Infrastructuring When You Don't – End-User Development and Organizational Infrastructure

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Abstract. Technologies promoting End-User Development enable domain experts to adjust and develop tools to fit with their specific work practice and thus to be efficient with respect to their professional tasks. In today's organizations, however, single applications become part of organizational infrastructures. Such infrastructures enable integration between different applications and tasks but, at the same time, introduce constraints to ensure interoperability. How can the advantages of End-User Development be kept without jeopardizing the integration between different applications? The article presents an empirical study on End-User Development in the context of the development of an organizational IT infrastructure. Based on the analysis of the empirical material we discuss the challenges the infrastructure context provides for End-User Development.

Keywords: End-User Development, IT Infrastructure Development.

1   Introduction

End user development (EUD) allows users to develop and evolve their computer based working tools to support their specific tasks in an efficient way thus enabling users to be more effective. EUD possibilities furthermore allow innovations of processes and work practices to be mapped easily into the supportive technology.

In today's organizations, single applications become more and more part of joint technical infrastructure supporting the cross-organizational and sometimes inter-organizational cooperation. The necessary standardization can be expected to constrain the freedom for specific adaptation and development on a local level. [1]

The majority of the contribution to the End-User Development (EUD) discourse focuses on the tailoring and development of specific applications – like spreadsheet systems [2], or CAD systems [3] – or individual parts of infrastructures – like search tools [4]. Few contributions address the appropriation of common communication and cooperation infrastructures. (See [5] as an exception.)

Based on an empirical study of End-User Development the article explores two related questions: What are the challenges End-User Developers face when developing (parts of) an IT infrastructure? How do they tackle them? What can be done to keep the advantage of EUD and when integrating applications to an IT infrastructure?

The study is set at the World Maritime University (WMU) in Malmö, Sweden.. Under the auspices of the of the International Maritime Organization (U.N), WMU is an international university that provide Master degree educations in the maritime area for around 250 students predominately from developing countries each year.

The research presented here is part of a more comprehensive study on Participatory Design (PD) as basis for infrastructure development in an intercultural organization. During the research, WMU has been moving towards a more integrated technical and organizational infrastructure to consolidate the university's IT systems. EUD has been part of the organizational ICT development practice from the very beginning. As the innovative potential of EUD and the contribution of domain experts to the design of common infrastructure has early been recognized, the subject of this article is an important contribution to the development of an organizational IT strategy.

The cases subject to this article have been selected because the End User developers have both been active for more than 20 years. Their development activities have been acknowledged as important for the organization. As the scope, technical sophistication, and size and character of the user community differ significantly, the cases together provide a consolidated picture of EUD at WMU.

The remainder of the article is structured as follows: Section 2 summarizes the relevant literature on organizational End-User Development and infrastructure development in order to provide a conceptual framework for the article. Thereafter we introduce the research methods. The empirical section presents the two cases. In the following, the analysis is presented and discussed. The challenges of EUD in infrastructure settings are developed with respect to five aspects. The central and main dimension is the fragility of EUD practices in an organizational context. This fragility also influences cooperation with developers and users. The informal character of EUD practices makes it difficult to coordinate with professional development. And finally the technical platform and its development provide a challenge for EU developers.

2   End User Development, Organizations, and Infrastructures

Early research in EUD mainly focused on development and tailoring of individual performance tools in single user work environments like e.g. computer aided design [3, 6], excel sheets [3]. However, already then the cooperation between End User Developers (EU developers) and other users became visible as an important theme. [3] Organizational support for the development and maintenance of common customizations has been addressed as well. Only a few articles address EUD in the context of infrastructure development. Empirical research on infrastructure development, though, indicates the importance of bottom up, participatory approaches to keep the infrastructure in line with developing organizational requirements.

2.1   Tailoring of Common Tools

Already one of the first articles on tailoring [7] reports on EU-Developers exchanging self developed features and add-ons with other users. As early as 1992, Gantt and Nardi describe patterns of cooperation between EU-Developers and other users of

CAD systems. [8] They observe the development of formal and semiformal positions in organizations where local developers do not only act as 'gurus' – acquiring and sharing knowledge about how to tweak the system on an individual base – but as 'gardeners' – maintaining a set of customizations and tailorings for their group or department and continuously enhancing the common work tools and thus improving the productivity of the whole team.

Early on, support for sharing and cooperation among user communities has been a research topic. (see e.g. [9]. Pipek provides in [10] a categorization of cooperative tailoring scenarios: *Shared usage* requires the least coordination and user groups are a self help feature in both commercial and private contexts. Cooperative tailoring in a *shared context* provides better possibilities for sharing customizations, but might result in conflicts if changes to the individual tool hinder the sharing of work results. When users tailor a *shared tool*, they need to negotiate not only the adaptations but also the usage of the common tool. *Shared infrastructure* scenarios are least re-searched and provide additional challenges. Here tailoring results can effect configu-rations of other systems. The design space for EUD of an individual application is constrained by the interoperability requirements. Heterogeneous user groups are de-pendent on each other though they neither share a common work practice nor a com-mon tool. Dittrich and Lindeberg discuss such a case; in infrastructures that support data-intensive businesses like telecommunication, the flexibility of a specific applica-tion can only be deployed when other applications in the same network and the inter-operability platform can be tailored accordingly. [11] The importance of combining EUD and professional development activities when evolving such a common infra-structure and support for it is addressed in. [12]

2.2   Organizational Support for EUD

Already Gantt and Nardi [8], [3] emphasize the importance of organizational recogni-tion of End-User Developers. Other researchers emphasized the contribution of 'gar-dener type' local designers as well. The notion of shop floor IT Management [16] highlights the importance the users' work that makes IT-infrastructures work. Dittrich et al. report about local designers developing and maintaining infrastructures for mu-nicipal service provision. [13] Kanstrup presents a study on a local IT-support by a gardener type EU developers and in depth analyzes the practices that allow them to foster the IT-use in their organizations. [14] However, EUD done "on the behalf of the organization or group in which they [the EU developers] work" [15] needs to be deliberated with this group. Trigg and Bodker discuss this phenomenon as systemati-zation of EUD. [15] Beyond addressing the EU developer's requirements, organiza-tional EUD might require technical, organizational and in Trigg and Bødker's case even legal deliberation. [15, 17] The organizational forms and methods to do so are so far only discussed as challenges. [17]

2.3   Infrastructure Development

Infrastructure development is discussed in the discourses on e-Governance and Enter-prise Architecture. The mainstream of these discourses emphasizes a control oriented perspective on IT infrastructure development. (See for example [18, 19].) Empirical

research however challenges the feasibility of a rigor top-down approach. [20] Furthermore, to support innovation and creativity, the IT infrastructure of an organization needs to be flexible and accommodate bottom up design-in-use. [21] Karasti and her co-authors emphasize the need for PD and shop floor IT-management in the context of scientific infrastructure development and evolution. [22, 23] One of the core aims of the research project the current study is part of is to understand and develop PD as an organizational implementation strategy. [24]

Up until now, little research addresses tailoring in the context of IT-infrastructure evolution. Wulf et al. develop and investigate the usage and tailoring of a fully flexible search tool. That tool was part of an infrastructure supporting distance collaboration between a Bonn and Berlin office when the German government moved from one city to the other. [4] Studies of continuous infrastructure tailoring would have been interesting in this respect. However, the usage of the platform was not continued when the research project ended. [25] Eriksson emphasizes the need to relate tailoring and professional software engineering when evolving infrastructures for data intensive businesses like telecommunications [26]. In earlier research, we reflected of how the technology used for the implementation of infrastructure influences the possibility for user participation in design and the space for tailoring. [27]

The study presented here addresses practices of organizationally recognized EUD before, during, and after the introduction of an integrating infrastructure to. It allows addressing the complex interaction between EUD practices and IT infrastructure evolution.

3   Research Methods

The research project this study is part of follows Cooperative Method Development (CMD) [28] as a research approach. CMD anchors process and method improvements in the understanding of shop floor development practices. Empirical research aiming at understanding the practitioner's problems is followed by a joint deliberation of improvements and the implementation of the improvements that again are accompanied by empirical research. This study positions itself as a case study in the first phase of a new cycle where the idea is to further the understanding of the EUD activities in the context of infrastructure development. This enables more informed deliberations of improvements later.

The first author combines his PhD studies with his work as faculty IT specialist at WMU. The second author is the supervisor of the PhD project and has also participated in the data collection.

Data gathering and analysis. Though the cases have been selected based on previous research, the empirical material analyzed here has been collected to understand EUD practices from the EU developers' point of view. The empirical material entails both participatory observation and interviews.

With respect to the first case, Liz developing electronic forms and a contact database, the first author carried out two participatory observation sessions. The sessions were conducted in Liz's office in front of Liz's computer. Liz practically showed how she worked with the electronic forms and the contact database. At the same time, she

exemplified her approach regarding the design and implementation process. For this purpose sketches and paper printouts of relevant artifacts were also used. The second author, as an external actor and research supervisor, later conducted a follow-up interview. The purpose of the interview was both to relate back to findings of the participatory observation sessions and to inquire about Liz's relation to official IT-development beyond the specific EUD activities. Her experience of how the organization of IT development has changed over time provided valuable insight into the impact of organizational IT development on EUD practices. All material gathered has been recorded, transcribed undergone qualitative analysis.

With respect to the second case, John's development of WMU's registry system, six participatory observation sessions have been conducted with the Registrar John. These were done explicitly in the context of an upcoming ERP project where the intention was to understand if and how the current registry system could be integrated in the new application environment. All sessions were carried out in John office according to the same manner as the former case. An interview with the senior registry assistant, Sue, was conducted at an offsite location to get an alternate perspective. Three of the participatory observation sessions together with the follow-up interview have been transcribed and undergone qualitative analysis (all material is recorded).

The transcriptions have been analyzed with the qualitative research tool HyperResearch. The analysis started with identifying codes in the transcribed material. Based on this open coding, a number of categories where developed which where used for axial coding, relating the different transcripts. The categories provide the structure for the analysis below.

Trustworthiness. To assure the validity of the research, we applied various triangulation strategies. Already the two cases allows for cross case triangulation. Within each of the cases we used different data collection methods: participatory observation and interviews. Where we judged that the main researcher was too involved in the organization, the interview was implemented by second author who is not been part of the organization. In the registry case, a second person, a representative of the user group of the registry system was interviewed as well. The empirical research presented here is triangulated by earlier and parallel long term ethnographical research. Where relevant we draw on this additional research in the presentation of the analysis results. The rich description provided below provides the reader with the means to judge the conclusion drawn based on the analysis. The final as well as intermediary analysis results have been checked with the EUD practitioners whose practice was subject to the research presented here. However, as qualitative research and based on a single organization, we do not claim generalizability of the results. It is left to future research to confirm, contest and detail the findings of this article.

4   The Two Cases

4.1   Case 1: Electronic Forms and Contact Database

The End-User developer of our first case is Liz, a long-term and today senior administrative assistant at WMU. Liz has been a member of staff for almost thirty years and

has been part of the university's journey from a manual typewriter operation to an increasingly integrated technical infrastructure. Talking with her, one recognizes her genuine interest in smart solutions, which save time and effort. E.g. when she refers to her first encounter with computer based forms: "So I learned that you can do online forms […]. I thought this was just the best thing since sliced bread."

Her role in developing IT support for administrative purposes for the whole organization is acknowledged, but not organizationally defined in for example her work description. Referring to this semiformal position, Liz describes herself as "sort of a spider in the net". For eight years she was also a member of the computer committee that gathers key domain experts and IT developers deciding on the IT infrastructure, until WMU hired professional IT developers to work with IT-support for faculty and related administrative tasks.

Two of Liz's areas of responsibility are to administrate (1) internal forms such as leave and travel requests and (2) a repository of WMU of contacts. From the beginning, these were based on paper and typewriter. This started to change when word processing programs with contemporary features became available. Liz especially recalls version eight of Word Perfect where it became possible to set up electronic forms:

"We are going back 20 years you know. […] I thought it was super […] So I use help a lot, and I have learned to read the screen […] I went through it step by step you know. Click on the name, textbox and fields, and all that you know. I learned about the fields. Trial and error, first it didn't work you know. So I made a leave request form […] I take a form that is for everybody, then you get something that is across the board. And my boss at that time […] I tried it on him of-course".

Liz ended up not only migrating the leave request form to Word Perfect, but also the rest of the administrative forms.

In addition, contact information also began to be maintained in Word Perfect. Many administrators experienced the initial approach as insufficient: Contact information became scattered throughout the organization. In order to get hold of information about a certain person, one had to know who internally was maintaining a particular record. This led to a discussion of the benefits of having a central point of reference for contacts: a database with generic and standardized fields appropriate for different functions that anybody could access and query. In the end, the development of a Microsoft Access database was decided on. All the administrative assistants and secretaries were sent on a Microsoft Access short course to be able to develop and maintain the database internally. Upon their training, Liz - then already known for her technical interest and expertise - ended up taking charge of the development of the contact database, creating both the database and associated interfaces. The idea was that the secretaries would primarily be in charge of inputting data, whereas professors and others also could extract it. In the end, the contact database contained altogether about contact 640 records.

For both the electronic forms and the contact database, Liz gradually developed a model for user involvement. In regard to the electronic forms Liz for example describes how she works with actively getting feedback from other users. Acknowledging a wide range of competences, she has developed an implicit ranking of users from computer illiterate to technical experts that she tests prototypes on. Already when

migrating the forms to Word Perfect, Liz started to work with different colors, fonts, and layouts to make the user experience more intuitive for the different user groups and purposes. In regard to the contact database, she produced manuals and trained the other secretaries of how to use the interfaces of the database.

Both the electronic forms and the contact database have undergone major revisions. For the electronic forms, the next major technical infrastructure change was an organization wide change to the Microsoft Office suite and Word. For Liz this meant that it was back to the books and the help files to learn. The Word version of the forms were in operation for 18 years and became the de facto standard in the organization and also part of other technical infrastructures such as the web-based intranet. However, although new and advanced technical features became available with the Word-based forms such as mail merge and calculation capabilities, Liz was never altogether satisfied with the format. She experienced Microsoft as more "fuzzy […] if you are a new user to forms". The latest revision embarked on involves using pdf and adobe life cycle as a technical base. This change enables a full integration of the forms with other applications, and allows Liz to continue to improve usability aspects. For the technical integration, Liz has had to learn how the XML based backend of the forms works. She has then been involved in creating several prototypes in cooperation with one of the IT-program officers, where the forms exchange information via web-services with the in-house intranet. In addition, the easier design of the pdf forms has opened up for Liz to train other EU developers to create their own forms.

The biggest changes to the contact database have been of organizational nature. Coming up to four years in operation, the contact database and Liz's role in developing and maintaining it became subject to fluctuation. One after another, the other administrators retired or left the organization. At the same time, the university started to build a professional IT department. This for example meant that Liz was relieved from the coordinating computer committee and replaced by IT professionals hired to support the faculty and related administration. Gradually, this implied a disruption in the organizational anchoring of the usage and development of the contact database. The Access database was turned into a dedicated address database with Liz herself as also the main user. During the last years, again a discussion has emerged about the benefits of having a central contact database. The first pursuit to re-establish such a database, came with the development of a new external website. Using the contact database as a foundation, Liz again became involved in implementing new features and updating the contact records. The intention is that these records subsequently will be moved to an ERP system in the pipeline for implementation.

4.4   Case 2: The Registry System

The registry system for WMU was developed from scratch by its Registrar John. John came to WMU from the United States in 1992 and had already then comprehensive experience of the function from American universities. In the United States, technical expertise is often a mandatory requirement for the Registrar. Being able to operate databases and reporting tools to for example extract student data to provide decision support is a fundamental task. Today, the most common off-the-shelf system is Banner. When John initiated his career, such systems were still in a pilot stage. Before John started his employment at WMU, he participated as a domain expert in the

development of an early registry software tool. Through this involvement, he advanced his technical expertise by gaining his first experience of high-level programming.

The registry function at WMU is modeled partly after the US system, which implies that the Registrar holds a managerial position on the same level as a Vice-President. The registry department at WMU is made up of four employees: the Registrar John, the Associate Registrar, the Student Services Officer, and the Senior Registry Assistant Sue.

In 1992, WMU did not have satisfactory university standards for core registry functions such as course, subject, credit, and grade management. Instead of subjects that had a direct relation to weighted credits, programs were made up of modules that defined broad teaching areas. The modules were not individually graded, and the certificates presented to the graduates only contained an overall evaluative statement "Can you imagine, can you imagine, coming into this situation?" John reflects back.

So when John initiated his employment at WMU, he gradually started to construct an accountable academic management system. Parallel, he began to design and implement a computerized system himself. Building on his previous experiences, he picked a high-level programming language and database called DataFlex together with the reporting tool Crystal Reports. After a number of generations of the system – alone the grade management has undergone eight successively evolutions – John believes that he has succeeded towards accomplishing his initial vision: "what we do is we built the system to basically do our jobs, all of our jobs, all the four people in the registry, and that was exactly the purpose, to go from a manual paper based operation, to a computerized electronic method". Today, a dedicated and tailored computer support is in place for major WMU registry functions such as admissions, student profiles, courses and subjects, grade management, and quality assurance. The system has come to contain additional components such as alumni records and hostel management.

Despite the vision of a comprehensive computerized system, some processes still need a combination of electronic and paper operations. The start of the admission process is for example marked with the registry department receiving a paper application form. The data is transferred into the registry system. Thereafter, the application is subject to a complex admission process involving both internal committees and external agencies, which is supported and documented in the system. Once the student is admitted, all study activities and results are documented as well

Sue has been one of the main users of the system cooperating with John around the design of it. She recalls the evolution of the data entry interface: "I know that in the beginning, when I started, these tabs where divided in three different databases, and I thought it was rather complicated to remember which tabs that belonged to which […] you can always call him, go in to him, and he listens […] it is not like it is a small petites, he does do, writes it down on his little notepad. I have not thought about it before, but now when we are talking about it, it is pretty great […] and then he either says it works, if it works […] when he says it doesn't, it is because it must be possible to extract some report".

Members of staff outside the registry department, though, are less satisfied with their access to the registry system: they cannot for example extract reports from registry system apart from a number of pre-defined template reports without acquiring substantial knowledge about the database structure and the report tool. According to

John, he down prioritized requirements from outside the registry department due to time constrains: "the whole concept behind this wasn't to be for the university, it was supposed to be for the registry only, and then we decided to give it to people, it wasn't meant to be the ERP system for the whole university, it was for us to get our work done, and then people wanted things so, I then, I had to go in there, and then they were never happy, the main thing is I would have had a full time job just coding this".

5   Analysis and Discussion

In this section, we both analyze the field material and discuss the findings. The sub-section headings were derived from the field material in the manner described in the method section. In each subsection we start with introducing the theme we then summarize and cite from our empirical research and finally discuss the implications for supporting EUD in the context of infrastructure development and evolution.

5.1   Maneuvering as an Informal Developer

As an informal or semi-formal developer, EU developers are in a vulnerable position. On the one hand, they develop part of the IT infrastructure for the whole organization and provide important tools. They are aware of their role, and e.g. consciously include relevant stakeholders. On the other hand, as the episode with contact database shows, they are not officially recognized as developers and other organizational actors might not be aware of their activity, especially when personnel changes.

Liz: An unprofessionally professional developer. Though also being one of the main beneficiaries of her work, Liz consciously targets other staff with her development. She not only gathers 'requirements' in an informal way but consciously addresses lifecycle management such as training, further development, and maintenance. She for example does not only develop the electronic forms, but runs informal user tests and provides help. The contact database comes with a user manual. Both are maintained and adjusted to changing requirements and technologies. While her EU-development in many ways resembles that of an IT-professional, she is only informally recognized as a champion user in the organization. IT-development is nowhere to be found in her work description. Acquiring new IT competences is often done on her spare time and she for example carries expenses for books. Though her efforts are appreciated, her ability to maneuver in the organization – for good and for bad – is affected by her "unprofessional" status. E.g. where her IT-professional colleagues should take part in IT- forums such as the computer committee as part of their role, this is not the case for Liz.

The necessary cross-departmental IT-coordination takes place in a different way: Liz describes herself as "sort of a spider in the net" when it comes to development and coordination of the IT related ventures she has been involved in. This allowed her to continue being part of the forms development and the contact database, just that the coordination takes place outside the formally arranged forums. In the latest attempt to revive the contact database in the context of a new external website, it was WMU's president that turned to Liz to assist with the coordination. The reason is that through her day-to-day work, she has an established relationship to staff stakeholders and

knows who to ask for requirements and how different people could contribute. Liz has continued to maintain her relationships with the professional IT developers and in many cases acts as a broker between the users and the IT developers.

John: "The captain that controls all the pieces" Like Liz, John is not explicitly recognized as an IT professional at WMU. However, as a Registrar, he is a senior management member. With respect to his development mandate, this implies that John has space to basically carry out development for the registry system as he sees fit as long as his department meets the university's overall expectations. To this end, John has also taken on tasks beyond the 'normal' EUD and developed support for the whole registry and integrated his registry system with e.g. the office suite. Even though he also is a central beneficiary himself – throughout the interviews both John and Sue emphasize that the core function the of registry system is to output student management reports – the client interfaces and integration with other software such as mail merge for Microsoft Office are on the grand scheme more used by the other registry staff.

In his capacity as a manager and (recognized) key domain expert of his department, John has a permanent place in the computer committee. However, except from securing his annual development budget, his use out of the committee is limited. John's vision was to build an "electronic method" for all core functions of the registry department, but only for the staff members of the registry department. At the same time as the registry department has the most comprehensive support, all input into and export of information beyond the department is done manually. E.g. grades arrive to the registry department in an electronic format, but have to be manually transferred one by one. Though some client interfaces for faculty exist, people call John and ask for different reports to be exported.

During the interviews, the possibility to integrate the registry system with the surrounding infrastructure was discussed. It turned out that this would have been technically possible. However, the protective attitude of John that enabled him to develop a comprehensive and consistent application, hindered an earlier exploration of such possibilities.

Discussion. EU Developers have a vulnerable position in the organization, as their expertise both regarding their development tasks and regarding the organizational needs are often not recognized. Liz and John follow different strategies to cope with this challenge. Liz follows a networking approach whereas John uses his role as a manager to define the borders and control use and development of the registry system. When establishing an organization to coordinate infrastructure development their 'shop floor IT-management' [16] and their ability to act as brokers between users and IT professionals [14] need to be preserved for the benefit of the organization. Adequate forms of representation need to be established.

5.2 Frontline User Cooperation

When EU Developers develop systems for others to use, cooperation with these other users is important as well. Not surprisingly both the EU Developers we interviewed and observed have an established practice to involve other users in the development.

Liz: An EU Developer learning about usage. Rightfully, Liz describes herself as "one of them" – her users – and claim that she has a good conception of how the contact database and the electronic forms will be used. However, instead of only using herself as a reference user, she also works actively to understand the perspectives of other users through for example prototyping and testing against different stakeholder segments. The reason is that she is directly confronted with the problems other users have with her applications. As an administrative assistant she is placed in the middle of organizational activities with long-term established relationship with other staff. She is, therefore, one of the first to get notified if her development ventures do not work: "I end up with more questions then, and if there 's is more question I end up with people who don't use it." And people "who don't use it" mean more work for herself.

John: Caring for his users. The motivation for John to involve his department in the development is a different one. The change, e.g., initiated by Sue was not a malfunction per se. The program was fully functional. Its prior design was developed in accordance to the preferences of the previous registry assistant. The changes that Sue called for involved John changing both the interfaces and the database.

During the interview with Sue, she compared the way John cooperates with the members of the registry department to previous experiences. She worked as a secretary at a major company during a migration to SAP: "I mean, there was never any question of us having any input to it. It was like it was, but they had some sort of groups, from different department where they went through what was needed. But then afterwards, it was like it was. […] But I guess, there are pros and cons with everything". One con is raised against John's way of development: "Honestly speaking, it can appear a bit stiff, for example you have to save here, there. One perceives it as a bit old fashioned one enters information."

Discussion. EU developers care about usability; they are confronted with the problems of not usable software; and they develop ways to cooperate with the users of their systems around their design and development. The EU developers' expertise could be used by professional developers when working with IT infrastructures: As members of the user community and as shop floor IT managers, they might be able to help with recruiting the right people for user participation and also be able to prioritize between crucial problems leading to users refusing an application and 'good to have' features that can wait until developers have time.

5.3   From One Software Developer to Another

Modern IT infrastructures for educational organizations with needs to support both external and internal cooperation are not possible to maintain without professional IT developers. WMU decided to have IT competences close to faculty and administration. Over the last 7 years, two fulltime positions were established. This requires the EU developers to cooperate with their IT professional colleagues.

Liz: Including the professional developers in her network. IT professionals are colleagues too. Liz's way of managing the professional IT developers is to include

them in her network as well. That way she is consulted and included in the development interfacing with and impacting her applications. In the case of the pdf forms she for example negotiated the backend development with the IT-professionals in order for the results to be compatible with a future integration in a wider IT-infrastructure. In regard to the updated contact database she had to coordinate the interface development with both professional developers and contributing staff members. As the integration into the infrastructure poses new technical problems this cooperation includes opportunities for learning new technologies.

John: Isolating the own application. Due to the need to limit the complexity of an already complex system, John isolated the own application from the development of IT-infrastructures around the registry department. One result of this is that the possibility of technical integration has not been explored.

Discussion. In the context of infrastructure development, the cooperation between professional IT developers and EU developers seems to be a more viable strategy in order to coordinate more substantial technical development with the EUD of parts of the infrastructure. E.g. evolution of the electronic forms and the contact database needs to be coordinated with the Infrastructure development. The formal organization of the IT infrastructure development needs to accommodate the need for coordination and cooperation between professional and EU development.

5.4 … Something that Otherwise Would Be Defined as a Project

The need to coordinate EUD and professional development of the same infrastructure has been highlighted above. However, already the 'gardening' metaphor coined based on previous research [7, 14] indicates that EUD takes often place without a formal project organization, interlaced with the actual tasks of the EU developer.

Liz: Focusing on specific applications. Both the development of the electronic forms and contact database would normally be defined as projects, except that in Liz's case they don't qualify as such. At least not according to what can be recognized traditional IT-project criteria like predefined scope, resources, and start and end point. The scope is negotiated between Liz and her users; the time resources are found whenever there is no urgent other task; the whole ends when there is nobody using the results anymore. There is no project charter, no formally defined objective, identified constraints and stakeholders. Even the implementation platform changes over time. However, both development activities are clearly limited. The forms development is about administrative forms. Requests to develop forms for other departments are answered by teaching the person to do it him or herself. The contact database is about people and addresses. Other functionality did vary over time.

John: Developing for the registry department. Also John did not organize even major revisions of the registry system in any formal way. When Sue is asked about how improvement proposals are handled, she answers: "Ehh, I don't know, I was just happy that it was reduced [in reference to the databases connecting to the tabs and fields]." The developments of the registry system and the cooperation between the

four staff are not done with a formal project management or a project charter. Judging from the interviews, the question however is if such measures not only would have been bureaucratic red tape. The development seems to be coordinated by informal meetings. However, John clearly limits his development activities to the support for the registry department.

Discussion. As EUD does not take place in the form of projects, it is less visible in the organizational context. Professional development needs to develop ways to coordinate infrastructure development with the more informal ways EUD takes place. Formal committees like the computer committee provide a place where some of the coordination can take place. However, it is not sure whether simply providing a meeting place scales when the organization grows beyond a size where professional and EU developers can sit around one table.

5.5   Technical Platform

From the EU developer's perspectives the technical platform provides challenges to cope with. From an organizational IT infrastructure perspective it both enables and constrains development. Below we again summarize relevant parts of the field material and discuss the implications.

Liz: combining reading manuals and trial and error. How do EU developers acquire the necessary competences for developing stabile applications for usage by others? Liz applies two strategies: Continuous trial and error and step-by-step development is used to solve technical problems arising from her everyday work. In the end, this leads to the intimate knowledge of the workings of a technical platform: "I know how they were thinking when they made it [MS Word]". The other strategy is to acquire more abstract knowledge. Liz herself emphasize the importance of her own diligence and when it comes to always reading books and manuals to learn about the existence and properties of technical features and possibilities before and during her development. She for example describes how she reads up on the workings of a new feature, makes a small prototype for testing at home, and then transforms that into working functionality in relation to a current task.

Liz's ability to assimilate de-contextualized technical knowledge and put it into practice allowed her to port the electronic forms across three different technical platforms: from Word Perfect over MS Word to the adobe suite. The last change provided an additional dimension. As the forms now should interface to databases and other applications, the data model behind the forms needed to be more independent from the form as the user sees it. To cope with this challenge, it was necessary to understand notions like data structure and mark-up languages (XML). The cooperation with one of the professional developers helped to master this learning step.

John: Technical proficiency as part of the job description. That John is a technical domain expert is not so strange: Technical proficiency is "the first thing they list in any job advertisement" in the United States. As presented above, John has acquired programming expertise. John himself developed the majority of registry system's

code. In addition, DataFlex has an active community that contributes with script that has been incorporated to for example create more advanced menu structures.

Discussion. The implementation platform, respectively exchanging it, shows in our empirical material as technical challenges. Interfacing EUD results to an infrastructure does contribute additionally to the requirements for technical and conceptual know-how. From an infrastructuring point of view, the implementation platform for the infrastructure has to be selected carefully to provide the possibility to interface to heterogeneous applications and to allow for non IT professionals to use it for a base for EUD. (See [27] for further discussion.) And interfaces between EUD results and the infrastructure indicates where coordination between professional and EU developers is needed. When evolving and introducing new technical platforms, however, impacts on the EUD results need to be considered and the EU developers need to be provided the necessary support to update their technical proficiency.

6   Conclusions

The article addressed the relationship between EUD and organizational infrastructure development and evolution. EU developers' expertise in shop floor IT management and their established role as brokers between professional developers and users can provide a resource for professional infrastructure development as well. The meeting of these two different practices of development is, however, not an easy one.

In the discussion we outlined five sets of challenges. The first and central is the fragility of EUD practices due to their informal character. The cooperation with users, with professional IT developers and the scoping of EUD is subject to individual strategies. Finally, the technical platform connecting heterogeneous applications provides a challenge for EU developers, who might need help to conquer new technology.

In the two cases, two different strategies to cope with these challenges became visible: networking and isolation and control. With the growing requirement to integrate individual applications into an IT infrastructure, the former appears to be the more viable.

We identified a number of means to address the challenges from an IT infrastructure perspective: Representing EUD in organizational IT committees, fostering cooperation between EU developers and professional developers, acknowledging EU Developers on an organizational level, and selecting the technical platform and designing the infrastructure to accommodate local EUD.

Based on the analysis and discussion, we conclude that EUD and organizational infrastructure development can be combined. In our future research, we will explore how to solve the issues identified in the previous section when introducing an ERP system of WMU to integrate the financial and personnel administration with other parts of the infrastructure.

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