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Analysis of the Survey: “IT-Platforms for Cooperation Projects”

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ANALYSIS OF THE SURVEY: “IT-PLATFORMS FOR COOPERATION PROJECTS”

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Abstract

This report presents the analysis of the data collected in the context of the survey “IT-Platforms for Cooperation Projects” processed principally in the industry with experts of cooperation projects. This survey has the purpose to determine which IT-tools are the most appropriate for each type of engineering project configuration.

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1. Introduction

Nowadays globalization is still increasing and plays an extremely important role on the market: The types of cooperation span from exchange over locations and time zones, from an in-house to a general enterprise cooperation as well as from conception to production, in the form of joint ventures, technology and production agreement. The variety of partners together with the complexity of the forms of cooperation demonstrates that the complexity and specificity of particular situations are challenges. Practice has shown that different factors like spatial distance, differences in culture and language, inconsistency of processes, as well as the lack of transparency of information and communication can be reasons for failure of cooperation even at the operative work level. Coordination and exchange of information between participants in a distributed product development team is technically difficult and time consuming, while different locations and time zones further complicate communication. When a project is distributed and/or interdisciplinary, unconnected islands of knowledge need to be merged. Nevertheless the persons involved have to cooperate with each other on common tasks. To coordinate their activities communicating and exchanging information is indispensable. Information and communication systems help such projects to become a success by supporting exchange between multiple partners.

2. Object of the Survey

The empirical study has the purpose to determine which IT-support-tool is the most appropriate one for each type of engineering project configuration. The IT-tools supporting collaboration and communication have been rated by experts in the support of cooperation projects, regarding different influencing factors (see paragraph 5). The survey is dedicated to experts in:

- Distributed projects
- Interdisciplinary projects
- Cooperation projects
- Information Technology (IT)

3. Instructions of the Survey

Imagine you are the manager of a new engineering project. Your project is starting and you have to propose an IT-Collaboration-Platform to support your communication, coordination, and collaboration processes.

The questionnaire presents various project configurations. For each configuration, please rate the proposed IT-tools to support your team work.

For the evaluation you can rate every system with the following attributes:

- '+' I would like to use it
- '0' not particularly appropriate but can be used
- '-' can not support this configuration

4. Evaluated IT-Tools

In this study the following systems which support collaboration and information processes have been evaluated:

E-Mail system: Electronic mail, abbreviated e-mail or email, is a method of composing, sending, storing, and receiving messages over electronic communication systems.

Instant Messaging requires the use of a client program that hooks up an instant messaging service and differs from e-mail in that conversations are then able to happen in real-time. Most services offer a presence information feature, indicating whether people on one's list of contacts are available to chat (e.g. Messenger, ICQ, AOL Buddy-List, etc.).

Online-Conferencing is used to hold group meetings or live presentations over the Internet. The most basic feature of a web conference is screen sharing. Usually this is accompanied by voice communication, either through a traditional telephone conference, or through VoIP, although sometimes text chat is used in place of voice.

Chat Room is an online site in which people can talk by broadcasting messages to people on the same site in real time. Sometimes these venues are moderated either by limiting who is allowed to speak, or by having moderation volunteers patrol the venue watching for disruptive or otherwise undesirable behaviour.

Whiteboard: Internet-based software such as Microsoft NetMeeting, Groupboard, or E-Chalk, which allows people to draw together on a virtual whiteboard over the internet without requiring any special hardware. Each user connects to the whiteboard and can see what other users are drawing in real-time on their computer screen.

Forum: Platform to facilitate and manage discussions persistently among team members over a long period of time (not real time like chat room)

Document-Management-Systems are made up of software designed to manage all types of documents, including scanned, electronic, and paper. All documents are stored in a single repository that facilitates all actions that need to take place from search and retrieval to email and printing.

Knowledge-Management-Systems collect, organize, manage, and share various forms of information; Knowledge Management System (KMS) is a distributed hypermedia system for managing knowledge in organizations, supporting creation, capture, storage, and dissemination of expertise and knowledge.

Electronic Calendars schedule events and automatically notify and remind project members. Project Management System Schedule, track, and chart the steps in a project as being completed.

Workflow System: Collaborative management of tasks and documents within a knowledge-based business process.

Social Software Systems organize social relations of Group (e.g. Social Network Search Engines, Virtual Presence, Awareness, Mailing Lists, etc.)

Problem Solving System: Software supporting problem solving processes and creative work (e.g. Brainstorm, Mind Mapper, etc.)

Co-Author-Systems: The terms co-authoring or collaborative writing refer to projects where written works are created collaboratively by multiple people together (collaboratively) rather than individually (e.g. wikipedia).

Online-Translation is a form of translation wherein a human translator translates texts using computer software designed to support and facilitate the translation process.

Requirement and Change-Management Tools support requirement, change management and configuration management activities (e.g. DOORS, SCM, etc.)

Discipline Specific Tools (e.g. CAx-Tools, PDM-Systems, Electronic Resources Planning Systems, Production Planning Systems, Simulation, Testing Systems, etc.)

Electronic Meeting System (EMS) or Group Decision Support System (GDSS) is a suite of highly-configurable collaborative software tools that can be used to create predictable, repeatable patterns of collaboration among people working toward a goal. People can contribute anonymously to most electronic meeting systems tool and so the system which provides an equal opportunity for participation. Typical Tools of an EMS: Electronic Brainstorming (Problem-Solving), Categorizer, Group Outliner, Rank Order Vote, Alternative Analysis, Topic Commenter.

5. Factors

These IT-Tools have been rated regarding the following influencing factors:

Type	N°	Factor	Possible Values		
CEE	1	Cooperation partners	2	2 --> 5	>5
	2	Location	Same Location	Same company	Other country
	3	Skill level in the agreed language	Insufficient	Satisfying	Excellent
	4	Type of engineering process	Parallel	Sequential	
	5	Organisation and companies' culture	Same Business Unit	Same company	Other company
	6	Size of the organisation	Small	Middle	Big
	7	Intensity of collaboration	Low&irregular	Integrated	
	8	Distribution model	Equal	Unequal	
	9	Number of interfaces	Low	Average	High
	10	Access to data	Very Difficult	Difficult	Easy
	11	Skill level in the use of IT	Low	Average	High
	12	Influence of time	Sufficient	Insufficient	
	13	Methods and instruments	Same	Different	
CDE	14	Vocabulary	Same	Different	Contradictory
	13	Methods and instruments	Same	Different	
	15	Standards and laws	Same	Different	
	16	Dependencies to own domain	Yes	No	

Figure 1: Factors of the evaluation.

6. Results

The following diagrams show statistics about the persons, who have taken part to the survey: their experience with IT and their field of work:

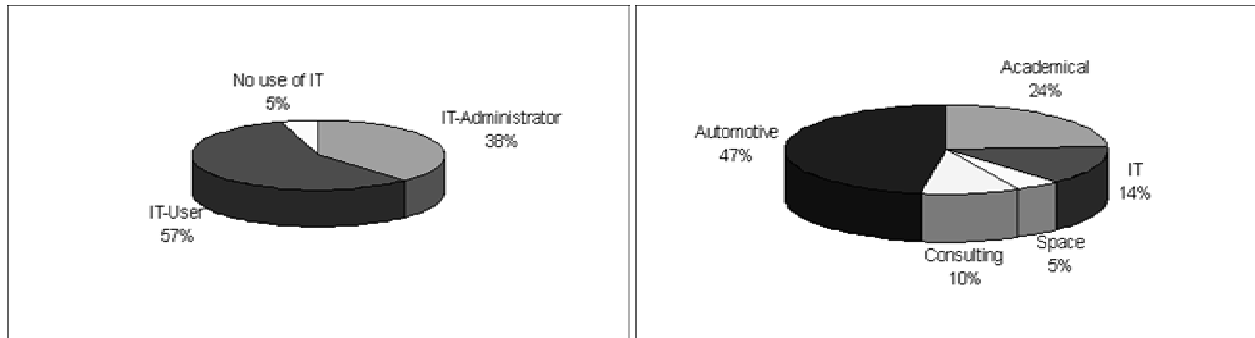


Figure 2: Experience with IT and field of work of the participants.

6.1. Detailed Analysis of the Results

In order to permit a traceable analysis of the results obtained we have defined 7 scenarios corresponding to typical configuration of cooperation projects that are in a cross-domain context, a cross-enterprise context, and/or a cross-cultural context.

1. Small cooperation project without cross-domain context.
2. Small cooperation project with cross-domain context.
3. Small cooperation project with cultural differences (organisation's culture).
4. Big cooperation project with cultural differences (country's culture).
5. Big cooperation project with cultural differences (country's culture and organisation's culture).
6. Big cooperation project with cultural differences (country's culture and organisation's culture) and cross-domain context.
7. Cooperation projects with high security level.

For each of the following scenarios, we make a proposition of IT-Tools with the help of the collected expert-data.

6.1.1. Small cooperation project without cross-domain context

Typical characteristics of these projects are:

- A small distribution.
- The participants of the project often speak the same language.
- There exist some organisational differences but technical barriers are marginal.
- The participants are from the same field of work: approximately same vocabulary, standards, and methods.
- It often represents a relation: client-supplier.

According to the experts-data, following IT-tools are recommended (also accordant with [1]):



Figure 3: Results for scenario 1 with details of the 1st proposition.

6.1.2. Small cooperation project with cross-domain context

Typical characteristics of these projects are:

- A small distribution.
- The participants of the project often speak the same language.
- The participants are from different fields of work: they use a different vocabulary, different standards, and methods.
- It could be for example the configuration of: a SE-Team (Simultaneous Engineering), a research project between different faculties, a cooperation project between different Business Units of the same company.

According to the experts-data, following IT-tools are recommended (also accordant with [1]):



Figure 4: Results for scenario 2 with details of the 1st proposition.

6.1.3. Small cooperation project with cultural differences (organisation's culture)

Typical characteristics of these projects are:

- A small distribution.
- The participants of the project often speak the same language.
- The participants are from different enterprises with another culture, which could have repercussion on the goal they have, the methods they use, their flexibility, the access to data and number of interfaces, and as a consequence the intensity of collaboration.
- A concurrence between the enterprises may exist.
- It could be for example the configuration of a development project between 2 enterprises having the same calibre and same fields of work.

According to the experts-data, following IT-tools are recommended (also accordant with [1]):



Figure 5: Results for scenario 3 with details of the 1st proposition.

6.1.4. Big cooperation project with cultural differences (country's culture)

Typical characteristics of these projects are:

- An important distribution.
- The participants of the project often speak another language.
- The participants are from different enterprises in different countries with different cultures, which could have repercussion on the habits of work they have, the methods they use, the number of interfaces and their global level in the IT.
- It could be for example the configuration of a development project between enterprises in different countries having the same fields of work or a client-supplier relation across the country's borders.

According to the experts-data, following IT-tools are recommended (also accordant with [1]):



Figure 6: Results for scenario 4 with details of the 1st proposition.

6.1.5. Big cooperation project with cultural differences (country's and organisation's culture)

Typical characteristics of these projects are:

- An important distribution,
- The participants of the project often speak another language,
- The participants are from different enterprises in different countries with different cultures, which could have repercussion on the habits of work they have, the methods they use, the number of interfaces and their global level in the IT.
- The participants are from different enterprises with another culture, which could have repercussion on the goal they have, the methods they use, their flexibility, the access to data and number of interfaces, and as a consequence the intensity of collaboration.
- A concurrence between the enterprises may exist.
- It could be for example the configuration of a development project between enterprises in different countries having the same fields of work and the same range (e.g. OEMs' cooperation).

According to the experts-data, following IT-tools are recommended (evaluated with the help of the method introduced in [1]):



Figure 7: Results for scenario 5 with details of the 1st proposition.

6.1.6. Big cooperation project with cultural differences (country's and organisation's culture) and cross-domain context

Typical characteristics of these projects are:

- An important distribution
- The participants of the project often speak another language.
- The participants are from different enterprises in different countries with different cultures, which could have repercussion on the habits of work they have, the methods they use, the number of interfaces and their global level in the IT.
- The participants are from different enterprises with another culture, which could have repercussion on the goal they have, the methods they use, their flexibility, the access to data and number of interfaces, and as a consequence the intensity of collaboration.
- The participants are from different fields of work: they use a different vocabulary, different standards, and methods.
- Concurrence between the enterprises may exist.
- It could be for example the configuration of a development project between enterprises in different countries having the same range or of a SE-Team, in which the participants are distributed in different countries and organisations.

According to the experts-data, following IT-tools are recommended (also accordant with [1]):



Figure 8: Results for scenario 6 with details of the 1st proposition.

6.1.7. Cooperation projects with high security level

The participants are from different enterprises, which may be concurrent or in countries that are considered as critical (plagiarism, piracy, etc.), which could have repercussion on the goal they have, the methods they use, their flexibility, the access to data and number of interfaces, and as a consequence the intensity of collaboration.

According to the experts-data, following IT-tools are recommended (also accordant with [1]):



Figure 9: Results for scenario 7 with details of the 1st proposition.

6.2. Sensitivity Analysis

A brief overview of the results of the empirical study shows that some influencing factors have much more impact on the choice of the experts than the others. Moreover this is not automatically the same factors that have impact on the choice of one tool or another. To determine, which factors have the biggest impact, we have made a sensitivity analysis on the expert data. We have realised the sensitivity analysis with the tool SimLab, with the setting Factor Prioritisation, the method FAST, and 50000 random samples (see [3])

The sensitivity analysis on the expert data gives for the tool Workflow System for example following results:

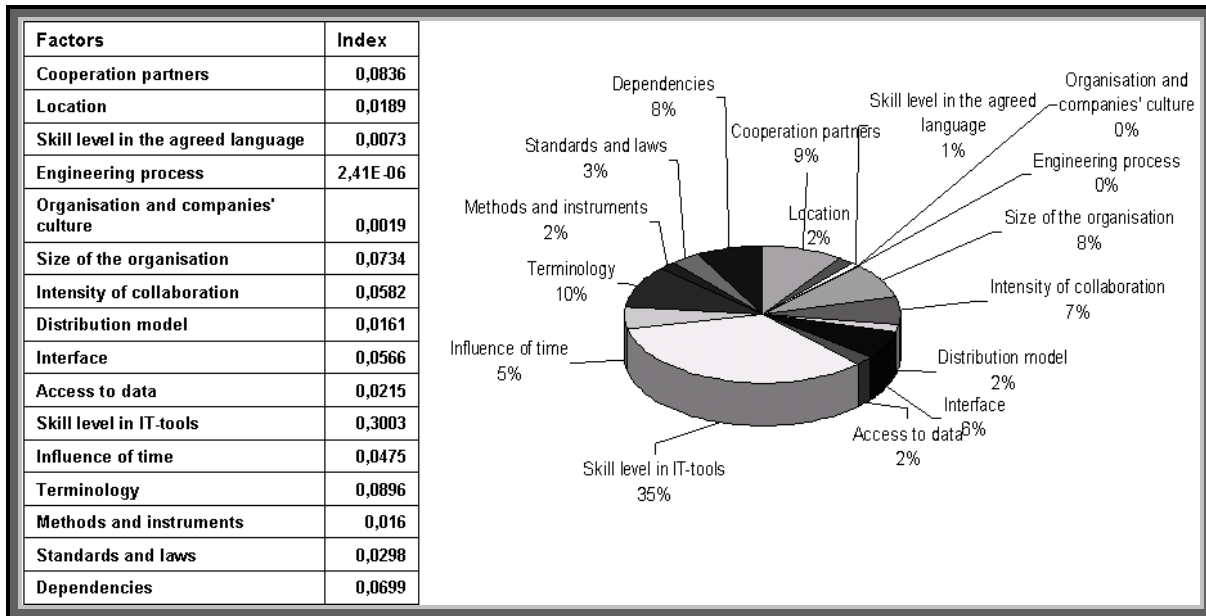


Figure 10: FAST first order indexes for the tool Workflow System.

The entire results of the sensitivity analysis are available in Appendix 8.2.

A global overview of the factors impact on the choice of IT-tools is shown in figure 4 and 5. This table gives for each tool the 3 most important factors.

	Factor 1	Factor 2	Factor 3
E-Mail system	Vocabulary	Language	Number of Interfaces
Instant messaging	Language	Intensity of collaboration	Vocabulary
Online conferencing	Location	Language	Skill level in the IT
Chat room	Intensity of Collaboration	Language	Dependencies
Whiteboard	Location	Intensity of collaboration	Influence of time
Forum	Cooperation partners	Skill level in the IT	Location
Document management	Skill level in the IT	Cooperation partners	Dependencies
Knowledge management	Skill level in the IT	Influence of time	Intensity of collaboration
Electronic calendar	Skill level in the IT	Vocabulary	Size of the organisation
Project management system	Skill level in the IT	Vocabulary	Cooperation partners
Workflow system	Skill level in the IT	Vocabulary	Cooperation partners
Social software system	Influence of time	Skill level in the IT	Size of the organisation
Problem solving system	Intensity of Collaboration	Vocabulary	Language
Co-Author system	Dependencies	Intensity of collaboration	Skill level in the IT
Online translation	Location	Language	Influence of time
Change management tool	Skill level in the IT	Vocabulary	Standards and laws
Discipline specific tool	Skill level in the IT	Vocabulary	Dependencies
Electronic meeting system	Skill level in the IT	Location	Intensity of collaboration

Figure 11: Impact of the influencing factors (1).

Importance of the influencing factors

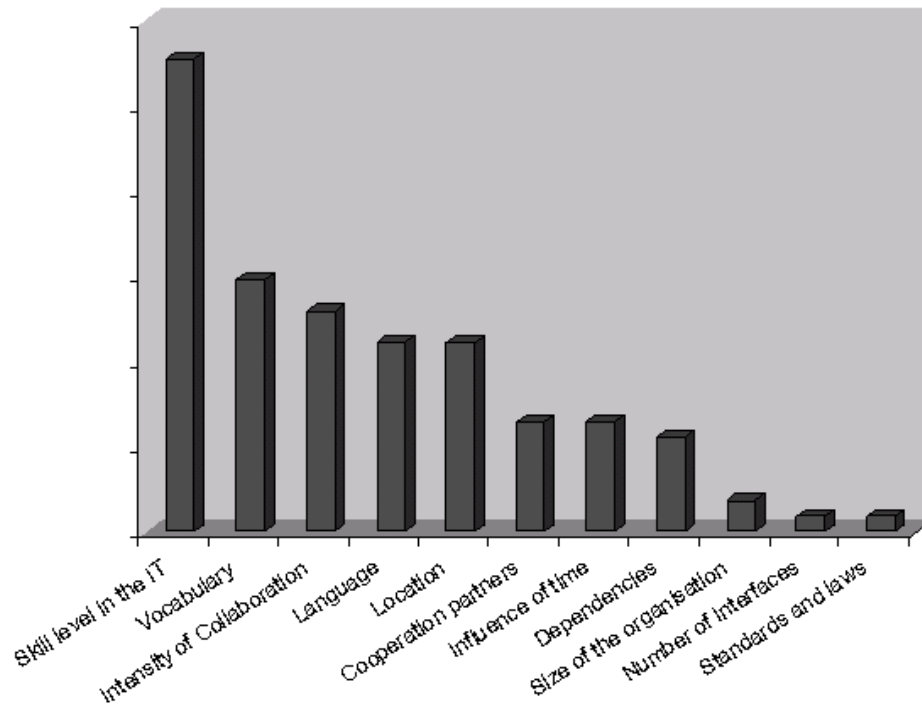


Figure 12: Impact of the influencing factors (2).

6.3. Conclusion

Globally, the empirical research points out that the preferred tools are Electronic Calendars, Project-Management-Systems, Document-Management-Systems, Workflow-Systems, and E-Mail-Systems. Nevertheless E-Mail-Systems seem to be inappropriate for big cooperation projects. It turns out that the majority of the users would use IT-support-systems to support organization and coordination activities, rather than purely communication and information processes

Communication and collaboration tools like Online-Conferencing or Electronic-Meeting-Systems are often seen as too complex, and make sense only in a non-cross-domain context according to the results. However, for small projects with participants speaking the same language and in a trusted environment, these tools are often rated as very useful.

Instant-messaging and chat-rooms have been rated as inappropriate for almost every project configuration. First these tools enable synchronous communication, which is very complicated to manage for cooperation projects above different countries and different companies. Finding by chance the right person at the right place and at the right moment is for the users a too big challenge. Moreover they often make by users a futile impression.

Whiteboards, forums, social-software, co-authoring-systems, and Problem-Solving systems find a middle acceptance. In fact users seem to be attracted by these tools, because they partly offer new opportunities but on the other side fear that no one will use them because, they aren't part of the daily work.

Knowledge-Management-Systems find also a very middle acceptance and are generally well received by participants in cooperation projects with important cultural differences or sensitive work contexts, as well as Change-management-Tools. Discipline specific tools are applicable in

general but rather seem to be suited only to small projects with participants from the same discipline (cf. [1]).

7. References

- [1] Design of IT-collaboration-platforms with fuzzy logic, Laurent, C., Proc. 1st International Conference on Multidisciplinary Information Sciences and Technologies, Mérida, Spain, 2006.
 [2] Technical Report: Survey “IT-Platforms for Cooperation Projects”, Laurent, C., 2007.
 [3] SimLab 2.2. <http://webfarm.jrc.cec.eu.int/uasa/primer/index.asp>, 2005.

8. Appendices

8.1. Extract of the Raw Data

The following data is an extract of the database containing the raw data of the survey. It may be of interest for researchers in CSCW and collaboration ('0' means not appropriate, '1' means very appropriate).

8.1.1. Cooperation partners

The number of cooperation partners (including yourself) has an influence on the collaboration in your engineering project.

If you are working with:

	2 partners	from 2 to 5 partners	more than 5 partners
E-Mail system	0.92	0.92	0.89
Instant messaging	0.64	0.58	0.58
Online conferencing	0.61	0.78	0.75
Chat room	0.39	0.44	0.42
Whiteboard	0.67	0.78	0.75
Forum	0.25	0.61	0.86
Document management system	0.72	0.92	0.97
Knowledge management system	0.64	0.75	0.89
Electronic calendar	0.92	0.94	1
Project management system	0.75	0.92	0.94
Workflow system	0.53	0.75	0.83
Social software system	0.28	0.42	0.53
Problem solving system	0.56	0.72	0.69
Co-Author system	0.64	0.64	0.75
Online translation	0.61	0.64	0.69
Change management tool	0.58	0.78	0.89
Discipline specific tool	0.67	0.69	0.75

Electronic meeting system	0.53	0.69	0.78
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8.1.2. Location

The location of your cooperation partners also has influence on your project. In fact coordination between two partners is much more complicated by increasing distance. If companies in different countries are involved, this factor also includes cultural differences as well as different time zones.

If you are working in:

	The same location but an other room	Same country, but an other site	An other country
E-Mail system	0.83	0.97	1
Instant messaging	0.43	0.8	0.73
Online conferencing	0.13	0.77	0.87
Chat room	0.17	0.47	0.53
Whiteboard	0.37	0.8	0.77
Forum	0.53	0.77	0.83
Document management system	0.87	0.97	0.97
Knowledge management system	0.77	0.83	0.83
Electronic calendar	0.97	0.97	0.97
Project management system	0.83	0.93	0.93
Workflow system	0.77	0.9	0.9
Social software system	0.47	0.63	0.7
Problem solving system	0.57	0.67	0.73
Co-Author system	0.57	0.7	0.87
Online translation	0.57	0.6	0.9
Change management tool	0.8	0.83	0.9
Discipline specific tool	0.77	0.77	0.8
Electronic meeting system	0.37	0.67	0.77

8.1.3. Skill level in the agreed language

The skill level in the agreed language also influences the cooperation. This question refers to the level in a common tongue not to discipline specific language. Please take into account that the spoken as well as the written level influence your team work.

If the average level of the team in the common language is:

	Insufficient	Satisfying	Excellent (native speaker or bilingual)
E-Mail system	0.54	0.86	0.93
Instant messaging	0.07	0.57	0.86
Online conferencing	0.11	0.68	0.96

Chat room	0.11	0.43	0.75
Whiteboard	0.61	0.68	0.75
Forum	0.54	0.68	0.86
Document management system	0.86	0.93	0.93
Knowledge management system	0.71	0.82	0.86
Electronic calendar	0.82	0.82	0.86
Project management system	0.79	0.89	0.93
Workflow system	0.68	0.75	0.79
Social software system	0.61	0.61	0.71
Problem solving system	0.5	0.64	0.75
Co-Author system	0.5	0.71	0.79
Online translation	0.93	0.75	0.5
Change management tool	0.75	0.82	0.82
Discipline specific tool	0.71	0.79	0.79
Electronic meeting system	0.39	0.64	0.79

8.1.4. Type of engineering process

The type of engineering process also plays a role. In fact, for collaboration there are principally two approaches: sequential or parallel development. Sequential: development based on previous results. Parallel: partners work parallel on their tasks. Mixed form: everyone works on his task, results are regularly exchanged, so that the partner can continue his work.

If the way you organise your work with the partner is:

	Sequential	Parallel
E-Mail system	0.93	0.93
Instant messaging	0.57	0.89
Online conferencing	0.71	0.89
Chat room	0.39	0.64
Whiteboard	0.68	0.79
Forum	0.75	0.75
Document management system	0.96	0.89
Knowledge management system	0.86	0.86
Electronic calendar	0.86	0.93
Project management system	0.93	0.96
Workflow system	0.82	0.82
Social software system	0.5	0.64
Problem solving system	0.61	0.71
Co-Author system	0.71	0.89
Online translation	0.54	0.68
Change management tool	0.82	0.86

Discipline specific tool	0.75	0.79
Electronic meeting system	0.54	0.71

8.1.5. Organisation and companies' culture

The organisation also has an influence on the communication in your engineering project. In fact the invisible barriers within or beyond organisations, as well as the culture of each company, play an important role in collaborations.

If you work in:

	The same department	The same company	Another company
E-Mail system	0.82	0.89	0.96
Instant messaging	0.57	0.71	0.61
Online conferencing	0.36	0.61	0.86
Chat room	0.29	0.39	0.43
Whiteboard	0.54	0.61	0.64
Forum	0.71	0.68	0.68
Document management system	0.86	0.86	0.86
Knowledge management system	0.79	0.75	0.71
Electronic calendar	0.89	0.86	0.82
Project management system	0.89	0.89	0.93
Workflow system	0.82	0.82	0.86
Social software system	0.54	0.61	0.54
Problem solving system	0.61	0.64	0.61
Co-Author system	0.64	0.68	0.79
Online translation	0.57	0.57	0.61
Change management tool	0.79	0.79	0.71
Discipline specific tool	0.79	0.75	0.75
Electronic meeting system	0.5	0.57	0.71

8.1.6. Size of the organisation

The size of the organisation influences the flexibility of the cooperation partners and therefore the cooperation.

If the concerned companies have:

	50 employees	500 employees	5000 employees
E-Mail system	0.89	0.96	0.96
Instant messaging	0.75	0.57	0.36
Online conferencing	0.5	0.57	0.68
Chat room	0.32	0.32	0.32
Whiteboard	0.61	0.68	0.64
Forum	0.64	0.79	0.75

Document management system	0.86	0.96	0.96
Knowledge management system	0.71	0.82	0.86
Electronic calendar	0.89	1	1
Project management system	0.93	1	1
Workflow system	0.71	0.89	1
Social software system	0.43	0.68	0.79
Problem solving system	0.61	0.68	0.75
Co-Author system	0.61	0.75	0.89
Online translation	0.61	0.57	0.79
Change management tool	0.75	0.86	0.86
Discipline specific tool	0.82	0.86	0.86
Electronic meeting system	0.61	0.71	0.86

8.1.7. Intensity of collaboration

The intensity of collaboration describes the way how they work together; that is to say if the partners exchange only few results or if the collaboration is integrated in the daily work.

If the collaboration is:

	Low & irregular	Integrated
E-Mail system	0.93	0.93
Instant messaging	0.21	0.75
Online conferencing	0.54	0.82
Chat room	0.04	0.5
Whiteboard	0.43	0.71
Forum	0.54	0.64
Document management system	0.75	0.93
Knowledge management system	0.57	0.86
Electronic calendar	0.86	0.96
Project management system	0.89	0.96
Workflow system	0.68	0.89
Social software system	0.54	0.61
Problem solving system	0.46	0.68
Co-Author system	0.5	0.82
Online translation	0.57	0.68
Change management tool	0.68	0.75
Discipline specific tool	0.68	0.75
Electronic meeting system	0.5	0.82

8.1.8. Distribution model

The distribution of the tasks differs from a project to another and influences the cooperation processes. In fact the tasks may not be equally distributed between the partners, for example one partner can have the entire responsibility, whereas the other one only develops some functions. This fact also influences the collaboration processes and the way the partners interact on each other works.

If the tasks are:

	Equally distributed	Unequally distributed
E-Mail system	0.93	0.93
Instant messaging	0.79	0.54
Online conferencing	0.82	0.61
Chat room	0.5	0.32
Whiteboard	0.75	0.57
Forum	0.75	0.71
Document management system	0.89	0.89
Knowledge management system	0.82	0.75
Electronic calendar	0.96	0.93
Project management system	0.96	0.89
Workflow system	0.93	0.82
Social software system	0.64	0.43
Problem solving system	0.68	0.64
Co-Author system	0.86	0.79
Online translation	0.68	0.61
Change management tool	0.93	0.75
Discipline specific tool	0.82	0.64
Electronic meeting system	0.79	0.64

8.1.9. Interfaces

The number of interfaces between all partners also increases the complexity and so influences the cooperation in your engineering project. The more technical and organisational interfaces you have, the more difficult it will be to transfer information clearly and complete.

If the number of interfaces is:

	Low (<2)	Average (<5)	High
E-Mail system	0.96	0.86	0.64
Instant messaging	0.64	0.46	0.36
Online conferencing	0.61	0.68	0.68
Chat room	0.43	0.39	0.36
Whiteboard	0.57	0.57	0.61
Forum	0.57	0.64	0.82
Document management system	0.79	0.86	0.86

Knowledge management system	0.64	0.68	0.79
Electronic calendar	0.82	0.82	0.79
Project management system	0.86	0.89	0.93
Workflow system	0.64	0.79	0.89
Social software system	0.5	0.5	0.61
Problem solving system	0.54	0.61	0.64
Co-Author system	0.64	0.71	0.75
Online translation	0.57	0.54	0.61
Change management tool	0.68	0.64	0.75
Discipline specific tool	0.79	0.64	0.71
Electronic meeting system	0.57	0.54	0.64

8.1.10. Access to data

This point characterizes the technical and organisational ability for every partner to access the data that are relevant for the engineering project (e.g. access authorization, existing infrastructures, etc.).

If the access to information and data is:

	Very difficult	Difficult	Easy
E-Mail system	0.73	0.77	0.77
Instant messaging	0.5	0.54	0.62
Online conferencing	0.73	0.69	0.58
Chat room	0.38	0.42	0.5
Whiteboard	0.5	0.54	0.62
Forum	0.54	0.54	0.62
Document management system	0.69	0.69	0.88
Knowledge management system	0.54	0.62	0.77
Electronic calendar	0.62	0.62	0.81
Project management system	0.69	0.77	0.85
Workflow system	0.62	0.73	0.77
Social software system	0.35	0.42	0.54
Problem solving system	0.46	0.58	0.62
Co-Author system	0.54	0.62	0.65
Online translation	0.5	0.54	0.62
Change management tool	0.58	0.73	0.73
Discipline specific tool	0.58	0.77	0.77
Electronic meeting system	0.46	0.5	0.58

8.1.11. Skill level in the use of IT-tools

The competence of the projects participants also plays a role in the cooperation processes and in the choice of an IT-Tool. In fact you must take into account that some IT-Tools are easier to use than other ones.

If the average level of the team in the use of IT is:

	Low	Average	High
E-Mail system	0.92	0.88	0.77
Instant messaging	0.38	0.62	0.77
Online conferencing	0.23	0.58	0.92
Chat room	0.38	0.62	0.58
Whiteboard	0.5	0.65	0.69
Forum	0.5	0.81	0.73
Document management system	0.5	0.85	0.92
Knowledge management system	0.19	0.54	0.85
Electronic calendar	0.77	0.92	0.88
Project management system	0.42	0.81	0.92
Workflow system	0.31	0.77	0.85
Social software system	0.23	0.5	0.58
Problem solving system	0.46	0.54	0.62
Co-Author system	0.38	0.58	0.73
Online translation	0.54	0.58	0.65
Change management tool	0.31	0.69	0.92
Discipline specific tool	0.58	0.85	0.92
Electronic meeting system	0.23	0.54	0.77

8.1.12. Influence of time

The less time you have to finish your project, the less time you will have to adjust your collaboration. That is why the remaining available time for your project influences the quality of collaboration.

If the available time to complete the project is:

	Sufficient	Insufficient
E-Mail system	0.88	0.85
Instant messaging	0.73	0.5
Online conferencing	0.77	0.58
Chat room	0.58	0.31
Whiteboard	0.73	0.46
Forum	0.77	0.58
Document management system	0.88	0.73
Knowledge management system	0.69	0.31

Electronic calendar	0.96	0.92
Project management system	0.92	0.85
Workflow system	0.88	0.69
Social software system	0.65	0.27
Problem solving system	0.65	0.62
Co-Author system	0.65	0.46
Online translation	0.65	0.5
Change management tool	0.81	0.58
Discipline specific tool	0.85	0.81
Electronic meeting system	0.65	0.58

8.1.13. Terminology

The participants of the project could be specialists in different disciplines. Therefore they may use different terminology; in a bad case the same terms can have different meanings. All this may cause difficulties of understanding, what also influences the cooperation.

If the terminology used by the participants is:

	The same	Different	Contradictory
E-Mail system	0.96	0.71	0.61
Instant messaging	0.82	0.46	0.18
Online conferencing	0.82	0.71	0.57
Chat room	0.71	0.39	0.36
Whiteboard	0.54	0.43	0.43
Forum	0.64	0.61	0.5
Document management system	0.89	0.71	0.71
Knowledge management system	0.75	0.71	0.64
Electronic calendar	0.93	0.82	0.79
Project management system	0.96	0.79	0.68
Workflow system	0.93	0.71	0.61
Social software system	0.68	0.57	0.5
Problem solving system	0.68	0.54	0.43
Co-Author system	0.75	0.5	0.5
Online translation	0.68	0.61	0.57
Change management tool	0.89	0.68	0.5
Discipline specific tool	0.89	0.64	0.54
Electronic meeting system	0.79	0.54	0.57

8.1.14. Methods and instruments

If the people in a project are specialists in different disciplines, they also may use different methods and instruments and follow different processes, which may also influence the communication in your project.

If the methods and instruments of the participants are:

	The same	Different
E-Mail system	0.92	0.88
Instant messaging	0.88	0.62
Online conferencing	0.77	0.77
Chat room	0.58	0.54
Whiteboard	0.62	0.65
Forum	0.81	0.65
Document management system	0.92	0.81
Knowledge management system	0.77	0.69
Electronic calendar	0.92	0.85
Project management system	0.92	0.81
Workflow system	0.92	0.81
Social software system	0.58	0.65
Problem solving system	0.58	0.65
Co-Author system	0.73	0.69
Online translation	0.65	0.62
Change management tool	0.88	0.65
Discipline specific tool	0.85	0.65
Electronic meeting system	0.81	0.73

8.1.15. Standard and laws

If the people in a project are specialists in different disciplines, they also may have different standards and laws, which may also influence the communication in your project.

If the standards and laws of the participants are:

	The same	Different
E-Mail system	0.85	0.85
Instant messaging	0.73	0.5
Online conferencing	0.85	0.65
Chat room	0.58	0.42
Whiteboard	0.65	0.73
Forum	0.73	0.69
Document management system	0.88	0.81
Knowledge management system	0.73	0.65
Electronic calendar	0.96	0.88

Project management system	0.92	0.77
Workflow system	0.88	0.73
Social software system	0.58	0.62
Problem solving system	0.62	0.62
Co-Author system	0.69	0.69
Online translation	0.58	0.58
Change management tool	0.85	0.54
Discipline specific tool	0.85	0.69
Electronic meeting system	0.81	0.65

8.1.16. Dependencies

If the people in a project are specialists in different disciplines, they also may have their own discipline paradigm. They depend on a community, and have prejudices on the other disciplines. They also may have the view, that discussions within their community are more important than interdisciplinary collaboration. These points all influence the communication processes. The fact that they are influenced by their own communities makes the communication processes more difficult.

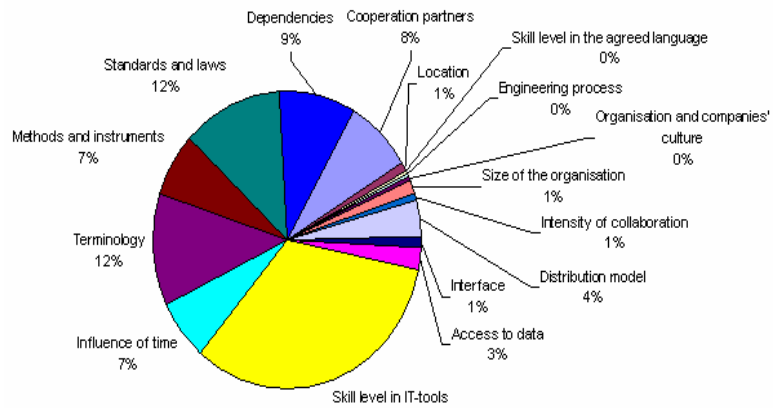
If the participants are:

	Influenced by a community	Not influenced: open-minded
E-Mail system	0.88	0.92
Instant messaging	0.5	0.85
Online conferencing	0.54	0.81
Chat room	0.35	0.73
Whiteboard	0.62	0.73
Forum	0.54	0.77
Document management system	0.73	0.92
Knowledge management system	0.5	0.77
Electronic calendar	0.88	0.88
Project management system	0.77	0.88
Workflow system	0.62	0.85
Social software system	0.54	0.69
Problem solving system	0.54	0.65
Co-Author system	0.46	0.85
Online translation	0.54	0.65
Change management tool	0.58	0.85
Discipline specific tool	0.58	0.77
Electronic meeting system	0.65	0.81

8.2. Complete Results of the Sensitivity Analysis

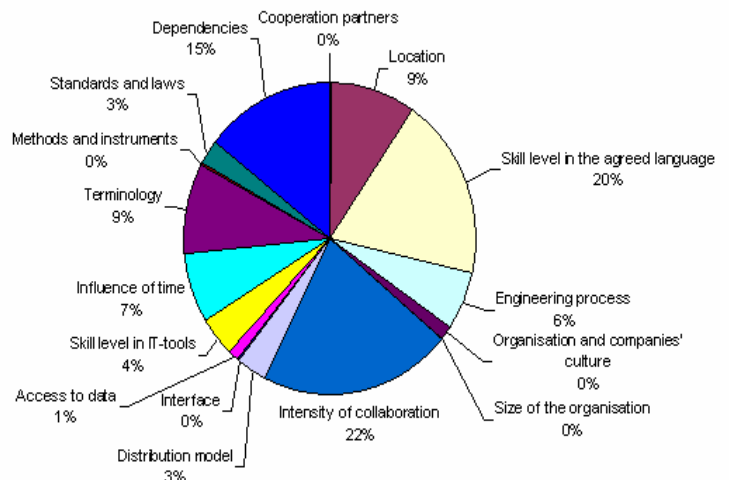
Change management tool

Input Factor	Index
Cooperation partners	0,0732
Location	0,0078
Skill level in the agreed language	0,0036
Engineering process	0,0019
Organisation and companies' culture	0,0064
Size of the organisation	0,0121
Intensity of collaboration	0,0056
Distribution model	0,0371
Interface	0,0092
Access to data	0,0227
Skill level in IT-tools	0,2915
Influence of time	0,06
Terminology	0,1108
Methods and instruments	0,0602
Standards and laws	0,1095
Dependencies	0,0829



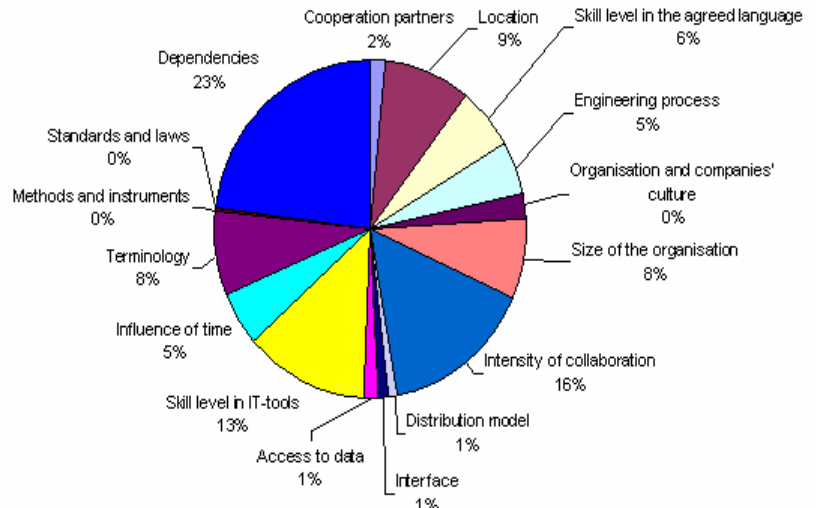
Chat room

Input Factor	Index
Cooperation partners	0,0015
Location	0,0825
Skill level in the agreed language	0,1657
Engineering process	0,0546
Organisation and companies' culture	0,0122
Size of the organisation	0,00000248
Intensity of collaboration	0,1851
Distribution model	0,0284
Interface	0,0029
Access to data	0,0088
Skill level in IT-tools	0,038
Influence of time	0,0637
Terminology	0,0826
Methods and instruments	0,0014
Standards and laws	0,0224
Dependencies	0,1261



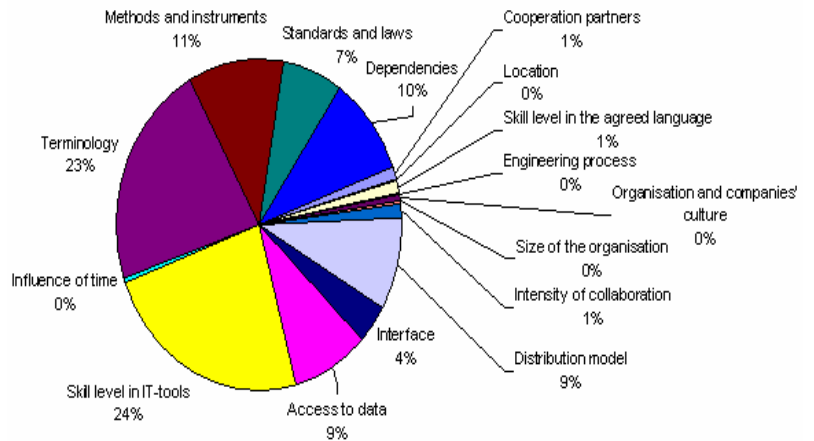
Co-author system

Input Factor	Index
Cooperation partners	0,0136
Location	0,0789
Skill level in the agreed language	0,055
Engineering process	0,0438
Organisation and companies' culture	0,0218
Size of the organisation	0,0678
Intensity of collaboration	0,1379
Distribution model	0,0066
Interface	0,0113
Access to data	0,0117
Skill level in IT-tools	0,1121
Influence of time	0,0485
Terminology	0,0704
Methods and instruments	0,0022
Standards and laws	0,0000
Dependencies	0,2048



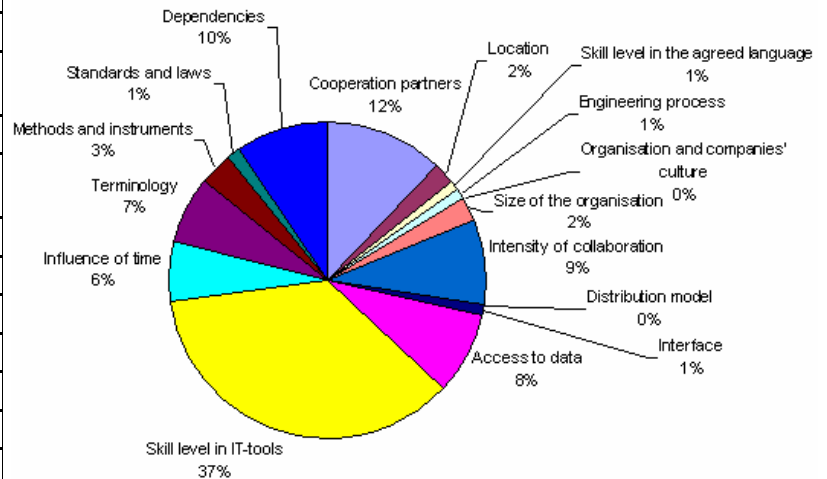
Discipline specific tool

Input Factor	Index
Cooperation partners	0,0105
Location	0,0019
Skill level in the agreed language	0,0092
Engineering process	0,0039
Organisation and companies' culture	0,0034
Size of the organisation	0,0034
Intensity of collaboration	0,0117
Distribution model	0,078
Interface	0,0347
Access to data	0,0767
Skill level in IT-tools	0,2075
Influence of time	0,0038
Terminology	0,1972
Methods and instruments	0,096
Standards and laws	0,0616
Dependencies	0,0865



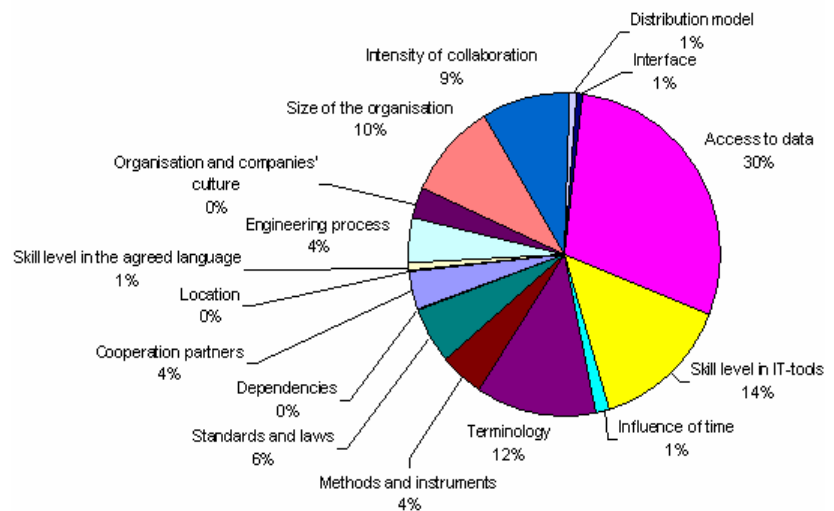
Document Management System

Input Factor	Index
Cooperation partners	0,1089
Location	0,02
Skill level in the agreed language	0,0066
Engineering process	0,0115
Organisation and companies' culture	0,000000144
Size of the organisation	0,0209
Intensity of collaboration	0,0764
Distribution model	0,00000062
Interface	0,0103
Access to data	0,0756
Skill level in IT-tools	0,3201
Influence of time	0,0529
Terminology	0,0641
Methods and instruments	0,0286
Standards and laws	0,0116
Dependencies	0,0852



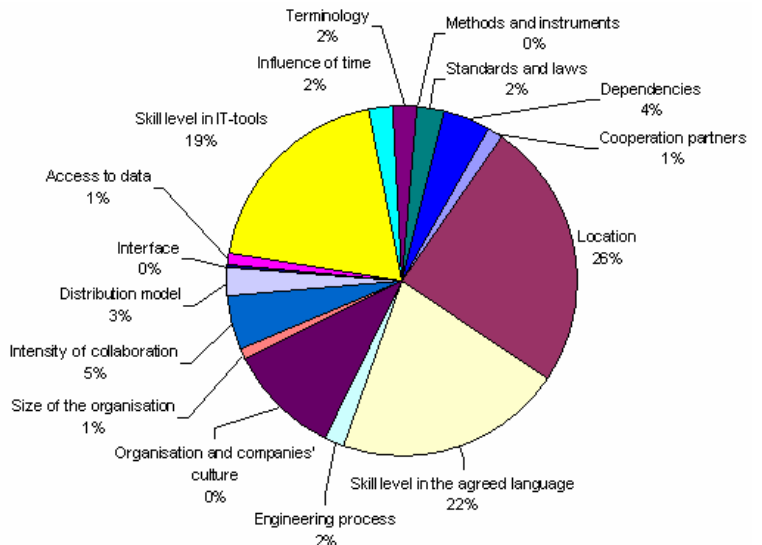
Electronic calendar

Input Factor	Index
Cooperation partners	0,0352
Location	0,0000
Skill level in the agreed language	0,0072
Engineering process	0,0397
Organisation and companies' culture	0,0268
Size of the organisation	0,0861
Intensity of collaboration	0,0801
Distribution model	0,0073
Interface	0,0063
Access to data	0,257
Skill level in IT-tools	0,1264
Influence of time	0,0128
Terminology	0,1101
Methods and instruments	0,0394
Standards and laws	0,0515
Dependencies	0,0000
Dependencies	291



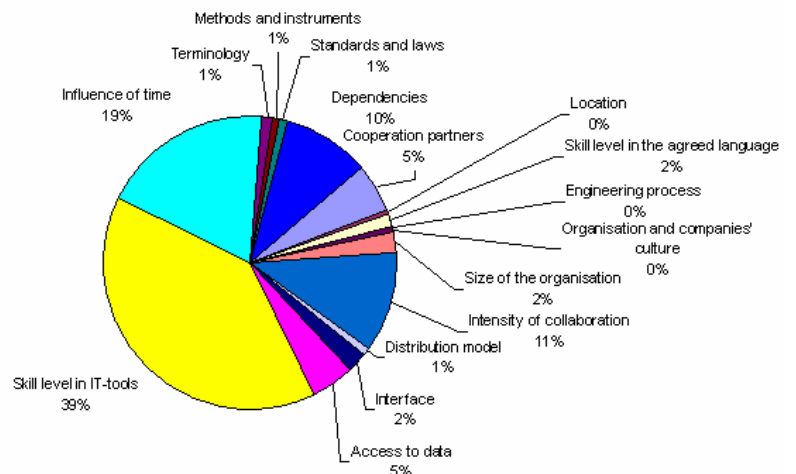
Online conferencing

Input Factor	Index
Cooperation partners	0,0117
Location	0,2168
Skill level in the agreed language	0,183
Engineering process	0,0172
Organisation and companies' culture	0,0895
Size of the organisation	0,0111
Intensity of collaboration	0,0416
Distribution model	0,0235
Interface	0,0023
Access to data	0,0086
Skill level in IT-tools	0,1704
Influence of time	0,0191
Terminology	0,0214
Methods and instruments	0,000000303
Standards and laws	0,0213
Dependencies	0,0387



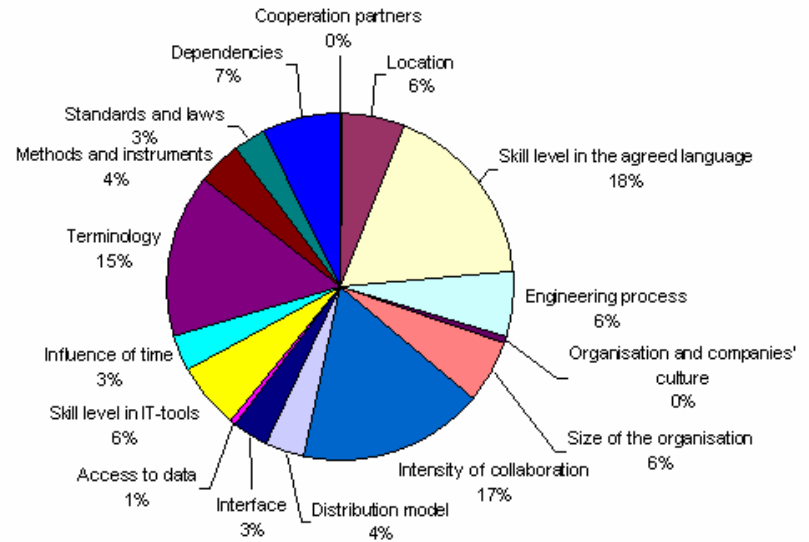
Knowledge management system

Input Factor	Index
Cooperation partners	0,0484
Location	0,0037
Skill level in the agreed language	0,0139
Engineering process	0,00000663
Organisation and companies' culture	0,0052
Size of the organisation	0,0189
Intensity of collaboration	0,1009
Distribution model	0,006
Interface	0,0196
Access to data	0,0442
Skill level in IT-tools	0,3538
Influence of time	0,173
Terminology	0,0097
Methods and instruments	0,0077
Standards and laws	0,0077
Dependencies	0,0876



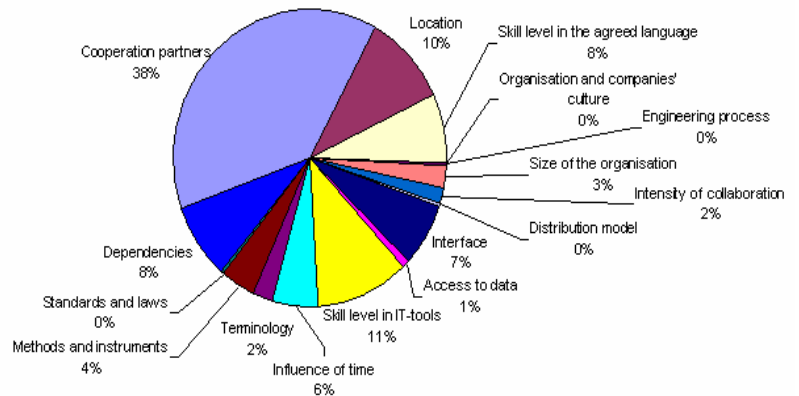
Instant messaging

Input Factor	Index
Cooperation partners	0,0017
Location	0,0508
Skill level in the agreed language	0,154
Engineering process	0,0531
Organisation and companies' culture	0,0068
Size of the organisation	0,0506
Intensity of collaboration	0,1511
Distribution model	0,0325
Interface	0,0281
Access to data	0,0052
Skill level in IT-tools	0,0541
Influence of time	0,0274
Terminology	0,1358
Methods and instruments	0,035
Standards and laws	0,0275
Dependencies	0,0634



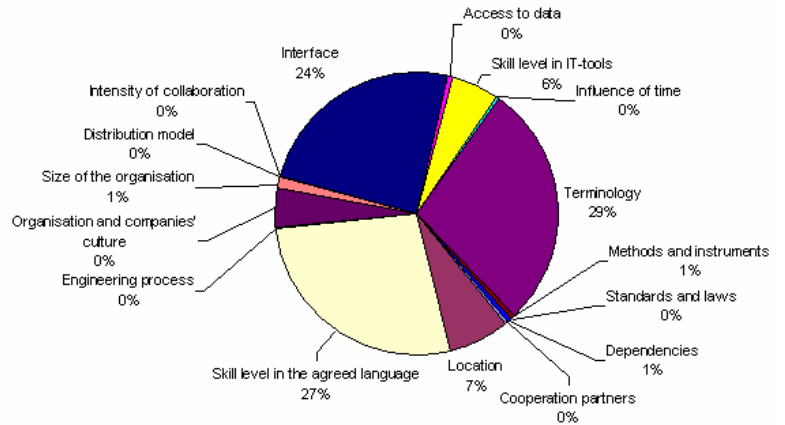
Forum

Input Factor	Index
Cooperation partners	0,3384
Location	0,0888
Skill level in the agreed language	0,0659
Engineering process	0,00000 678
Organisation and companies' culture	0,0011
Size of the organisation	0,0225
Intensity of collaboration	0,0139
Distribution model	0,0022
Interface	0,0622
Access to data	0,008
Skill level in IT-tools	0,0938
Influence of time	0,0497
Terminology	0,0197
Methods and instruments	0,0355
Standards and laws	0,0022
Dependencies	0,0733



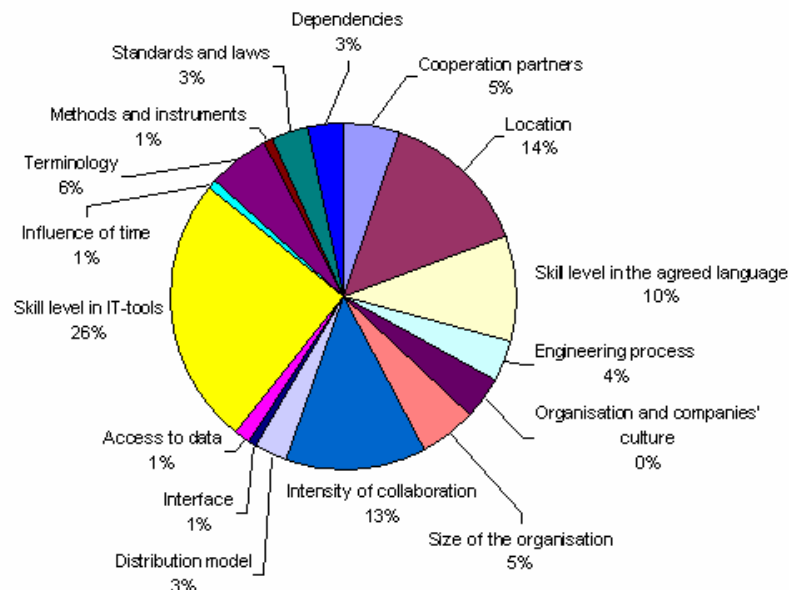
E-mail system

Input Factor	Index
Cooperation partners	0,0022
Location	0,0615
Skill level in the agreed language	0,234
Engineering process	0,000001 97
Organisation and companies' culture	0,0389
Size of the organisation	0,0127
Intensity of collaboration	0,000000 871
Distribution model	0,000000 122
Interface	0,2122
Access to data	0,0042
Skill level in IT-tools	0,0477
Influence of time	0,0027
Terminology	0,2415
Methods and instruments	0,0047
Standards and laws	0,000000 0723
Dependencies	0,0047



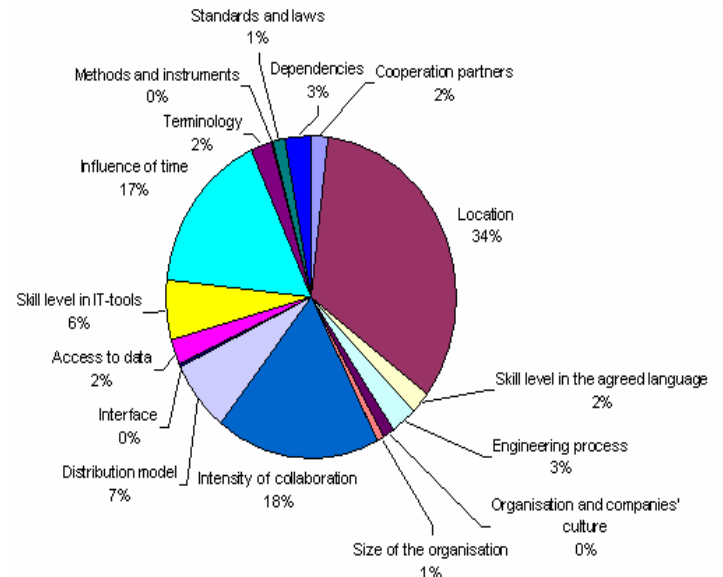
Electronic meeting system

Input Factor	Index
Cooperation partners	0,0472
Location	0,1252
Skill level in the agreed language	0,0856
Engineering process	0,033
Organisation and companies' culture	0,035
Size of the organisation	0,0459
Intensity of collaboration	0,1163
Distribution model	0,0257
Interface	0,0079
Access to data	0,0115
Skill level in IT-tools	0,2252
Influence of time	0,0055
Terminology	0,0532
Methods and instruments	0,0073
Standards and laws	0,0291
Dependencies	0,0291



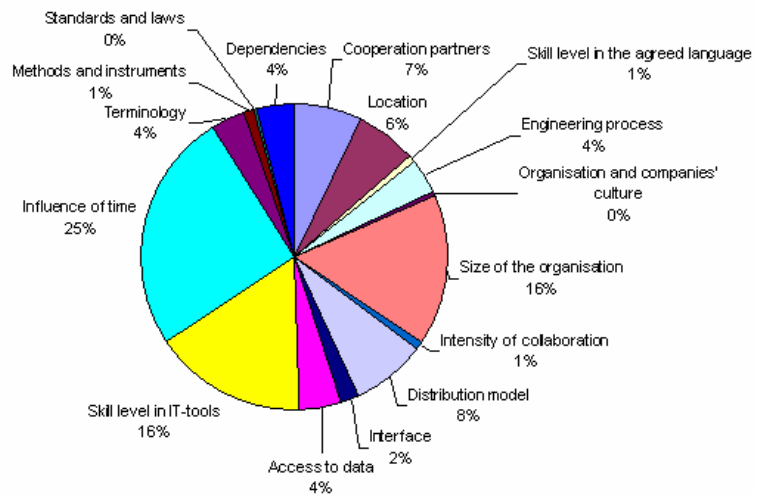
Whiteboard

Input Factor	Index
Cooperation partners	0,0175
Location	0,2941
Skill level in the agreed language	0,0179
Engineering process	0,0243
Organisation and companies' culture	0,0142
Size of the organisation	0,0068
Intensity of collaboration	0,1579
Distribution model	0,0653
Interface	0,0029
Access to data	0,0202
Skill level in IT-tools	0,0542
Influence of time	0,1467
Terminology	0,0204
Methods and instruments	0,0018
Standards and laws	0,0128
Dependencies	0,0244



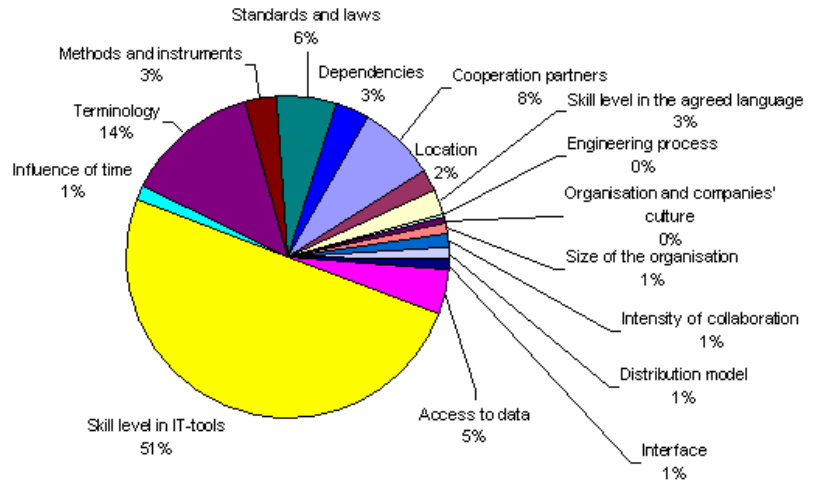
Social software system

Input Factor	Index
Cooperation partners	0,0639
Location	0,0559
Skill level in the agreed language	0,0089
Engineering process	0,0312
Organisation and companies' culture	0,0065
Size of the organisation	0,1401
Intensity of collaboration	0,0077
Distribution model	0,0698
Interface	0,0171
Access to data	0,0394
Skill level in IT-tools	0,1425
Influence of time	0,2275
Terminology	0,033
Methods and instruments	0,0077
Standards and laws	0,0025
Dependencies	0,0355



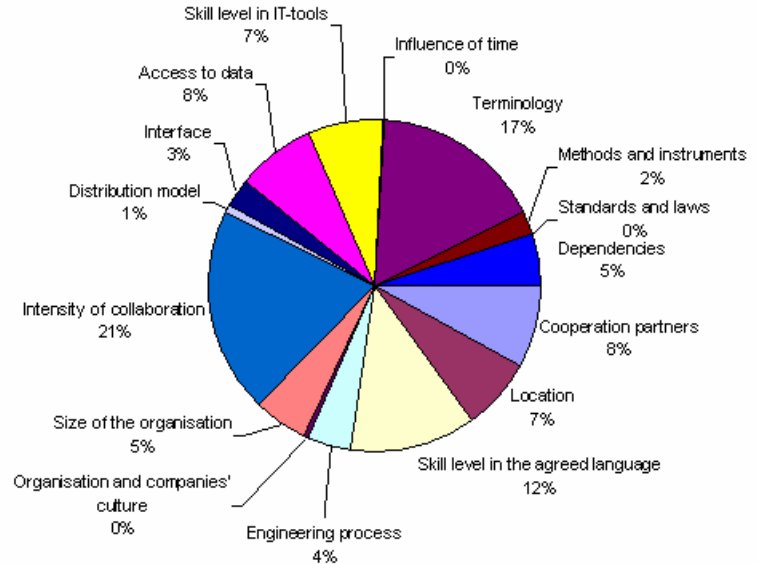
Project management system

Input Factor	Index
Cooperation partners	0,0693
Location	0,0203
Skill level in the agreed language	0,0232
Engineering process	0,0022
Organisation and companies' culture	0,0034
Size of the organisation	0,0104
Intensity of collaboration	0,0117
Distribution model	0,0119
Interface	0,008
Access to data	0,0416
Skill level in IT-tools	0,4454
Influence of time	0,0117
Terminology	0,1216
Methods and instruments	0,0291
Standards and laws	0,0541
Dependencies	0,029



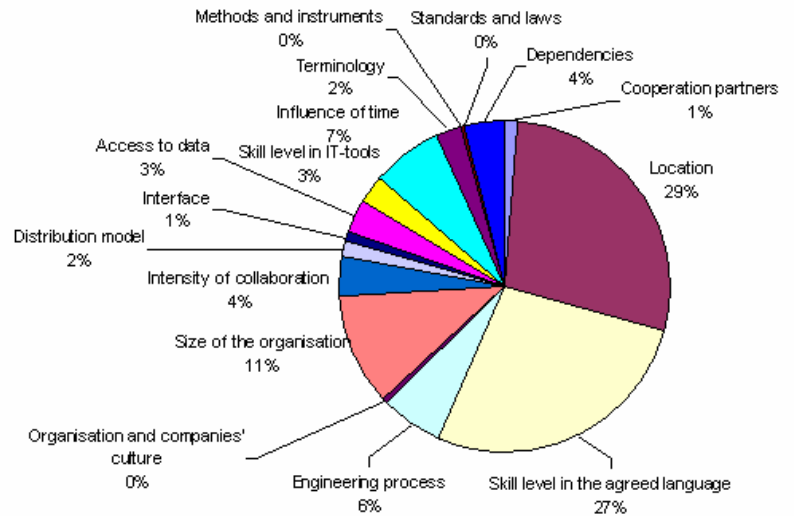
Problem solving system

Input Factor	Index
Cooperation partners	0,0713
Location	0,0614
Skill level in the agreed language	0,108
Engineering process	0,0369
Organisation and companies' culture	0,0028
Size of the organisation	0,0462
Intensity of collaboration	0,1776
Distribution model	0,0059
Interface	0,0261
Access to data	0,0683
Skill level in IT-tools	0,0635
Influence of time	0,0033
Terminology	0,147
Methods and instruments	0,018
Standards and laws	0,0000
Dependencies	0,0444



Online translation

Input Factor	Index
Cooperation partners	0,0114
Location	0,2439
Skill level in the agreed language	0,235
Engineering process	0,0544
Organisation and companies' culture	0,0039
Size of the organisation	0,096
Intensity of collaboration	0,0334
Distribution model	0,0136
Interface	0,0088
Access to data	0,0279
Skill level in IT-tools	0,0231
Influence of time	0,0621
Terminology	0,0217
Methods and instruments	0,0025
Standards and laws	0,000000
Dependencies	809
	0,0334



Workflow System

Input Factor	Index
Cooperation partners	0,0836
Location	0,0189
Skill level in the agreed language	0,0073
Engineering process	0,0000
Organisation and companies' culture	0,0019
Size of the organisation	0,0734
Intensity of collaboration	0,0582
Distribution model	0,0161
Interface	0,0566
Access to data	0,0215
Skill level in IT-tools	0,3003
Influence of time	0,0475
Terminology	0,0896
Methods and instruments	0,016
Standards and laws	0,0298
Dependencies	0,0699

