focused primarily on brand building instead of the whole delivery chain, like many of the dot.coms, have not been able to gain

sustainable profits. Established middlemen have well-established brands, and the necessary infrastructure and expertise to manage the whole supply chain leading to order fulfilment. (Coltman et al, 2001, Ravindra, 2001)

4. THE CONSTRUCTION AND FACILITIES MANAGEMENT (CFM) INDUSTRY

The CFM industry has some characteristic features that make it different from other manufacturing industries. The same features make it particularly interesting from an e-business point of view. It is an industry with a heavy significance in the national economy. It employs about 20% of the workforce. About 2/3 of the national assets consist of the built environment. With the exception of some prefabricated houses and industry buildings, most buildings are unique, designed for a specific use(r) and site, and built only once. The design and construction team is more often than not, assembled from different players for every new project. Even though the most visual result of the team's efforts is a constructed building, the production, flow and storage of information has an essential role throughout the whole lifecycle of a building. Until the construction has started, information is actually the only thing that is being produced, stored and delivered. During this initial phase, approximately 85-90% of the construction costs become fixed through decisions.

4.1 The CFM process, the information flow and the value chain

The CFM process is often described as a cyclical process consisting of sequential phases. One way of illustrating it is shown in figure 4. Even though the process can be divided into sequential phases, Maver and Landsdown (1984) have pointed out that the process is holistic and fluid, and that all major parts might be manipulated at once, and that there is no generally accepted sequence of work which automatically will guide design teams to a satisfactory solution. In relation to Fig. 4 the following text describes architectural design, structural design and building services as a first phase, prefabrication, bills of quantities, construction and marketing as a second, and use, maintenance and operation as a third.

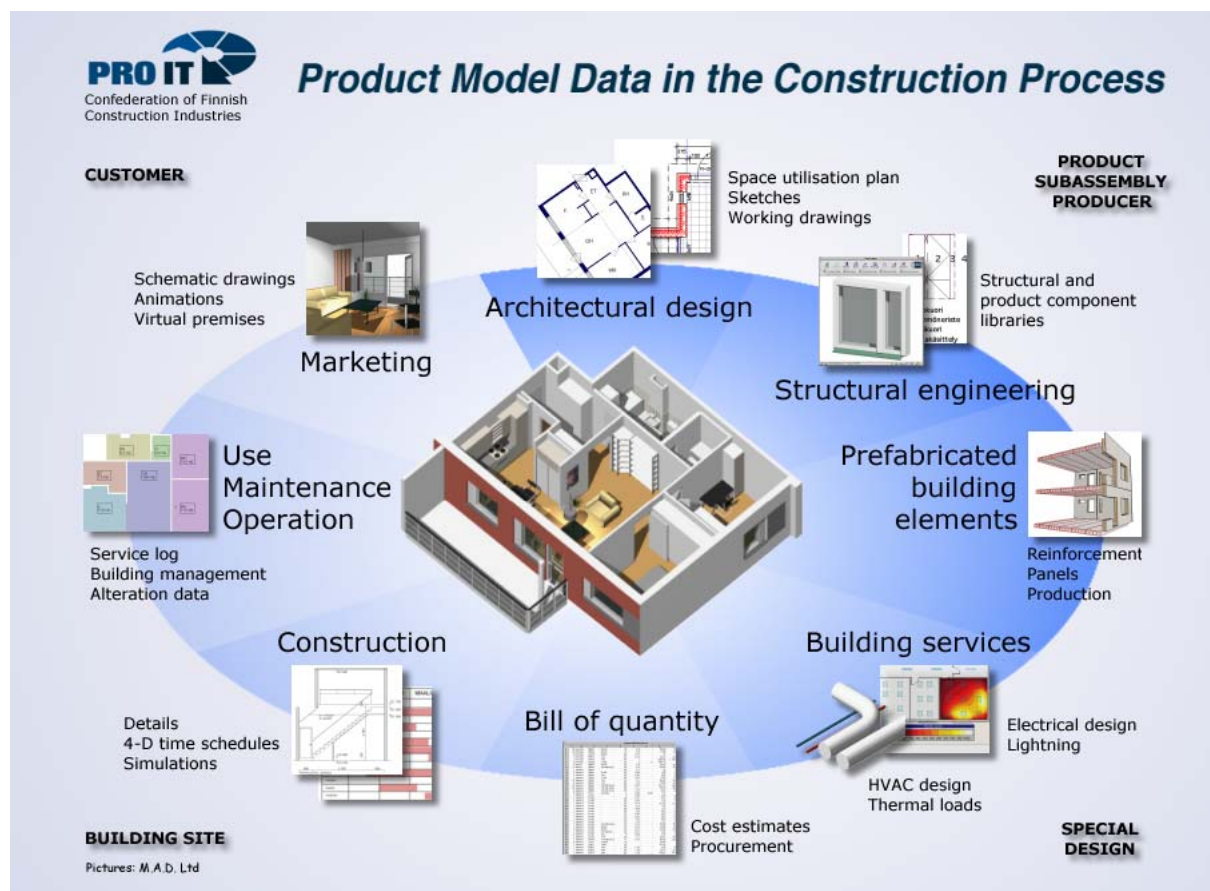


Figure 4: The main players in the CFM Industry value chain as illustrated in the Finnish ProIT-project owned by the Confederation of Finnish Construction Industries. (Romo 2002a)

The design process usually starts with some change in the owner's, or user's needs, which sets off the process. During the programming phase the needs are transformed into a brief, which functions as a starting point for the building design. During the design phase the brief is elaborated into a plan, or model, of the building to be built. The model typically consists of drawings, schedules and specifications. When the model is stored digitally, the format depends on which tools are used. There are two main principles. The information is either stored as separate document files, which together constitute the model, or as a product model. The first principle is the traditional one, and can be realised with paper documents as well as with digital files produced by conventional CAD-systems. Increasingly today these files are managed using Internet based electronic data management (EDM) systems. (Björk et al, 1995, Sulankivi et al, 2002s) The product model is always in digital format. In the ideal case it is one single data model in which all players store, and from which they derive all their data, from early design to use and maintenance. (Björk, 2003, Eastman, 1999) Drawings and other documents could mainly be understood as a user interface to the actual model. In Fig. 4 it is represented, by the building in the centre of the picture.

A rising issue is the interoperability between product models, a problem accessed by Koivu (2002). His study shows that a majority of industry experts see the development towards a non-proprietary, value-adding area as the major trend. The main standardisation initiative at the time being is IAI/IFC (International Alliance for Interoperability/Industry Foundation Classes). (ITCON 2003, Koivu, 2002) Existing digital models are not complete, so various mixed procedures are likely to exist coexist for some time still. (Romo, 2002a, Romo 2002b)

The model, or excerpts of it, serves several purposes. A first one is to illustrate the design to the client/owner/user and enable a compliance check with the brief, and for evaluation in general. A second, very similar, is that a model is built of explicit, exact data, quite the contrary to implicit data in vague artistic drawings, or even tacit knowledge. A third one is to function as data input and data output repository throughout the whole building life cycle. A fourth one is that building is subject to permits. Particular sets of drawings are used by the authorities to check compliance with the laws and building regulations, and for the approval of building permits. Finally, a fifth purpose is to enable the actual construction of the building.

4.2 Use of ICT in the CFM Industry.

The use of Information and communications technologies (ICT) and the Internet in the CFM Industry has lately been the object of numerous benchmarks, surveys and R&D programmes. These are targeted at somewhat different aspects. Some deal with the field of interest in general, some focus on small and middle sized enterprises (SMEs), a specific country or region, and some on the CFM Industry. (Arif and Karam, 2001, Dunt and Harper, 2002, eEurope, 2002, ITBOF, 2003, Lim et al, 2001, Rivard, 2000, Romo, 2002a, Romo, 2002b, Samuelson, 2002)

From an analysis of existing literature and the scopes of national programmes, some patterns can be discerned. In the CFM industry, most of the information exists in one digital form or another, providing a promising foundation for e-business and computer-based communication. All mayor players use computer programs, produce, store, and transfer their data in some digital format.

There seems to be a widespread consensus about the future. The industry should invest in ICT and B-webs/value nets. The principles described in section 2 of this paper apply for the CFM industry, too. Consequently, strategies for the future should be based on these, and a profound understanding of the possibilities and threats of ICT, networks and the Internet. There seems to be a variety of new possibilities to use ICT to enhance competitiveness, improve quality, speed up processes, and develop new services. This trend is backed, even subsidized, by the EU and the governments in several countries. An impression of the direction the CFM sector is committed to take is provided by the EU ROADCON-project, which suggests a common vision of model-based, knowledge driven ICT in the construction sector in order to enable realisation of important societal, environmental, industry and business priorities. ROADCON is supported by 287 organizations in 28 countries. (Roadcon, 2002)

Secondly, the present situation is still far from the visions, and the time span to substantial benefits might well be more than 10 years. (Koivu, 2002) Even though most data exists in some digital format, the information resident in drawings and other documents still cannot be exploited to its full potential, because of numerous organisational, structural and compatibility shortcomings. Partnerships, new business models and technical solutions, and standards need to be developed. SMEs lack resources for extensive development work, and lag behind in the uptake of ICT in general. The most popular use of ICT is e-mail, information search on the Internet, office applications and CAD. There is relatively little integration between the players. (Samuelson, 2002) The present

situation seems to be as Froese (2002) puts it in an evaluation report of a Finnish CFM technology programme, "the shift has not yet taken place, but the momentum has definitely been created and there is a strong feeling that the critical mass has been reached to make this shift inevitable."

4.3 The players and the value network

Who the end user is in the CFM industry can of course be discussed, but the owner is one main customer. Sometimes the owner is the same as the user, sometimes not. The owner participates in all phases of the process. During the early design phase, the owner is often the only player, sometimes aided by a consultant. Later in the design phase, additional players come into the process. Usually there are at least four main disciplines represented: An architect, a civil engineer, an automation and electricity consultant, and a HVAC consultant. Often, additional consultants are engaged: Landscape architects, interior architects, geotechnical engineers, acoustic consultants etc.

Even though the players in the design phase make their main contribution during the design phase, they generally also participate in the next phase, the construction phase. The new players in this phase are the contractors. A construction project can be organized in many ways, but usually the same disciplines are represented among the contractors as among the designers. The organizations of contractors are often such that the work of one contractor is actually performed by a chain of subcontractors. From an information point of view, a contractor has several relevant sub-processes. First, there is the quantity take off, which in some countries is done by separate players. Then there is the bidding procedure, and the contracts between the client and the contractor. After this come the contractor's purchases of building materials, products, services and subcontracts. When the construction work is finished, come the final control calculations and financial aftermath.

In the use and maintenance phase, the user is sometimes again the only player. In business contexts, professional house managers, caretakers and economists are mostly engaged.

In addition to these main players, there are some essential players who don't participate directly in the actual value chain, but they serve the main players, adding value to their services. The authorities publish laws, regulations and guidelines. The material industry provides the construction industry with material and products, and information about these. The research community provide research and information. The copy shops print, duplicate and distribute information produced by the players. Standardization bodies and many professional societies provide standards, guidelines and reference databases. The Internet has brought along a new set of players providing various online services such as document repositories, model servers, information portals, auction sites and virtual shops. The information middlemen are important, but often unnoticed, players in the CFM industry. They provide information support in digital form over the Internet, on CD-roms, and in traditional form as printed matter.

In the following, information middlemen and other additional players, together with the main players, are considered parts of one value chain in a fluid holistic process with sequential phases, where each phase adds value to the previous part. If Coase's TCT is applied, crucial for the need of any service of any player are transaction costs understood in the widest sense of the word, as experienced by its client/owner/user.

5. INFORMATION MIDDLEMEN IN THE CONSTRUCTION AND FACILITY MANAGEMENT (CFM) INDUSTRY

The information middleman is a value adding service provider, whose customers are the players in the CFM industry, which are illustrated by Fig. 4. CFM information middlemen are often neutral organizations with a broad representation of the CFM players among the owners. They are founded to be a neutral part to which the publication of common guidelines and references can be outsourced.

CFM Information middlemen provide information support such as design and planning guidelines, quality and cost data, classifications, contract forms, product information, and technical literature. (Jones, 2000, UICB, 2003b) There is typically at least one major information middleman per country. (UICB, 2003a) A summary of services provided by 23 CFM information middlemen in 17 countries is presented in Fig. 5.

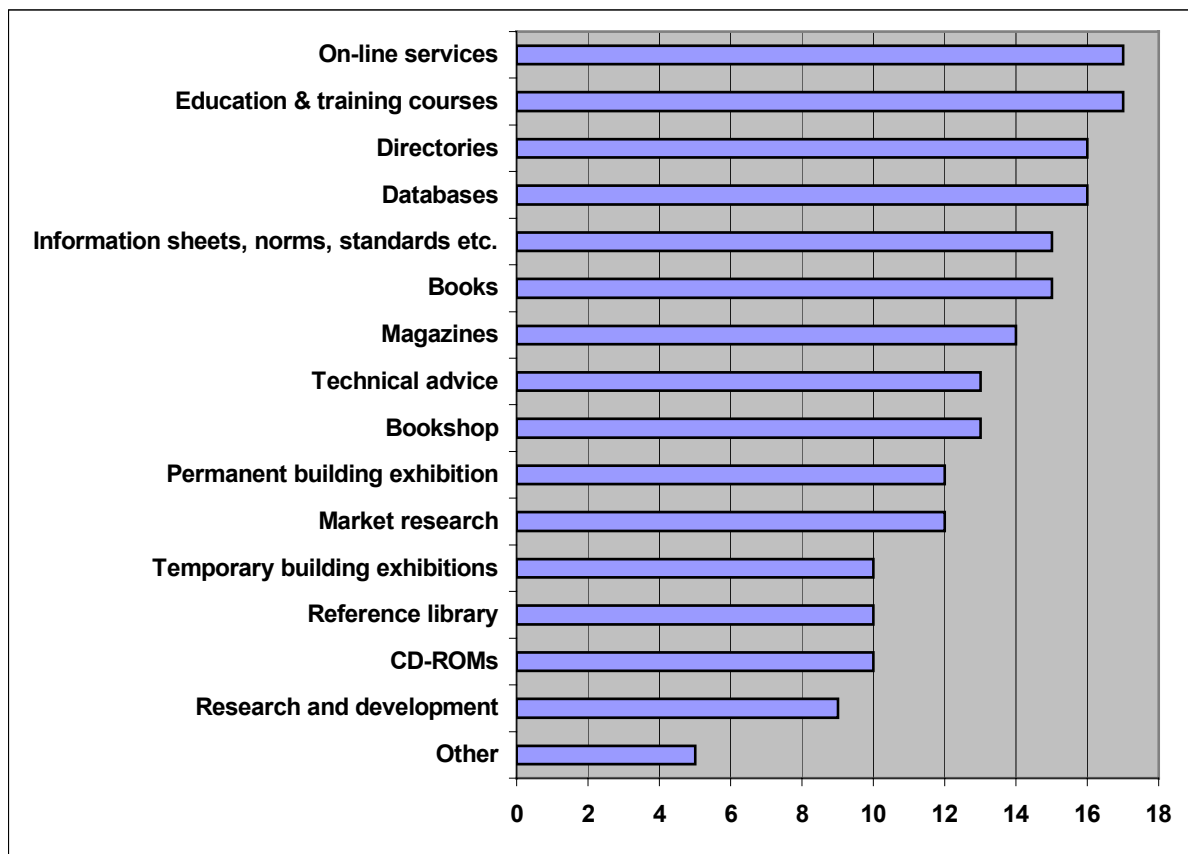


Figure 6: Services provided by information middlemen in the CFM Industry (UICB 2003b)

The CFM information middlemen have two categories of customers

- those who have information and need to get it distributed
- those who need this information

For the customers who provide information (producers), the middlemen add value by spreading, or distributing it to the right players. One large group of customers in this category can be found among the building material industry. For them it is important that information about their products reach those who make design or purchase decisions. Another large group is those who issue laws, regulations, standards and guidelines. These customers can be found among various authorities and professional societies, who often prefer to outsource the publishing of their to information middlemen, even if they could, and sometimes do, publish it themselves.

For the customers who use information (consumers) the middleman adds value by providing it. The information provided, can be either passed on from the previous group of customers, or produced by the middleman himself. The main customers in this category are architects, engineers, constructors, users and clients, i.e. the main players in the construction process, which are located in the centre of Fig. 4.

These customers mainly get the information through one of these services:

- Publishing of books and other traditional publications, and electronic publishing
- Services, which are based on databases, like product selectors, product directories and data sheets.
- The bookshop and distribution of others' printed matter
- Exhibitions and virtual exhibitions

5.1 Publishing and electronic publishing

At their core, the information middlemen are publishers of information. Since information is, or can be made digital, it is well suited for e-business. The publishing process has undergone a development similar to the one of the CFM industry. The information is produced, stored, communicated and distributed in digital format. All writing, editing, and lay out work is done using computers. The information content is stored on data servers.

The contents of printed books and other documents are sent to printing houses in digital format, mostly as PDF-files.

Traditional books, paper catalogues and other types of printed matter, are now often supplemented by CD-ROMs and web-services. There is a need for digital data to be used, and re-used, in several output media, paper, CD-ROMs, web pages and mobile devices. The data also has the potential to be tailored for various individual customers. This multi-faceted use of the contents has led to a need for a digital publication production process, where data production and input, data storage, and output can be separated from each other, and outputs for various media can be generated. Additional needs are tools for the Internet, customer resource management and economic resource planning.

5.2 Services, which are based on databases, like product selectors, product directories and product data sheets

A special case of publications is product catalogues, and other directories. These are well fitted to exploit the possibilities of data base programs and on-line services on the Internet. The building centres run several databases suited for being developed to web-based services. One, which has much potential, is building product information. Of the UICB members, most run building product databases or directories. There are numerous ones outside UICB as well. The span of depth and functionality varies from very basic data to on-line purchasing portals.

5.3 The bookshop and distribution of third party printed products

Many CFM information middlemen do, as publishers often do, run bookshops. For sale is production of their own, as well as other publishers' products. The bookshops are often specialised, with the ambition to cover the needs of the players of the whole CFM sector. The emergence of the Internet, lead to many publishers building web-bookshops.

Internet based bookshops, of which Amazon.com is probably the best known, are a new competitors for established bookshops. In a study Coltman et al (2001) show that books have been among the few products, actually successful in business. They also argue that even though Amazon has set the standards, and continues to do so, traditional publishers like Barnes and Noble or Bertelsmann, are successful in closing the gap. Both Barnes & Noble and Bertelsmann are big publishers also in the CFM sector. The launching in 2003 of a large joint web service, <http://www.construction.com>, of McGraw Hill, Sweets and others supports the observations of Coltman et al.

According to these experiences, publishers' web-bookshops have remained important content providers in the CFM value network.

5.4 Exhibitions and virtual exhibitions

The idea of an exhibition is the physical presence of what is exhibited. Virtual exhibitions have been on the agenda several years in UICB's internal discussions, but so far the solutions shown are various databases or product selectors. They all have a common setback. It is difficult to get a good comprehension of properties like texture, scale, feel and colour of a product, by merely looking on a data screen.

6. CONCLUSIONS

The processes of the CFM information middlemen and those of their customers seem to have undergone changes which together with the developments of the Internet offer many possibilities for the middlemen. The conclusions for CFM information middlemen are divided in three parts, following the text above:

- general changes in business prerequisites
- the value networks in the CFM Industry develop new needs for information services
- the business processes of the CFM middlemen change

6.1 General changes in business prerequisites

Coase's TCT states that a firm, (service or product) is needed if it lowers the customer's costs in the widest sense of the word, in such a way that $T_2+T_3 < T_1$. Fig. 6 illustrates the TCT for CFM information middlemen. The black arrows show the data flows between the two categories and the information middleman. (The grey arrows

illustrate a potential information flow facilitated by mechanisms in software for electronic commerce, making new information services possible. However, the elaboration of this potential is left outside the scope of this paper.)

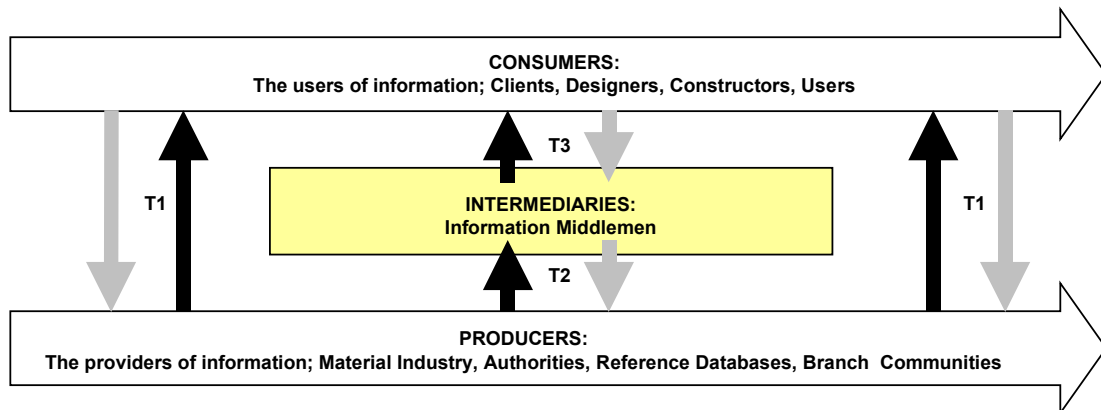


Figure 7: The information flow, the Middleman, and the two customer categories

Porter (1999) has taken the concept further with the concept of value chains, where each player adds value to the whole chain. The value chain has, in turn, been elaborated into business-webs (B-webs) by Tapscott et al (2002), alt. value nets by Parolini (1999).

Several studies show that those, who have and been successful in the Internet have taken a customer oriented approach, have digital goods, strong brands, and functioning delivery processes. Middlemen can reduce information asymmetry, and can focus customer attention. The notion that Internet will inevitably lead to cheaper prices has been proved false.

Information can be treated as a good, with some special features. It is, or can be made digital. Once it is produced, the costs for the production are sunk costs. Since copying and distribution is very cheap, these costs may often be ignored. Bundling and versioning are recommended tools for maintaining profitability of producing information goods. Network externalities work in the favour of those who can gain a sufficiently large part of the market. (Many CFM information middlemen are market leaders in their respective countries.) Customer costs for switching from one system to another (Lock-in) is often considerable. The management of Lock-in is crucial to producers of information goods. (Shapiro and Varian, 1999a) These preconditions are promising for the CFM information middlemen, who have designed their strategies correspondingly.

6.2 The value networks in the CFM Industry develop new needs for information services

The players in the CFM sector have, in particular from a Nordic/European perspective, have started to see strategic advantages in considering themselves parts of a value network covering the whole lifespan of the CFM process, from preliminary design to facility management, re-design and renovation, including life-cycle assessments. The use of ICT has become increasingly important, in particular the possibility to digitally reuse project data throughout the whole process. (ITBOF, 2003, Roadcon, 2002, Romo, 2002a, Vision, 2001)

This change of perspective from parts to the whole, has corresponding consequences for where customer value accumulates, and thus the basis for CFM information middlemen services. The CFM value network is large and difficult to overview, and the amount of players is very large. The CFM information middlemen can help both their customer groups (Fig. 6) by offering a one-stop entrance to the other group. They have strong brands, which they can reinforce by various assessments and approvals. Their neutral status and a central position in the CFM value network strengthen it. Beside intermediating information, they also often have information production of their own.

Digital information is increasingly important. The format of the digital information should be compatible with that of the customers'. The compatibility between different systems is still largely unsolved. Despite some successful pilots using IAI/IFC the shift is just on the brink of taking place. Customers will still need information provided in the formats of widespread CAD-systems and office programs. IAI/IFC is increasingly important.

Product data/product selectors offer promising perspectives, as mere trustworthy data is crucial in itself, and it can be supplemented by additional data, and bundled with other services, like appraisals, life cycle assessments, and tools like specification writers. Product information has three levels:

Level 1: - Basic contact information about firms: Name, Address, telephone, web-site etc
 - Basic product information: Name, type
 - Search by basic information or (national) classification

Level 2: - Detailed product information. Traditionally presented in product data sheets.
 - Product descriptions, properties, pictures, formulas, drawings and CAD-files
 - Property-based searches

Level 3: - Fully functional on-line auctions and purchasing portals

When the distribution media is paper-based, the contents are restricted to levels 1 and 2. When information and its distribution is digital (CDs and web-sites), a whole new range of possibilities opens up: Enhanced search facilities, more multifaceted data, expansion of target groups towards the later phases of the CFM process, provision of data directly into the customers' computer applications, data in various data formats e.g. IFCs for data modelling, drag-and-drop, etc. Also programs that use this type of information seem a promising field for data providers. For instance in Finland alone, there are more than 40 different programs for maintaining building service books, and a project for definition of a common XML standard has started in summer 2003. (e-ehyt, 2003) In a value net, a web bookshop can be a link that refines information. In an information architecture described in the next section, it could also have a role as an integrated distribution channel for pay services. The exhibitions might be used as show rooms for products in the product selectors. This principle is used by Material ConneXion, whose concept is a combination of a web-service, and a 'touch and feel pet zoo'. (Savolainen, 2002). Furthermore the exhibitions could be equipped with extensive data equipment providing additional information, and possibilities to invite bids, order or purchase the product on-line.

6.3 The business processes of the CFM middlemen change

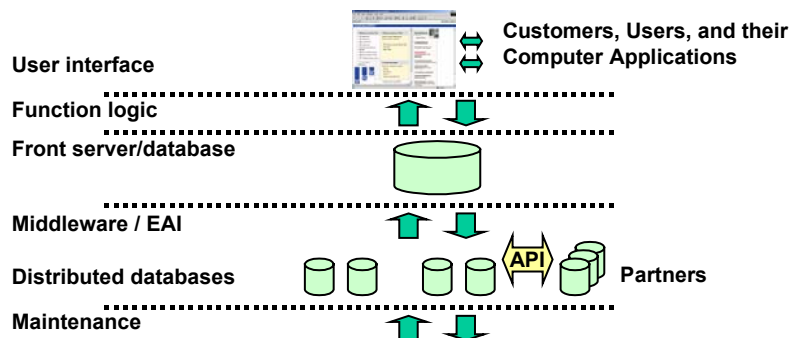


Figure 8: A multi-tier Architecture for CFM information middlemen

The processes and products of CFM information middlemen have become digital, like those of their customers. As a consequence of this, and the need to respond to the challenges of the Internet, CFM information middlemen are confronted with the need to redesign their business processes, and their ICT systems architecture.

The need to separate the outputs from the rest of the process forms the prerequisites for a multi-tier data architecture, which makes it possible to re-use the data in various products and services. The modularity makes it possible to develop new services quickly and with great flexibility. In this context the contents are separated from the other tiers, a middle tier, which provides the functionality of the system and interacts with the first tier containing the data storage, and the front-end tier, which provides the user interface, which is what the customer meets. It should be noted that the end user might need two types of data; 1) for human interpretation i.e. reading, and 2) input into various data programs such as word processors, calculation programs, CAD-programs and databases. The concept can be further elaborated into an architecture where the contents are further separated into separate (production-) databases and a front server (publication-) database (Earl and Khan, 2001, Jansson et al, 2001) The architecture also allows the coupling of other information providers' databases to the services, which is important in a value net, and also proposed by Smith (2001). Fig. 7.

A solution for the need of process re-engineering, is proposed by Kalakota and Robinson (1999) as an integrated solution based on three parts:

- A customer relationship management (CRM) module, that enables customer recognition and logging of customer behaviour. This provides essential data for fulfilment of a customer oriented strategy, and enables customisation of information products according to individual customers.
- An enterprise resource planning (ERP) module, that handles all economic transactions and accounting. This is a basic module for electronic transactions. In large systems it also provides tools for handling all resources in the company.
- A product data management (PDM) module, which provides the tools for production, storage and output of data.

Together these three make it possible to recognise the customer, deliver the goods, and invoice him. Ideally, all of these are seamlessly interconnected to each other and fully compatible. Such an application package is a very large development project, and the costs and risks are considerable. It is also a project that takes years to realize. In Fig. 8, a simplified value chain of the players in the CFM Industry is combined with the multi-tier in Fig. 7, and a triangle formed by PDM-CRM-ERP.

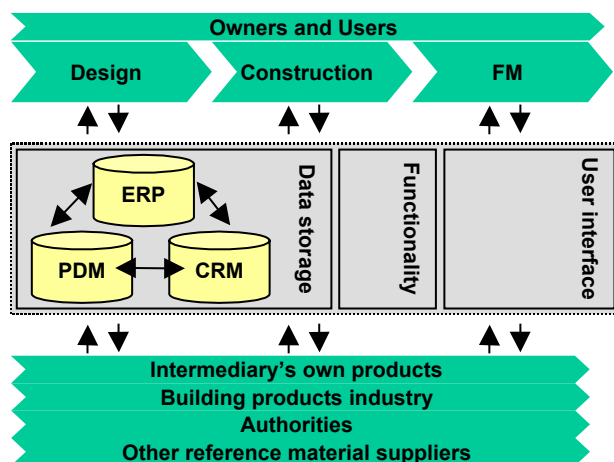


Figure 9: Customers' processes, a multi-tier architecture and the PDM/CRM/ERP-triangle

The pursuit of what the actual customer value might be in more detail when this picture is combined with the TCT illustrated in Fig. 6, and placed into the CFM value net, is the subject of follow up research. Too little is known in detail about which the actual customer needs are. Who needs what information when, where, and in what format? How should it be delivered, using what media, in what format? What should the products and their business logic be like? What might the value proposition for each product be? To show how this might be done in practise, and which the actual products and their value propositions should be, will need further research.

7. DISCUSSION

CFM information middlemen in their present form have existed long before computers and the Internet. (UICB 2003b) Their basic value proposition to their customers is that they act as intermediaries between those who have information and those who need it. They also produce information by themselves. The Internet and the use of computer applications has brought along changes. Today most of the information, which is produced, stored and passed on between the players in the CFM value chain, exists in some digital format. The Internet is available as a ubiquitous source of information.

Something fundamental has changed in the preconditions for the existence of CFM Middlemen. In the previous sections, it has been argued that the basic value propositions for CFM information middlemen still stand. They can still provide those who have information (mainly the building product industry and various authorities and publishers of guidelines and standards) with channels that offer lower costs for reaching those who need it (Mainly architects, engineers, contractors and users/owners), and vice versa. The starting point for the argumentation, in particular in section 6, is that the customers of the CFM information middlemen need their information in digital format. It is delivered through some network, and the information should increasingly be received by

computer applications, in addition to various outputs, intended to be read by a human being. However many of the applications are not compatible with each other. The most developed solution for the moment is the IAI/IFC-standard, and it might even last 10-20 years before it is developed to such a level that it can enable full electronic commerce. (Koivu, 2002). It could be also be argued that standards should be avoided, even fought, because they prevent differentiation and lock-in, and thus premium pricing. (Shapiro and Varian, 1999a, Shapiro and Varian, 1999b)

It is thus possible that the standards fail to develop, or the players might decide to stick to their paper-mimicking way of acting. They might also fail to accept the arguments for forming close value nets. However, the solutions described for the information middlemen have their roots in general strategic theory for electronic business, and as information easily can be made a digital good, the theories apply to this extent. The solutions are not directly dependent on how the digital process of the CFM industry will evolve. If the CFM players fail to develop common standards, the architecture proposed in section 6 could still be used, as it separates production and storage from output and deliver. In such a case it could be used to provide outputs in several standards. To customers using a paper-mimicking way of doing work, the solutions enable the CFM middleman to provide the data in a form, which supports this.

Another question, not addressed in this paper, is the general prerequisites for when information middlemen exist. If, for instance there were only very few construction firms, and very few building product firms, it seems unlikely that these few players would need a middleman to find each other. The need for middlemen emanates from a business environment, where the costs for one single player to reach the other players he needs, exceed the costs of the use of a middleman. For the time being the actors in the construction industry are so many that information middlemen exist. If the industry would start to merge into fewer players, this might be a real threat to the middlemen.

A third question, for which there still is little evidence, is the willingness of the CFM information middlemen's customers to pay for services on the web. Even though the general possibilities seem obvious, paper based media still has a substantial role. Information in digital form is distributed using CDs, which are in widespread use. Mobile devices are not really on the agenda yet, even though the Finnish Building Centre launched an application in spring 2003, where building regulations can be read using one of Nokia's mobile phones. The web is seen as increasingly important, and there are well-functioning web bookshops and directories. But the real challenge is to develop extensive and ubiquitous web based services which cover all players throughout the whole CFM process, and which generate revenue.

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