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Strategy to Enhance Use of ICT in Construction

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ABSTRACT

Construction is a late adaptor of ICT. Applications for bookkeeping and drawing are generally accepted. Advanced applications such as modelling, GPS and internet are incidentally applied. For the development of the industry ICT is of major importance. A research project was performed to find why construction is such a late adaptor and what ICT can do for the development of the construction industry.

Suppliers claim that they offer a range of tailor made ICT tools, while clients report that little suitable software is available. Other constraints are the requested return on investments within 3 years, a traditional culture and a lack of a drive for innovation. Another major problem is the lack of standards required for an effective exchange of data between parties.

In a follow-up study was found that for construction the most promising development is mobile internet combined with GPS-technology. A guide was made for successful development and introduction of ICT solutions.

KEYWORDS: Construction, ICT, Mobile Internet, E-commerce, Constraints.

1. INTRODUCTION

The construction industry is rather slowly adopting ICT technology. Stand alone applications for bookkeeping and 2-dimensional drawings are generally accepted. But more advanced applications such as 3 and 4-dimensional modelling, GPS and internet technology are still only incidentally applied.

In 2004 the Dutch Building Research Foundation SBR initiated a research project on ICT in Construction. The first goal was to assess which ICT-based technologies are available for the construction industry and to what extent these technologies are being used. In a second stage it was investigated which of the identified technologies are likely to be introduced on a larger scale and why this did not already happen.

SBR is not a research institute. The SBR foundation is primarily an editor and a publisher. SBR was founded and is governed by the Dutch construction industry. In the board of management and in the program committee we find representatives of contractors, designers and consultants.

As SBR cannot perform substantial research projects themselves they contract specialised institutes to do the actual research work. They contracted for the research project reported here not a typical construction orientated research institute, but an institute known for their ability to enhance industrial processes. The aim was to benefit from experience and innovative insights from other industries.

The methodology used consisted primarily of data collection through questionnaires sent to suppliers and users of ICT in construction. The addresses were selected from the data base of VGBouw, the Dutch association of contractors. After evaluation of the questionnaires the leading experts in the VGBouw data base were also interviewed for a more in-depth picture of the researched field.

1.1. Definitions

For a good understanding of the research it is useful to define first the stages of development of the construction process and the characteristic of the tools used and tasks performed. An overview of the stages of development of the construction industry seen from the view point of the personnel and their tools is shown below. (Gassel 1997)

	Physical tasks	Brain tasks in execution of the work	Brain tasks in organizing the work
Traditional	People Equipment	People	People
Mechanized	Equipment	People	People
Mechatronized	Equipment	Computers Telecom	People
Automated	Equipment	Computers Telecom	Computers Telecom

Figure 1, Types of production systems (van Gassel 1997)

The matrix above has a clear focus on the employees on the construction site. The step-by-step development of their physical tasks and brain tasks on-site is analysed and framed in.

Another way to categorize the stages of development is by analysing the move from on-site production to off-site production. This development goes - as the research team sees it - from traditional construction, through industrialisation to integration. This development, with the building site as the central focus point, is shown in the frame below.

Traditional construction	Industrial construction 1 st generation	Integrated construction 2 nd generation
No off-site production	Off-site production of components	Off-site production of components and large elements
On-site assembly of construction materials	On-site assembly of components and materials.	On-site assembly of components, elements and materials.
Stand alone design	Design in consultancy with construction team	Integrated design,
		optimized production and logistics
Hand craft	Mechanized tools	Automated systems

Figure 2. Relations between traditional construction, industrial construction and integrated construction.

2. CONSTRAINTS TO THE INTRODUCTION OF NEW TECHNOLOGIES.

2.1. Discrepancy between supply and demand

The research project started with an investigation why ICT Technology is not more often and more widely used in construction. The most noticeable finding was the discrepancy between the view of suppliers and users of software for construction. Where the suppliers appeared to be convinced to propose a tailor made line of software products the demand side stated that little suitable software was available. There was a 100% consensus among both parties, that in the near future the construction industry cannot continue without adopting the available ICT tools.

2.2. Organisational constraints

The reason why available ICT technology was not fully introduced in construction companies was not only because of a lack of perceived suitability of the software. Also factors in the organization of the industry were found. A listing of all major factors is given in the next matrix.

Reasons why ICT was not (fully) adopted.	percentage of respondents
Investment too high	78
Return on investment too uncertain	56
Lack of flexibility of new technologies	55
Uncertain economic situation	48
Risk of technical malfunction	42
Difficult to integrate in existing process	37
Lack of reliability	36
Maintenance cost	35
No innovative culture	32
No market information	31
Limited technical life cycle	30
No acceptance by employees.	24

Figure 4, the constraints to introduction of ICT in construction

2.3. Perception of constraints experienced by peer group

Remarkable is also that most client respondents were of the opinion that their company experienced more constraints than others. A majority of 55% found that their company was on a low level of ICT use, while they thought that among their competitors 69% was on a medium level of ICT use. Remarkable is also that all respondents, suppliers and buyers of ICT, without any exception, expressed as their opinion that it is of the highest importance that construction companies should adopt ICT solutions in the near future.

Opinion of peer group.	Supply side			Demand side		
	high	medium	low	high	medium	low
To what extent are ICT-technologies already applied in construction companies ?	16	50	34	6	69	25
To what extent are ICT-systems applied in <u>your</u> (construction) company				22	23	55
How important is increased introduction of ICT technology for construction	75	25	0	75	25	
How important consider construction companies the increased use of ICT	75	25	0	62	25	12
Suitability of the actual supply of ICT tools for construction companies	75	25	0	0	94	6
To what extent should construction companies adopt ICT solutions in the near future	100			100		

Tabel 3, opinion of experts on status and potential of ICT in construction

3. THE MOST PROMISING TECHNOLOGIES

Before searching for tools to enhance the application of ICT in Construction the researchers tried to identify the technologies that are most promising

as these are the technologies to be promoted strongest. A technology is considered promising if the technology is already available, affordable, and easy to handle. Affordability is defined as the ability to provide a return on investment within 3 years. This is considered rather short by the standards of most other industries, but it is general practice in construction. The found technologies can be divided in three main groups.

- Modelling technologies, ranging from the general accepted

2D-CAD via the emerging 3D-CAD to the futuristic 4D-CAD. Document management systems and model-based planning and estimating are part of this group.

Satellite enabled positioning such as GPS and Galileo.

Integrated software such as ERP systems. Better known under the brand name SAP.

Internet based data exchange such as Project web and E-commerce.

3.1. Stage of the introduction of new technologies

In management literature the introduction of new technologies and processes is divided in 5 stages. The research team investigated how far we are with the introduction of the most promising ICT technologies in construction. Below an overview is presented of the state so far.

Technologies > Stages v	2D CAD	3D CAD	4D CAD	Mobile data & GPS	Doc. Man. Syst.	ERP	Proj. Web	E- com- merce
Idea			X	X				X
Investigation		X					X	
Decision		X			X	X	X	
Introduction	X					X		
Daily use	X							

Figure 5, the most promising technologies and their 5 stages of introduction

For the newest technologies a reference group was asked if they were already in one of the process stages and if not they were asked if

they expected to be in the idea stage in the foreseeable future. Their responses are shown below.

Systems	Already in process	Soon in idea stage
3D modelling	16 %	38 %
4D modelling	3 %	32 %
Mobile data	8 %	31 %
E- Commerce	9 %	38 %

Figure 6, How soon will latest technologies reach the idea state.

4. MOBILE INTERNET

4.1. Activities supported by internet

The last two technologies mentioned, Project Web and E-commerce are impossible without internet technology. Document management systems may be used without, but gain value if used in combination with internet. Mobile internet was indicated by the respondents as the most promising technology of all technologies identified. For that reason a more in-depth study of the possibilities offered by mobile internet was performed.

Mobile internet may support a number of other activities. The most important options found by the project team were clustered into 7 main groups:

- Exchange of drawings
- Exchange of planning
- Time registration and worksheets
- Material identification
- Equipment identification
- Access to experts knowledge
- Registration of inspections

4.2. Penetration of internet in the construction industry

While the research project we are reporting here was carried out another Dutch institute investigated the use of internet by construction companies. In this report by EIB, (Economic Institute for the Building industry) the findings were that in 2004 over 90% of all construction companies used internet. The non-users were almost exclusively small companies with less than 5 employees. Of the internet users most companies used internet only for E-mail and only 8% had internet connections installed on building sites. About 30% of the companies that used internet, uses it also for E-commerce. And 25% used internet for communication with external parties in the building process. EIB concluded that the use of internet in construction was growing dramatically over the period 1999 till 2004, but that the use is still rather limited when compared to the potential.

CPB, an other Dutch research institute found that where internet technology is adapted the profit margin initially develops positive, but that lasting improvement only occurs where the organization of the work is adjusted to the new technology.

5. THE INTRODUCTION OF NEW TECHNOLOGIES

From the list in figure 4 it can be concluded that successful introduction of a new ICT technology needs a carefully managed process. In management literature we found the Y-model. (Cozijnsen and Vrakking 2004) The Y-model was developed to steer in a rational way strategic change processes but was not specifically designed for introduction of ICT. The Triam-model is another model, less rational, but more focussed on people in an organisation. Triam 2005) A merger of the two procedures was developed for the introduction of ICT in Construction. This model the "YT-model" (Ripper 2006) is shown in the matrix below. Ripper found that the stages where the organisation as a whole and the individual employees are confronted with new technologies are the most critical ones. He proposes special attention for the ICT-scan of the organisation and a SWOT-analysis of the personnel.

Stage	Activity	Tools	Focus
1	Define motive	Step analysis SWOT-analysis	Environment
2a	Attunement between	ICT Scan of organization	Application
2b	organization and	SWOT-analysis	User

	personnel	for personnel	
3	Decision making	7S model	Organization
4	Introduction	Implementation square	Management
5	Routine	Intervention wheel	
6	Optimization	Evaluation model	

Figure 7, The intervention steps based on Y-model and Triam-model as modified by Ripper.

6. CONCLUSIONS

The construction industry is not yet very far in adopting available ICT-tools and the suppliers are not yet very well organized to serve the construction sector. But both supply-side and demand-side are aware of the fact that in the near future adoption of ICT-technologies will be inevitable for the industry. The competitive advance can not be denied nor ignored.

Mobile internet is considered to be the most promising technology for the construction sector, followed by Satellite based positioning systems and ERP systems.

For a successful and effective introduction of new technologies special care has to be given to the step-by-step process, where acceptance and dedicated adoption by personnel is of a decisive importance.

7. REFERENCES

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