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Henri Korvela

Virtual Communities

A Virtual Treasure Trove for End-User Developers

Turku Centre for Computer Science

TUCS Dissertations
No 174, June 2014

Virtual Communities

A Virtual Treasure Trove for End-User Developers

Henri Korvela

To be presented, with the permission of the Department of
Information Technologies at Åbo Akademi University, for public
criticism in the Auditorium of Gamma on June 6th, 2014 at 12 noon.

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2014

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ISBN 978-952-12-3060-8
ISSN 1239-1883

Abstract

End-user development is a very common but often largely overlooked phenomenon in information systems research and practice. End-user development means that regular people, the end-users of software, and not professional developers are doing software development. A large number of people are directly or indirectly impacted by the results of these non-professional development activities. The numbers of users performing end-user development activities are difficult to ascertain precisely. But it is very large, and still growing. Computer adoption is growing towards 100% and many new types of computational devices are continually introduced. In addition, other devices not previously programmable are becoming so. This means that, at this very moment, hundreds of millions of people are likely struggling with development problems. Furthermore, software itself is continually being adapted for more flexibility, enabling users to change the behaviour of their software themselves. New software and services are helping to transform users from consumers to producers. Much of this is now found on-line.

The problem for the end-user developer is that little of this development is supported by anyone. Often organisations do not notice end-user development and consequently neither provide support for it, nor are equipped to be able to do so. Many end-user developers do not belong to any organisation at all. Also, the end-user development process may be aggravating the problem. End-users are usually not really committed to the development process, which tends to be more iterative and ad hoc. This means support becomes a distant third behind getting the job done and figuring out the development issues to get the job done. Sometimes the software itself may exacerbate the issue by simplifying the development process, deemphasising the difficulty of the task being undertaken.

On-line support could be the lifeline the end-user developer needs. Going on-line one can find all the knowledge one could ever need. However, that does still not help the end-user apply this information or knowledge in practice. A virtual community, through its ability to adopt the end-user's specific context, could surmount this final obstacle.

This thesis explores the concept of end-user development and how it could be supported through on-line sources, in particular virtual communities, which it is argued here, seem to fit the end-user developer's needs very well. The experiences of real end-user developers and prior literature were used in this process. Emphasis has been on those end-user developers, e.g. small business owners, who may have literally nowhere to turn to for support.

Adopting the viewpoint of the end-user developer, the thesis examines the question of how an end-user could use a virtual community effectively, improving the results of the support process. Assuming the common situation where the demand for support outstrips the supply.

Sammanfattning

Användarutveckling, ibland anveckling, (eng. end-user development eller end-user computing) innebär att användarna själva utvecklar sina verktyg, i det här fallet, applikationer eller system. Användarutveckling är ett mycket utbrett men ofta ganska förbisett fenomen inom informationssystemforskning och praktik. Många personer är direkt eller indirekt påverkade av användarutveckling.

Antalet personer som utför användarutveckling är svårt att bestämma, men betydande. Datoranvändningen närmar sig 100 % och det tillkommer kontinuerligt nya apparater. Därutöver blir många apparater programmerbara som tidigare inte varit det. Det betyder att i denna stund sitter antagligen hundratals miljoner användare och kämpar med utvecklingsproblem. Dessutom blir mjukvaran i sig ofta mera användarvänlig och förändringsbar vilket möjliggör det för användarna att modifiera den. Ny mjukvara och nya tjänster håller på att förvandla konsumenter till producenter och mycket av detta hittas på nätet.

Problemet för användarutvecklarna är att de ofta inte har någonstans att vända sig om de har problem med utvecklingsarbetet. Organisationer ser inte användarutvecklingen och stöder den därmed inte. Sällan har organisationen kompetensen för det heller. En annan del av problemet är processen för användarutveckling. Användarutvecklaren är inte intresserad av utvecklandet och det sker ofta iterativt och informellt. Stöd för denna process blir därmed lågprioriterat och fokus ligger på att få jobbet gjort, på något sätt. I och med att mjukvara ofta försöker förenkla processen och gömma komplexitet kan detta problem förvärras.

En lösning för användarutvecklarens behov av stöd är att söka den på Internet. På nätet kan man i princip hitta all den kunskap man behöver. Det löser dock inte problemet med att applicera kunskapen i praktiken. En virtuell gemenskap kunde lösa detta sista problem genom sin möjlighet att anpassa sig till användarutvecklarens situation.

Den här avhandlingen behandlar fenomenet användarutveckling och hur man kunde stöda denna genom hjälp på Internet. Framförallt genom användandet av virtuella gemenskaper, vilket jag hävdar här, verkar vara mycket lämpliga för användarutvecklaren. Tonvikt har varit på de användarutvecklare som i stort saknar stödmöjligheter, t.ex. egenföretagare.

Avhandlingen har tagit som utgångspunkt dessa användarutvecklare och analyserar hur de mera effektivt kunde utnyttja virtuella gemenskaper som stödkällor och öka kvaliteten på det stöd de får, med antagandet en situation där det råder ett utbudsunderskott på stöd.

Tiivistelmä

Käyttäjäkehitys tai loppukäyttäjän sovelluskehitys (eng. end-user development, myös end-user computing) tarkoittaa sitä, että (loppu)käyttäjä itse kehittää työkalunsa, tässä tapauksessa tietokoneohjelman tai sovelluksen. Käyttäjäkehitys on hyvin yleinen ilmiö, mutta jäänyt jokseenkin huomiotta sekä tietojärjestelmätieteen tutkimuksessa että käytännössä.

Käyttäjäkehittäjien lukumäärä on merkittävä, vaikkakin vaikea määritellä. Tietokoneiden käyttöaste lähestyy sataa prosenttia ja uudentyyppisiä tietokonelaitteita tulee käyttöön jatkuvasti. Tämän lisäksi yhä useammat laitteet ovat ohjelmoitavissa. Juuri tällä hetkellä satoja miljoonia ihmisiä todennäköisesti kamppaileekin kehittämisessä ilmenevien ongelmien kanssa. Myös itse ohjelmistojen joustavuutta lisätään jatkuvasti, mikä antaa käyttäjille mahdollisuuden muuttaa ohjelmistojensa toiminallisuutta. Uusien ohjelmistojen ja palveluiden myötä käyttäjät muuntuvat kuluttajista tuottajiksi. Suuri osa tästä tapahtuu verkossa.

Käyttäjäkehittäjän ongelma on, että tätä kehitystyötä ei tueta juuri mitenkään. Usein organisaatiot eivät joko huomaa käyttäjäkehitystä tai pysty tukemaan sitä. Monet käyttäjäkehittäjät eivät välttämättä edes kuulu mihinkään organisaatioon. Itse käyttäjäkehitysprosessikin voi pahentaa ongelmaa. Loppukäyttäjät eivät yleensä ole sitoutuneet kehitysprosessiin, joka usein on iteratiivinen ja epämuodollinen. Prosessin tukeminen saa tällöin vähemmän huomiota ja painopiste on työn saamisessa jotenkin tehdyksi. Joskus ohjelmisto sinänsä voi pahentaa asiaa yksinkertaistamalla kehitysprosessia ja peittämällä tehtävän vaikeutta.

Yksi ratkaisu käyttäjäkehittäjän tuen tarpeeseen on tiedon hakeminen Internetistä. Verkosta yleensä löytyy kaikki tarvittava tieto. Tämä ei kuitenkaan ratkaise tiedon käytäntöön soveltamisen ongelmaa. Tähän haasteeseen sopiva ratkaisu voisi olla virtuaalinen yhteisö, koska sillä on mahdollisuus mukautua käyttäjäkehittäjän tilanteeseen.

Tämä väitöskirja käsittelee käyttäjäkehitysilmiötä ja miten sitä voidaan tukea Internetiä käyttämällä. Erityisesti virtuaaliset yhteisöt näyttäisivät väitöstutkimuksen perusteella sopivan hyvin käyttäjäkehittäjien tarpeisiin. Tutkimuksen painopiste on ollut sellaisissa käyttäjäkehittäjissä, joilta suurelta osin puuttuvat tukimahdollisuudet. Tällaisia ovat esimerkiksi itsenäiset ammatinharjoittajat ja pienyritykset.

Nämä käyttäjäkehittäjät lähtökohtana väitöskirjassa on analysoitu miten he tehokkaammin voisivat hyödyntää virtuaalisia yhteisöjä ja parantaa saamansa tuen laatua tilanteessa, jossa tuesta on riittämätön tarjonta.

Acknowledgements

Writing a Ph. D. dissertation (and the research process this entails) is like a voyage of discovery not only into one’s field of research, but sometimes also into oneself. Like any good expedition, one needs ample provisions, a good crew and just the right amount of ignorance not to believe in the tales of sea monsters.

First and foremost I would like to thank my supervisor professor Barbro Back for her support during these years. The process has been longer and more arduous than either of us could have imagined when I started. An honourable mention also goes to docent Tomas Eklund who, while not officially a supervisor, has always had his door open for questions and problems and provided support for the process. You were sorely missed during your time in the crow’s nest at the top of the mast.

I would like to thank the reviewers, professors Anders Mørch and Elizabeth Regan for their kind words and insightful comments on both my thesis and research in general. Especially, Elizabeth “Betty” Regan for volunteering to perform the duties of being the opponent of my dissertation. In addition, I would like to mention professor Robert “Bob” Brookshire. “Betty” and “Bob” gave me sorely needed encouragement during my first tottering steps as a publishing researcher when I found myself alone and quite mystified in the strange new lands known to us brave explorers as “your first international research conference”. It is quite appropriate then that this new journey for me also started with a voyage to the New World, where I found the “natives” not restless, but instead incredibly kind and helpful.

I would probably never have considered doing a Ph.D. dissertation in the first place unless lured by the tall tales of vast riches (more metaphorical than actual, I will admit) and the example set by my good friend, colleague and co-author Kristian Packalén. It is really his fault I am writing this today, so thank you for that! We were a great writing team. Onwards to new adventures!

The sea journey can be a long one, but with the help of a good crew (and plenty of bottles of rum) the worst effects can be staved off. This is why I want to thank my friends and colleagues (in no particular order, honest!) Annika Holmbom (for putting up with me as a roommate and encouraging me when I needed it), Zhiyuan Yao (for much the same reasons), Hongyan Liu, Piia Hirkman, Peter Sarlin, Samuel Rönnqvist, Henrik Nyman, Xiaolu Wang, Robin Wikström and Sonja Leskinen for providing such an enjoyable and close atmosphere and sharing my woes both in calms and storms during this voyage of discovery.

Not all my friends have been along for the voyage, some have been standing on the quayside waiting for me to return. Thank you Peik and Igge for always having my back and providing rides and cake, as appropriate. I could not have done this without you.

Important are also the dockworkers, the secretaries and other personnel, administrative as well as teaching, at the Department of Information Technologies who quietly toil away to ensure mine and other’s voyages go as smoothly as possible. To this should be added Irmeli Laine and Tomi Mäntylä of Turku Centre of Computer Science (TUCS).

No expedition can be successful without provisions which in this case took the form of financial support, which is gratefully acknowledged, from the Academy of Finland (Kermit project – No 127592), Dagmar och Ferdinand Jacobssons fond, Department of Information Technologies at Åbo Akademi University, Fabian Klingendahls fond, TUCS, Stiftelsen för Åbo Akademi and Turun Kauppaopetussäätiö.

I would also like to thank the administration and community of the Mr Excel forums for providing such an excellent example everything that is good about virtual communities and allowing me to examine them.

Finally, but definitely not least, I would like to thank my family for always being there for me.

Henri Korvela
Åbo
May 9, 2014

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List of Original Research Publications

Publication 1

Korvela, Henri and Packalen, Kristian, "On-line support - a virtual treasure trove for end-user developers in small organisations?" (2009). *AMCIS 2009 Proceedings*. Paper 630. http://aisel.aisnet.org/amcis2009/630

Publication 2

Korvela, Henri and Packalén, Kristian, "Looking beyond the veil – what makes the micro organisation end-user developers tick?" (2010). *AMCIS 2010 Proceedings.* Paper 360. http://aisel.aisnet.org/amcis2010/360

Publication 3

Korvela, Henri and Back, Barbro, "The impact of skills and demographics on end-user developers’ use of support" (2012). *AMCIS 2012 Proceedings.* Paper 14. http://aisel.aisnet.org/amcis2012/proceedings/EndUserIS/14

Publication 4

Korvela, Henri, “Forums and Blogs and Wikis, Oh My! – An analysis of On-line Sources of Support for End-User Development” (2014). In: Jan Devos, Hendrik van Landeghem, Dirk Deschoolmeester (Eds.), *Information Systems for Small and Medium-sized Enterprises, State of Art of IS Research in SMEs*, Progress in IS, 353–373, Springer.

Publication 5

Korvela, Henri, “Plz urgent help needed! 1!!–Aspects of on-line knowledge sharing in end-user development support” (2013). *AMCIS 2013 Proceedings.*

http://aisel.aisnet.org/amcis2013/EndUserIS/GeneralPresentations/17

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Part I

Research Summary

1 Introduction

1.1 Background

> ***It is Friday afternoon and you are struggling to create a budgeting application for your project in a spreadsheet. Since you are stuck you try to contact the helpdesk, but they have already left.***
>
> ***You are the owner of a small business and would like to get a better grip on your inventories. After hacking the spreadsheet for a week you are stuck. Who will help you sort out the model?***

Above are presented two very typical scenarios for end-user developers. In both cases support have failed the user undertaking development activities due to a mixture of lack of availability and suitability of support sources. The practice of end-user development (EUD) is becoming increasingly common and so the problems faced by the users in the two scenarios above are affecting more and more people.

According to Scaffidi, Shaw and Myers (2005) there are more end-user developers than professional programmers. Extrapolating the Scaffidi et al. estimate for computer usage in 2012 suggests that around 55 million, potential and actual, end-user developers exist in the United States alone[1]. General computer usage surveys lend support to the growth of user numbers as adoption nears 100% (Tilastokeskus, 2012; Zickuhr and Smith, 2012). The exact number of users is difficult to estimate, but will be considerably larger than the number of professional programmers (Scaffidi et al., 2005). In addition to the more traditional areas of EUD, such as spreadsheets and databases considered in the Scaffidi et al. study, web design/development and related activities like content management systems and web mash-up are new areas where end-user developers can be found (Ardito, Buono, Costabile, Lanzilotti and Piccinno, 2012; Cappiello, Daniel, Matera, Picozzi and Weiss, 2011; Lin, Wong, Nichols, Cypher and Lau, 2009; McGill and Klisc, 2006). Fischer (2009) notes end-users are an important part of the so called “Web 2.0” world. In fact, it is reliant on user-provided content, though, not always actual end-user software development. However, again the latter becomes more important as interfaces increase in complexity, extending functionality and services beyond mere uploading and file hosting. The growth of cloud-computing will mean that more people without development training are putting together information systems from pre-fabricated components using different service or infrastructure platforms like Google Apps and Amazon Web Services. While these actions may not require the user to write code, it does form a higher level development activity if the users wants to integrate the different components.

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[1] The estimate is based on older US Bureau of Labor Statistics data, an analysis of more recent survey data is not available.

The meta-design framework, that extends the systems development to include users as co-designers during the system's entire life-cycle (Fischer, Giaccardi, Ye, Sutcliffe and Mehandjiev, 2004; Fischer and Giaccardi, 2006; Fischer, 2009), similarly extends the end-users support needs beyond "how to use it" to "how to do it". A further area where the need for support is found is in open source software (OSS), where more and more people find themselves operating, even regular users. Here, the sometimes rather ad-hoc nature of the software development can result in a lack of formal support, leading to such questions as who will provide the necessary, but low profile, support function (Lakhani and Von Hippel, 2003).

Increasingly, regular software also allows for extensive customisation that is pushing the envelope towards being outright EUD, e.g. through the introduction of macros and scripting (Blackwell, 2002). In all of these cases users are gradually taking on the role of developers, performing activities normally associated with trained information systems or technology personnel. Users are facing a situation where there is a growing need for support for these new tasks.

The end-user developers generally lack the training a professional developer would have. In fact, the definition of an end-user developer and associated development usually revolves around the lack of formal training in programming or development activities (Lieberman, Paternò, Klann and Wulf, 2006). Not only is end-user development done by people not formally trained as developers, but these activities are often secondary to their main goals. End-user development seems primarily intended to support other work or activities and does not form the main focal point for the effort (Ko and Myers, 2005; Nardi, 1993; Segal, 2005; Segal, 2007; Sutcliffe, Lee and Mehandjiev, 2003). The application is just a tool, not the product. As such, a large number of people doing something they are not trained to do, nor consider particularly critical. Consequently, there is a great need to support these development activities, but real world experience suggests that often there is a lack of adequate support.

End-user development is very common and it should come as no surprise that the phenomenon is found in organisations of all types and sizes. There are approximately 23 million small and medium-sized enterprises (SMEs) in the European Union which represents 99% of all businesses. Also, according to the Association for Enterprise Opportunity, the United States has more than 23 million micro enterprises representing 87% of all US businesses (Kamal, 2011). The businesses, according to the European Commission[2]: "*are a key driver for*

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[2] http://ec.europa.eu/enterprise/policies/sme/index_en.htm

economic growth, innovation, employment and social integration" and that *"[it] aims to promote successful entrepreneurship and improve the business environment for SMEs, to allow them to realize their full potential in today's global economy*". A big part of this will undoubtedly be the use of information systems (IS) and information and communication technology (ICT) to enable improvements in current work methods and introduce new possibilities as suggested by Brynjolfsson and Hitt (1998). However, SMEs usually have less resources to acquire and maintain IS (Dörner, Heß and Pipek, 2007; Kamal, 2011; Moffitt, 2006; Xiao and Farooq, 2012), which may lead to problems with the understanding of and application of ICT (Kamal, 2011; Moffitt, 2006). This should be especially true among the smallest section, the so-called micro enterprises, since naturally, the smaller the organisation the fewer resources, financial and otherwise, it has.

In small organisations, many of the traditional forms of support, such as helpdesks, are limited or non-existent. Furthermore, a small-organisation emphasizes the problem where development is not the main focal point for the effort. In smaller organisations each member will have more responsibilities, which are likely increased further by incorporating information technology in the organisation. This all culminates in the single business proprietor or small business owner (SBO), who has sole responsibility for not only the core business, but also all ancillary tasks.

For a number of SME organisations state of the art is still represented by basic software solutions, many of which they have developed themselves. At the beginning of the research process I was involved in a couple of ICT projects involving micro enterprises. During these projects I noticed how these organisations were still mainly relying on basic office applications and using these to create simple IS. One example was a billing form with some database functions created in Microsoft Excel. While rudimentary in function, these applications could still represent a major improvement in functionality and/or efficiency over manual processes. The problem for the people doing this basic software development was often the lack of adequate support sources to assist them, if they had difficulties. They had the ideas, but lacked in ability to execute them.

Taken together, all of this seems to point towards a situation where there are many people creating applications without development experience and with little engagement in the development process. This appears to be the case even in organisations where there is room for perhaps quite significant improvement. In most cases, there seems to be a lack of adequate support for this development process, partly due to support not being available, but also because end-user developers simply do not consider development an important activity.

1.2 Research Aim

The aim of my research is to understand and explore how virtual communities can be harnessed to support end-user development activities, particularly in smaller organizations. The overall research question (RQ) is: **How can on-line support, particularly virtual communities, be harnessed effectively to improve end-user development?** This is further divided into the following sub-questions:

RQ1. What is end-user development?

RQ2. What sources are available? What are their characteristics?

RQ3. How do the sources compare to each other? What could the benefits of a virtual community be?

RQ4. What type of support is used now?

RQ5. Who are the end-users?

RQ6. What impact do the demographic/skill attributes have?

RQ7. Are there any connections between groups, demographics/skill and support use?

RQ8. What can the end-user do to increase the quality of support on a virtual community?

An overview of these questions fit into the thesis and are answered is described in sections 1.5 and 1.6 and illustrated in Figure 3.

End-user development is a very broad topic. With so many different areas and environments it may therefore be necessary to focus more narrowly on only one or a few end-user technologies or areas. Much of this research has been on the developers I have met with in practice, who have been mainly characterised by being less skilled and working in small organisations. Therefore, in this thesis I have picked spreadsheets as the end-user development environment to focus on, providing the lens with which I look upon end-user development. Spreadsheets seem ubiquitous and would most likely be familiar and used by most small organisations, as was also the case in the user populations studied in Publication 1 and Publication 2.

1.3 Related Research in End-User and Development Support

1.3.1 Previous Research in End-User and Development Support

Previous research has focused on the use of computer support in general, often within one organisation, e.g. Carr (2006), Constant, Sproull and Kiesler (1996), Govindarajulu, Reithel and Sethi (2000), Govindarajulu (2002), Govindarajulu

(2003), Nilsen and Sein (2004), Seeley and Targett (1997), Shaw, DeLone and Niederman (2002) and van Velsen, Steehouder and de Jong (2007).

Studies on support sources often focus on the characteristics of one type of source in a general setting, e.g. Phang, Kankanhalli and Sabherwal (2009) and Purchase and Worrill (2002) or on a certain tool, e.g. Stylos and Myers (2006) or in a different setting, e.g. Lakhani and Von Hippel (2003).

1.3.2 End-User Development Research is Inter-disciplinary

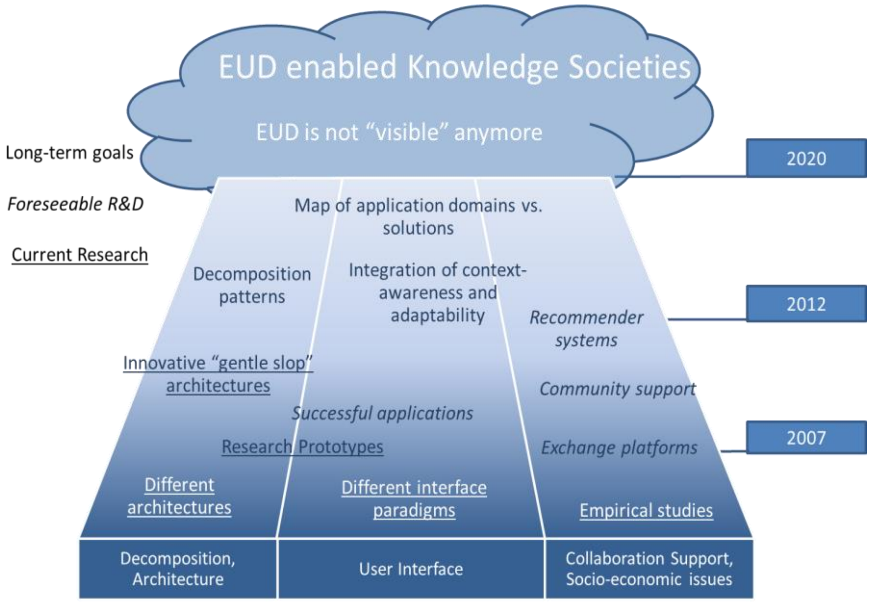
End user development is a broad and inter-disciplinary field where many interests and viewpoints meet, e.g. information systems, human-computer interaction, software engineering and psychology of programming, to name but a few. At the centre of end-user development are the users that modify IT systems. (Klann, Paternò and Wulf, 2006; Mørch, 2011)

End-user development can be approached in several different ways depending on whether the point of focus is on the developer, the artefact or the process in general. Some examples of perspective that can and have been used based, among others, on: Costabile, Dittrich, Fischer and Piccinno (2011), Dittrich, Burnett, Mørch and Redmiles (2013), Ko et al. (2011), Lieberman, Paternò and Wulf (2006), Pipek, Rosson, Ruyter and Wulf (2009), are listed below.

1. Psychology of programming
    a. How are end-user developers creating their models?
    b. What are the problems encountered by developers?
    c. How can the applications be made error free and efficient?
    d. What are appropriate tools and methods to achieve this?
2. Software engineering
    a. Designing frameworks for supporting EUD
    b. Applying methods and techniques from formal software development to EUD to improve quality.
3. Human-computer interaction
    a. Features of end-user development enabled software, how does the program help/hinder the development activities?
    b. Different methods of programming, e.g. visual languages, programming by demonstration.
4. Sociology, culture and behaviour, gender studies
    a. Who are end-user developers?
    b. Why do they develop applications?
    c. What impact does gender have on development/tools/features?
5. By subject field
    a. End-user development in health care, accounting, etc.
    b. Case studies in organisations
6. Application focused
    a. Different applications
    b. Case studies of applications

The information systems outlook can combine many of these. Traditionally, in information systems research the focus has been on the information system artefact being constructed. However, in end-user development it is difficult to separate the artefact from the creator.

Furthermore, Klann et al. (2006) present a suggestion for future work on end-user development including a focus on decomposition and architecture, user interfaces, collaboration support and socio-economic issues (see Figure 1). This thesis falls into the third category, *collaboration support*.



EUD enabled Knowledge Societies
EUD is not "visible" anymore
Long-term goals
Foreseeable R&D
Current Research
2020
Map of application domains vs. solutions
Decomposition patterns
Integration of context-awareness and adaptability
Recommender systems
2012
Innovative "gentle slop" architectures
Community support
Successful applications
Research Prototypes
Exchange platforms
2007
Different architectures
Different interface paradigms
Empirical studies
Decomposition, Architecture
User Interface
Collaboration Support, Socio-economic issues

Figure 1. The future of end-user development research (Klann et al., 2006).

1.3.3 Suggestions for End-User Development Research

Klann et al. (2006) give three suggestions for EUD research.

1. Research should be driven by sound theoretical assumptions about user needs.
2. There is a strong consensus for the need of a sound empirical base.
3. EUD research must find good solutions for a number of trade-offs created by empowering end-users to carry out substantial adaptations of IT-systems at a complexity level no higher than needed for the task at hand.

This research adopts the first and second suggestion, the third not being applicable when not looking at an actual EUD tool. In addition, Segal (2005) notes how end-users are heterogeneous and that research should be done with actual end-user developers, which has also been a guiding principle in this research.

1.4 Research Methodology and Framework

The foundations of the research in this thesis are grounded in the constructivist perspective following Cross and Sproull (2004) as it fits the domain of end-user developers well, with a strong focus on context and a more holistic approach. Unlike some of the previous studies, this thesis adopts a more general view of end-user support, including development support. This thesis uses a mixed-strategy approach to research. This has led to some practical and methodological challenges, e.g. is it survey research or a case study if one collects structured data from part of the population in one setting with consideration of the context? There is limited prior work to build on and concepts from several various fields have to be taken together to give a faceted view of a very complex problem.

1.4.1 Constructivism

Constructivism means we view the subjects and objects of the research as existing and meaningful within their own context. This ontological view is opposed to *objectivism,* which views the objects of research as external to the subjects and beyond their reach and influence. (Andrews, 2012; Bryman, 2012)

In this case, the constructivist perspective is applied to both knowledge transfer and social constructs (people and the communities). I consider that both *knowledge transfer* (Cross and Sproull, 2004; Elkjaer, 2003; Lave and Wenger, 1991; Weick and Westley, 1999) and *social constructs* (Bryman, 2012) influence and are influenced by their contexts. However, as discussed by Andrews (2012) and Bryman (2012) that does not necessarily completely deny the potential of objectivism. My viewpoint is therefore something akin to the *subtle realism* of Hammersley (1992), which acknowledges objective social constructs but rejects the ability to objectively describe them.

Constructivism seems to align well with the subject of end-user development as both share in the importance of looking at objects in their context. It also fits the qualitative aspects of my research.

1.4.2 Survey Research

Survey research is a methodology characterised by the structured data collected to analyse a sample of a population. It should not be confused with the survey method, i.e. administering questionnaires to collect data, although they are usually closely linked as questionnaires are perhaps the main data collection method within survey research. (De Vaus, 2002; Järvinen, 2004; Pinsonneault and Kraemer, 1993)

Pinsonneault and Kraemer (1993) contrast survey research and case studies. Both are done in the natural settings of the research objects, however the former in a variety of natural settings and the latter only in one. The question is whether the research presented in this thesis is survey research or a case study? This distinction may be problematic to determine at least for part of the research. Communities are very context dependent places and I have strongly considered the specific case of the community while investigating it. On the other hand, the investigations of the end-users themselves have specifically tried to increase the variety of settings investigated. The lack of variety in communities investigated is more due to time and resources than any other factor.

Furthermore, Pinsonneault and Kraemer (1993) suggest that the research questions *how*, *what* and *why* are characteristic for survey research. In this thesis the questions are mainly *how* and *what* and therefore this research fits better under the paradigm of the survey research methodology.

Part of the methodological issues stems from the perceived divide between quantitative and qualitative research. This thesis' research has adopted a multi-strategy approach, but e.g. Pinsonneault and Kraemer (1993) state that survey research is inherently quantitative, whereas De Vaus (2002) says it can be both. Furthermore, he suggests that the distinction between quantitative and qualitative research is unhelpful and misleading.

Pinsonneault and Kraemer (1993) describe survey research as having three purposes:

- *Exploration* – developing concepts and methods for future studies
- *Description* – examining what the current context of population is
- *Explanation* – aiming to test causal relations

This thesis incorporates all three in the research process and they are discussed in more detail in the survey description in chapter 5 which covers methods and data. Pinsonneault and Kraemer (1993) also suggest qualitative research to be particularly appropriate in the explorative phase and this thesis follows that line, though the use of the qualitative methods have been extended to later stages as well.

1.4.3 Research Framework

As mentioned above, this research used a mixed-strategy approach to research and the research process has largely been inductive and inspired by the constructivism viewpoint. The inductive research process used in this research is depicted in Figure 2.

The mixed-strategy was mainly chosen to leverage the strengths of both qualitative and quantitative research, basically by using qualitative methods to create more precise and relevant quantitative data and supporting the subsequent data analysis. Bryman (2012) describes it as qualitative research facilitating quantitative research. In this way aspects of qualitative research have strongly influenced the quantitative aspects. Qualitative data can also give a deeper understanding of the subject which it was thought would be important with the expectation of small sample sizes. Järvinen (2004) suggests survey research has samples large enough to do extensive statistical analysis. However, the groups of SBOs and small-organizations considered here are on their own very small populations so the statistical power of even a full set of replies might not be adequate.

A quantitative survey depends on the researcher assuming they know the right questions to ask. Usually, only data asked about is received. Acknowledging my own limitations, qualitative methods were used to try and capture data outside the experience of the researcher or previous literature, in essence a form of triangulation process (Bryman, 2012; Bryman, 2006).

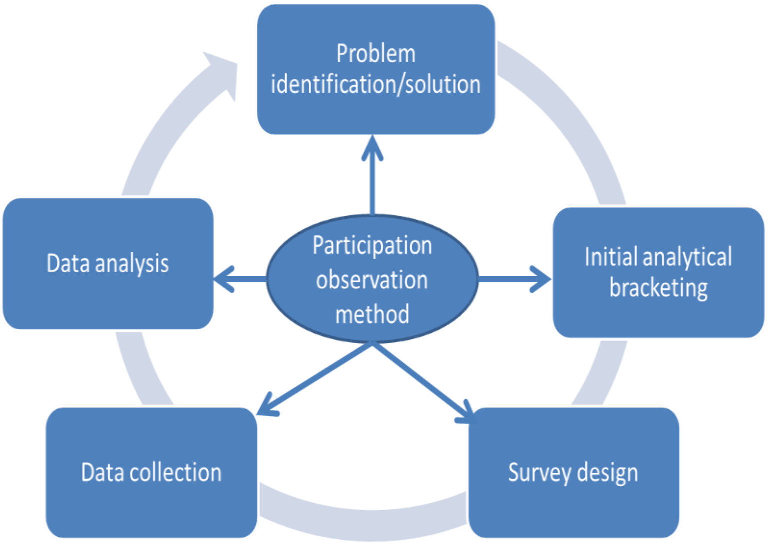

Problem identification/solution
Initial analytical bracketing
Survey design
Data collection
Data analysis
Participation observation method

Figure 2. The research process.

To secure the contextual aspects a participation observation method has been used throughout the research process. The research process started with a participation observation phase which was used to inform on which problems and potentials were evident in using virtual communities as support in EUD. Similarly, participation observation has to some degree impacted on all steps of the research process, i.e. *problem identification*, *initial analytical bracketing*, *survey design*, *data collection* and *data analysis*, as illustrated in Figure 2. The research process is briefly summarised here, but a more detailed description of the data collection process, the methods used and how the steps of the research process impacted on each different publication is found in chapter 5 “Methods and Data” and in the chapters describing the various publications.

Problem identification, Initial analytical bracketing

Participation observation served as a foundation for much of this research. The ideas and problem formulation in part came from my own experiences during my graduate thesis project in creating a spreadsheet budgeting application, a typical end-user developer scenario. Additionally, participation in a teaching project for SBOs showed how the developers had similar problems that I had solved by going on-line to look for help. In this way, a unique understanding of the problem became possible through participation observation.

Survey design

The surveys were designed based on previous studies and literature, but also on experiences from participation observation, particularly in an effort to make them contextually relevant and understandable for the respondents.

Data collection

Most of the data collection was done through the surveys, but since I participated in the populations studied there are a number of insights gained from this as well.

Data analysis

Beyond the first steps, data analysis is probably the step in the process most heavily reliant on support from the participant observation. The survey data collected was interpreted with participation observation insights because the setting was fairly distinct from previous studies. In this way participation observation could also give a measure of face validation, since the results were congruent with observations about the community and its participants.

1.5 Publications and Contributions

> ***Cooperation is an essential part of EUD. Future research will have to investigate effective means for communities of end-users to communicate about their adaptation problems, negotiate solutions, and share both their EUD expertise and reusable EUD artifacts. Cooperation on EUD activities is largely a social phenomenon and research will have to understand how an appropriate EUD culture can be fostered by incentive mechanisms, trust building, and community awareness.***
>
> ***(Klann et al., 2006)***

The above quotation essentially summarises what this thesis investigates. To use the Internet, and specifically virtual communities, as a source of support falls in the category *Collaboration support* as a virtual communities works as both an *exchange platform* and a source of *community support* (see Figure 1). Based on my research presented in this thesis I would argue virtual communities can be important in providing the ability to communicate about problems, negotiate solutions and share knowledge. Publication 5 furthers our understanding of collaborative support.

This thesis takes a holistic and end-user focused view of end-user developer's relation to sources and the sources themselves in general, which previous research often has not done. For example, previous research only focuses very narrowly on certain aspects of support as described in section 1.3.1. Moreover, Panko and Port (2012a) call for a more comprehensive investigation into the end-user developers by more descriptive research. The research presented in this thesis considers multiple sources and contrasts them against each other based on aspects that are important for end-user developers, the people using them in this case. I also do some descriptive research of the end-users themselves to find out more about them.

Chapter 2 addresses RQ1 by describing previous research about end-user development and examining the various definitions in existence. To answer RQ1 a taxonomy is provided that can support our understanding of this very eclectic field.

Publication 1 and Publication 2 provide an examination of end-users and the sources they use by surveying end-user development populations, addressing RQ4 and RQ5. Not all end-users are the same so it is important to understand their context. Publication 2 also relates the end-user's demographics to support use addressing RQ6. The surveys reported on in the two publications were designed, administered and analysed in collaboration between the authors. I am the main author of both papers and they are written from the perspective of my research.

Publication 3 presents a multidimensional analysis of how the end-user's characteristics may impact on support use addressing RQ6 and RQ7. The data was the same as in Publication 2, but transformed into a form more suitable for the analysis. The data transformation and analysis was done by me and I am also the main author of the paper.

Publication 4 outlines a framework for understanding and examining support sources in the end-user development context addressing RQ2. It applies this framework to a set of sources helping to explain why some sources are used and others are not, addressing RQ3. I am the sole author of this paper.

Publication 5 investigates how knowledge seeking in a virtual community can work and how the end-user can improve the quality of support they get addressing RQ8. I created the surveys, performed the data collection and analysis and I am the sole author of this paper.

1.6 Overview of the Thesis

An overview of this thesis and how the chapters, publications and research questions relate to each other is provided in Figure 3. The rest of the thesis is organised as follows.

Chapter 2 introduces the subject of end-user development with a brief history of the subject and concepts. Other topics touched upon include the definition of end-user development, the end-user and user developed applications, the end-user development process and research related to this.

In chapter 3 sources of support are discussed in a general and more specifically an end-user development context. A framework for understanding support sources based on an extensive literature review is presented.

Chapter 4 describes how knowledge sharing applies to virtual communities and gives a model for how on-line knowledge sharing can be viewed.

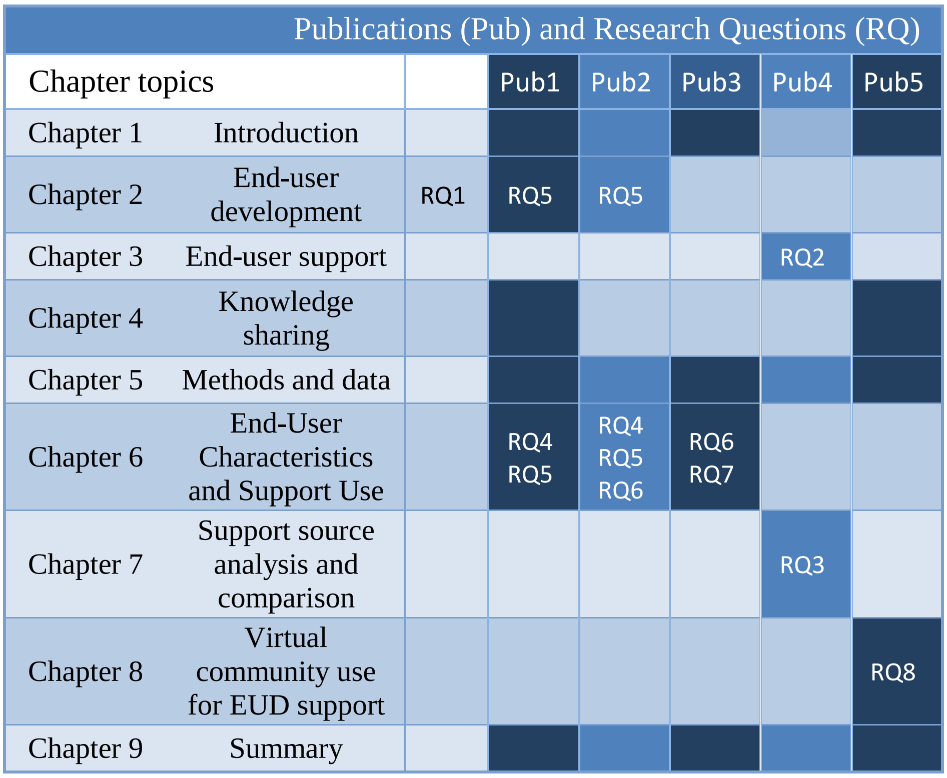
Chapter 5 presents the data collection and data analysis methods used in this thesis.

Chapter 6 presents the results from two surveys. It describes the end-user developers, the support sources used and examines connections between these.

In chapter 7 an analysis and comparison of various support sources end-user developers have and could potentially use is described.

Chapter 8 explores knowledge sharing in a virtual community and discusses how end-users could make better use of a virtual community for support.

Chapter 9 summaries and concludes the thesis, discussing the implications, limitations and future work of this research.



			Publications (Pub) and Research Questions (RQ)				
Chapter topics			Pub1	Pub2	Pub3	Pub4	Pub5
Chapter 1	Introduction		■	■	■	■	■
Chapter 2	End-user development	RQ1	RQ5	RQ5			
Chapter 3	End-user support					RQ2	
Chapter 4	Knowledge sharing		■				■
Chapter 5	Methods and data		■	■	■	■	■
Chapter 6	End-User Characteristics and Support Use		RQ4 RQ5	RQ4 RQ5 RQ6	RQ6 RQ7		
Chapter 7	Support source analysis and comparison					RQ3	
Chapter 8	Virtual community use for EUD support						RQ8
Chapter 9	Summary		■	■	■	■	■

Figure 3. Thesis overview of chapters, publications and research questions.

2 End-User Development

2.1 Introduction

The practice of end-user development is very common and has been part of computer science since the very beginning. The first computer users were all essentially end-user developers. End-users have often been at the forefront of introducing or using information technology in organisations. More and more regular software also allows for extensive customisation that is pushing the envelope towards being outright end-user development. This leads to a very rich and diverse history and present of end-user development, but also means that it is difficult to fathom due to its changing and many-faceted nature.

In this chapter I will briefly outline the over 50 years of end-user development history and research associated with it. I will describe the problems of delineating a general and broadly accepted definition for end-user development and how this term relates to other terms variously used as synonyms or not (section 2.3). This chapter will also cover some aspects of the developers, who they are (section 2.4), what they are doing (section 2.5) and the development process (section 2.6).

2.2 A Brief History of End-User Computing, Development and Research

There is a long history of users creating their own software. The first users of computers in the 1940s up to the 1960s-70s would normally have to create the programs they wanted to run on mainframe type computers themselves, as there was no one else to do it for them. With the increasing numbers of users requesting computing users started to diverge into pure end-users (which at this time meant people only using the computer output, e.g. reports) and the professional users supporting them. The late 1970s saw the first papers on end-user computing (S. Barker, 2007) and we started to see a population of users not directly programming the (mainframe) computers, although even at this early juncture there were suggestions that end-users should do their own development, e.g. McLean (1979).

In the 1980s there was a shift from mainframe to personal computers (S. Barker, 2007; Benson, 1983) fuelled, in part, by the emergence of spreadsheet applications for personal computers. For example, VisiCalc in 1979 became for many users the reason to acquire a personal computer (Power, 2004). This development led to an explosion of end-users and end-user computing became an important management issue for the late 1980s and early 1990s, e.g. see (Halloran, 1993; Henderson and Treacy, 1986; Powell and Moore, 2002; Regan and O'Connor, 1994). That research stream dealt with such issues as procuring information and computing assets and how to utilize and support the systems and users.

Other important issues in the 1990s have been end-user satisfaction with systems, e.g. the seminal works on measuring information systems success (DeLone and McLean, 1992, 2002) and end-user satisfaction (Doll and Torkzadeh, 1988), computer usage, identifying users and organisational and technological aspects (S. Barker, 2007). With the increasing importance of those using the systems, research looked at aspects of the users, their characteristics, abilities and needs (Powell and Moore, 2002). The late 1990s seemed to again move focus away from the end-user, at least as a controller and developer of computing resources. One result of managing end-user resources and the growth in general of computing meant that it became feasible to get off the shelf solutions for most computing needs. Powell and Moore (2002) note a reduction in studies focusing on the end-user dimension from the 1980s to the 1990s. In contrast, Downey and Bartczak (2005) come to the opposite conclusion in their review, though they do note a reduction in importance of end-user computing. This discrepancy is probably due to Downey and Bartczak not comparing the review with earlier research and the somewhat different classifications for what was included as relevant articles. They note that as a management issue end-user computing becomes less important as the technological maturity of an organisation increases. On the research side, focus tended more towards viewing the end-users as simply users of systems provided by others, e.g. the information systems success and end-user satisfaction research was and is mainly concerned with users' opinions of existing systems.

This focus away from end-user computing/development is most evident with the surprise of how much organisational computing relies on end-user developed spreadsheets which came to light as a result of the 2002 Sarbanes-Oxley legislation[3] in the United States. (Panko, 2006; Panko and Ordway, 2005) Since Sarbanes-Oxley required management to control financial information flows, they found the neglected end-users again and realised how many user developed applications they really had in their organisations. Panko often refers to end-user computing and development as the "dark matter of IT" because they are:

> ***"…enormous in quantity and importance yet have been largely invisible to corporate IT departments, information systems researchers, and corporate management."***
>
> ***Panko and Port (2012b)***

---

[3] The Sarbanes-Oxley regulation was a response to massive corporate financial fraud and accounting misuse and, among other things, required companies to be able to identify how and by whom economic information was produced and reported as well as regulate this process. Much of this information turned up outside documented financial systems or the systems were importing data from unspecified sources, often from spreadsheets.

Changes in technology and increasing computer literacy (S. Barker, 2007) have also impacted on the activity in end-user computing/development research. The spread of the Internet has brought in magnitudes more users into the end-user computing fold and the so called Web 2.0 has given them motivation and power to become developers (Fischer, 2009). Concurrent with this, in the early 2000s several initiatives on end-user development were started in the research community (Lieberman et al., 2006; Mørch, 2011), such as the EUD-NET running 2002-2003 (EUD-Net, 2003) and the EUSES Consortium starting in 2003 (EUSES, 2011). All in all, research and interest in end-user computing/development seems to have increased in the 2000s with cooperation and new research outlets.

Going into the 2010s many earlier questions and issues are still with us. Managing end-user computing/development is still relevant. Questions on the quality of user developed applications and how to improve that remain open. Improved tools, training and support may all form part of the solution. More platforms and areas open up for potential end-user impact. The user numbers of computational devices is steadily increasing, as does the different types of devices which support end-user computing/development activities. We are in the middle of another paradigm change where much computation is moving away from the desktop, and ironically, back into a distributed computing model, i.e. cloud-computing.

2.3 Is it End-User Computing, End-User Software Engineering, End-User Programming, End-User Development or Something Else?

End-user development is variously known under different terms, sometimes indicating subtle differences. The main terms used for the phenomena are: **end-user computing, end-user software engineering, end-user programming** and **end-user development**. All alternatives are variously in use to describe largely the same phenomena, i.e. non-professionals developing software. According to Blackwell (2002) “*[e]nd-user development, end-user customization and end-user software engineering have all been proposed as terms expressing the challenges faced by users encountering these new tools*.”, i.e. software the users can modify themselves.

One reason for the different terminologies used is that there is such a broad spectrum that needs to be covered. Costabile, Mussio, Provenza and Piccinno (2008) suggest that there is a spectrum between using and developing software. Y. Ye and Fischer (2007) introduced the spectrum of software-related activities, which provides a useful description of the progression from using to developing software, as shown in Figure 4. It may sometimes be difficult to delineate when one activity becomes another, although a certain categorisation is done here, it should not be seen to imply there are very distinct boundaries for these categories.

In addition, technological development is shifting the goal posts, and changes in technology and the technological environment have not been reflected in end-user computing/development definitions (S. Barker, 2007).

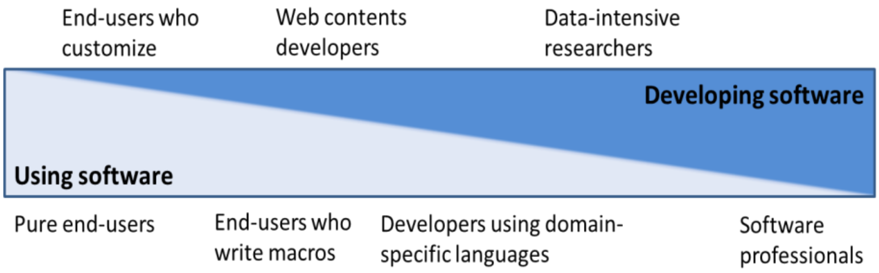

End-users who customize
Web contents developers
Data-intensive researchers
Developing software
Using software
Pure end-users
End-users who write macros
Developers using domain-specific languages
Software professionals

Figure 4. The spectrum of software-related activities (Y. Ye and Fischer, 2007).

2.3.1 End-User Computing

The term end-user computing commonly refers to the more general aspects of end-users using computers and not specifically programming or development activities, e.g. in R. M. Barker (1995), Costabile, Fogli, Mussio and Piccinno (2005), Downey and Bartczak (2005), Ein-Dor and Segev (1992), Guimaraes, Gupta and Rainer (1999), McGill and Klisc (2006) as well as Shaw, Lee-Partridge and Ang (2003). A typical example would be R.M. Barker's definition:

> ***[End-user computing] will be defined as the application of computing resources for the purpose of producing information by the information consumer.***
>
> ***R. M. Barker (1995)***

However, in some cases it is instead used to denote application development such as by Brancheau and Brown (1993) and Kreie, Cronan, Pendley and Renwick (2000). Brancheau and Brown give the following definition of end-user computing:

> ***"…end-user computing is defined as the adoption and use of information technology by people outside the information system department, to DEVELOP software applications in support of organizational tasks."***
>
> ***Brancheau and Brown (1993)***

We note the emphasis on the word "develop" used by Brancheau and Brown. As such, it actually forms an early definition of end-user development and not a definition of more general computer usage by non-professionals as one would expect.

Downey and Bartczak (2005) observe that there are two views of what end-user computing is, one more general and one focusing on application development. They also illustrate some of the problems of having many definitions, it is difficult to establish a common ground e.g. between academia and practice, something Barker agrees with (S. Barker, 2007).

Do we still need a general meaning term like end-user computing for just "using computers" anymore? Can it be seen as a depreciated term? Computers and computing has become so ubiquitous, it is hard to separate them from our modern society and daily life. There is, therefore, less need to make a specific mention of an activity as end-user computing. For example, "doing taxes" (using a spreadsheet or application to make calculations), "booking a hotel" (using a web-based information system), "watching movies" (using a web-based service to stream video) or "managing the household budget" (using a self-developed spreadsheet) are all activities where computers are now an important and sometimes almost inseparable part. I would suggest we can still use the term end-user computing. The term's usefulness lies more in delineating that computing is not the main task the user is concerned with, rather than signalling that it includes computing aspects. S. Barker and Fiedler (2011) propose an updated and extended definition of end-user computing:

> ***"End-User Computing is the use of computing technology and/or software applications, together with the enhancement, modification and/or development of information systems by end-users for individual, departmental or organisational use."***
>
> ***S. Barker and Fiedler (2011)***

As such, it forms a useable definition including development as a part of a larger umbrella of computer usage. In this thesis, I will be using the term end-user computing in this way, meaning non-professional use of computers.

2.3.2 End-User Software Engineering

The term **end-user software engineering** (Ko et al., 2011; Segal, 2005) is also used to describe the practice of users developing applications. While sometimes the term end-user software engineering is used analogously to end-user programming or development, most often it seems it has a more specific meaning.

End-user software engineering takes the view that developers should be trained in and utilize software development practices to improve the quality of user developed applications. These include creating requirements, code reuse, testing and verification and a number of other techniques already used in the professional software development world. End-user software engineering partly also implies the use of tools that can support these activities. (Ko et al., 2011) This concept aims to merge the established discipline of software engineering with all the associated benefits of structured development (i.e. software quality) to the strengths of the end-user developer, mainly in the form of better problem definition and domain fit. In theory, there is less need for a time consuming and error prone requirements elicitation process if the end-user can (co-)develop the software.

The challenge is to persuade people who do not consider the development as a critical task (see section 2.6) to do so. It is certainly not helped by software trying to hide the "hard stuff", i.e. programming, behind pleasant user interfaces or otherwise reduce the development effort, commendable as that is from a usability standpoint. In some cases, end-user software engineering carries an implied professionalism or sophistication. Or the reverse, end-user programming is considered less professional and simpler, as mentioned by Ko et al. (2011). Figure 4 shows that the activities to the right on the spectrum suggest a more complicated development process and perhaps a more complex problem. In this thesis, I consider end-user software engineering as the software development activities performed by non-professionals using structured development methods (see Figure 5).

2.3.3 End-User Parameterization/Customization/Tailoring

End-user parameterization, customization and **tailoring** (hereafter simply parameterization) is a set of terms that is occasionally used to express various degrees of end-user development modifications of software. End-user parameterization seems to mainly be used where the end-users' actions and impact are more limited, perhaps even entirely predetermined, e.g. picking among predefined options (Lieberman et al., 2006). Ko et al. (2011) imply anything not modifying source code is parameterization, but that would exclude most spreadsheet creation which is normally considered development or indeed, as Blackwell (2002) suggests, programming. Further, Blackwell suggests that the term may "*deemphasise the sophistication of the programming required*". The activities on the left side of the spectrum (Figure 4) are very different from the middle and the right side. It is also difficult to delineate when one activity becomes another. In this thesis, parameterization is taken to mean a more limited form of modification of software applications.

2.3.4 End-User Programming and End-User Development

The terms end-user programming and end-user development are used largely interchangeably for end users creating applications. Nardi (1993) uses the term **end-user programming** and the same term, but a different connotation also appears in Ko et al. (2011). Nardi uses the term to describe the *identity* of the developer whereas Ko et al. use it to describe the *intent* of the development effort. The term **end-user development** itself is somewhat newer. Part of the need for a new definition is that the concept of users developing software has changed and incorporates different threads of discussion from other fields (Lieberman et al., 2006).

To some degree it could be said that there has been a shift over time from programming to development. The term end-user development is, at least in wider usage, somewhat newer. In a review of end-user computing and development definitions S. Barker (2007) lists the most commonly referenced definitions in a study. With the exception of the definition presented by Amoroso (1988) all others referring to end-user development are from the 2000s e.g. Chaffey and Wood (2004), Costabile et al. (2005), McGill (2005) and Sutcliffe and Mehandjiev (2004).

To some degree the change of term could be related to changes in what is possible for end-user to do. Whereas earlier any user developed application would be done through programming, developments in software have allowed users to use different techniques to create software artefacts that can be less technically taxing, such as visual languages (Blackwell and Hague, 2001), and programming by example (Lieberman, 2001). The use of the word development itself can be useful to highlight how the users themselves often do not consider what they do as programming activities[4] called *unwitting software developers* by Costabile et al. (2008) and *unwitting end-user programmers* by Petre and Blackwell (2007). Segal (2007) notes that spreadsheet users do not describe themselves as programmers or software developers.

Another important aspect to distinguish between is 1) end-users participating in the **design phase** and 2) end-users modifying software **during use** (Lieberman et al., 2006). This seems to be the key separator between end-user programming and end-user development in Ko et al. (2011). The former is usually not considered end-user development whereas the latter would. However, both terms are still variously used by different authors and not always with intended differences in meaning.

Finding a unique definition for end-user development is not easy. There are many different definitions depending on the point of view of the one who defined it (Downey and Bartczak, 2005; Lieberman et al., 2006). The common theme is that the person developing or writing the software is not formally trained as a programmer or developer (or experienced in doing so) and/or have this as their main focus of activity.

As mentioned above, software may be developed in different stages with different amounts of end-user participation in the design phase or during use. The key difference is in the end-user’s agency in the design/development process. The first option (participation during the design phase) is more the case of traditional software development processes where users are asked to provide specifications and feedback. The second case (modification during use), the one considered in this thesis, is actual development done by end-users.

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[4] It should be noted that there are also numerous definitions as to what exactly constitutes “programming”. The question is discussed e.g. in Blackwell (2002) with regards to the end-user domain. One interesting aspect is that regular people would call something “programming” that a trained programmer would not. Conversely a regular person may not consider end-user development activities to be programming when by definition they often are. As such, we adopt the broader view of what “programming” is as presented by Blackwell, without necessarily taking a stand on what constitutes “programming”.

The definition of end-user development and associated developer usually revolves around the lack of formal training in programming or development activities. In this thesis I have chosen to follow the definition of Lieberman et al. who formulates it thus:

> ***"[End-user development] can be defined as a set of methods, techniques, and tools that allow users of software systems, who are acting as non-professional software developers, at some point to create, modify, or extend a software artifact"***
>
> ***Lieberman et al. (2006)***

This definition is relatively broad and inclusive, covering many aspects of different degrees of development activities making no assumptions of the skill level of the developer or the size and intent of the development effort.

2.3.5 Taxonomy of End-User Computing Concepts

In light of the somewhat different meanings of the terms a taxonomy is proposed (outlined in Figure 5) that will be used throughout this thesis. Similarly to S. Barker and Fiedler (2011) in this thesis *end-user computing* is considered as the overall concept of people without formal training in computer science or other related domains (or with equivalent experience) using computers. The other terms form subsets of this overall concept.

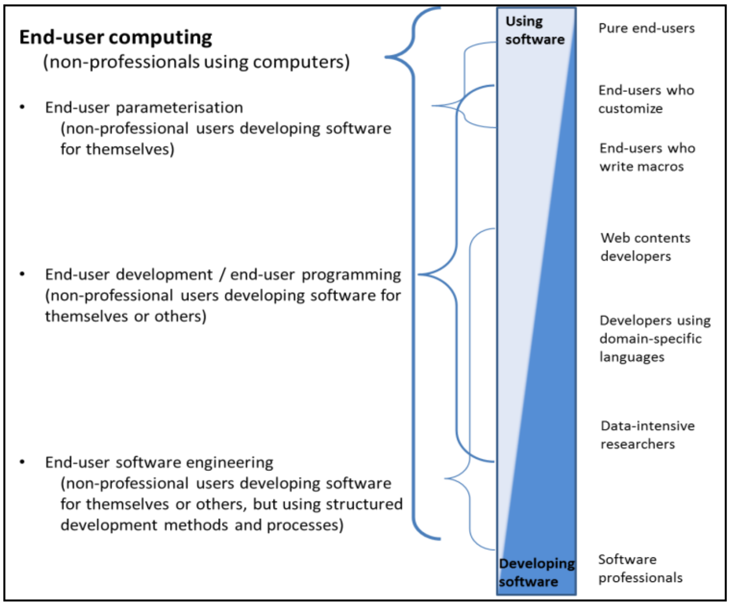
End-user computing
(non-professionals using computers)
End-user parameterisation
(non-professional users developing software for themselves)
End-user development / end-user programming
(non-professional users developing software for themselves or others)
End-user software engineering
(non-professional users developing software for themselves or others, but using structured development methods and processes)
Using software
Developing software
Pure end-users
End-users who customize
End-users who write macros
Web contents developers
Developers using domain-specific languages
Data-intensive researchers
Software professionals

Figure 5. Taxonomy of end-user computing concepts mapped to the spectrum of software-related activities.

End-user parameterization is a more limited modification of software whereas end-user development and end-user software engineering both represent wholesale changes or development from scratch. In Figure 5 the taxonomy is mapped against the Y. Ye and Fischer (2007) *spectrum of software-related activities*. It should be noted that the bottom part of the spectrum is not end-user computing, but instead professional software development.

While it could be argued there is a natural progression of complexity from one term to another this distinction is not made here, other than to illustrating the gradual migration from one extreme to another. The difference between end-user development and end-user software engineering here becomes one of the degree to which structured methods and processes are applied. While it would be natural to suggest more complex and extensive problems should be done with more formal processes that choice is left to the end-users themselves.

2.4 The End-User and Developer

If defining what end-user computing and development really is has been difficult, then trying to define the end-user may be even more so. End-users are not all the same (Segal, 2005). Rather, they are a very heterogeneous group consisting of people with a variety of skills, tasks and motivations. (Klann et al., 2006; Lieberman et al., 2006) The early paper of Rockart and Flannery (1983) mentions the importance of knowing who the end-users are and further notes that *“[t]here is no single, stereotyped ‘end-user’ with a single, defined set of characteristics*”. The difficulty of defining the end-user and thus the end-user developer has been a problem for almost as long as there have been end-user computing and development.

The many views of what end-user development is result in several ways of looking at the end-users as developers, for example:

1. Through their level of computer/development skill, or lack thereof.
2. As a function of their jobs/tasks/other processes.
3. The respective role the users fill as producer, consumer, owner and/or controller of information/computing resources/etc.
4. The intent of the development. Is it only for personal or also wider use? Is the development a goal in itself or just a means to an end?

S. Barker (2007) notes that changes in technology and the technological environment have not been reflected in end-user computing/development definitions. By extending that thought, it would suggest that to some degree we are working with outdated concepts of who the users are. It is suggested that many researchers use the Rockart and Flannery classification despite it being somewhat outdated (Govindarajulu, 2003; Govindarajulu and Arinze, 2008). Some of the early investigations into end-user computing, like McLean (1979) and Rockart and Flannery (1983), mainly concentrate on the skill, utilization and function aspects of end-users as distinct from other developers.

As technology has matured, many of the underlying assumptions have changed. Some of the earlier classification types have no real meaning in today’s world. There is also the issue where a user may be a skilled IT-professional, but an unskilled developer, or the intent is not one of development. Ko et al. (2011) discuss the difference between *goals* and *intent* of the development effort and experience/skill. Professional programmers can do end-user development to support some part of their work, even though that work in itself would constitute regular software development. This closely relates to the idea that end-users do not really consider the development activities as a focal effort (Costabile, Fogli, Mussio and Piccinno, 2006; Ko and Myers, 2005; Nardi, 1993; Segal, 2005; Segal, 2007). It is also too easy to equate inexperience as a developer with general computing inexperience and the resultant efforts as not meaningful. However, there are end-user developers who are skilled and create important software despite little formal training (Segal, 2007).

A more systematic view of user types is the user cube with operation-development-control dimensions (Cotterman and Kumar, 1989; Govindarajulu and Arinze, 2008), where end-users are organized depending on their relative fit to the dimensions. However, the end-user developer in small organisations is almost always in full control of the operation-development-control dimensions. Therefore, this view does not fit this type of end-user developers very well.

From the prior literature it is clear then that end-users are complex people with wide-ranging motivations and abilities and that it is important to consider their differing aspects for why and how they chose to do things. While it is apt to describe end-user developers as regular users developing software, there is really nothing regular about them. Panko and Port (2012a) call for more descriptive research to provide a more thorough investigation into the end-user developers.

As noted in the introduction in chapter 1, this thesis focuses on small organisations, so this initial limitation delineates the potential user population. For an end-user developer in a small organisation neither views number 3 or 4 provide differentiation. The intent (4) is generally of personal development and there is no difference in the role the user fills (3). Therefore in the research presented in this thesis views 1 and 2 are the ones considered.

2.5 End-User Developed Applications

As mentioned earlier, there are more end-user developers than professional programmers (Scaffidi et al., 2005). Building on the Scaffidi et al. estimate for computer usage would suggest that by 2012 around 55 million end-user developers exists in the United States. The Scaffidi et al. study covered the more traditional areas of end-user development, such as spreadsheets and databases. In addition to these, web design/development (McGill and Klisc, 2006) and related activities such as content management systems (Ardito et al., 2012) and web mash-ups (Cappiello et al., 2011; Lin et al., 2009) are relatively new areas that give development power to end-users. The growth of cloud-computing will also mean more non-professional developers are putting together information systems. These can be created from pre-fabricated components using different service or infrastructure platforms, e.g. running back office functions in Google Apps and using Amazon Web Services for a consumer front end. While these activities may not require the user to explicitly write code it does represent a high level development activity if the users wants to integrate the different components. Taken together this means there are most likely hundreds of millions of end-user developers creating various kinds of software or modifying applications in greater or lesser ways. Table 1 below illustrates the wide range of end-user developers and types of software they produce. These examples give only a small sample of end-user development activities.

Table 1. Some end-user developers and their programs, after Ko et al. (2011).

Class of people	Programming activities and tools/languages used
System administrators	Use scripting languages to glue systems together
Interaction designers	Prototype user interfaces with Visual Basic and Flash
Artists	Create interactive art with languages like Processing
Teachers	Teach science and math with spreadsheets[5]
Accountants	Tabulate and summarize financial data with spreadsheets
Actuaries	Calculate and assess risks using financial simulation tools
Architects	Model and design structures in FormZ or other 3D modellers
Children	Create animations and games with Alice[6] and Scratch
Middle school girls	Use Alice to tell stories[7]
Webmasters	Manage databases and websites using Access and Javascript
Health care workers	Write specifications to generate medical report forms
Scientists/engineers	Use MATLAB and Prograph[8] to do tests and simulations
E-mail users	Write e-mail rules to manage, sort and filter e-mail
Video game players	Author “mods” for various games, e.g. The Sims, Fallout 3
Musicians	Create digital music with musical dataflow languages
VCR and TiVo users	Record television programs in advance
Home owners	Write/control heating/lighting system schedules with X10
Apple OS X users	Automate workflow using AppleScript and Automator
Calculator users	Process and graph data with calculator scripting languages
Managers	Produce data-base backed reports with Crystal Reports

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[5] Niess, Sadri and Lee (2007)
[6] Dann, Cooper and Pausch (2008)
[7] Kelleher and Pausch (2006) and Kelleher, Pausch and Kiesler (2007)
[8] Cox, Giles and Pietrzykowski (1989)

As with the users themselves, the applications and methods used to create them are very diverse. As such, it is necessary to somewhat limit the scope. Arguably the most common environment for end-user development is the spreadsheet. Most developers have access to or experience of it, and it forms something of archetype for the end-user development. This was true for the developers working in small organisations I have met in real life and whose situation formed one basic motivation for this research. While this research has not consciously excluded any one technology, software or technique, in practice most of it has considered or been strongly influenced by the spreadsheet development paradigm due to its real life importance and ubiquity.

2.6 The End-User Development Process

To understand end-user development, to understand why complex problems are solved with relatively little regard for quality or process, we need to acknowledge and understand the inherent dichotomy of end-user development by looking at the end-user development process. End-user development is primarily intended to support other work or activities and does not form the main focal point for the developer's effort (Costabile et al., 2006; Ko and Myers, 2005; Nardi, 1993; Segal, 2005; Segal, 2007). Therefore, only the results really matter, not how you get there. End-user development, unlike regular software development, is a burden the end-user must first evaluate whether it will be worth the development effort or not (Blackwell, 2002).

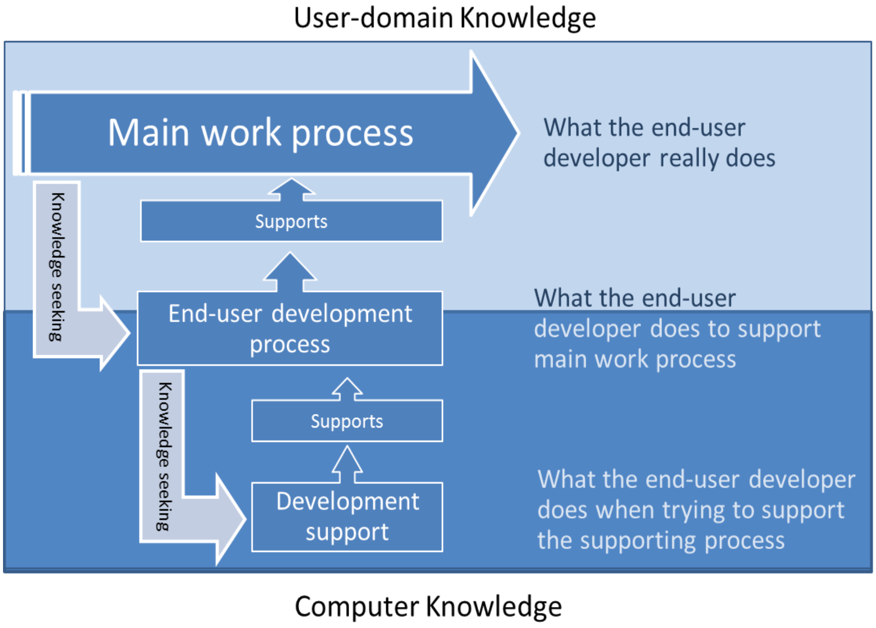
User-domain Knowledge
Main work process
What the end-user developer really does
Knowledge seeking
Supports
End-user development process
What the end-user developer does to support main work process
Knowledge seeking
Supports
Development support
What the end-user developer does when trying to support the supporting process
Computer Knowledge

Figure 6. End-user development process levels.

In addition to the particular skills and abilities of an end-user developer, the end-user development process lends itself towards certain types of working and can influence the choice of support. Figure 6 illustrates how end-user development and development support are process loops ever further removed from the main work process, which is the main focus for an end-user developer (Ko and Myers, 2005; Nardi, 1993; Segal, 2005; Segal, 2007; Sutcliffe et al., 2003).

End-user development is a knowledge-intensive process that combines user-domain knowledge and computer knowledge. For the developer this process of knowledge seeking and problem solving has the goal of achieving *actionable knowledge* (Cross and Sproull, 2004), which in this case is represented by an application to solve a problem or task. If the user needs to access development support, then this complicates the process further as this is an additional process of knowledge seeking in the domain the developer is often weaker in, i.e. computers.

The end-user developers have a more holistic approach to development with strong focus on context (Repenning and Ioannidou, 2006) and iterative development (Brandt, Guo, Lewenstein and Klemmer, 2008; Repenning and Ioannidou, 2006), which makes the developer very much like Clarke's "opportunistic developer" who:

> - ***Writes code in an exploratory fashion.***
> - ***Develops a sufficient understanding of a technology to understand how it can solve a business problem.***
> - ***Prides themselves on solving business problems.***
>
> ***Clarke (2007)***

The iterative process is then coupled with a tendency to learn "just enough", take the simpler approach, immediate but less useful feedback and other cognitive biases (Ko and Myers, 2005). Naturally, not all end-user development follows an iterative model, but it seems typical for many cases and descriptions in the literature of iterative end-user development e.g. Ko and Myers (2005), Repenning and Ioannidou (2006) and Segal (2005, 2007).

This concept is also supported by software that may not require the developer to write explicit code, further detaching the end-user from what is usually considered to be something complex. Instead, programming can be performed through programming by example (Lieberman, 2001), visual means (Blackwell and Hague, 2001), pseudo code and numerous combinations thereof.

The spreadsheet environment is a very good example of this, where the cell grid abstracts the process and need for defining a data structure and you simply add data, built-in formulas or construct formulas which will form a rudimentary computer program. For example, Blackwell (2002) describes the spreadsheet as "*itself a declarative programming language*". However, few spreadsheet users describe themselves as programmers or software developers (Segal, 2007). In other words, not only is the end-user developer not focused on the task as a deliverable but his or her tools are also actively downplaying the complexity of the task.

2.7 Summary

This chapter has outlined the history of end-user development. It has also described the many definitions for end-user development in use and provided a taxonomy for understanding the terms used in this thesis and how they relate to other research. The concept of the end-user developer, user developed applications and the end-user development process was also explained as they apply to this thesis. End-user development and end-user developers are very heterogeneous concepts and groups, both in practice and research today, as well as in the past. To help triangulate the research small-organisations and mainly spreadsheet development has been the focus of much of it, picked as representative and accessible.

The next chapter will describe the sources of support and introduce a framework for understanding support in the context of end-user development.

3 Sources of Support

3.1 Introduction

There are many support sources available for the end-user developer to consult. The number and type of sources available varies from end-user to end-user depending on the particular environment they work in. From the available sources an end-user will pick one or more that fits their preferences.

There are numerous ways to analyse and understand support. Some are based on traditional views of who provides the support. Another way is to examine different attributes of sources, e.g. if they are found on-line or not. Neither of these views adequately considers support from the perspective of the end-user developer. For the end-user developer the distinctions of who is producing the support or where to find/access it are mostly irrelevant. This chapter introduces a framework based on an extensive literature review for the most important factors that are relevant for end-user development support. This framework considers the characteristics of knowledge seeker, source and relationship simultaneously.

The chapter is structured as follows. Section 3.2 introduces the concept of support for end-user development and available sources and section 3.3 describes what the implications of on-line versus off-line support are. Section 3.4 discusses the problems inherent in end-user support and section 3.5 whether some sources are more preferred than others. Sections 3.6 and 3.7 introduce and present the framework of four EUD factors that can impact on the choice of what source is used.

3.2 End-User Support

Chapter 2 described how end-user development can be seen as an extension to end-user computing. Consequently, general end-user support forms the basis for understanding development support. Traditionally, support for end-users is divided into two categories: *formal* and *informal* support. Formal support consists mainly of help from an IT or IS department, which is sometimes called the information centre (IC) or the helpdesk. That department is usually a support unit separate from other departments. Other formal support sources include manuals or vendors. Informal support usually consists of a user’s social network, usually in the form of colleagues or friends and family.

Additionally, one should consider the local IS/IT staff and other localised support, a practice sometimes referred to as *super users* by Asand and Mørch (2006), Mitrusevska and Pettersson (2005) and Nilsen and Sein (2002), *power users* by Fischer et al. (2004) and Jones and Price (2004), *master users* by

Spitler (2005) or other (similar) connotations[9]. This form of support can be formalised to various degrees, but often combines some of the best aspects of formal and informal support, i.e. IT knowledge and local understanding. Local IS/IT staff are people from the IS/IT departments placed in various other departments or business functions to provide local support. The so called super users are people who as part of their work tasks provide support for other people, as they are recognized experts e.g. on certain applications (Jones and Price, 2004; Nardi, 1993) or perform tasks more related to the computer science domain, e.g. serving as mediators between users and developers (Asand and Mørch, 2006).

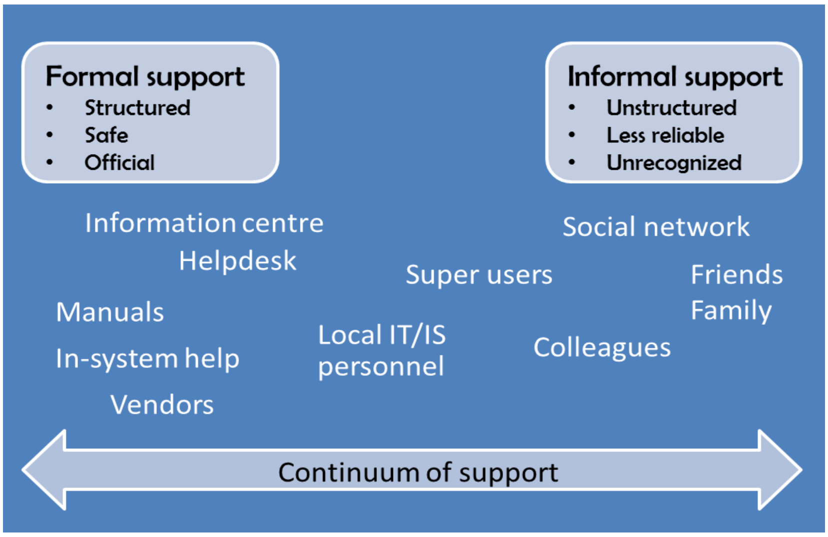
Formal support
Structured
Safe
Official
Informal support
Unstructured
Less reliable
Unrecognized
Information centre
Helpdesk
Manuals
In-system help
Vendors
Local IT/IS personnel
Super users
Social network
Friends
Family
Colleagues
Continuum of support

Figure 7. Illustration of the traditional view on support

To further complicate the matter, sometimes the super users are not a formal part of the support structure, but rather, part of the informal social network like “that guy we always call when we have computer problems”, to paraphrase one survey respondent. As the practice of local IS/IT staff and super users can be formalised to various degrees (Speier and Brown, 1997) they can be seen as a continuum. On one end of the spectrum are IS/IT staff originating from the IS/IT department, with a technical background, and on the other super users, who are domain experts on the tools of their function and business processes. Often their responsibilities will vary depending on their background and hence suitability for different kinds of support. Similarly, most sources could be placed within such a continuum of support, with regards to degree of formality, as seen in

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[9] The super/power user concept is also used in other computing contexts, usually to denote particularly skilled people. A similar connotation is normally also assumed in the EUD context.

Figure 7. It should be noted that formality seldom matters to the actual users and is more interesting if we want to organise and manage support. As such the exact degree of formality is largely irrelevant in the context of this thesis and provided here more to place this research in a historical context.

3.3 On-Line End-User Support

The traditional way of categorising support relies on the distinction of who is producing it. When looking at sources on-line the traditional categorisation of formal and informal loses much of its relevance. Instead, it might make more sense to look at whether sources are found either on- or off-line and how that changes the aspects of a source.

Most sources are available both on- and off-line, in one form or another. They can be either a direct *copy* (the same source, but in a different medium) or exist as a *substitute* (similar content/function, but a different source). Table 2 shows the corresponding off-/on-line versions of sources. They are categorised based on typical content and the way information is provided. E.g. magazine articles can be found on-line (as copies), but they also share a similarity in content to blogs (substitute). Both typically describe a feature the author thought interesting and wanted to share to a wider public. Many organisations have an on-line version of their helpdesk where you can post questions or access other available support resources; the on-line source is a copy of the off-line version. A virtual community works as a substitute for contacting colleagues, friends and family through various methods such as e-mail, chats and forums, both sources have the same core function. On-line sources are generally speaking the same as off-line sources. What makes the on-line sources special is usually that they can use features brought in by the medium that enhance their function (Purchase and Worrill, 2002).

Table 2. On-line and corresponding off-line support sources.

Off-line source	On-line source
Magazines and other articles	Articles (*copy*) Blogs and “tips & tricks” webpages (*substitute*)
Manuals, books	Manuals, books (*copy*) Knowledge bases, wikis (*substitute*)
Application help function	Knowledge bases, wikis (*copy*/*substitute*)
Software libraries/APIs	Software libraries/APIs (*copy*)
Personal contacts, advice from social network	E-mail, instant messaging, chat (*copy*) Virtual communities (*substitute*)
Helpdesk/Information centre	Helpdesk (*copy*)
-	Internet search
Trial and error	-

3.4 Challenges of End-User and Development Support

Quite often it is assumed support is always available, that it exists and it is only a matter of the user picking what fits, which may or may not be the case. Supporting end-users can be difficult, as found in many previous studies of end-user support and/or end-users' satisfaction with support. All too often there is a pronounced dissatisfaction with the support on the end-user's part, which in turn pushes end-users to seek alternative means of support. (Asand and Mørch, 2006; Carr, 2006; Constant et al., 1996; Govindarajulu and Reithel, 1998; Govindarajulu et al., 2000; Govindarajulu, 2002; Jennex, 2006; Nilsen and Sein, 2002; Nilsen and Sein, 2004; Shaw et al., 2003; Shaw et al., 2002; Spitler, 2005)

Furthermore, as mentioned earlier in chapter 2, the user population is very varied and there are many tasks and application for support to cover (Carr, 2006; Shaw et al., 2003). Sometimes the complexity of the population can hide aspects of and needs for support when doing general surveys, as what is important for one part of the population is not always salient for others (Shaw et al., 2002). McGill and Klisc (2006) give training as an example where end-user expectations and formal support do not meet. Development support seems a particular problem, despite a few positive examples such as Speier and Brown (1996) and Guimaraes et al. (1999). Govindarajulu et al. (2000) note that development support was not part of the responsibilities of local IS/IT support. Furthermore, Govindarajulu (2002) notes how helpdesks appear to provide only limited support for end-user development activities. Spitler (2005) describes how the IT support does not provide support for office applications, which are one of the major sources of end-user development activities. Jennex (2006) describes a situation where the development activities were largely ignored by support. In short, support for end-users, particularly developers, tends to be rather limited in most organisations.

To make matters worse, small organisations may not have the resources for a formal support structure, such as a helpdesk, as was the case in (Xiao and Farooq, 2012) and similarly a lack of resources was a problem in (Moffitt, 2006). There are large numbers of end-user developers that do not belong to any organisation, such as those small-business owners in the studies performed for Publication 1 and Publication 2. These people face many challenges when trying to adopt IT (Kamal, 2011). To this should be added the numbers of home users who also suffer from similar problems of lack of support and are usually not considered in discussions on support.

3.5 Do End-Users Prefer Some Forms of Support?

Literature shows that there is some ambiguity to the question of what support users prefer. Previous studies have investigated what support users prefer. In (Govindarajulu, 2003) user groups ranked friends the most preferred support method. Furthermore, friends and local IS/IT support were preferred over helpdesks in (Govindarajulu, 2002), while executives mentioned contacting colleagues for assistance in most cases in (Seeley and Targett, 1997). Similarly, Hriberšek, Werber and Zupancic (2005) reported informal support usage over the IS/IT department and local IS/IT staff. However, in (Govindarajulu, 2000) middle level managers preferred the local IS/IT staff and IS/IT department over other support. In (Cross and Sproull, 2004) most managers mentioned people as important sources of information instead of the computerized knowledge repositories that were promoted in the organisation examined. Spitler (2005) describes how colleagues were picked over available support personnel.

Instead of asking whether some type of support is more or less preferable it would seem more fruitful to look at why users choose certain sources of support. Govindarajulu et al. (2000) suggest that user attitudes toward a source of support will influence their choice more than subjective norms. If formal support is found to be useful, responsive and knowledgeable it will be used. If not, users will find other sources. But how are these attitudes formed? The requirements for support may depend on the characteristics of the users themselves.

It seems informal support in many cases is the default source, possibly because it is more accessible to the user, whereas formal support needs to demonstrate a benefit to be considered by users. Thus, what the preferred support source is and the sources used will vary according to the end-user's characteristics and expectations, as well as the characteristics of the support sources themselves. There is unfortunately no "one size fits all" solution (Shaw et al., 2003), which is important when considering different types of sources. Different users can and will prefer to use different sources.

3.6 Factors Impacting Choice of Support for End-User Development

As mentioned earlier, end-users may have problems with finding and/or using support, and this seems to be even more pronounced for end-user developers. Indeed, in many cases the end-user developer has nowhere to turn to for support. The helpdesk and other IT support may provide only limited development support (Govindarajulu, 2002) or none at all (Govindarajulu et al., 2000). Small organisations may not have the resources to provide support and others are not part of any organisation at all. As a result, many developers are left with limited support options, mainly from their social network. These sources may not always able to provide adequate and reliable advice. It is likely that the user's social network is on par with the user in terms of knowledge (Constant et al., 1996) and Gallivan, Spitler and Koufaris (2003) note how people in organisations and groups are often on a similar level of self-efficacy. Compared to earlier decades today's developers have a virtual (figurative and literal) treasure trove of information in the form of the Internet. Using the Internet as a channel allows an end-user developer to access support sources that could potentially overcome many of the obstacles that often make traditional sources inadequate for end-users.

User attitudes toward a source will influence their choice more than subjective norms (Govindarajulu, 2000). Informal support like a developer's social network often seems the default source, probably because it is easily accessible. Other sources may need to show a benefit to be considered by users. Since we cannot normatively change support use we must tackle the attitude towards it instead. But how are these attitudes formed?

The preference and usage of support sources will vary according to the end-user's characteristics and expectations, as well as the properties of the support sources themselves. End-user developers are a very heterogeneous group (Klann et al., 2006) so the impact will likely be considerable. Some characteristics are prevalent for all types of information seeking such as gender, job type and relation to the source (Cross and Sproull, 2004). Also, characteristics such as age, computer self-efficacy and computer skills form the basic contextual frame of reference for the end-user and will influence the choice of support source.

Skill is related to usage, higher computer skills increases confidence in using computers (Liaw, 2002). Gender and computer self-efficacy is likely to influence the choices of support source (Beckwith and Burnett, 2004; Nilsen and Sein, 2004). Males are more comfortable with computers and the web (Liaw, 2002) and gender impact areas of end-user development such as debugging (Beckwith et al., 2006) and self-efficacy in end-user developers (Beckwith, Inman, Rector and Burnett, 2007). People need to be comfortable with computers and using the Internet and search engines to be able to use Internet sources (Liaw, 2002). People who have grown up with technology are more familiar and comfortable with it (Brown, 2002). Proximity (both mentally and physically) to the user can also be an important factor (Govindarajulu et al., 2000; Nilsen and Sein, 2004). All these attributes will impact on the choice of support.

3.7 A Framework for Understanding End-User Development Support

For the end-user developer the distinctions of who is producing the support or where to find/access it are immaterial. The end-user developer would likely be looking at other factors for deciding what type of source to access. Like Cross and Sproull (2004) the characteristics of knowledge seeker, source and relationship are here modelled simultaneously. The sources have very different characteristics, and concepts such as "ease of use" and "ease of access" have widely different meanings for an electronic version of a paper manual versus a virtual community and are thus not easily used to compare sources. With the great many factors potentially impacting choice of source the following question is posed: are there any factors unique to or particularly interesting with regards to the end-user developer?

3.7.1 Deriving the End-User Development Support Framework

The framework was derived from secondary data in the form of a literature review. The literature was reviewed by searching with Google Scholar and other research and science journal databases such as ACM Portal, Elsevier, Emerald, EBSCOHost, IEEE Explorer, Science Direct and SAGE. The keywords used were: *end-user computing/development/programming*, *on-line support* and *end-user support*. Since end-user computing and development cuts across many subject matters, a number of different sources were accessed. Additionally, the main research outlets covering end-user development and human-computer interaction, including workshops and conferences, such as CoPD@ – Cultures of Participation in the Digital Age, Americas Conference on Information Systems (AMCIS), European Conference on Information Systems (ECIS), IEEE Symposium on Visual Languages and Human-Centric Computing (VL/HCC) and International Symposium on End User Development (IS-EUD). Journals like the Journal of Organizational and End User Computing (JOEUC) and MIS Quarterly (MISQ) were also examined by searching for the above keywords. Other sources were also examined where literature provided references to other less well known conferences and journals.

Reading through the material relating to end-user development certain common themes, particularly relevant for the end-user developer's pursuit of actionable knowledge, were repeated. I posit that these themes could be distilled into four factors i.e. *context*, *cooperation*, *interaction* and *immediacy*.

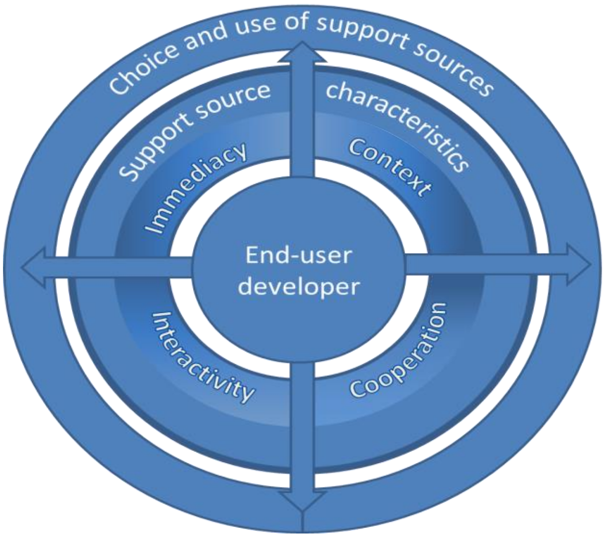


Figure 8. End-user development support framework.

Figure 8 illustrates how it is proposed the factors relate to the choice and use of support sources and form a framework for understanding end-user development support. An end-user's choice or use of a support source will depend on the combined skills and characteristics of the end-user developer. These have a direct relationship to the source. Adopting the holistic constructivist perspective of gaining actionable knowledge (Cross and Sproull, 2004) I place the end-user developer at the centre of the process, i.e. *the characteristics of knowledge seeker* (Cross and Sproull, 2004). I propose that the collective abilities of a developer will also be mediated through the four end-user developer factors, i.e. *characteristics of knowledge source* (Cross and Sproull, 2004). Therefore, by supporting these factors to various degrees a support source will impact on how desirable they are to people seeking support. Since this research takes a holistic view of the support concept it will be critical to understand the aspects of support sources in the context of end-user development.

3.7.2 Context

Why am I doing this again..?

Context represents the domain the developer works within, the language by which the developer understands his or her field and the motivation to make the development effort. Age, gender, job, skill and organisational context (Beckwith et al., 2006; Beckwith et al., 2007; Brown, 2002; Cross and Sproull, 2004; Ko and Myers, 2005; Ko et al., 2011; Liaw, 2002; Nilsen and Sein, 2004) form part of the context in which the end-user developer works. *Syntonicity* (Papert and Harel, 1993), i.e. being able to put oneself into the context, is important in end-user development (Repenning and Ioannidou, 2006). This could be accomplished by proximity (both mentally and physically) to the user (Constant et al., 1996; Mitrusevska and Pettersson, 2005; Nilsen and Sein, 2004). Brandt et al. (2008) describe programmers using web-searches to translate syntax and terminology. The dialect a domain experts use in their work and the tacit knowledge they can apply is important for context (Costabile et al., 2006). Sykes, Venkatesh and Gosain (2009) note that employees turn to peers for contextual support. The importance of context is also evident in the localised support praxis. The reason for co-locating IT/IS staff with functional units and the existence of the local helpdesk/super users is to be close to the user being helped, to understand their context (Nilsen and Sein, 2004). Both Harris (1994), according to Sørebø, Sørebø and Sein (2008), and Speier and Brown (1997) note that the principal sources of support are those close to the users. Shachak et al. (2013) highlight the importance of context in support. Purchase and Worrill (2002) note the importance of context and context sensitive support in on-line help systems.

A developer will need to be able to recognize a future benefit so as to motivate the development effort (Blackwell and Green, 1999; Blackwell, 2002; Sutcliffe et al., 2003) as the development effort is often a secondary activity to the end-user and attention is not focused on the implementation used in the environment (Ko and Myers, 2005; Nardi, 1993; Segal, 2005; Segal, 2007; Sutcliffe et al., 2003). It should also be noted that context here implies information easily available or visible to the user. A large database, while containing the information sought, will not support context if the end-user is unable to find it or sift it from all the other information. For example, Stylos and Myers (2006) note how web searches helped programmers overcome barriers resulting from phrasing issues, due to looking at sources such as discussion forums where other phrasing was used to describe problems. This also relates to immediacy as the speed at which information can be digested could be considered part of providing a timely answer.

3.7.3 Cooperation

Can you tell me if I'm doing this right?

Cooperation means users pool their skills together. Nardi notes how developing spreadsheets is often a collaborative work effort rather than an individual effort (Nardi, 1993). Furthermore, cooperation was important for successful end-user development (Nardi, 1993). Ko et al. describe programmers contacting more expert users forming "informal apprenticeships" (Ko and Myers, 2005) and Spitler (2005) recounts a similar situation. In (Repenning and Ioannidou, 2006) it is suggested that building community tools is beneficial to EUD. Mutual development is one form of cooperation and is prevalent in the meta-design framework (Fischer et al., 2004; Fischer and Giaccardi, 2006; Fischer, 2009) and evolutionary application development (Mørch, 2011).

Cooperation could also be considered involving a touch of human interaction. There is evidence for some users, presumably less knowledgeable users, emphasising friendliness and good communication skills over technical knowledge (Mitrusevska and Pettersson, 2005). Harris (1994) investigated the "caring nature of the support provider" according to Nilsen and Sein (2004) and Sørebø et al. (2008). Help involving other people may be preferable simply because it involves interaction with other humans (Costabile et al., 2008), as we humans are social beings (Goldhaber, 2006). Constant et al. (1996) describe how strong ties are often accessed for technical advice. Cooperation can be leveraged as a supporting mechanism for introducing new systems (Sykes et al., 2009). Moreover, as mentioned earlier there certainly seems to be a strong bias towards using people as sources, e.g. in (Cross and Sproull, 2004; Govindarajulu, 2000; Govindarajulu, 2002; Govindarajulu, 2003; Seeley and Targett, 1997; Spitler, 2005).

3.7.4 Interactivity

Oh, so if I push this, then that happens…

Interactivity in end-user development means that the developer can more or less directly see the cause and effect between code and action performed. Several authors indicate a close relationship with development and execution (Ko and Myers, 2005; Nardi, 1993; Segal, 2005; Segal, 2007) and using short edit-debug cycles (Brandt et al., 2008). End-user development tools should support incremental development and allow for immersion (Repenning and Ioannidou, 2006). The end-user's tenuous grasp of the development environment, and what code will actually do (Ko and Myers, 2005), means they are not apt at predicting behaviour of code, or understanding it, even their own code which e.g. Segal (2007) found. Being able to relate actions to consequences in the program seems a key consideration, and may be one reason that the iterative model is so popular for end-user developers, as was discussed in chapter 2.6.

3.7.5 Immediacy

I want it done now! I have other things to do...

Immediacy is the ability to act, exactly when the developer wants to. Repenning and Ioannidou suggest the developer experiences a *flow* (Csikszentmihalyi, 1990) state of mind (Repenning and Ioannidou, 2006). Immediacy would represent the need to get back into the flow. The end-user seems to be very much "in the moment" when developing. The importance of the ability to act (Arias, Eden, Fischer, Gorman and Scharff, 2000) and the users' wish to act or react to the situation at hand (Ko and Myers, 2005) are both indications of a need for immediacy. As mentioned above about context, immediacy is also being able to make use of the information. If the user is overloaded with information then the feel of being able to act rapidly will diminish, you will fall out of the flow experience. Brandt et al. (2008) describe programmers using just-in-time learning and Xiao and Farooq (2012) note how learning of tools should be accomplished in minutes. Timeliness was an important factor for users in (Shachak et al., 2013). Often one can observe people on-line who solicit multiple sources simultaneously to increase the audience and hence the likelihood of getting a timely reply. Furthermore, many people try to indicate the urgency of the situation by tagging their question as urgent and/or noting the requirement of a timely reply.

3.7.6 Discussion

Some of the factors relate closely to each other, it is only for analytical clarity that we separate them. Indeed, sometimes it can be difficult to separate between them or say which of the two (or more) that is in effect. As noted above, context and immediacy can be closely related. Large amounts of information can be problematic as it reduces the contextual relevance of it resulting in an immediacy problem as timeliness suffers due to information overload. It can be difficult to distinguish between the context and cooperation factors in e.g. localised or peer support, the source could be preferred due to its proximity, the contextual relevance it enables, the human interaction or all three.

Considering the constructivist perspective of gaining knowledge, we must acknowledge the particulars of the physical and social aspects (Brown and Duguid, 1991). Cooperation may be part of the context of the situation.

Similarly, interactivity and immediacy are closely related. Interactive and iterative development allows for immediacy, and it is the immediacy of the iterative development that allows for interactivity. Figure 9 illustrates how the factors should be seen as a related continuum of aspects rather than distinct categories.

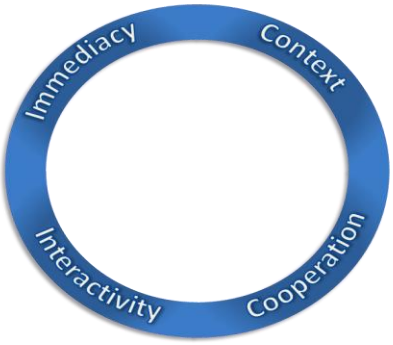


Figure 9. The end-user development factor continuum.

While I argue that these four factors are especially important for end-user developers, this does not imply that other factors are less or not at all important. Nor that the factors are only relevant for end-user developers. Just as end-user development extends end-user computing, these factors are an extension of factors pertinent for end-user computing support and thus most likely more generally relevant outside the end-user development context.

When using information systems usability is an important factor, e.g. when using a virtual community (Phang et al., 2009). Similarly, ease of use and system reliability (Phang et al., 2009) and the system and information quality (DeLone and McLean, 2002) provided by the source are important if the source is an information system. If investigating a particular source, e.g. the help desk in one organisation, then information quality will be an important measure such as it was in (van Velsen et al., 2007).

Nevertheless, this is equally true for all types of sources and all types of users. We cannot assume that a type of source has low information quality or has usability issues in theory, even though in practice some instances of a type of source may suffer from this. In other words, this framework avoids such measures that would require the analysis of a particular source and then generalising to all sources from that. In addition, this framework attempts to analyse sources that are very different from each other. Computer help systems and books have very different characteristics and therefore cannot be measured by information systems standards. This framework is adapted with end-user developers in mind and intended to analyse and compare very different sources of support.

3.8 Summary

This chapter has described the basics of end-user development support and looked at previous research on support. The challenges with supporting end-users have been examined and a framework was presented for a holistic understanding of the connections between users, their characteristics and sources of support. The framework focused on four factors: context, cooperation, interactivity and immediacy. It was argued these factors would be pertinent for an end-user developer’s choice of source. This framework presented here was used to analyse support sources and the result of this analysis is presented in chapter 7.

The next chapter will discuss knowledge sharing in the context of virtual communities.

4 Knowledge Sharing in Virtual Communities

4.1 Introduction

Community support (see Figure 1) can be important for end-user development (Klann et al., 2006). A virtual community is a viable way to get community support for end-user development through knowledge sharing. In the context of using a virtual community to support end-user development the knowledge sharing is characterised by a question-answer type support relationship. In this type of knowledge contribution processes there is an opportunity for the knowledge seeker to impact on the process in the way questions are asked and by making oneself more attractive to help, ostensibly by making the process easier for the knowledge contributor.

This chapter describes virtual communities, knowledge sharing and the knowledge sharing process in a virtual community.

4.2 Virtual Communities

4.2.1 Definitions of a Virtual Community

There are a number of definitions and variants of terminology for communication and collaboration utilizing the Internet, e.g. *Community of Practice*, (*Electronic) Networks of Practice*, *virtual communities* and others. Usually the terms mean the same thing, networks of people connected together in a community of sorts.

A definition of Community of Practice (CoP) is, according to Lave and Wenger (1991), an activity system that brings together individuals who are united in action and in the meaning the action has for them and for the larger collective. A CoP is described as an entity having an informal structure, based on the connections that exist between the members. Lave and Wenger highlight shared problems and areas of interest as key to a CoP. Success factors of a CoP are, according to Ardichvili, Page and Wentling (2003) its members' willingness to both contribute to the community and its knowledge base and their willingness to use it as a source for information and knowledge.

Brown and Duguid (2000) define Networks of Practice as a set of people who share a set of knowledge and practices, are mostly unknown to each other and indirectly linked, i.e. through newsletters, e-mail lists etc. Wasko, Teigland and Faraj (2009) refer to electronic networks of practice (eNoP) by extending the Brown and Duguid definition and further note that they are similar to CoPs. Essentially communities figure as a subset of the networks of practice (Brown and Duguid, 2000). Mattson (2012) defines eNoPs as special types of social structures focused on solving domain-specific problems in question and answer style forums.

These definitions and descriptions of CoPs and eNoPs correspond in great detail to definitions of virtual communities, which usually mention a common objective or background as the basis for the virtual community, see e.g. Hagel and Armstrong (1997) and Rheingold (1993). Wenger (2010) notes that communities and networks are not distinctly different things but instead usually coexist.

Whatever communication media or tool used, communities and networks are by and large the same thing. The focus here is on communities found on-line and not those of a physical nature. A CoP or virtual community can be formed in the real world as well as virtually, although community of practice sometimes has a strong local or off-line connotation e.g. as used by Segal (2007) and Brown and Duguid (2000). While it is entirely possible for these communities to have some off-line presence this will not be the normal way to access the communities for most people using them. In light of this, I will use the term **virtual community** throughout this thesis to describe the type of social networking and knowledge sharing community Mattson (2012) describes.

4.2.2 Problems and Possibilities for End-User Developers

The virtual community has the potential of being an effective way of reaching experts by transcending physical and other barriers. Segal (2007) mentions the lack of a local community of practice (i.e. experts) as a problem. The SBOs that formed the focus of this research were similarly affected, by among others, physical barriers. However, virtual communities might introduce their own set of barriers instead, such as language and technological barriers, though that will depend a lot on the specific end-user.

Potential issues with virtual communities are e.g. human nature, accessibility and timeliness. For example, Chambers and Scaffidi (2010) suggest people may have to wait a long time for answers, though Ardichvili et al. (2003) mention that people experienced with a virtual community have learned who is knowledgeable about what and can pinpoint questions to that expert. This increases the chance of getting accurate answers on a relatively short notice. Gaining access to a community is not necessarily straightforward. It will normally require registration and a short waiting period, due to among other things, the need to vet out computer agents posting spam. Running a community with real people means there is every chance for harmful human behaviour to impact on the knowledge sharing process. Most of these issues are, however, the topic for those actually creating and maintaining communities and fall outside the scope of this thesis.

Ardichvili et al. (2003) suggest that virtual communities can be an effective tool for problem solving, enabling, in theory, anyone to receive help from experts specialised in specific areas. The participants of the communities will have a common interest as the definition of community states. However, the participants usually have slightly different approaches as a result of having different backgrounds and possessing different knowledge, connections and expertise. This interplay of competences is essential to communities (Wenger, 2000) and Constant et al. (1996) note the importance of weak ties to expand the range and diversity of advice.

This interplay between people enables another function for the virtual community, retaining information and operating as a knowledge base. When a community reaches a critical mass of collaborators a highly accurate and information rich knowledge base can presumably be produced. In a utopian virtual community, everybody should be able to focus on what they know best, and contribute with this knowledge, while receiving help with other, less familiar topics.

Virtual communities come with the benefit of being interactive and potentially intelligent. As they are formed by actual humans the community will be able to interact with the end-user developers in need of support. This helps solve one of the biggest problems for end-user developers, applying knowledge in the appropriate context (see chapter 2.6 and 3).

One of the strengths of virtual communities is the interactivity which means end-user developers can go through several iterations to solve the problem or refine the solution often while still working on e.g. a spreadsheet. The interactivity also enables a form of cooperative development, which is considered a key activity in end-user development (Gantt and Nardi, 1992; Nardi and Miller, 1991). This interactivity also support immediacy, end-user developers can get help and feedback almost immediately, at least in theory, to their specific problem.

Nardi and Miller (1991) mention more advanced users contributing code to less experienced users, thus teaching less experienced users. In their example this happens inside the same organisation. Segal (2007) notes that a developer might not have a local CoP to access. However, the virtual community enables this behaviour to extend outside the boundaries of the end-user developer’s immediate environment, allowing a much broader base of experts to be contacted easily (Constant et al., 1996). Ko and Myers (2005) mention these “informal apprenticeships” and suggest that systems could help users and experts to come together. The virtual community performs exactly this function, yet it avoids the need for specialised software or agents, such as those suggested by Stylos and Myers (2006) and Vivacqua and Lieberman (2000), allowing for an easier and more anonymous first contact with a community. Furthermore, such tools may add another layer of learning for the end-user developer do deal with, which they are unlikely to be interested in as they are already beyond their interests and comfort zone, see chapter 2.6.

A virtual community is also able to provide context, working with the end-user developer’s real problem. As one person once told me, it is often possible to find someone who has already experienced the same problem on-line. Davenport and Prusak (1998) note the importance of people speaking the same language when sharing knowledge. While the end-user developer’s vocabulary might not be the same as that used in the community, at least initially, the interactive aspect allows the end-user developer and community to work towards a common understanding of the problem (Arias et al., 2000). Unlike some support methods, e.g. books and manuals, that are static in their information content, the community has a living knowledge content (Wenger, 1998), that can adapt to the end-user developer's specific context. In this way, context is very much present and this task specific help will likely be very useful for end-user developers. The virtual community has features which support all four important factors, i.e. context, cooperation, interactivity, and immediacy described in chapter 3. It also supports them concurrently, providing much of the same benefits as having an actual co-developer present.

4.3 Knowledge Sharing in Virtual Communities

4.3.1 Defining Knowledge Sharing

To use a virtual community for support is a process of knowledge seeking and sharing, forming a knowledge management process between a knowledge seeker and one (or more) knowledge contributors. Davenport and Prusak (1998) define knowledge management as capturing, storing, sharing and using knowledge. The on-line community provides a platform for doing this by connecting knowledge seekers and contributors.

The knowledge seeker is trying to find information and solve a problem, i.e. gain actionable knowledge (Cross and Sproull, 2004). Knowledge is important to organisations, but there are still some differences in how the terms information and knowledge are applied (S. Wang and Noe, 2010). Like Wang and Noe I make no difference in this thesis between information and knowledge and the terms are used interchangeably. Following Wang and Noe, I define knowledge sharing here as *the action of providing task relevant information and know-how to help others to solve problems and develop new ideas collaboratively*.

4.3.2 Factors and Problems Impacting on On-Line Knowledge Sharing

Some of the more important factors influencing knowledge sharing can be the **ability of contributor** (Constant et al., 1996; Kankanhalli, Tan and Wei, 2005; Wasko and Faraj, 2005), **motivation** (Bock, Zmud, Kim and Lee, 2005; Constant et al., 1996; Kankanhalli et al., 2005; Osterloh and Frey, 2000; Szulanski, 2000) and expected **rewards** (Blau, 1964; Davenport and Prusak, 1998; Kankanhalli et al., 2005).

Knowledge sharing on-line (in the context of end-user development) is both similar and different from inter-organisational knowledge sharing. Bock et al. (2005) point out that increasing knowledge-sharing and contribution in organisations is challenging. There are some issues with knowledge sharing in organisations that may impact on on-line sharing. Bock et al. note the difficulty of changing behaviours from hoarding to sharing. It may be problematic for individuals in organisations if they lose control of their knowledge (Gray, 2001). You cannot force, only foster, knowledge sharing (Gibbert and Krause, 2002). Knowledge sharing is often considered in the context of an organisational setting. Promoting sharing in ad-hoc situations with weak relationships (Constant et al., 1996) and without organisational structures could be orders of magnitude more difficult, and Wasko and Faraj (2005) note how paradoxical this sharing is.

Normally an incentive is provided to promote knowledge contribution (Davenport and Prusak, 1998). This would be lacking outside an organisation. It is possible that going outside an organisation alleviates some of the knowledge sharing issues. Extrinsic rewards can inhibit intrinsic rewards (Deci, Koestner, and Ryan, 1999; Lakhani and Wolf, 2003). Loss of knowledge control (Gray, 2001) may not be an issue if the knowledge sharing activity becomes more like a public good (Wasko et al., 2009) and there will consequently be less incentive to hoard because extrinsic rewards are not forthcoming outside the organisation. To some degree this may depend on the community. For example, it has been suggested that the power of some reputational rewards will vary from community to community depending on whether people can derive value from their community presence (Kankanhalli et al., 2005).

Contributing knowledge takes time and effort from the contributor, it follows then that there must be powerful motivating forces influencing the decision to participate. In cases where there is a large demand of support this becomes vital, since the knowledge seeker’s cost is generally lower than the provider’s in this situation (Lakhani and Von Hippel, 2003). Kankanhalli et al. (2005) also proposes that knowledge contributor costs will impact the knowledge exchange. In essence then, suggestion here is to reduce the attention cost of knowledge contributors, at some additional cost to the seeker to help fostering knowledge contributions. There is some anecdotal evidence of general guidelines, such as the so called netiquette, and some communities have rules or other informal guidelines of behaviour to support the knowledge transfer process.

4.3.3 The Impact of the Social Dimension of On-Line Knowledge Sharing

An on-line community is the sum of its social interactions as facilitated by the system it runs on. Since all knowledge management happens through the system, its function i.e. usability, will have an impact on the social interaction, sociability. This is the socio-technical perspective (Maloney-Krichmar and Preece, 2005). Phang et al. (2009) adopt this socio-technical perspective and examine how ease of use, system reliability, knowledge tracking, social interactivity and moderator perception impact on knowledge seeking and contribution in an on-line community. Interestingly, some knowledge contribution studies lack this dimension, e.g. (Bock et al., 2005; C. Wang and Lai, 2006; Wasko and Faraj, 2005), and seem to assume that systems are used regardless of any usability issues in a “if we just build it, they will provide knowledge” situation. However, knowledge contribution and system use are much more complicated than that, see e.g. (Brazelton and Gorry, 2003; Davenport and Prusak, 1998; Markus and Keil, 1994) on the problems of focusing only on the creation aspects.

A virtual community can function as a *third place* (Mattson, 2012) improving the social aspects leading to social value (Ren, Kraut, and Kiesler, 2007; Ridings and Wasko, 2010). Wasko and Faraj (2005) discuss the impact of social capital and *social exchange theory* (Blau, 1964) on knowledge contribution where there is the expectation of some benefit from the exchange. They look at how various individual motivations, structural capital, cognitive capital and relational capital impact knowledge contribution. Social interaction is particular for on-line communities compared to other electronic knowledge repositories (Phang et al., 2009). In this type of knowledge contribution processes there is an opportunity for the knowledge seeker to impact on the process, an opportunity to foster knowledge sharing.

While Phang et al. (2009) and Wasko and Faraj (2005) acknowledge the social interaction and look at aspects such as social interactivity and relational capital respectively, neither directly examines the direct interaction between a knowledge seeker and contributor that happens in the on-line community knowledge sharing activity. These studies do not account for motivational factors, or only in a limited way. On the other hand Bock et al. (2005) do not consider socio-technical aspects in their model. Thus, previous studies have largely focused only on one aspect of knowledge sharing, e.g. contributing knowledge (Bock et al., 2005; Lakhani and Von Hippel, 2003) or have not included some aspects that may impact on knowledge contributions, e.g. (Phang et al., 2009; Wasko and Faraj, 2005).

4.3.4 A Model of On-Line Knowledge Sharing

To summarize how knowledge sharing on virtual communities may work Figure 10 illustrates the connections between the knowledge contribution and seeking aspects. This knowledge sharing process integrates several strands of knowledge management, i.e. behavioural intent, socio-technical aspects and social exchange theory, taking the viewpoint of the knowledge seeker. Phang et al. (2009) suggest there will be differences in factors that are important for knowledge seekers and contributors. Knowledge seekers, with various skills and other attributes (see Figure 10, A.) and knowledge contributors, with abilities, motivations and values towards sharing (B.) are people who interact with each other to share knowledge (C.). Inspired by the concept of behavioural intent to share knowledge a number of motivating attributes will impact on the knowledge-contributors’ willingness to engage in the knowledge-sharing activities, e.g. reputation, reciprocity, altruism, usefulness of the software platform, moderation and many others (Bock et al., 2005; Lakhani and Von Hippel, 2003; Phang et al., 2009; Wasko and Faraj, 2005). The socio-technical view says this interaction is mediated through the socio-technical system of the on-line community where hopefully a balanced knowledge-sharing market exists.

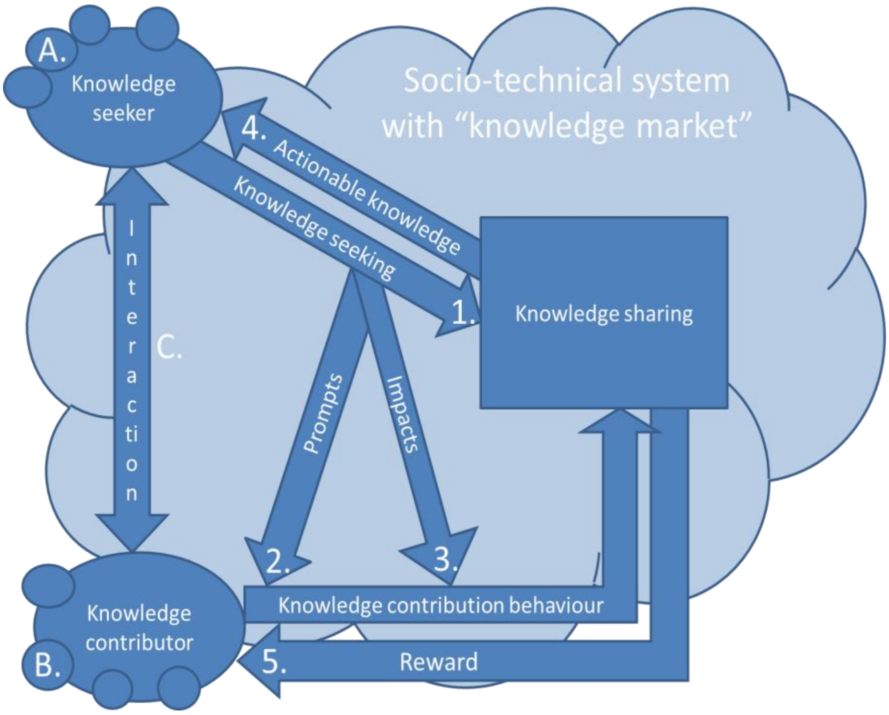

A.
Knowledge seeker
Socio-technical system with "knowledge market"
4. Actionable knowledge
Knowledge seeking
1.
Knowledge sharing
Interaction
C.
Prompts
Impacts
2.
3.
Knowledge contributor
B.
Knowledge contribution behaviour
5.
Reward

Figure 10. Knowledge sharing process in a virtual community

Social exchange theory suggests that for the knowledge seekers' actions to impact on the sharing of knowledge both parties need to get some benefit from the exchange, creating social capital (Blau, 1964; Wasko and Faraj, 2005), leading to a knowledge market (Davenport and Prusak, 1998). The seeker's action to gain knowledge (see Figure 10, 1.) prompts the contribution action (2.). The way the seeking action is done will also impact on the knowledge contribution behaviour (3.). The seeker gets actionable knowledge (4.) and the contributor some form of (in this case) intrinsic reward (5.) from the knowledge sharing activity.

While many attributes (see Figure 10, B.) impact on knowledge contribution behaviour, only a few of these are actually within the control of the knowledge seeker, mainly how one formulates the request for help. As the focus of this research stream is on the end-user developer and his/her needs emphasis has been on the specific issues where the seeker can impact the knowledge sharing. This thesis takes a broader view of knowledge sharing by bringing together both socio-technical aspects and the seeker/contributor relationship in knowledge sharing with previous models of knowledge contribution.

4.4 Summary

The focus in this thesis is on the sharing of knowledge where a direct social interaction occurs, i.e. a question is asked and someone answers it, as opposed to an exchange where knowledge was contributed earlier to a repository and was simply used by the knowledge seeker. Knowledge sharing in a virtual community differs from other cases as the act of helping is in essence interactive. This means socio-technical aspects become important.

Many studies on knowledge sharing only look at contributing knowledge, whether it is to knowledge repositories or virtual communities, e.g. (Bock et al., 2005; Kankanhalli et al., 2005; C. Wang and Lai, 2006; Wasko and Faraj, 2005; S. Ye, Chen, and Jin, 2006). Taking the more holistic approach of actionable knowledge (Cross and Sproull, 2004) we must also look at the seeker and the source.

This chapter has described how the knowledge sharing process in a virtual community can be examined by integrating different strands of knowledge management research to gain a broader insight in this complicated process. Chapter 7 discusses virtual communities in relation to other sources and chapter 8 reports on the result of the investigation of how the knowledge seeker can foster knowledge sharing.

The next chapter will describe the various methods used to collect and analyse data in this thesis.

5 Methods and Data

5.1 Introduction

End-user development support has been studied from different aspects and previous empirical research has shown that a key issue in end-user development support is to consider both social and technical aspects of the process. These empirical studies are mostly either quantitative, primarily using measures developed for similar but different situations, or case studies.

In the framework of constructivism the context of each situation is very important. End-users are very different people and research should be done with actual end-user developers (Segal, 2005). Aiming at practical relevance while remaining academic has led to some trade-offs that may have limited the research slightly. In this case, the ability to access real end-user developers instead of other substitutes, e.g. students, was deemed to be worth the trade-off in rigour.

Ultimately, the thesis concerns itself with knowledge acquisition and transfer. The end-user developer has a problem they are trying to solve and need support in overcoming that problem. This can be accomplished by acquiring or transferring that knowledge from a support source. Cross and Sproull (2004) term this *actionable knowledge* and suggests the constructivism viewpoint which highlights the context of each situation as important. This seems to fit the end-user developer very well as what they do is very specific to their own needs and situation. Inspired by this, the methods used in this thesis are chosen more for their (perceived) ability to acquire knowledge rather than methodological orthodoxy. That is, I have considered first and foremost what I want to investigate and then looked at what method might be appropriate for the situation. Consequently, this is why this research has been done with a mixed-method approach using both qualitative and quantitative methods, or by mixing the two as appropriate for a particular context.

This chapter describes the mixed-method approach used in this thesis, i.e. the participant observation method that I have used throughout in various stages of the research in conjunction with quantitative surveys. The mixed-method approach can improve the contextual fit of a study in different ways, e.g. by making the survey more appropriate to the setting or by supporting the analysis of results. Due to the limited number of responses to some of the surveys the qualitative aspects have been given more weight than was originally planned. In a curious echo of what Bryman (2006) describes as wealth of data due to use of multi-strategy research, although in this case it was more a case of relative wealth of data (in contrast to no data).

Two methods for gathering data were used in this thesis, namely **participant observation** and the **survey method.** Since there is a variety of methods used and data collected in the different publications this chapter will give a general description of the methods used and data collected. In the following chapters that cover the results from the publications I explain the research process in more detail separately for each publication. Thus, the chapter is structured as follows, section 5.2 describes the different ways participation observation methods were used in this research and section 5.3 describes the survey method and the data collected.

5.2 Participation Observation as a Method to Collect Data and Support Analysis

As described in chapter 1.4 and illustrated in Figure 2 I have used participation observation as a method numerous times during the research process, particularly in conjunction with Publication 5. This method, where the researcher participates in the community, was inspired by Kozinets' *netnography* (Kozinets, 2002). The original method was conceived for capturing marketing research data by participating in communities discussing products/brands/etc. This method has gained traction for other purposes as well, e.g. in analysing various on-line communities (Berg, 2011). In my research participation observation was used in different ways:

1) To support an analytical bracketing for the problem definition and foundation for the surveys, i.e. what to ask and of whom.
    - Publication 1, 2 and 5
2) To increase the contextual fit of surveys
    - Publication 1, 2 and 5
3) To support the analysis of data
    - Publication 2, 3 and 5

5.2.1 Using Participant Observation in Survey Design

It was a great benefit to have some insight into the populations when creating the surveys as it was possible to tailor them and ask relevant questions. Furthermore, there was the aspect of being an insider rather than outsider. My perception is that this helped when arranging the surveys. The people contacted knew who I was and had had prior dealings with me, in some cases face to face contact.

5.2.2 Using Participant Observation to Increase Contextual Fit

The particulars of context are important in end-user development. In Publication 1 and 2 participation observation allowed for adjusting the surveys to the context of the respondents. The wordings of questions and choice of data to collect were adapted to fit the respondents. In Publication 5 the survey was adapted to fit socio-technical aspects of the particular community studied. The socio-technical view stresses the importance of these factors acting together. Social aspects are important because communities have their own rules and processes. Technical aspects also need consideration. Communities and repositories use different technical solutions and these differences may impact on the knowledge seeker/contributor interactions and the contribution in general.

Without the participant observation many of these and other social and technical aspects would not have been covered in the survey. Not all questions inspired by participation observation were successful however. Trying to determine the impact of marking threads solved, which was a hotly discussed topic, some respondents noted that it was not possible on the forum in question, leading to uncertainty as to how the question was interpreted by the respondents.

5.2.3 Using Participant Observation to Support Data Analysis

Participating in a population or community can give insights for interpretation and analysis both directly and indirectly, i.e. potential problems are identified in participation observation and questions can be adjusted or included to provide better examination of the issue(s).

In both Publication 3 and Publication 5 insider knowledge and a deeper understanding of the populations and their specific context supported the choice of explanation where the data allowed for multiple interpretations.

A further use for the participant observation process is that it gives a measure of face validation of the results. Having a general idea of how a population is and what their opinions could be one can see if the results seem reasonable.

5.3 The Survey Method Used for Data Collection

The empirical data collected in the course of this research came from three surveys of real end-user developers and participants in end-user development support. The survey questionnaires are included in Appendices A-C. Two surveys targeted end-user developers and one survey experts providing support for end-user developers. The following is the main points of data collected during the research process:

- Information on support source use.
- Information on end-users’ demographic and skill variables.
- Information on contributors’ attitudes towards knowledge sharing.

Since the three surveys collected different types of data, the rationale for choosing the data collected is described here. A more detailed description of the data collection process is described separately for each publication in later chapters. Table 3 summarises the design and data collection aspects based on the considerations suggested by Pinsonneault and Kraemer (1993).

Table 3. The empirical surveys based on the Pinsonneault and Kraemer (1993) minimum dimensions of surveys.

Data collected	Survey 1	Survey 2	Survey 3
Support source use	X	X	
End-user skills and demographics	X	X	
Contributor attitudes towards knowledge sharing			X
Purpose of survey	Exploration Description	Description Explanation	Description Explanation
Research Design			
Survey type	Cross-sectional	Cross-sectional	Cross-sectional
Mix of research methods	Yes	Yes	Yes
Unit(s) of analysis	Individual	Individual	Individual Community
Respondents	SBOs	SBOs	Experts
Research hypotheses	None	Demographics, skill impact on support use	Seekers impact on knowledge contribution
Design for data analysis	None	Yes, causal model	Yes, PLS model based on literature
Sampling Procedures			
Representativeness of sample frame	Approximation, Explicit	Explicit, Logical argument	Logical argument, Reasonable choice among alternatives
Representativeness of the sample	Purposive, convenience sample, real users	Sample consisted of entire population	Self-selected experts
Sample size	35	357	41
Data Collection			
Pre-test of questionnaires	No	No, but based on earlier survey	Pilot-test and subsample
Response rate	56%	~22%	Not applicable
Mix of data collection methods	Participant observation Survey method	Participant observation Survey method	Participant observation Survey method

5.3.1 Support Sources

The main focus of this thesis is on support source use. Therefore, the surveys collected data on which sources of support were actually in use by end-user developers. Table 4 lists the support sources considered in the empirical surveys.

The question about support sources used in Publication 1 and Publication 2 was a compromise between scientific needs and practicality dedicated by the need to fit contextually. Based on previous experience, knowledge of the population targeted and literature, many of the respondents were not expected to have direct experience of end-user development (most were fairly novice users) or to recognize it as such (end-users may not recognize their efforts as software development (Segal, 2007). Therefore, people were asked to list the support sources used for "problems in your work" and the sources used for "computer-related problems" instead of asking about sources used with regards to "end-user development problems". This would give an indication of how developers might behave when performing development activities which combines the more familiar domain (work) knowledge with the potentially less familiar computer knowledge (see Figure 6, chapter 2).

Table 4. Support sources considered in this research

Support source	Publication 1	Publication 2
Personal contacts	x	x
Trial and error	x	x
Application help function	x	x
Internet forums	x	x
Internet searches	x	x
Books	x	x
Helpdesk		x

5.3.2 Demographic and Skill Attributes

As mentioned in chapter 2 Panko and Port (2012a) suggest more descriptive research on end-users. The characteristics of end-users may also impact on their use of support, as discussed in chapter 3. Therefore, where practicable, data on demographics and skills were collected. The demographic and skill attributes used were: *gender*, *job type*, *age*, *education*, *computer skill* and *internet skill*.

The attributes were chosen as a set that are routinely used in the literature, e.g. digital divide theory and computer/computing usage/satisfaction studies (Beckwith et al., 2006; Beckwith et al., 2007; Brown, 2002; Cross and Sproull, 2004; Gallivan et al., 2003; Ko and Myers, 2005; Ko et al., 2011; Larsen and Sorebo, 2005; Liaw, 2002; Nilsen and Sein, 2004), and could be argued might have some kind of classification effect. The choice was also based on information the respondents were likely to disclose, so the culturally somewhat sensitive issue of income was left out. Digital divide theory suggests household income is a determinant of computer/Internet use, e.g. Zickuhr and Smith, (2012). However, income is less important in organizations where a computer is a business expense. Indeed, almost 100% of even the smallest companies in Finland used computers and Internet in 2009 (Tilastokeskus, 2009). A detailed discussion for the motivations to include these attributes is presented below.

Gender has been found important in many cases. Males are more comfortable with computers and the web with higher confidence and skill (Hoxmeier, Nie, and Purvis, 2000; Liaw, 2002; Schumacher and Morahan-Martin, 2001). Gender and self-efficacy impacts areas of end-user development (Beckwith and Burnett, 2004; Burnett et al., 2008; Nilsen and Sein, 2004) such as, debugging (Beckwith et al., 2006) and self-efficacy (Beckwith et al., 2007) in end-user developers (Ko et al., 2011). Gender is a contextual factor for information seeking (Cross and Sproull, 2004).

However, it should be noted that a recent survey of Internet use shows little difference between genders (Tilastokeskus, 2012). Knight and Pearson (2005) found no gender effects. It may be that gender and self-efficacy may still play a role when using the Internet for particular tasks, similarly to how age had quantitative but no qualitative effects (Margaryan, Littlejohn, and Vojt, 2011), but reversed. In other words, gender effects may not be visible in the quantity of use, but rather in the quality.

Job Type. Task-relevant expertise and knowledge will impact the process, Cross and Sproull (2004) posit that job type/position influences knowledge seeking. In addition, job type affects what sources are available for the end-user and can determine which, if any, training a user has gotten. Small business owners (SBOs) do not have access to all the same support sources as those in the public-sector do. In comparatively larger organisations colleagues and formal support are more easily available, whereas SBOs are less likely to have access to personal contacts and other sources. Different work tasks will also lead to differing support needs.

Age. Previous empirical studies have shown that age is a contextual factor that could be expected to impact support use. People who have grown up with technology are more familiar and comfortable using it (Brown, 2002). While the author has encountered both old and young users of Internet and on-line sources, experience suggest younger people are more likely to use Internet sources. Computer/Internet usage surveys support the idea that young people use the Internet more frequently in the region studied (ÅSUB, 2001) as well as nationwide (Tilastokeskus, 2010). A similar trend is prevalent in the United States as well (Zickuhr and Smith, 2012). Knight and Pearson (2005) found no age effect on computer usage. However, interestingly Margaryan et al. (2011) note that while there is a difference in quantitative use of technology there is no qualitative difference. In other words, while younger people may use computers or Internet more, they might not be any better at it.

Education gives an opportunity for gaining computer knowledge through computer courses which are now common in syllabuses for most education level. The longer the time a person spent being educated, the more opportunities to partake of computer training. There is a strong link between higher education and higher Internet use. Education remains one of the bigger gaps of Internet access in the United States (Zickuhr and Smith, 2012). A similar correlation between Internet use and education is found in Finland (Tilastokeskus, 2011).

Computer and Internet skill would logically be key contextual attributes when using computerized and/or Internet based sources. Computer experience has a positive impact on computer confidence and attitudes towards computers according to Levine and Donitsa-Schmidt (1998). Computer anxiety can be a powerful influencer both on the systems level (Hackbarth, Grover, and Yi, 2003) and more generally (Venkatesh, 2000). People need to be comfortable with computers, the Internet and search engines to use them and skill increases confidence (Liaw, 2002). Anxiety towards a specific technology can also be a factor, e.g. using wikis (Cowan and Jack, 2011). Hoxmeier et al. (2000) found skill to be the most important influencer, in part mitigating for gender differences. Similarly, Knight and Pearson (2005) liken computer literacy with literacy in it being generally available, and further suggests anxiety is a moderating effect instead of age and gender.

The computer skill attribute is based on the respondents' reported skill in among others, office-, graphics- and e-mail applications, which also form the main avenues for end-user development. The Internet skill attribute is based on the respondents reported amount of Internet usage for different tasks, essentially describing the frequency and extensiveness of Internet use. Both "skill" attributes are self-reported and as such suffer from self-reporting issues. It may be a measure of confidence rather than skill (Hoxmeier et al., 2000). Gender studies suggest males have higher self-efficacy when using computers which could translate into higher reported computer skill. In this case it was not possible to do objective measures of actual skills, and the possibility of self-reporting bias is taken into consideration in the analysis. It should also be noted that for the purpose of looking at support use it does not necessarily matter if it is skill or confidence that drives the choice, either will be fine as long as it means the source is used.

5.3.3 Attitude Towards Knowledge Sharing

Chapter 4 discusses the knowledge sharing and how it applies to virtual communities. There are a number of factors that may impact on contributors' willingness to share knowledge. The basis for this research was inspired by the Bock et al. (2005) research model illustrated in Figure 11 which measures people's intention to share knowledge by looking at their attitudes towards sharing, any subjective norms that may influence it and the impact of the organizational climate. The choice of looking at attitudes is influenced by the voluntary participation and knowledge contribution an Internet forum represents. As mentioned in chapter 4, the contribution can be encouraged, but not forced by any outside agency. Herein lays the opportunity and challenge for the end-user developer, the assumption that end-user developers' actions might influence the knowledge sharing process. The discussion about the impact of the socio-technical view has also influenced the data collected. The changes to this model and the data collected are described in more detail in chapter 8.

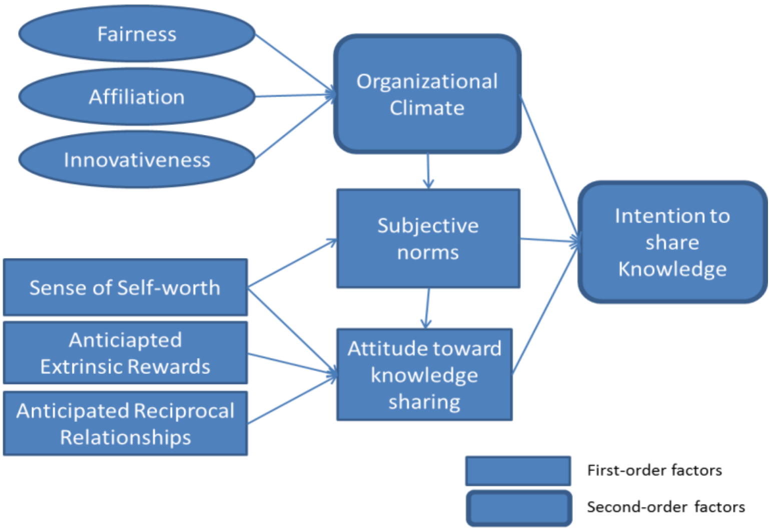

Fairness
Affiliation
Innovativeness
Organizational Climate
Subjective norms
Intention to share Knowledge
Sense of Self-worth
Anticiapted Extrinsic Rewards
Anticipated Reciprocal Relationships
Attitude toward knowledge sharing
First-order factors
Second-order factors

Figure 11. The Bock et al. (2005) research model.

5.4 Summary

In this chapter the data and methods used to collect it have been presented. The various publications have used different methods, as deemed appropriate for each situation, to collect and analyse the data. This is described in more details in the next two chapters. However, in most cases participation observation has been present to increase the contextual fit of surveys and support the data analysis as is illustrated in the inductive research process used in this thesis (see Figure 2).

The next two chapters will present a summary of the results of the empirical studies this thesis is based on.

6 Investigation of Characteristics of the End-Users and Their Impact on Use of Support

This chapter is based on Publications 1-3 and describes the characteristics of end-users and how these may impact on their use of support sources. Section 6.1 describes the research process (based on Figure 2, in chapter 1) for Publication 1, section 6.2 describes the research process for Publication 2 and section 6.3 describes the research process for Publication 3. In section 6.4 the results from these publications are presented and discussed.

6.1 Publication 1 – End-user Developers' Use of and Attitude Towards Support Sources

The aim of Publication 1 was to conduct an exploratory study of which sources of support were used by end-user developers and what their attitudes towards these sources were.

The survey respondents were part of a project conducted as an educational programme aimed at SBOs and municipal employees in two municipalities in the Finnish archipelago. Participatory observation during the project provided some insight into the population and formed a basis for creating the survey questionnaire sent to all participants in the project. The survey was designed as broadly as possible to examine (potential and actual) end-user developers' opinions and experiences of support.

6.1.1 Survey Design

The survey used qualitative and quantitative items. The exploratory nature of the research at this stage and small population surveyed led to the adoption of a mixed-method approach with quantitative and qualitative questions. The qualitative aspects were emphasized in the survey to gain as much insight into the issue as possible from the limited number of participants. Unfortunately, this was greatly hampered by the low number of responses to the qualitative items as very few responses on attitudes towards support sources were given. Demographic variables were not collected as the small sample size would not have supported a statistical analysis.

The questionnaire had both open-ended and multiple-choice questions. The multiple-choice questions asked which sources of support were currently used for solving work and computer problems respectively. The use of multiple-choice questions was motivated in that a person does not necessarily use only one support source. Table 4 lists the sources considered in Publication 1.

Then open-ended questions asked the respondents to describe their opinions, experiences and motivations for their choice and use of support sources.

The survey also asked about computer skill and Internet use. A set of statements using a 1-5 Likert scale (1=Strongly disagree, 2=Disagree, 3=Neither disagree nor agree, 4=Agree, 5=Strongly agree) asked respondents to assess their skill in basic computer usage (i.e. skills in using office applications). The respondents were asked to indicate their use of Internet and some on-line services on a scale of 1-5 (1=Never used, 2=Have tried it, 3=A few times a month, 4=Every week, 5=Daily). See Appendix A for the wordings of questionnaire items.

6.1.2 Data Collection

Two sets of questionnaires were sent, one to SBOs and the other to municipal employees. They were functionally identical. Only certain wordings were changed to reflect the difference in recipients. In total 35 questionnaires were sent out, 17 to SBOs and 18 to employees. The initial response rate was 53% for SBOs and 61% for municipal employees. One response from a municipal employee was discarded so the final response rate was 56%. The characteristics of the sampled organisations are presented in Table 5. The small businesses are mostly primary producers (in this case agriculture) or SBOs providing services. One surprise was, however, the respondents from the local branch of a national bank, which while technically not a small business does operate under similar conditions. Interestingly, the size of the organisations followed exactly their type. The municipal organisations are usually the largest organisations by far in this type of rural area and the smallest organisations usually consisted of sole proprietors providing their skilled labour as a service.

Table 5. Characteristics of the sampled organisations in Survey 1.

Types of organisations			
SMEs	9	Public organisation	10
Farming	2	Public Office	9
Services	3	Public Services	1
Banking	4		

Organisation size		type
(nr of employees)	(N)	
<=5	3	Services
5–10	2	Farming
10–15	4	Banking
15+	10	Public

6.1.3 Data Analysis

The data was analysed with basic statistical methods using Microsoft Excel. For support use a frequency table was created. The computer skill and Internet skill measures were operationalised in the analysis by calculating the arithmetic averages of computer skill and Internet use items for each respondent.

One problem with the data collection that was particularly challenging in the subsequent analysis was that some respondents had not responded to some parts of the questionnaire. At first it was considered to disregard these entirely, but due to the small population of respondents the decision was made to try and conserve as much data as possible. Since the statistical analysis was done separately for each question this discrepancy does not influence any of the calculations and each set of results therefore state how many respondents the results pertain to.

6.2 Publication 2 – End-User Developers' Characteristics and Use of Support

The aim of Publication 2 was to explore the connection between the characteristics of end-user developers and their use of support.

Publication 2 extended the empirical base with a larger but similar population to the one used in Publication 1. It also introduced demographic attributes and a wider assessment of skills as potential determinants of support use.

The groups surveyed in both Publication 1 and Publication 2 were similar as both represented a broad spectrum of small organisations, such as small businesses in hospitality, agriculture and other service industries. In addition, municipal organisations providing education, healthcare and other social services existed in both surveys. The surrounding business and other environment factors are also broadly similar with the same types of challenges in communications existing in both groups due to the geography and social structures. This would allow for an increased population of end-users to be examined and cross-referenced with Publication 1.

This set of data was collected as a part of a larger questionnaire sent to real and potential end-user developers as part of a proposed teaching project for developing ICT skills in small-organisations in a region in Finland. The project was mainly focused on potential participants' skill levels and current usage of ICT providing the demographic and skill data. The items pertaining to this research were included in the questionnaire at a late date in the survey design and so only the most salient questions were introduced.

6.2.1 Survey Design

Publication 2 used only quantitative items. Based on the experience of low rates of response to the qualitative questions in Publication 1 and the need to fit into the existing survey the qualitative questions, interesting as they would have been, were omitted. Publication 2 allows for a deeper analysis whether there are underlying reasons for the choice of a source of support due to the addition of the demographic variables.

In addition to questions about demographic and skill attributes, the survey for Publication 2 included the same items as Publication 1 asking about which support sources were currently used. With one minor addition, i.e. the helpdesk source was included, based on experience from Publication 1 where even the small public organisations sometimes had this type source available in some form. Table 4 lists which sources were considered in Publication 2.

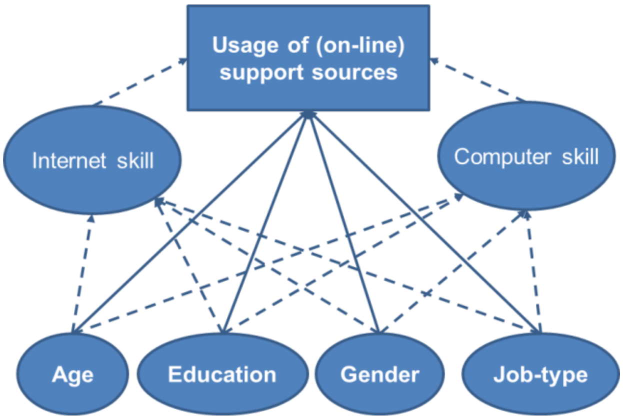


Figure 12. Preliminary research model for Publication 2.

Figure 12 presents the research model for Publication 2 and the data collected. Solid lines indicate the direct influence of an end-user's characteristics on choice of support and dashed lines the mediating effect the skill attributes were expected to have. However, Publication 2 only analysed the effect from demographic attributes (solid lines in Figure 12).

The skills were measured using the same scales used in Publication 1, but expanded for a broader range of computer usage. The respondents were asked to indicate their use of Internet and some on-line services on a scale of 1-5 (1=Never used, 2=Have tried it, 3=A few times a month, 4=Every week, 5=Daily) and to answer a set of statements using a 1-5 Likert scale (1=Strongly disagree, 2=Disagree, 3=Neither disagree nor agree, 4=Agree, 5=Strongly agree) to assess their skill in basic computer usage (i.e. skills in using office applications). The skill data from Publication 1 and Publication 2 are technically not directly comparable, although very similar. The questionnaire items are presented in Appendix B.

6.2.2 Data Collection

The questionnaires were sent to the municipal offices and to all companies registered in the six municipalities constituting the Åland Island archipelago. 209 companies were contacted and 36 responded, giving a final response rate of 17.2%. The municipal offices distributed the survey among the employees, who were encouraged, but not required, to fill in the questionnaire. According to ÅSUB (2010) there were a total of 148 employees in the public sectors in the Åland Island Archipelago, giving an approximate response rate of 27.7%. Of the 77 total responses, 60 were complete and could be used in this analysis. The characteristics of these 60 organisations are listed in Table 6. Most SMEs were SBOs providing various services in construction, enjoyment and health sectors or skilled labour such as artists, consultancies or accounting to give a few examples of over a dozen different businesses.

Table 6. Characteristics of the sampled organisations in Survey 2.

Types of organisations			
SMEs	27	Public organisation	33
Fishing/Farming	5	Public Office	18
Assorted Services	14	Public Services	15
Tourism	8		

6.2.3 Data Analysis

Publication 2 uses frequency tables to analyse the impact of demographic attributes on use of support sources for each type of problem (i.e. work and computer problems) respectively. The demographic attributes were categorised for the analysis as listed in Table 7.

Table 7. Categories used in the Publication 2 analysis.

Gender	Job-type	Age	Education
Male	SBO	25–35	Elementary
Female	Public	36–45	High-school
		46–55	Lower academic
		56+	Higher academic

6.3 Publication 3 – The Impact of Skills and Demographics on the Use of Support

Publication 3 extended the analysis from Publication 2, presented in Figure 12, to include skill attributes (dashed lines in Figure 12) by using a self-organising map (described below in the data analysis section). The data used for the analysis in Publication 3 was the same data collected for Publication 2.

6.3.1 Data Analysis

The data was analysed using a self-organising map (SOM). This data-mining technique was used here to determine potential groups of users and relationships between the different factors and support sources.

The SOM is a neural network using unsupervised, competitive learning. It uses a two-layer (input/output) design where multi-dimensional data is, through the training process, mapped onto a two-dimensional plane, i.e. the map. One feature of the SOM is that items of data are placed on the map in a manner where the items resemble those around them, creating clusters of similar data items.

The SOM was chosen for the ability to model complex relationships. Even a relatively small sample can be ponderous to examine for each attribute if relationships are likely to be fairly complex. The SOM software package used, in this case Viscovery SOMine 5.2, allowed for analysis and visualisation of the data in multiple ways. An important feature was the relative ease with which categorical data could be handled as well as the SOM being robust with regards to missing values (Kohonen, 2001). In addition, the software provided us with basic statistical information/tools that have been used in the analysis, e.g. correlations between attributes. Another reason for using the SOM was that it does not require an *a priori* definition of categories and is often used for segmentation of populations, e.g. customer segmentation. This avoids potential categorical biases in the analysis.

A central ingredient when using SOM is the choice and pre-processing of relevant input variables for it. The input variables were derived from a questionnaire. The SOM will usually be adapted to the data to be analysed. In this case, most of the parameters were left at the software package's default values. The main adjustments were to map-size and the attributes included in the training of the map. This differed somewhat from the suggested map-size, e.g. (Kohonen, 2001), but it seemed to fit the data better. The target size was set at 100 nodes, but as suggested by the software's heuristics the map-size eventually used in training was 72 nodes (an 8x9 grid). Although comparatively large for a small dataset of 60 items, the smaller map-sizes seemed to lose explanatory power, when otherwise mutually exclusive items were stacking in the same nodes.

Table 8. Breakdown of the 19 attributes used in the Publication 3 analysis.

Demographic and skill attributes (independent variables)	Work-problem support sources (dependent variables)	Computer-problem support sources (dependent variables)
Gender	Books	Books
Job	Personal contacts	Personal contacts
Industry	Trial and error	Trial and error
Age	Internet search	Internet search
Education	Internet forum	Internet forum
Computer skill		Help function
Internet skill		Helpdesk

The data items were grouped into 19 attributes compiled from the original raw data. The attributes are listed in Table 8. The seven demographic and skill attributes represented factors impacting on the use of support sources and as independent variables were included in the map's training. The remaining 12 represented each type of support source for respective type of problem and as dependent variables were given zero priority in training. That meant they are visible to aid analysis, but did not affect the result of the map.

6.4 Results from Publications 1 – 3

6.4.1 Use of Support

Part of understanding end-user development support comes from looking at what support is used. Chapter 3 summarized what previous literature has found about support usage in general. However, most of these studies are looking at support in larger organizations, not at what users in the real world, specifically in small organizations do for their support needs.

Publication 1 and Publication 2 found that end-user developers favour personal contacts (see Table 9). There was strong support for personal contacts (between 78–85 % reported using them), followed by Internet searches (used by 21–68 %) and Trial and error (used by 26–47 %). The strong reliance on personal contacts is in line with other studies made on support usage (see chapter 3). The most popular sources are also those that score strongly for the end-user development factors (see chapter 7, Table 16) suggesting the framework can explain some of these issues. For example "Trial and error", while not a source that actually provides knowledge content, is used a lot for problem solving. It scores highly on the EUD factors, being very close to the way many developers work, despite seemingly not being a very good way. Trial and error essentially requires the user to have the knowledge they need already. There is something of a problem in that a source is utilised that actually may not help very much.

Table 9. Results of support use in small organisations.

	Publication 2				**Publication 1**			
Support source used	**Work problems (n=60)**		**Computer problems (n=60)**		**Work problems (n=19)**		**Computer problems (n=19)**	
Personal contacts	47	78%	51	85%	15	79 %	15	79 %
Trial and error	18	30%	28	47%	5	26 %	9	47 %
Internet searches	41	68%	21	35%	11	58 %	4	21 %
Internet forums	8	13%	6	10%	3	16 %	3	16 %
Application help function	-	N/A*	16	27%	-	N/A*	5	26 %
Helpdesk	-	N/A*	6	10%	-	-**	-	-**
Books	19	32%	1	2%	2	11 %	3	16 %

* not applicable to work-related problems; ** was not included in Publication 1

Interestingly, there is a switch in usage between Internet searches and Trial and error in the two types of problems. This could be due to a knowledge gap in skills and/or self-efficacy for computer problems compared to work problems, highlighting the challenge the user experiences when working outside their knowledge domain. This view is confirmed in Publication 3 through the central importance of skill factors.

This also seems to be at the heart of the support problem. Sources that could provide information are hardly used (exempting personal contacts) because they are not aligned to the way the developer thinks and works. As noted in chapter 7.3, knowledge repositories only answer the "*what to do*" problem, not how to apply the knowledge for a specific problem.

The work domain is familiar to the respondents and they can make meaningful use of information searches, whereas the unfamiliar computer domain leads to not using information searches and attempting to solve a problem with whatever information the developer has. This has been observed in other end-users and developers, e.g. by Ko and Myers (2005). It is ironic that end-user developers shun knowledge sources and instead persist in using a source where their own knowledge is crucial, and any lack thereof will be detrimental for their efforts.

Other sources were hardly used. Especially troubling, is that for problems where the end-user are weaker they do not really use a source that could help them, and very few use the source that could solve both problems of getting and applying knowledge. It seems we are facing a situation where the developers do not know enough to make use of the sources available to them.

6.4.2 Characteristics of the End-Users

The typical respondent in Publication 1 (Survey 1) and Publication 2 (Survey 2) conformed quite closely to the stereotypical view of end-user developers as novice computer users who use personal contacts as support. The reported computer and Internet skills in the two studies are shown in Table 10. The respondents in Publication 1 scored themselves slightly higher. However, they were answering after a teaching project so would naturally be more confident in their skills. It should be noted that the measuring items were comparable but not identical between the two studies (Survey 2 had a few more items measuring computer and Internet skill), which may also explain some of the difference.

Table 10. End-users' self-reported skill levels.

	Survey 1 (N=17)		**Survey 2 (N=60)**	
	Mean	St.Dv.	Mean	St.Dv.
Computer Skill	3.56	1.37	2.59	1.07
Internet skill	2.56	1.36	2.48	0.73

The analysis of the results in Publication 2 confirmed the expected impacts of various demographic attributes such as gender and job type. In addition, age and education seemed to have some influence on support use. However, when doing the analysis it seemed that these effects were more complex than simple demographical differences. A good example was the group of people who only had elementary school education. On the face of it one could relate the sameness to the education attribute, but it also turned out that this group were all old, male and farmers. Any, all or a combination of these attributes could therefore be behind any correlation between education and use of support. People are more complex than single demographic attributes. Furthermore, in many cases when analysing the differences deeper they seemed more tied to the skill dimension than demographic attributes, i.e. differences for demographic attributes were tied to categories that also had reported higher skill rates.

Table 11. Demographics of respondents in Publication 2.

Gender		Job-type		Age		Education	
Male	43 %	SBO	32 %	25-35	17 %	Elementary	7 %
Female	57 %	Public	55 %	36-45	27 %	High-school	38 %
		Both	13 %	46-55	43 %	Lower academic	22 %
				56+	13 %	Higher academic	33 %

Many of the demographic attributes are related, and correlate in complex ways. For example, education has relatively recently included computer training, especially from the point of view of many in the workforce who would have had time to start careers before computers were widespread. In this sense age and education might correlate with regards to skills, a younger person will have been subject to more computer training while in school. The reverse is also true. A younger person with longer education history may gain computer experience more due to the current society than the longer education. Other relations between attributes can be similarly complex. In a relatively small sample, as was used here, the relative impact of people as a whole may be greater than a breakdown of their characteristics, like in the example where the effect of “elementary education” in reality meant “this group of people with several correlating attributes”. The impact of the skill attributes also had to be included in the analysis, further increasing the complexity of connections between the end-users and their use of support. In addition, the population itself was very heterogeneous, as end-users often are.

The very complex connections between the different attributes and the somewhat inconclusive analysis in Publication 2 lead to a need for a deeper analysis. This was done in Publication 3 using the technique of self-organising maps as described in section 6.3. In addition to demographics, Publication 3 includes the effect of the skill attributes which further increases the complexity of the analysis.

Publication 3 identified 6 groups of end-user developers, named according to their major characteristics, namely*: female public office*, *male public sector*, *female SBOs*, *male SBOs*, *female public service*, *female job type: both*. Gender, job type, education and skills were the attributes that gave the grouping effect, whereas age had very little impact. The groups' major defining characteristics are described in Table 12 and descriptive statistics are given in Table 13.

Table 12. Major characteristics of the end-user developer groups.

Male public sector	**Female SBOs**
High education	Low education
High computer/internet skills	Low computer skills
Older	Moderate internet skills
Female public service	**Male SBOs**
High education	Low education
Low computer/internet skills	Low computer/internet skills
Younger	
Female public office	**Female job type:both**
Moderate education	High education
Low computer/internet skills	Moderate computer/internet skills

Table 13. Breakdown of the identified groups' size, skills, education and ages.

Group name		Group size	Comp. skill	Inet. skill	Education	Age
Female public office	Mean	20.0%	2.26	2.26	3.08	43.8
	StDv		0.73	0.32	1.38	9.98
Male public sector	Mean	21.7%	3.70	3.18	4.69	49.2
	StDv		0.81	0.81	0.48	9.49
Female SBOs	Mean	16.7%	2.28	2.42	2.20	44.9
	StDv		1.31	0.64	1.03	8.03
Male SBOs	Mean	13.3%	2.12	2.30	1.88	47.9
	StDv		0.90	1.03	0.99	11.8
Female public service	Mean	16.7%	2.31	2.15	4.00	42.3
	StDv		0.92	0.51	1.16	11.2
Female job type: both	Mean	11.7%	2.47	2.33	3.86	43.4
	StDv		0.87	0.35	1.35	9.48
All	Mean	100.0%	2.59	2.48	3.37	45.4
	StDv		1.07	0.73	1.45	9.91

These groups are of course particular to the populations studied, i.e. other populations might have other groupings. Consequently, there are some strong connections between attributes that we may need to be aware of for the analysis. For example public sector jobs require certain levels of formal education resulting in higher education naturally being related to some types of jobs. While the labour market is largely gender neutral there is still a tendency for males to be overrepresented in managerial positions. We see this here with the ‘male public sector’ group where public sector males are brought together by the requirements of broadly similar managerial positions, whereas females in the public sector are divided into two groups depending on the particularities of their work.

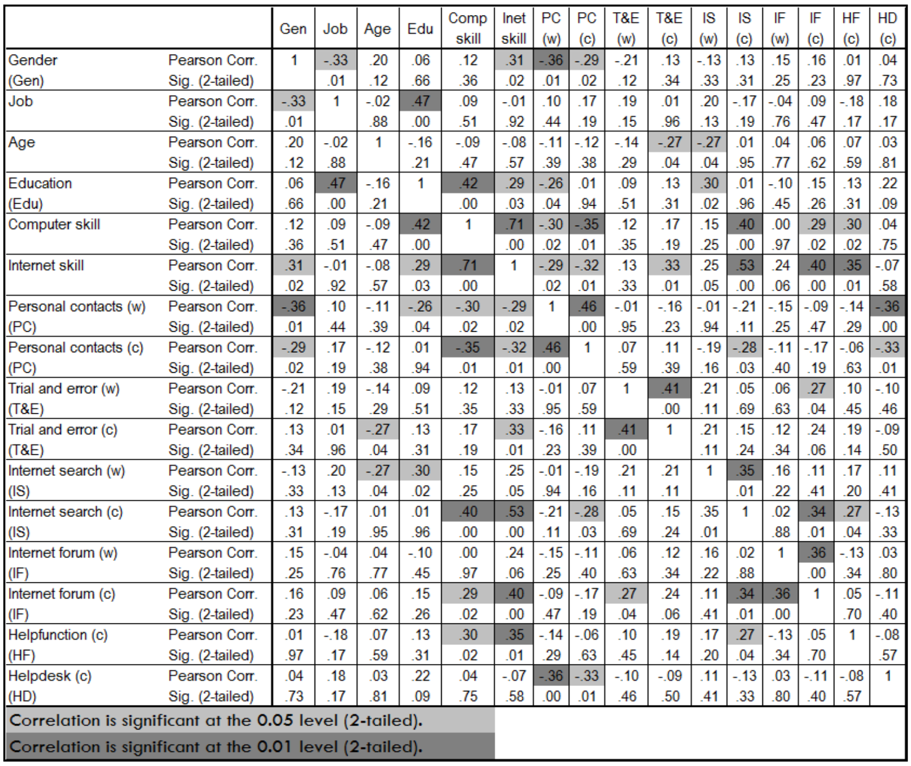
Internet skill and computer skill are closely connected. It seems in this case Internet skills might be considered as a continuation of computer skills because it correlates in a similar way as computer skills do to sources, just more strongly (see Table 14). Why exactly this would be is not clear from the data, however, especially since according to previous research Internet use should be fairly uniformly widespread in the population. In the survey males scored themselves higher with regard to computer skills, this may to some degree represent overconfidence. This could lead to less reliance on other support sources, but does not seem to be the case as higher skill increases use of most support sources except personal contacts. Overconfidence may not be a problem when seeking support if it gives the confidence to actually go out and ask questions.

6.4.3 Impact of End-Users Characteristics on Use of Support

The distribution of usage of sources (see Table 9) means that some discretion must be taken when interpreting the results. Especially since books, help desk and unfortunately Internet forums were barely used. Overall **knowledge repositories** were used to some extent. The more popular sources were one **communicative source** (personal contacts) and the **other sources**. Noteworthy is the strong internal correlation for support sources. If a person used a source for one type of problem they generally used it for the other as well. Initially, when constructing the surveys it was uncertain if splitting the end-user development problems into a work and a computer problem item was valid. However, splitting the questions into work and computer domain problems does not seem to be a factor affecting the results.

In order to find out whether there are connections at all between attributes and support sources a statistical correlation analysis was also carried out. The results are illustrated in Table 14. Based on the connections in Table 14 that were found significant at the 0.05 and 0.01 level Figure 13 was constructed to illustrate the connections between attributes and sources. The arrow thickness indicates strength of the correlation and a solid arrow a positive correlation while the dashed arrows are negative correlations. Arrow direction indicates the assumed causal relationship. From the demographic and skill attributes it is fairly straightforward to establish causal relationships. Higher education leads to more computer skills, having better computer skill will not increase someone's educational level helpful as it may be. Higher computer skill leads to more use of support sources for computer problems, using certain sources for computer problems would not increase the computer skill measure. The correlations between support attributes are depicted as two-way arrows as it is impossible to say whether the use of one source of support is the cause of using another, especially for the internal correlations.

Table 14. Correlations of the attributes.



		Gen	Job	Age	Edu	Comp skill	Inet skill	PC (w)	PC (c)	T&E (w)	T&E (c)	IS (w)	IS (c)	IF (w)	IF (c)	HF (c)	HD (c)
Gender	Pearson Corr.	1	-.33	.20	.06	.12	.31	-.36	-.29	-.21	.13	-.13	.13	.15	.16	.01	.04
(Gen)	Sig. (2-tailed)		.01	.12	.66	.36	.02	.01	.02	.12	.34	.33	.31	.25	.23	.97	.73
Job	Pearson Corr.	-.33	1	-.02	.47	.09	-.01	.10	.17	.19	.01	.20	-.17	-.04	.09	-.18	.18
	Sig. (2-tailed)	.01		.88	.00	.51	.92	.44	.19	.15	.96	.13	.19	.76	.47	.17	.17
Age	Pearson Corr.	.20	-.02	1	-.16	-.09	-.08	-.11	-.12	-.14	-.27	-.27	.01	.04	.06	.07	.03
	Sig. (2-tailed)	.12	.88		.21	.47	.57	.39	.38	.29	.04	.04	.95	.77	.62	.59	.81
Education	Pearson Corr.	.06	.47	-.16	1	.42	.29	-.26	.01	.09	.13	.30	.01	-.10	.15	.13	.22
(Edu)	Sig. (2-tailed)	.66	.00	.21		.00	.03	.04	.94	.51	.31	.02	.96	.45	.26	.31	.09
Computer skill	Pearson Corr.	.12	.09	-.09	.42	1	.71	-.30	-.35	.12	.17	.15	.40	.00	.29	.30	.04
	Sig. (2-tailed)	.36	.51	.47	.00		.00	.02	.01	.35	.19	.25	.00	.97	.02	.02	.75
Internet skill	Pearson Corr.	.31	-.01	-.08	.29	.71	1	-.29	-.32	.13	.33	.25	.53	.24	.40	.35	-.07
	Sig. (2-tailed)	.02	.92	.57	.03	.00		.02	.01	.33	.01	.05	.00	.06	.00	.01	.58
Personal contacts (w)	Pearson Corr.	-.36	.10	-.11	-.26	-.30	-.29	1	.46	-.01	-.16	-.01	-.21	-.15	-.09	-.14	-.36
(PC)	Sig. (2-tailed)	.01	.44	.39	.04	.02	.02		.00	.95	.23	.94	.11	.25	.47	.29	.00
Personal contacts (c)	Pearson Corr.	-.29	.17	-.12	.01	-.35	-.32	.46	1	.07	.11	-.19	-.28	-.11	-.17	-.06	-.33
(PC)	Sig. (2-tailed)	.02	.19	.38	.94	.01	.01	.00		.59	.39	.16	.03	.40	.19	.63	.01
Trial and error (w)	Pearson Corr.	-.21	.19	-.14	.09	.12	.13	-.01	.07	1	.41	.21	.05	.06	.27	.10	-.10
(T&E)	Sig. (2-tailed)	.12	.15	.29	.51	.35	.33	.95	.59		.00	.11	.69	.63	.04	.45	.46
Trial and error (c)	Pearson Corr.	.13	.01	-.27	.13	.17	.33	-.16	.11	.41	1	.21	.15	.12	.24	.19	-.09
(T&E)	Sig. (2-tailed)	.34	.96	.04	.31	.19	.01	.23	.39	.00		.11	.24	.34	.06	.14	.50
Internet search (w)	Pearson Corr.	-.13	.20	-.27	.30	.15	.25	-.01	-.19	.21	.21	1	.35	.16	.11	.17	.11
(IS)	Sig. (2-tailed)	.33	.13	.04	.02	.25	.05	.94	.16	.11	.11		.01	.22	.41	.20	.41
Internet search (c)	Pearson Corr.	.13	-.17	.01	.01	.40	.53	-.21	-.28	.05	.15	.35	1	.02	.34	.27	-.13
(IS)	Sig. (2-tailed)	.31	.19	.95	.96	.00	.00	.11	.03	.69	.24	.01		.88	.01	.04	.33
Internet forum (w)	Pearson Corr.	.15	-.04	.04	-.10	.00	.24	-.15	-.11	.06	.12	.16	.02	1	.36	-.13	.03
(IF)	Sig. (2-tailed)	.25	.76	.77	.45	.97	.06	.25	.40	.63	.34	.22	.88		.00	.34	.80
Internet forum (c)	Pearson Corr.	.16	.09	.06	.15	.29	.40	-.09	-.17	.27	.24	.11	.34	.36	1	.05	-.11
(IF)	Sig. (2-tailed)	.23	.47	.62	.26	.02	.00	.47	.19	.04	.06	.41	.01	.00		.70	.40
Helpfunction (c)	Pearson Corr.	.01	-.18	.07	.13	.30	.35	-.14	-.06	.10	.19	.17	.27	-.13	.05	1	-.08
(HF)	Sig. (2-tailed)	.97	.17	.59	.31	.02	.01	.29	.63	.45	.14	.20	.04	.34	.70		.57
Helpdesk (c)	Pearson Corr.	.04	.18	.03	.22	.04	-.07	-.36	-.33	-.10	-.09	.11	-.13	.03	-.11	-.08	1
(HD)	Sig. (2-tailed)	.73	.17	.81	.09	.75	.58	.00	.01	.46	.50	.41	.33	.80	.40	.57	

Correlation is significant at the 0.05 level (2-tailed).

Correlation is significant at the 0.01 level (2-tailed).

The (w) stands for work problems and the (c) for computer problems.

The findings in Publication 3 indicated that in this population there is a very strong connection to work with groups forming more along types of tasks performed rather than traditional demographic factors. This fits the task centeredness and heterogeneous nature of end-user development (Klann et al., 2006; Nardi, 1993). Like Shaw et al. (2002) differences are found across groups, most clearly in the non-use of some sources. Some of these differences can be explained by the groups, but some cannot. It is fairly clear that the "male public sector" group is not using personal contacts and that the females in the public sector do not generally use trial and error or Internet searches, whereas these are more prevalent in SBO clusters. It was also surprising to find so many SBOs using personal contacts, because initially SBOs were not expected to have ready access to such.

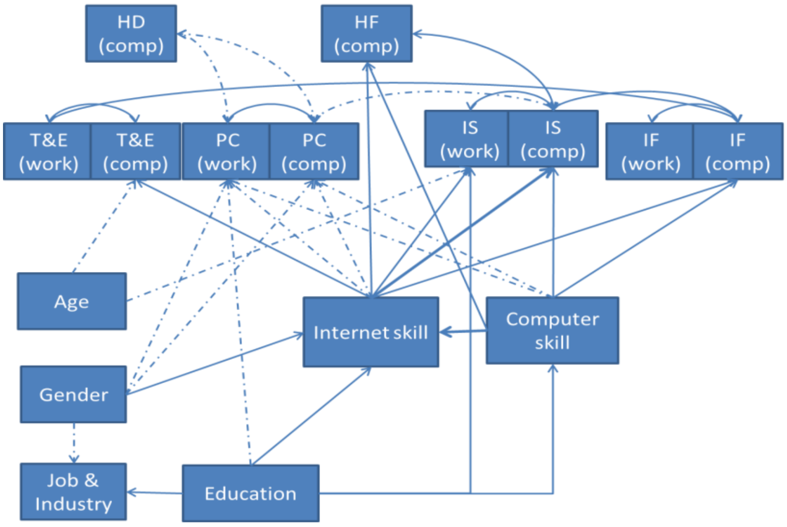


Figure 13. The correlations between support sources and the demographic and skill attributes.

Demographic factors. In some cases support usage seems mainly tied to certain attributes instead of groups. Cross and Sproull (2004) list factors that impact on information seeking such as gender, job type and relation to the source. Some of these effects are seen in the use of support, however, not in the degree that was expected. The general lack of impact of the demographic factors is somewhat surprising. Publication 2 found some minor effects, but these seemed to vanish when skill attributes were included in the analysis. Gender has less impact than was expected considering the effect it has had on other areas of end-user development (Ko et al., 2011; Nilsen and Sein, 2004) and as noted in chapter 5.3.2. However, males are more likely to experiment by tinkering (Ko et al., 2011) explaining their larger use of trial and error for computer problems. Job types influence somewhat what support sources are available, but not necessary what support is used, which is in line with previous research on preferred sources (see chapter 3.5). Simply put, people find whatever methods works for them, to some degree regardless of what others may think. Age was expected to influence skill and computers use more (Brown, 2002) as was discussed in chapter 5.3.2, but it seems this working population is not yet computer/Internet “savvy”. At least in a way that matters, as Margaryan et al. (2011) report regarding quantity and quality of use, young people use computers more but not more effectively. In addition, Table 11 shows us that most (83%) respondents were older than 35 and might not have had as much computer exposure. There are simply not enough young people with adequate skill (as opposed to general experience) for age to have an effect. Only the education attribute seems to have a broader impact on the use of support, directly or indirectly through the skill attributes. This factor has a larger impact than expected, though in line with previous research and statistical reports presented in chapter 5.3.2. It would seem education provides opportunities for expanding computer and Internet skills.

Skill factors. The clearest impact on support use comes from the computer and Internet skill attributes. In of itself this is not surprising as previous literature has shown skill and/or self-efficacy is important (see chapter 5.3.2), however, when combined with an almost complete lack of impact from other factors this warrants some further consideration. The population surveyed were somewhat novice in computer usage (see Table 10) and very heterogeneous, which may have exacerbated the impact of skills contra other factors. Computer skill is strongly connected to the use of support methods for computer problems. Higher skill positively correlated to use of "self-helping", i.e. internet searches, trial and error and internet forums which mirrors the findings of Munkvold (2003). The same is true for Internet skill, to an even higher degree. The central importance of Internet skill (see Table 14 and Figure 13) is rather interesting. The strong connection to Internet sources is expected, yet the connection to the other computer sources less so. The answer seemingly lies in the strong tie between computer and Internet skill as those with the highest computer skill also have good Internet skill. On the other side of the coin higher skills correlates to less use of personal contacts. Personal contacts seem to be the default source, it correlates negatively with most other attributes which could be an indication that it is used instead of other sources or when other sources are not available.

This high impact of skills is a two-edged sword. While the importance of skill means that people can with training and experience become better at using Internet based sources, in the short term it is problematic if it forms a barrier for end-user developers and solidifies their reliance on usually less reliable support, such as personal contacts.

Other factors. Some of the results are undoubtedly artefacts of the specific population and the variation in usage of sources as some sources were used almost universally and some almost not at all. With such a diverse population as end-user developers are, it may not be surprising that the only common factors are those which are in fact common to all respondents. The results here suggest that when providing or considering support it will not be as important who people are, but rather what they do. The important thing is not the composition of these groups, as that will vary over different populations, but that there are indeed groupings which can be found. You can still target groups despite a population that is heterogeneous, but groups will be more eclectic and less distinct.

6.5 Summary

This chapter has presented the results from two surveys of two end-user populations. The end-user studies collected data on use of support and user attributes among two similar, but separate, populations of small organisations. The results indicated that the main sources accessed were personal contacts, searching the Internet and trial and error. However, none of these may be particularly suitable to actually solving development problems due to bad fit and high requirements in skills.

Although the end-users are a very eclectic population, it was possible to find some similarities. However, these groups were mostly unrelated to support use. The impact of demographic and skill attributes on the use of support sources was examined. The demographic attributes appeared to have only a limited effect. A second analysis suggested that skill is the most important attribute impacting on use of support.

The next chapter describes an analysis and comparison of the various support sources end-user developers could use.

7 Analysis and Comparison of Support Sources

7.1 Introduction

This chapter reports on the findings from Publication 4, how the framework with the four EUD factors: **context**, **cooperation**, **interaction** and **immediacy**, described in chapter 3.7, has been used to analyse and compare the different support sources identified in Publications 1 and 2. Moreover, a few sources not present in the earlier studies have been included in the analysis/comparison, namely: blogs, wikis, web sites, knowledge bases, application programming interfaces and software libraries. In particular, the research aimed to analyse and compare the effectiveness of support for end-user developers. It aims to answer **RQ3: How do the sources compare to each other? What could the benefits of a virtual community be?**

The chapter is structured as follows. Section 7.2 presents an analysis of the sources of support listed in Table 15 using support sources for the Microsoft Excel spreadsheet application as a case. Section 7.3 contains a comparison of the effectiveness of sources with a focus on novice users as the end-user developers in need of support.

Table 15. The sources considered in the analysis

Knowledge repositories	Communicative sources	Other sources
Software libraries and application programming interfaces	Personal contacts and helpdesk	Internet searches
Books, manuals and application help function Knowledge bases, on-line manuals and wikis	Virtual communities: • Discussion forums • E-mail lists • Social networks	Trial and error
Blogs and “tips and tricks” web-pages		

7.2 Analysis of the Different Support Sources

To aid this analysis the sources are primarily categorised based on their main function: sources that act as *knowledge repositories* described in section 7.2.1 and sources that facilitate communication between people (*communicative sources*) in section 7.2.2. Some sources do not easily fall into either category and are here listed as *other sources* in section 7.2.3. Furthermore, some sources combine features of both, the implication of this is discussed later on in section 7.2.4 about *hybrid and mixed sources*. In addition, a within category ordering has been used for sources that are similar in structure, content and/or producer to avoid repetitions. E.g. books, manuals and application help function are all similar. They are structured and formalized knowledge repositories, contain a lot of information described in a general manner and are normally produced by whoever created the end-user development environment. Table 15 presents a breakdown of the sources considered here.

7.2.1 Knowledge Repositories

The knowledge repositories analysed are: **software libraries** and **application programming interfaces**, **books**, **manuals** and **application help function**, **knowledge bases**, on-line **manuals** and **wikis** and finally **blogs** and **"tips and tricks" web-pages**. Their main function is that they provide information for users, though some of these have a communicative function as well. They contain a wealth of information of various levels, ranging from quick answers to simple questions to advanced technical information and source code. Knowledge repositories provide developers with information on development, as well as how-to and code examples. To some degree they all share two fundamental problems:

1) How to find information.
2) How to apply the information once found.

There is a general **problem of finding information** in large information systems (Belkin, 2000). In addition to the so called vocabulary problem (Furnas, Landauer, Gomez, and Dumais, 1987), potential issues with syntax exist (Mili, Mili, and Mittermeir, 1998). These two problems are often interconnected as you need to know the exact terms used (vocabulary problem) and in what order to use them (syntax problem). Modern search engine technologies and other enhancements such as tagging (Heymann, Koutrika, and Garcia-Molina, 2008), and tools, such as Mica (Stylos and Myers, 2006), can alleviate some of the issues. Stylos and Myers (2006) note how web searches helped programmers overcome barriers resulting from phrasing issues, but fundamentally the problem remains that searchers need to some degree know what they are looking for. It is ironic that the large amount of information usually found in knowledge repositories is the reason they suffer contextually.

The other problem is that the solution needs to be fitted into the developer's work. The developers face the **problem of adapting information or code found** in the knowledge repository to their needs. Ko and Meyers (2005) mention how end-users had difficulties understanding what and how code worked, even code they themselves had previously written. Furthermore, end-users will tend to learn just enough of programming to do what they want instead of a whole process (Ko and Myers, 2005). Connected to this second problem is the issue where manuals only explain features and not their use (McGill and Klisc, 2006). This problem of making use of information can also be described as Dörner et al. (2007) does as being "*written from experts for experts*". This problem is broadly applicable to all knowledge repositories.

Software libraries and application programming interfaces

Microsoft Excel's functions can be extended with the help of the Visual Basic for Applications programming language[10]. As with many other programming languages there are thousands of built-in or externally produced objects, classes or functions. These built-in functions and extensions can be utilized by a developer in their own applications. For this purpose programmers can use (on-line) software libraries (SL) or application programming interfaces (API), which are structured repositories of information containing code (usually in modules). The main difference to a knowledge base or wiki is that the SL/API predominantly contains code, though the two forms are similar and may be combined. A SL/API will have a wide range of solutions (i.e. different code modules) available and can thus provide extensive developer support solving a wide range of problems.

A developer using a SL/API may suffer from the problem of finding the right code to use. Despite considerable effort problems associated with finding code in the library remain (Mili et al., 1998). Users of the SL/API cannot formulate queries correctly if they do not know the correct syntax used. The correct syntax is dependent on what kind of structure the software library has (Mili et al., 1998). Better searching tools in general or specific tools for searching/browsing for code, such as Mica (Stylos and Myers, 2006), help to some degree. However, a developer would usually need to know or be able to guess what a function is called in the development environment to be able to find it in a SL/API. Also, the code would likely need to be adopted for the developer's specific problem, something end-users often struggle with (Ko and Myers, 2005). Ko et al. (2011) suggest SL/APIs need to be designed to support end-user development activities and Segal (2007) notes that they may be difficult to implement in organisations and for end-user developers.

A SL/API can be a valuable tool for those able to make use of them. However, for most end-user developers they leave a lot to be desired. Context is therefore weakly supported as the developer is faced with a significant attention investment. Similarly, immediacy is weakly supported as syntax and vocabulary needs to be understood and searching strategies developed based on them disengaging the user further from the development process. A SL/API supports cooperation and interactivity only weakly, if at all, because there is normally no communication or feedback function.

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[10] Available at: http://msdn.microsoft.com/en-us/library/bb726434(v=office.12)

Books, manuals and application help function

Books and manuals were one of the main ways to provide support for software before widespread use of application help functions. Their purpose and content is similar to that of the help function that has largely replaced them, except that the help function can easily contain more information and can take advantage of the computer's information processing capabilities. Microsoft Excel has a built-in help function that contains information on most aspects of use, e.g. tutorials and examples, as well as technical information about the application. That books are bad at help often seems to be treated as a truism and indeed Spitler (2005) found many negative views on books and manuals. Manuals also only teach knowledge of features, not how to use them. (McGill and Klisc, 2006)

The information content in these sources is as general and broad as possible to appeal to the largest potential audience. There is also a risk for information overload due to the large amount of information provided. If the search is too general it may provide too many or inappropriate answers that detach the user from the development process. The information overload problem reduces both context and immediacy for the user. Therefore, context is weakly supported in these sources. Books and manuals also have weak immediacy and no interactivity due to the physical limitations of the medium, i.e. flipping through a book. The help function can be shown side by side to the application. The user can copy and paste a solution or an example directly from the help to the application thus strengthening interactivity and immediacy. This means interactivity and immediacy can be considered weakly to moderately supported for the help function. A complex problem may require significant effort of finding and applying the answer found in these sources.

Knowledge bases/on-line manuals and wikis

It is common that vendors provide on-line manuals for products in electronic form, e.g. a pdf version of the paper manual. In this basic form there is little difference to a paper version, except for the ability to keep it updated with corrections and other modifications more easily. A living (hypertext) document or wiki is a form of manual that uses the capabilities of the medium more directly, by using hypertext capabilities to link different parts together. It can also be seamlessly updated with new information. Lists of frequently asked questions (FAQs) along with answers are also commonly found on-line. A knowledge base is a database that has information on known problems and workarounds or answers to question users may have, in essence an advanced FAQ system. You can do text searches in the knowledge base to try and find solutions to problems. Some software programs can link directly to knowledge bases based on an error code or use the code as a search parameter. Most of these sources are official support from the software provider, but a wiki can easily be semi or completely unofficial. Using these on-line sources makes it easy to distribute information and to keep it current for all potential users to benefit, whereas distributed help (manuals, application help function) is current to the situation when it was written. It is also possible to use the medium to further expand the available support by linking to other forms of help, e.g. on-line tutorials. There is an extensive knowledge base for Microsoft Excel[11].

Context is not focused on the end-user developer's specific interest, but instead general and as broad as possible to appeal to the largest audience. Manuals and knowledge bases are not inherently cooperative, though wikis are. However, this cooperation in wikis may not exist in way that supports the end-user developer, particularly if it is an official wiki, which likely limits the editing permissions. While these sources have some interactivity and can be changed and expanded easily, they do not change in response to a developer's specific problem. The large amount of information contained and the associated issues with finding the right information means immediacy is usually weakly supported. While closely related to the application help function these types of sources suffer in comparison by being one step removed from the development process. Context, cooperation, interactivity and immediacy are all weakly supported.

Blogs and "tips and tricks" web-pages

A "tips and tricks" site contains a number of solutions that people are likely to be interested in. Similarly, a blog can contain pieces of code or ideas the author thought was interesting. Often these will consist of simple but clever tricks, e.g. HTML and/or Java Script tricks, such as how to create different effects when the cursor is scrolled over a link or an image. These are often simple to create if you know the correct syntax. These sites can also contain more exotic code that is not extensively covered in manuals or the application help function or have interesting workarounds that the author has discovered. A good example of such sites is "Jon's Excel Charts and Tutorials", containing advanced Excel charting tricks[12].

In essence these are akin to software libraries, containing code to copy and use, except that they are not as extensive and probably not organised as rigorously. This has two implications. One is that the potential exists for vocabulary issues (Furnas et al., 1987). On the other hand it is more likely that colloquial terms are used which would help those not knowledgeable in the terms used in a specific programming language. The code will generally work with little modification and is usually self-encompassing and straightforward to use, literally a question of copy and paste. This reduces the need to understand the code and the issues associated with this (Ko and Myers, 2005; Ko et al., 2011). In many cases the user only needs to replace the "your text here" part. In many ways the software libraries and "tips and tricks" sites are opposites of each other, one is broad in scope, structured and formal, the other narrower and unstructured, but less formal and perhaps easier to use.

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[11] Available at: http://support.microsoft.com/

[12] Available at: http://peltiertech.com/Excel/Charts/ChartIndex.html

As knowledge repositories with more limited scopes one would perhaps expect that correspondingly to other knowledge repositories the EUD factors would be weakly supported. However, the limited scope has some potential advantages. It is possible to consider context moderately supported as the information is presented more easily and will have some contextual meaning. The narrower scope also moderately supports immediacy as any answers should be easier and quicker to find. Interactivity and cooperation is possible as these sites can support a limited form of commenting and discussion. However, the nature of these sites lends itself more to discussion of the information already posted rather than new topics. As such we can conclude that, though technically possible, for the purpose of providing support in response to the developers problems interaction and cooperation are not adequately supported.

7.2.2 Communicative Sources

The communicative support sources considered here are **personal contacts**, **helpdesk** and various forms of **virtual communities**. Their primary function is to enable communication between people allowing them to engage in support activities. In other words the primary function is not in providing information, but in facilitating communication. They can also function as knowledge repositories if the record of the communications are stored and made available. As such, communicative sources are only as good as the people who are available to provide the support. If the knowledge repositories’ main issue is in finding the information they contain, communicative sources are instead potentially hampered by a lack of adequate information and issues arising from the human component.

Personal contacts and helpdesk

Personal contacts are very popular as a source (see Table 9) and as such may be the first port of call for a developer with a problem. It entails contacting colleagues, friends or other persons for advice on solving a problem. The helpdesk is an ICT support function found in many organisations. Both cases are similar as the developer is contacting people with whom they have a formal or informal relationship.

This allows the developer to present their specific problem context and focusing on how to solve their problem. They can work in cooperation with the contact. This work can be done interactively, while the likely relatively rapid response would support immediacy. All four factors are thus strongly supported. The main problem with contacts lies in availability and knowledge content. Helpdesks may provide none (Govindarajulu et al., 2000) or only limited development support (Govindarajulu, 2002) and it is likely that the user’s social network is on par with the user in terms of knowledge (Constant et al., 1996).

Even if it is contextually specific and quick it does not help if the answer is “I can’t help with you problem”. Not everyone have their own spreadsheet guru at hand, unfortunately.

Virtual communities

Internet forums are places where people can post messages creating a platform for asynchronous communication and discussion. A forum is a collection of topics that members can read and post a reply to, which can then in turn be commented upon by others, creating a chain of discussion or discussion thread. Email discussion lists are similar to forums and provide essentially the same function. The main difference is the separate channel (email client versus web browser) it is accessed by and that emails are pushed to the user while the user has to pull information from the forum. A social network works similarly to a forum, but usually includes an assortment of other facilities that allow people to connect, share information and interact in different ways. All of these can be considered as different types of virtual communities. In addition to allowing communication between members a virtual community normally saves the messages that have been posted. Old messages and discussions can be read or even revived with new replies. In this way they will also function as knowledge repositories, though due to their communicative focus this function is often less effective compared to regular knowledge repositories. This ad-hoc knowledge repository will share the burden of vetting and maintaining it over many individuals, though at a potential cost to accuracy (Ko et al., 2011). A very good example of a community for Excel help is the Mr Excel forums[13] .

As a communicative source a virtual community allows interaction between the end-user developer seeking support and the information providers. This allows a negotiated or mediated approach, which forms a natural “informal apprenticeship” (Ko and Myers, 2005). This interaction and cooperation means that during the process both parties have the ability to interpret what the other is saying and if required ask for clarifications and work towards a common understanding of the problem. (Arias et al., 2000) Neither is bound to a frame of reference fixed at some previous point and can adapt, e.g. negotiating a common vocabulary if one did not previously exist. The same is true for the knowledge, which is described by Wenger (1998) as *living knowledge content*, meaning it is not defined at some earlier time and is dynamic and continually changing. When a problem has been posted the members of the community can then either correct the code, provide information on how to solve the problem or where to find the information to do so or even provide alternate solutions leading to a cooperative development effort similar to those described in (Nardi, 1993).

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[13] Available at: http://www.mrexcel.com/forum/forum.php

A virtual community strongly supports context, collaboration and interactivity. The developer can go through several iterations to solve the problem or refine the solution as well as explaining the exact circumstances with real data if needed supporting an iterative development process. In this way context is very much present. It also makes the supporting activity collaborative and interactive. The helpers can explain a difficult concept to the developer or correct code that would have had a different behaviour from what was expected. Immediacy can be anything from weakly to strongly supported as the timeliness of any answers will depend on the activity of other users.

7.2.3 Other Sources

Several additional support sources are found on-line. In many cases, they are not unique for the medium though again their usefulness is greater as an on-line version as they can more easily be updated and linked together with other sources. Some examples include, but are not limited to on-line training, tutorials, video/animated demonstrations. Often these are found as a part of another knowledge repository or communicative source.

Internet searches

In some senses the search engine could be considered a support source. For the end-user “searching the Internet” is a perfectly valid source, even though the search engine merely reflects other sources. In this capacity it will be a knowledge repository with dynamic content reflecting the keywords/search term used. Similarly to other knowledge repositories context, interactivity and cooperation is weakly supported while immediacy will be weak to moderate. While responses will essentially be immediate the large amount of information likely provided by the search engine will require considerable effort to sift through. This will be compounded by the impact of the used terms, i.e. the vocabulary used. However, unlike a formal knowledge repository the user can provide their own keywords (which do not need to correspond to the formal terms used) and still likely get some relevant responses due to the wider range of sources accessed by the search engine. The search engine will likely form the initial contact point for most information seekers providing a way to find the other support sources. It is in fact unlikely that the end-user can find any other source without the search engine (unless directed to them somehow, e.g. a colleague or some other referral). For most intents and purposes the search engine equals the information sources it can find even though it is technically speaking a tool and not a source.

Trial and error

Trial and error simply means the developer experimenting with different solutions to find what works, testing different approaches and variables. It is not a support source as such, but more of an iterative development process that may or may not include referring to other sources. It is, however, a common way of solving development problems, in many ways for end-user developers the whole development process is one of trial and error (i.e. iterative development, see chapter 2.6).

Context, interactivity and immediacy are all strongly supported as the process is naturally anchored in what the developer is trying to do and results will be immediately visible as each change is made. Cooperation may be a part of the process, but in that case, we may find that it is a question of accessing personal contacts.

Table 16. Degree of support for end-user development factors in the sources.

EUD factors	**Support sources**			
Knowledge repositories	*Context*	*Cooperation*	*Interactivity*	*Immediacy*
Software libraries/APIs	Weak	-	-	Weak
Books, manuals	Weak	-	-	Weak
Application help function	Weak	-	Weak→ Moderate	Weak→ Moderate
Knowledge bases, on-line manuals, wikis	Weak	Weak	Weak	Weak
Blogs, “tips and tricks” web-pages	Moderate	Weak	Weak	Moderate
Communicative sources				
Personal contacts, helpdesk	Strong	Strong	Strong	Strong
Virtual communities	Strong	Strong	Strong	Weak→ Strong
Other sources				
Internet search	Weak→ Strong	-	-	Weak→ Moderate
Trial and error	Strong	-	Strong	Strong

7.2.4 Hybrid and Mixed Sources

While the different types of sources are presented here as separate entities it is common to find several sources combined, or co-existing, together in the same place i.e. a website. Modern web technologies makes it fairly easy, one could even say encourage, the integration of the different functions into a complete package. As we have noted earlier some of the knowledge repositories can have communicative functions, for example a feature for posting comments enabling discussions. Likewise, a communicative source that archives the messages will form a basic knowledge repository. In this way most on-line sources will probably combine features and provide both communicative and information resources as well as including several different sources on the same site. It is perhaps not a question of what type of support one picks but more which site one uses. We can also see how the lines between types and support sources start to blur in many cases. E.g. in the Excel help we find that the application help function can work in an on-line mode connecting to the official Excel knowledge base as well as providing a communication channel for a community. In addition links to other third party sources, such as the Mr Excel forums mentioned earlier, are provided when searching in the application help function. This combines distributed help, extended dynamic on-line content and community aspects. Such a package will likely create a sum total value higher than its constituent parts.

7.3 Comparison of End-User Development Support Sources

As noted earlier in chapter 2 end-user developers are a very diverse group and are likely to pick those sources that seem to fit their personal preferences and abilities. If we can understand those preferences better it is possible to provide better support for people, or at least provide a starting point for their own support seeking.

The end-user developer has two issues to solve *what* to do and *how* to do it. The strong point of knowledge resources is answering *what* to do, i.e. the information content. Ironically it becomes a liability since finding and especially applying information are some of the main barriers for end-user developers. Conversely the communicative sources solve these problems of finding and applying information, the *how* portion, by largely outsourcing this knowledge acquisition process to the knowledge provider. However, communication sources may be hampered by a lack of information. If not then they are superior sources to consult as they solve the main end-user developer issues while still providing the knowledge sought. As McGill and Klisc (2006) note, a book teaches knowledge about a feature, but not how to use it. That is where knowledge repositories break down for the end-user developer.

7.3.1 Knowledge Repositories

Software libraries/APIs seem the least appropriate for the end-user developer, especially a novice. Not only does it require understanding of the development language it also requires knowledge about the library itself. This requires a much larger investment of attention than the average end-user developer may feel is justified. There is also the issue with adapting generic code to the specific problem at hand. On the plus side, a software library/API has solutions for a wide range of issues, but the developer has to find them and be able to adapt them for their own problem.

Knowledge bases, wikis, books, manuals and the **application help function** similarly contain a wide range of solutions, but suffer from the same issues with formalism as software libraries/APIs. They are geared toward as many people as possible and will therefore provide less contextually relevant support. To benefit fully from these sources the developer needs a larger degree of skill to find and apply the information they require.

Blogs and "tips and tricks" sites have less extensive information content, but the information they contain would mostly be easier to absorb for the end-user developer. The skill needed to apply them is less as examples tend to be presented in context. Further, the facility for communication allows for some interaction and thus an option for even more specifically contextual support. This source has some benefits for the less experienced user. The content may be geared more towards them and have stronger contextual support, but the main issue is a lack of breadth of information.

7.3.2 Communicative Sources

Personal contacts and **helpdesks,** as communication sources, provide strong support for the end-user development factors, but can often lack in information content. As mentioned earlier a developer's social network may not contain the requisite knowledge and the helpdesk most likely cannot provide this type of support. If it does then, naturally, it will be a very powerful method of support, perhaps the most effective one for the end-user developer. It is not surprising that it remains the most popular way to get support. The issue is of course that people persist in employing it even if or when it no longer works as well.

A virtual community seems to solve both the problem of finding information and how to apply it by allowing its members to interact and discuss a problem. Developers can post their problem in their own words and provide sample data or troubleshoot their existing code by posting it. The information to solve even the most complex problems can usually be found. Furthermore, even a very novice user can make use of the answers as through interaction the solution can be explained to them. In an extreme case the end-user need not even understand the solution as it can be served to them ready to use based on the data they provided.

As such a virtual community not only has a wide range of solutions, but it allows any type of user to benefit from it. Much of the interesting features of a virtual community come from the interaction of its members of differing abilities and knowledge. This interaction with novice and other advanced users is part of the pay-off for participating in a virtual community. Participating in a community rewards all participants and not only, as one would surmise, the people being helped. As we can see from Table 16 virtual communities rate strongly in all factors and should therefore be acceptable to most developers. For the spreadsheet developer considered here this is as close to having one's own personal spreadsheet guru by one's side as most people are going to get.

7.3.3 Other Sources

Internet searches reflect the information content of knowledge repositories featured in the results and as such its suitability for end-user developers is largely the same as the knowledge repositories. The main issue lies in being able to make sense of and applying the results received.

The trial and error process relies on the developer having a good knowledge of the software and problem to make informed decisions. If the developers is less knowledgeable then it effectiveness must be questioned. The strong support for the end-user development factors (in part due to the similarity to the interactive development process) helps explain why it is so popular even though it may be ineffective for those lacking knowledge.

7.4 Summary

This chapter has analysed and compared the effectiveness of different sources of support for end-user developers. Essentially answering **RQ3: How do the sources compare to each other? What could the benefits of a virtual community be?**

Table 16 provides part of this answer by summarizing the properties of on-line sources. The sources have been given a rating of weak, moderate or strong as discussed in the analysis in section 7.2 based on how well the sources map to the requirements of the four factors as described in the framework in chapter 3. Special regard was given to the abilities and considerations found in actual and potential end-user developers in the real world which are the focus of this research, such as those encountered as part the research in Publication 1 and Publication 2 (see chapter 6).

As noted earlier virtual communities seem to be a very suitable support source for end-user developers, as they strongly support the four EUD factors. With properties similar to the very popular personal contacts there is some hope that users can be steered to virtual communities and thus benefit from a much broader range of expertise than is normally available from a user's social network. By replacing "ask the colleagues" with "ask the experts" there is a lot to be gained for the end-user developer.

The next chapter presents the results from Publication 5 that examines knowledge sharing and in particular how end-user developers could benefit from using virtual communities.

8 Using Virtual Communities to Support End-User Development

8.1 Introduction

Publication 5 investigated how end-user developers could improve the outcome of the support process by looking closer at the knowledge acquisition process in a virtual community and examine how the end-user can influence the outcome in a positive direction. The goal was to give a set of guidelines for best practice knowledge seeking in a community to answer **RQ8: What can the end-user do to increase the quality of support on a virtual community?**

The chapter is structured as follows. Section 8.2 discusses the rationale and design of the survey used. Section 8.3 describes the data collection process and section 8.4 the analysis of the data. Section 8.5 presents the results and section 8.6 summarises the guidelines derived from the results for how the end-user can improve the experience of using a virtual community for support.

8.2 Survey Design

Publication 5 was based on a survey executed on-line with qualitative and quantitative questions. The survey was designed to investigate the knowledge exchange process in a virtual community as discussed in chapter 4. The survey was designed purely for research so there were less practical constraints than in the previous surveys, although some aspects of the setting had to be considered. Some questions were included or modified to accommodate the community management who wanted some things examined. There were also limitations in how the survey could be presented and advertised.

This research stream examined the usefulness of support from the end-user's perspective. Phang et al. (2009) note the importance of socio-technical issues. That is, knowing what the features available to members are and the interactions among them, since this is a particular feature of an on-line community. When designing the survey these aspects had to be considered.

Social aspects are important because communities have their own rules and processes. For example, contacting respondents through private messages was not allowed by the forum administration. Participation observation allowed the author to determine something of the knowledge seeker/contributor interactions and cover these issues in the survey. In addition, participation allowed the author to have a (small) presence on the forum. Even if I was not personally known to most members, I could demonstrably, through post count and join date, be seen as a member of some note and not a total outsider.

Technical aspects also need consideration, as different types of communities and repositories have technical aspects that may impact on the knowledge seeker/contributor interactions and the contribution. A recent software upgrade added a special search feature to find questions with no replies that strongly impacted the knowledge contribution process in the community. Respondents reported extensive use of this feature and comments suggested it was central to the knowledge contribution process. Another example was examining the potential use of marking threads as solved, which was directly inspired from a discussion among community members on the pros and cons of such a feature.

As discussed earlier in chapter 4.3.3 the social interaction becomes important when considering a community. It is important because prior literature has often been focused mainly on knowledge contribution as a process between a provider and a knowledge repository e.g. in (Bock et al., 2005) or considered the centrality of knowledge providers as in (Wasko and Faraj, 2005) or easiness of social interaction (Phang et al., 2009). None of these seemed to capture how, in this setting, the knowledge seeker can in fact impact on the knowledge contribution process by their own actions.

The survey for Publication 5 was inspired by the virtual community knowledge sharing process illustrated in Figure 10. The research model is based on the (Bock et al., 2005) behavioural intention model depicted in Figure 11, but expanded to include socio-technical aspects, which affect the on-line community setting, and the knowledge seeker’s impact. To take into account these socio-technical aspects and the impact of knowledge seekers the original model depicted in Figure 11 was modified and extended as described below. This modified research model is pictured in Figure 14.

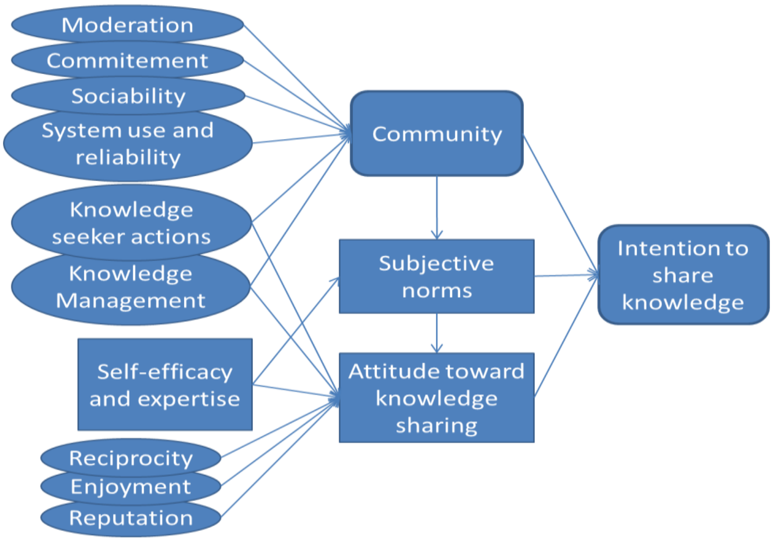
Moderation
Commitement
Sociability
System use and reliability
Knowledge seeker actions
Knowledge Management
Self-efficacy and expertise
Reciprocity
Enjoyment
Reputation
Community
Subjective norms
Attitude toward knowledge sharing
Intention to share knowledge

Figure 14. The preliminary research model, used for data collection.

Organisational climate was replaced by **Community** as there is no formal organisation on-line, only whatever bonds are formed between people. The original items (*fairness*, *affiliation* and *innovativeness*) were replaced by attributes from the social capital and socio-technical viewpoint, i.e. *moderation*, *sociability*, *system use/reliability* (Phang et al., 2009) and *commitment* (Wasko and Faraj, 2005) as these represent factors that will affect communities.

Sense of self-worth was changed to **Self-efficacy and expertise**, based on the social capital framework (Nahapiet and Ghoshal, 1998) and the Bock et al. (2005) and Wasko and Faraj (2005) thoughts on self-worth and expertise. To contribute a contributor needs a sense of self-worth. Your sense of expertise is one way of gaining that. This is the essence of self-efficacy, i.e. you think you can do something.

Knowledge management was added based on the thoughts that tracking knowledge contribution supports reputational motivations and will lower the cost of providing information. (Lakhani and Von Hippel, 2003; Phang et al., 2009)

Anticipated Reciprocal Relationships and **Extrinsic Rewards** were changed to motivational factors better in-line with the on-line context. **Reciprocity**,

Enjoyment and **Reputation** are a set of motivational factors that have been used in previous literature. (Constant et al., 1996; Lakhani and Von Hippel, 2003; Wasko and Faraj, 2005)

The main addition was the self-developed construct of **Seeker actions** which aims to capture the specifics of the interaction between seeker and contributor in this type of on-line knowledge exchange.

Most of the data was collected as with a number of items where respondents were asked to indicate their agreement to statements about various aspects of knowledge contribution. The items were measured on a seven point Likert scale (1–strongly disagree to 7–strongly agree). A wider Likert scale was adopted to allow for more variation in the answers to help the analysis and to encourage respondents to consider their answers more thoroughly. For details on the items included in the survey, see Appendix C.

Participation observation in the on-line community was deeply involved in this step of the research process and used to create new items as well as modify those from literature to fit the context better. Participation observation before and during the survey design was used to adapt knowledge contribution research models from (Bock et al., 2005; Constant et al., 1996; Lakhani and Von Hippel, 2003; Phang et al., 2009; Wasko and Faraj, 2005) (as described above) to a more socio-technical perspective and allowed for a number of qualitative questions to be converted into quantitative ones that had contextual meaning in the research setting. Though in many cases participation suggested that what was observed was only part of the potential behaviour and as such some question had to remain open to respondents. In addition, an open comment field was given for each group of questions for this purpose

8.3 Data Collection

The on-line community where the study was performed is a community built around discussion/support for Microsoft Excel run by a third party. It has over 233,000 members (at the time of writing). The community is very active with hundreds of messages every day. A request for participation was posted in the off-topic section of the boards, containing an explanation of the questionnaire and a link. The questionnaire was also promoted by the administration among the group of community recognized experts in a section not publicly accessible. These people include many prolific contributors.

The questionnaire was open from late September through December 2012. A total of 41 responses were given, of which 36 were sufficiently complete to be included in the analysis. As any members can potentially be knowledge-contributors there is no way of properly defining the target group and consequently a rate of response cannot be calculated. Table 17 shows the basic demographics of respondents. Respondents are fairly similar as a group. Most respondents were male, have a bachelor degree, are experienced in spreadsheet use and live in the UK or US.

Table 17. Demographic factors of knowledge contributors.

Gender	%	Education	%	Country	%
Male	94%	Elementary school	3%	UK	25%
Female	6%	High School	14%	South Africa	3%
Total	100%	Bachelor level degree	67%	USA	42%
		Master level degree	11%	Colombia	3%
		Ph.D. degree	6%	Germany	3%
		Total	100%	New Zealand	3%
				Australia	6%
				India	6%
				Canada	3%
				N/a	8%
				Total	100%

Respondents experience, percentage of respondents						
Years:	**0-3**	**3-6**	**6-9**	**9-12**	**12+**	**Total**
Work experience	0%	3%	11%	8%	78%	100%
Used spreadsheets	3%	11%	6%	19%	61%	100%
Used Microsoft Excel	3%	11%	9%	23%	54%	100%

With regards to the large number of potential respondents the response rate looks extremely low. However, the community's activity is highly skewed and the 90 most prolific posters (3940 or more posts each) contribute 30% of the community's total volume of posts despite representing only 0.04% of the total membership. It is not possible to directly tie this "top poster" group to the respondents. However, many of the respondents belonged to the group who contribute a disproportionate amount to the community. This is partly confirmed by participation observation during data collection. Several participants in the discussion thread created for promoting the survey belonged to the top posters group indicated that they had answered the survey. The problems with knowledge sharing on-line described earlier likely affected this research due to 1) attention limits for the survey request (it was posted in the lesser trafficked off-topic section and was thus less visible) and 2) the time and effort required from respondents.

8.4 Data Analysis

There are two fundamental problems for the knowledge seeker on a virtual community: *gaining the attention of knowledge providers* (Problem 1) and *how to present your problem* (Problem 2). While a functioning community has a balanced market of supply and demand (Davenport and Prusak, 1998), in practice it is usually not feasible to read everything in a large forum leading to a situation of excess demand.

Problem 1 stems from this traffic and turnover and the knowledge provider's attention limit, therefore, to some degree being on the first page equals being visible. Sometimes technical solutions are implemented to overcome this. In the community studied there is a function to find questions with zero replies, which poses an interesting dilemma for a knowledge seeker. Do I push my question to the top or hope that someone seeks it out anyway? What is more likely to be an effective strategy? Since the topic title is the main way to get attention it will be key in drawing attention to your problem. But, how do you effectively do this without potentially alienating knowledge contributors? There are again conflicts in priorities, i.e. describing your problem accurately versus being terse so as not to cause information overflow.

Problem 2 relates to the cost in time and effort for knowledge contributors. If you post a short informative thread with lots of example data, are you more likely to get replies? Can there be too much information? Are there other actions of the information seeker that can improve odds of getting answers? This creates a conflicting situation where the knowledge seeker may find it difficult and requiring effort to define the question/problem, but ultimately worth it to get higher quality support.

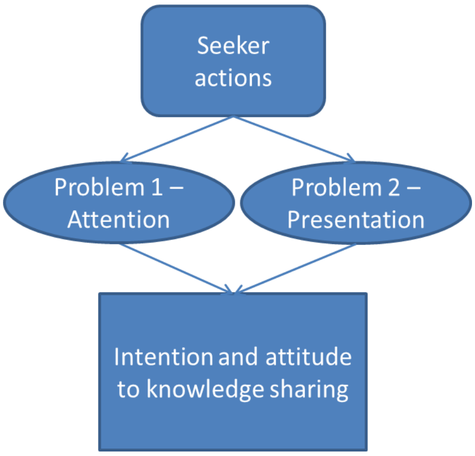

Figure 15. The research model used to analyse the knowledge seekers impact on knowledge contribution.

Bock et al.'s model employed partial least squares (PLS) as an analysis method. The PLS method is often used where sample sizes are small and some flexibility with regards to data is needed (Ringle, Sarstedt and Straub, 2012). However, the large number of questionnaire items compared to so few data points made the PLS method untenable and a more basic frequency and statistical analysis was used instead. The focus of this research is the end-user developer, so here only on the relationship between knowledge seeker and provider and how the actions of the former can influence the latter to contribute knowledge is discussed. This limited research model used for analysing part of the data is pictured in Figure 15. The following constructs were created from the collected data set and used to assess how seeker actions impact on intention and attitude to share knowledge:

- Impact of thread visibility and number of replies
- Impact of thread title
- Impact of problem complexity
- Impact of the content and quality of a post
- Impact of knowledge seeker's actions

Participating in the community gave insights for interpretation and analysis both directly and indirectly (i.e. potential "problems" were identified in participation observation and questions adjusted/included to provide better examination of the issue). A further use is the measure of face validation of the results provided. Having a general idea of how the community works one can see if the results seem reasonable.

8.5 Impact of the End-Users Actions on Knowledge Sharing

There are two problems for someone seeking help, 1) how to get noticed (the *attention* problem) and 2) how to ensure people will invest the effort of solving your problem (the *presentation* problem). Publication 5 examines this by looking at the following aspects:

- Impact of thread visibility and number of replies
- Impact of thread title
- Impact of problem complexity
- Impact of the content and quality of a post
- Impact of knowledge seeker's actions

Thread visibility and number of replies. The first or top page of a forum is usually what people see first. On a very active forum visibility can be important. The first step a knowledge contributor takes is to decide from the long list of topics, which deserve their attention.

The survey found that only the first few pages are considered. Knowledge contributors seem to prefer unsolved problems and to some degree avoid threads they can assume have been dealt with, e.g. by using a search function that finds threads with no replies.

Thread title. The topic is important to gauge the content, sparking interests or being red flags. The title helps in sorting out some threads. It is better to err on the side of too much information rather than too little.

Problem complexity. A complex problem does not reduce willingness to help, but it should be presented in its entirety. There is no benefit to cutting up a complex problem into smaller pieces. The knowledge contributors prefer to see the entire problem because the solution to the overall problem may be different from a solution to only a part of it.

The content and quality of a post. Providing sample data and a problem description makes answering questions easier for knowledge contributors. The most important things to note are that more information is better than too little, too much being better than too little information. Sample data/code and presenting prior effort are appreciated.

Seeker's actions. A community is a good place to get help and you never know when you may be back so it pays to consider future interactions. Good behaviour such as thanking for help leads to future positive results, and bad behaviour can get you ignored or even thrown out of the community.

8.6 Guidelines for Using a Virtual Community

Seeking help for a development problem is a process of knowledge acquisition. In this process a virtual community becomes a knowledge management system, the end-user developer a knowledge seeker and the people answering questions knowledge contributors, between the seeker and contributors. Albeit asynchronous, this particular knowledge exchange process is direct. There are a number of factors impacting the knowledge exchange process. Having taken the perspective of the end-user developer’s needs in this case we are mainly interested in the actions a knowledge seeker can take to positively impact on the process.

A key consideration for knowledge contribution seems to be time. Respondents gave many references to being limited by availability of time to help, and that when time was available even less preferred threads would be considered. The other notable issue is the conflicting problems a seeker has to consider. Increased visibility may make the topic harder to find by other means. Providing adequate information is advisable, but a point of too much information will eventually be reached. Similarly, being too descriptive can make the post confusing and difficult to read. Posting prior work is encouraged, but messy formulas and code should be avoided. An ideal post according to the respondents should have an informative topic, should include sample data and information on what was attempted and the desired and/or undesired result of that.

Taking this into consideration the following guidelines for knowledge seekers on on-line communities are proposed to help reduce the information processing load on contributors and improve the likelihood of a comprehensive answer and solution:

1. **Try to make the topic relevant to the question asked.** It makes it easier to find and adds to the knowledge base of the community.
2. **Do not reply to your own question simply to keep it on the first page.** Contributors specifically look for unanswered posts.
3. **Simple and complex problems are both fine.** But present the entire problem from the outset, do not try and parcel it out in many threads to hide a massive software development request.
4. **Define the problem clearly by outlining requirements and expectations.** There is nothing gained by trying to be brief or post quickly.
5. **It is usually better with more information than less.** Sample data and attempted solutions help defining the problem and also indicate commitment.
6. **A little courtesy goes a long way.** Remember that helpers are volunteers, giving away their time and effort for free. The golden rule applies on-line too.
7. **Do not contact people privately.** The community is a public discussion space and contributors prefer public postings so others can benefit and participate.

8.7 Summary

This chapter has reported on Publication 5 that looked at the actions a knowledge seeker can take to improve their chances of getting an answer in a virtual community. This was done by looking at two problems. The first is attention, how to be noticed in the flow. The second is how to present yourself and your problem. Further, Publication 5 provided a set of guidelines based on the examination of the knowledge contribution process that suggest how the end-user developers' actions could improve the quality of support.

The next chapter will conclude this thesis with a summary and implications for end-user developers and research.

9 Conclusions, Implications, Future work and Limitations

9.1 Conclusions

At the beginning of this thesis two hypothetical scenarios were presented. A knowledge worker in an organisation doing some development activities to support their work and a small business owner struggling to create an application to support their business. It was posited that in both cases these end-user developers have no help to turn too. To these young (or old) men (or women) I would like to say two words, just two words. Are you listening? Good. **Virtual communities**. There is a great future in virtual communities. Think about it.

In this thesis, I posit that in both above cases virtual communities could be instrumental in providing support where more traditional sources often fail. End-user development is a very broad subject, so in this thesis I have focused more on the small-business owner than a person in a larger organisation. However, the results of this research by and large apply to most end-user developers, regardless of organisational and other contexts.

The overall research question was: **How can on-line support, particularly virtual communities, be harnessed effectively to improve end-user development?** The main research question was split into sub-questions and answered as follows:

RQ1: What is end-user development? End-user development is a very broad and sometimes ill-defined area, in the sense that there are many various definitions with often quite similar meanings, yet sometimes the meaning of the same word can be quite different. Definitions tend to depend on the focus or viewpoint of the researcher using them, i.e. they can be fairly context specific. Aspects such as the end-user's characteristics, the organisational context, the applications created and the development process can all influence how end-user development is viewed. I have decided to the use the Lieberman et al. (2006) definition since it is relatively broad and inclusive, covering many aspects of different degrees of development activities and makes no assumptions of the skill level of the developer or the size and intent of the development effort. Furthermore, in chapter 2 I present a taxonomy that helps us in defining and therefore understanding end-user.

RQ2: What sources are available? What are their characteristics? There are a number of support sources available for end-user developers. The ones considered here are: books, personal contacts, virtual communities (e.g. Internet forums and e-mail lists), Internet searches, trial and error, the application help function and the helpdesk. Additionally potential end-user development sources such as, blogs, wikis, web sites, knowledge bases, application programming interfaces and software libraries were also included for a more thorough analysis.

These sources have various aspects users may relate to differently. Traditionally research has looked at whether sources are informal or formal and another way to categorise them are as on-line or off-line sources. Neither of these may be particularly relevant to end-user developers. Broadly speaking support sources tend to be either knowledge repositories or facilitate communication, although Internet technologies have done much to fuse these together to provide hybrid or mixed sources. Chapter 3 presents a framework for understanding support in the context of end-user development, based on four factors identified in an extensive literature review: contact, cooperation, interaction and immediacy.

These factors seem to better capture what end-user developers want or need form their sources than previous classifications. Using the framework also allows us to some degree to explain why some types of support are not used very much by users in real life. Books and manuals rate very poorly and as has been shown are not used very much. On the other hand, personal contacts is the most popular source and it rates strongly on all factors. Another often used source, trial and error, also has several strong ratings. The one exception, however, is virtual communities, which despite strong ratings was not used much.

RQ3: How do the sources compare to each other? What could the benefits of a virtual community be? The main challenge seems to be that sources with high information content rate poorly for most of the end-user development factors as they require more skill from the developer in applying any information found. In the context of end-user development virtual communities seem to "tick the boxes" for the end-user developer, providing a very analogous experience to asking a real life person for help. The latter solution seems very much the general default response to problem solving for end-users, though its effectiveness could perhaps be questioned. A virtual community could provide a similar experience but with better results.

RQ4: What type of support is used now? Publication 1 and 2 indicates the main sources consulted were other people, searching the Internet and trial and error. This fits with prior research which often found personal contacts to be the preferred source as discussed in section 3.5. Publication 3 and 4 suggests none of these may be particularly suitable to actually solving development problems due to bad fit and high requirements in skills.

RQ5: Who are the end-users? The users found in Publication 1 and 2 fit the stereotypical view of end-user developers as novices. Prior literature finds both novice and expert users, and considering how heterogeneous the end-user population is (Klann et al., 2006; Lieberman et al., 2006; Rockart and Flannery, 1983; Segal, 2005) we should remember there will always be users from the entire spectrum of skills. The groups targeted in the surveys were usually novice computer users, because the surveys were part of ICT training projects. While in-line with what many others have found, this is simply a picture of these particular populations and interesting mainly in light of other aspects analysed. Although similar in the skill aspect, the rest of the attributes supports the idea of a very eclectic mix of people in the end-user developer population.

RQ6: What impact do the demographic/skill attributes have? Publication 2 and 3 analysed the data to explore the existence of groupings and examine the impact of the demographic and skill attributes on use of support sources. The demographic attributes appeared to only have a limited effect. This differs somewhat from prior findings where e.g. gender tends to have an impact (Ko et al., 2011; Nilsen and Sein, 2004). Instead, the results suggested that skill is the most important determining attribute, which fits with e.g. the findings of Munkvold (2003). This need not be a drawback however, as skills can always be improved. Generally speaking, the overall low level of skills and heterogeneous nature of the population are probably shining through in the results. Keeping in mind what was noted above about the differences in populations the results, while different from what was expected, are in line with what previous research has found, broadly speaking.

RQ7: Are there any connections between groups, demographics/skill and support use? The end-users are a very eclectic mix of people (though strongly represented by novices in this case), but can nevertheless be grouped together. However, not by demographic factors as is usually done. While demographic attributes did contribute to such groupings, there was little evidence of any further connection to support use. Instead, skill attributes were much stronger linked to use of support sources with higher skill generally correlating to the use of more advanced support.

RQ8: What can the end-user do to increase the quality of support on a virtual community? Publication 1, 2, 3 and 4 established that end-user developers are not using virtual communities even though they would seem to fit them very well. The main reason for this seems to be a lack of skills or self-efficacy to do so. One way to increase this confidence could be to give a set of guidelines for how to use virtual communities effectively. By following a set of guidelines the end-users can make themselves a more attractive subject for help in the highly competitive knowledge market that a community can often be.

Publication 5 looked at the actions a knowledge seeker can take to improve their chances of getting an answer in an on-line community by looking at two problems. The first is attention, how to be noticed in the flow. The second is how to present yourself and your problem. Further, Publication 5 provides a set of guidelines based on an examination of the knowledge contribution process that suggest how the end-user developers' actions could improve the quality of support. In short, be patient, be polite to people and put some effort into describing the topic and problem you have. There is nothing gained by rushing a post or trying to force brevity in a problem description.

9.2 Implications

9.2.1 General Implications – Benefits for End-User Developers

The main implications of this research are of course those for the end-user developer. Previously in this thesis, I have argued that a virtual community would seem to be a very good solution to the problem of supporting end-user development (see chapters 3 and 7 and Publication 4). Hundreds of thousands of people are helped by on-line communities. However, as established in section 6.4.1 end-user developers in the real world are not using virtual communities much and then mostly if they are very skilled. This is unfortunate as a virtual community would have much to offer those with less skill since not only does it remove the burden of finding information from information seekers it also helps with applying the knowledge and provide opportunities for training and learning.

One way would be to teach people how to find information in a virtual community. Currently training tends towards teaching about functions of the program itself. E.g. in Microsoft Excel training people usually learn to use the IF and SUM functions and other specific tasks. What would also be needed is teaching something about development processes (which is essentially what end-user software engineering entails), but perhaps more realistically as a cost-effective[14] solution, how to find and make use of help. To use an old metaphor teaching the IF function is like giving someone a fish, it helps them for a day. Teaching someone how to use a virtual community would be like teaching them to fish, it helps them the rest of their lives.

The guidelines presented in section 8.6 could have two different benefits for the end-user developer. First, in a highly competitive (i.e. demand outstrips supply) knowledge marketplace there are pay-offs to make oneself more helpable by lowering attention investment for the knowledge contributors. And secondly, having a set of guidelines can also be used as scaffolding to encourage the use of virtual communities as a source of support, which should hopefully overcome some of the limitations many end-user developers will face when seeking support.

Enabling and encouraging virtual community use does not only have the immediate effect of solving knowledge problems, it may also have long term effects in giving access to and enabling learning and broader knowledge transfers than just the solution to a single problem.

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[14] Used in this case to mean it requires less attention investment on part of the end-user developer, and therefore hopefully with a lower entry barrier.

9.2.2 General Implications – Improvement of User Developed Application Quality

The use of virtual communities could have an unforeseen, but potentially very beneficial outcome. That is, to improve the quality of user developed applications. The quality of end-user applications is an ongoing concern, see e.g. Kreie et al. (2000) and McGill and Klisc (2006). Virtual communities could help by providing hooks for training and skill improvement, as well as provide ad hoc bug searching.

Training for end-user developers is important (Kreie et al., 2000), and virtual communities could disseminate good development practices. If we hope to teach proper development practices to large number of people then virtual communities are probably important places to do so. Training is better than control (McGill and Klisc, 2006). Communities also support self-training which may be important to end-user developers (McGill and Klisc, 2006) and anyone posting a problem on-line tends to learn new or more efficient ways of doing something. Often these are less error prone as well.

There has been much research done on errors in spreadsheets and the problems of finding bugs, see e.g. (Babbitt, Galletta, and Lopes, 1998; Galletta et al., 1993; Galletta, Hartzel, Johnson, Joseph, and Rustagi, 1996; Panko, 1995; Panko and Halverson Jr, 1996; Panko and Halverson Jr, 1997; Panko and Sprague Jr., 1998; Panko, 1999; Panko, 2000; Panko, 2003; Panko, 2005; Ruthruff et al., 2003; Ruthruff and Burnett, 2005). By posting a problem on-line a developer gets a number of people that will read their code increasing the odds that any bugs are found. Co-development and more eyes on bugs help reduce error rates (Karlsson, 2008; Panko and Halverson Jr, 1997; Panko, 1999) and most famously perhaps captured in “Linus’s Law” by Raymond (1999) who states that, given enough eyeballs, all bugs are shallow.

It should be noted here that I am not suggesting this as a primary reason to ask for community support, simply that as a consequence of this the code will be read by others and errors may be found. It is not to be considered a replacement of proper bug testing. It is simply an incidental benefit not usually present in other support sources. The actual support and training gained from community participation are the key benefits.

9.2.3 Research Implications – The End-User Development Support Framework

Research indicates that users in many cases are disappointed by traditional sources and as such do not utilise them extensively. Sometimes the sources are completely absent. Understanding the properties of sources and users and why users use a source is important to furthering our understanding of the relationship between users and the sources they use. The end-user developer factors and the framework based on them provide a useful tool for comprehending end-user development support. There exists other frameworks that are similar, but they tend to look specifically at narrower areas like e.g. Shachak et al. (2013). While end-user development is very contextually specific, as noted several times throughout this thesis, there is also a great need for a more general way of looking on the subject.

The results derived from the framework are logical and are applicable in the real world, e.g. it can to some degree provide an explanation for the truism that manuals are not used much. A manual is simply not tuned to the way the end-user developer works, mentally and practically.

9.2.4 Research Implications – Using the Participation Observation Method

Participation observation as a method gave many vital insights into the phenomena and populations studied, helping to inform the empirical studies and facilitate analysis (as described in chapter 5). In some cases the surveys (particularly for Publication 5) were not as successful as initially hoped, in part by being overly ambitious (i.e. too long). As a result detailed and interesting insights were gained that would not have been possible without first participating and observing the research object. E.g. while the number of responses to the survey in Publication 5 was disappointing, there is no guarantee that a simpler instrument would have generated a significant increase in responses. Then the situation would be that there were few responses and little data. The experience from the study in Publication 5 suggests that the benefits outweigh the drawbacks. End-user development research is often (and indeed should be (Segal, (2005)) close to the subjects and in these cases especially, participant observation can give vital insights into the object of study.

As a concrete example from this research process, the two measure often used for explaining knowledge contribution, *reciprocity* and *reputation*, e.g. in (Bock et al., 2005; Lakhani and Von Hippel, 2003; Wasko and Faraj, 2005), were in Publication 5 found to have relatively little impact. One answer could be that people are extremely altruistic and that the semi-anonymous nature of the forum precludes building of reputation. However, with the insight gained from participation, an alternative solution is presented. The people answering questions are very experienced members and so have lower support needs, thus making reciprocity less important to them. Reciprocity is only relevant in the sense that they expect that had the roles been reversed they would have been helped by others, i.e. the reciprocity is community oriented rather than direct.

While the forums are essentially anonymous, participation shows that it clearly is possible to maintain a reputation. Many of the participants are known and meet off-line and there is even the possibility to have official expert titles display as part of your on-line profile. However, reputation seemed less important than in some settings, in part because it is not perceived as important or likely to be of importance. Visibility of support was deemed important. Questions were preferred to be answered publicly, though contrastingly, features that showed contribution were not considered important at all. This dichotomy could be construed as an artefact of reputation, but it turned out it is more connected to the considerations of community and openness of knowledge. Public help will increase the sum total of knowledge and potentially help others. Private support will not do so.

In this way participation observation helped break down many of the extant motivators in literature into more specific questions since they take on slightly different aspects in this particular setting.

9.2.5 Practical Implications – The End-User Development Support Framework and the Heterogeneous End-User Developer Population

The end-user developer framework also has some implications for e.g. managers in larger organisations, depending on whether we are the actual providers of support or simply facilitators (e.g. an IT support function). By understanding the phenomena of support and end-user development better we can design support to fit the users better as suggested by Ko et al. (2011). If the potential users are novice developers then a massive manual or application help-system might not be as helpful and the resources would be better spent on a virtual community. On the other hand a more skilled set of users might be better served by more traditional knowledge repositories. Naturally, if the resources exist to do everything then that is the best solution. But the insight that end-user developers are a very varied population can also be applied to consider to what extent one approach is needed. E.g. supporting an existing or cofounding a third party site is a less resource intensive way to fill certain support needs.

Alternatively, as facilitators we can endorse and steer the user to certain types of support. E.g. local IT support may not possess the knowledge to support development in a particular application, but could refer the user to a good virtual community instead. That would represent a smaller commitment than learning the development before teaching it to the end-user, while at the same time removing some of the burdens of evaluating a source from the user and allowing the IT function to maintain some support and oversight over end-user development activities. In this way on-line sources can supplement the off-line sources and can also take advantage of the medium to leverage the supporting function to better help the users.

9.3 Limitations

9.3.1 Limitations of the Participant Observation Method

Using participation observation has some limits and inherent problems. The main issue is perhaps one of objectivity vis-à-vis the research object. The observer brings their own prior knowledge or lack thereof to the setting and there is always a question if the observed behaviour is actually typical. E.g. in the case of the virtual community it was very large and much discussion is concurrent, there is a limited on the amount of data the observer can sift through. This can perhaps to some degree be remedied by a more longitudinal approach, by randomly sampling the observation period(s) the risk of only seeing a select part is lessened. A longer time period of membership also allows the researcher to have more credibility as an insider. However, it may not be feasible to follow the object for a long time and communities can develop and change during that time. During this research process I've been a member and sporadically following the community for over three years.

Another major problem I experienced is that the participation observation in some respects introduced too much detail. By participating in the processes many interesting and potentially relevant questions cropped up and to some extent the final questionnaire became too extensive. Referring to the above problem of objectivity it can be hard to decide what was or was not relevant and the temptation is to investigate too many aspects resulting in a death by detail situation. It was only while administering the survey for Publication 5 I realised how extensive the survey instrument actually was for respondents to answer. This was further compounded by the planned analysis method not being able to cope with the large number of variables compared to the lower than expected number of respondents.

Being too close to the research object limits generalizability. Essentially it is a question of trade-offs. Tooling a survey to particular situation, e.g. a population or a community, means it may not be as representative of others and it can be difficult to tell if the observations are really representative of the research object (Kawulich, 2005).

9.3.2 Limitations of the Generalizability of Results

Like all research there are some limitations to the generalization of results. First and foremost the end-user populations surveyed were from two different but very similar regions of one country, Finland. This means there is aspects of culture, geography and, especially, language that impact on the respondents. The last is particularly interesting in so far as the Internet is largely English based whereas the respondents spoke Swedish and/or Finnish. While English language skills in the population are broadly speaking fairly good, some people have had less opportunity to use the skills taught in school. Language is one additional potential barrier not considered here that many non-English speakers can face on-line. (Zoe and DiMartino, 2000)

All three surveys had a somewhat small number of respondents. The diverse nature and small populations in the surveys are also problematic. While seemingly representative they are nevertheless few compared to the millions (if not billions) of other users in the world. For this research a more focused and representative sample was chosen instead of shallower and broader one. Since end-user development is very contextually specific this seemed like a reasonable trade-off especially in the light of e.g. Segal (2005) noting how important studies of actual end-user developers are.

While being close to the object has obvious contextual benefits, as discussed previously in this thesis, and is important in EUD research it should be noted that the small number of respondents and taking account of the particulars of a specific on-line community made the research in Publication 5 in some aspects a case study with all the limitations that apply when trying to generalize.

9.3.3 Limitations of the End-User Development Support Framework

The end-user development support framework and four factors presented in chapter 3 were derived mainly from existing literature and consequently lack empirical grounding. Furthermore, the framework may need expanding. There is no consideration whether the relative importance of the factors is the same to end-user developers and there may be other factors not readily identified in literature. This research has not primarily considered the information quality of different sources, but it would naturally vary between sources. E.g. it may be possible that other considerations are rated above information content. There have been some indications of this with regards to use of sources where information sources are used less, whereas sources with less robust information content are used more instead, such as personal contacts.

9.4 Future Research

First and foremost some of the inherent limitations of the surveyed populations need to be considered in future work, particularly how language barriers may be affecting the use of sources. Bigger samples of end-user developers would also be needed for a more detailed study of the connection between users’ aspects and use of support sources. In particular, samples where enough people used each source so a more statistically grounded comparison could be made. In the current studies many sources were hardly used at all which makes some of the comparisons uncertain.

Future work would also include verifying the end-user development support framework empirically with actual end-user developers. While it has been here considered specifically for end-user development it was, in part, derived from a more general set of end-user support literature so this potentially more general application should be explored.

Another interesting line of inquiry is how end-user developers work and seek help and what can be learned from examining this process. Experiments in a laboratory setting could potentially enable a deeper understanding of the end-user development process. Particularly how and when sources are used, which potentially could shed light on issues the users themselves may not be aware of.

The impact of the new end-user development technologies needs consideration as well. Especially cloud-computing, where it would seem users are taking on very high level development activities. No longer is it a question of creating an application, to some degree the end-users may be developing systems by themselves.

A further important issue is how the use of a virtual community could be promoted to those users it would most likely be beneficial to. Teaching the use of office suits tends to be limited to features and functions and not more general development skill. Publication 5 presented some results of how the knowledge seeker can impact the knowledge contribution. However, that was only part of the data collected, which included a more general knowledge contribution examination. This was somewhat out of scope for the thesis, but nonetheless should be analysed in the future.

As mentioned in chapter 2, there are continually more areas opening up for the end-user developers. Cloud-computing is interesting in that it moves the end-user from a programming application level to designing systems level. Whether this will reduce or increase the presence of end-users remains an open question.

Not all facets of end-user computing/development and research can or have been described in this thesis. Suffice to say end-user computing/development will be with us for a long time yet, at least until users stop using computational devices consciously.

Or the robots take over all the software design.

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Appendices

Appendix A – Survey Instrument for Survey 1

Appendix B – Survey Instrument for Survey 2

Appendix C – Survey Instrument for Survey 3

Appendix A – Survey Instrument for Survey 1

This section presents the questions used to gather data for Survey1 in Publication 1. The survey was used to collect data for other purposes than this research, so those questions not relevant here have been omitted. The survey present here is translated form the original Swedish into English. A full instrument is available from the author at request.

Survey sent to participants of the MobiReal ICT teaching project

[Questions 1-4 have been omitted.]

5. The company's industry 5b. The company employs

☐ Agriculture, forestry
☐ Fishing
☐ Manufacturing
☐ Construction
☐ Wholesale, retail
☐ Hospitality
☐ Transport, storage, communication
☐ Other, what: ____

☐ maximum of 5 people
☐ 5 – 10 people
☐ 10 – 15 people
☐ 15 – 20 people
☐ 25 – 30 people
☐ over 30 people

9. Which method(s) do you use to solve a work related problem?
Mark one or more alternatives.

☐ I look in books for a solution
☐ I contact someone I think has a solution
☐ I try various alternatives to find a solution
☐ I search the Internet for a solution
☐ I use an Internet forum to find a solution
☐ Other, what: ____________

10. Which method(s) do you use to solve a computer related problem?
Mark one or more alternatives.

☐ I look in books for a solution
☐ I contact someone I think has a solution
☐ I try various alternatives to find a solution
☐ I use the Windows or application help function
☐ I search the Internet for a solution
☐ I use an Internet forum to find a solution
☐ Other, what: ____________

11. How did the different support methods work? Did you resolve the issue using them?
Describe a typical problem situation and how it was solved with the help of the help method you used.
____

12. **Which (if any) are the advantages and disadvantages of the different help methods for you?**

____

13. **Please rank the different help methods from 1-7 depending on which you think is best.**
(1 represents the best, 7 the worst method)

___Testing to find a solution
___Windows or application help function
___Personal contacts with friends/family/others
___Books or manuals
___Internet chat
___Internet forum
___Other, what:________

14. **Do you prefer any support method over the others? Can you explain why?**

____

15. **Approximately how much do you use the Internet? Email not included.**
(Enter number of times and then circle the applicable: day, week, or month)

___hours per ☐ day ☐ week ☐ month

16. **For which purposes do you use the Internet?**
Mark the items you use regularly (at least 1 time / week)

☐ Finding new suppliers
☐ Finding new customers
☐ Maintaining contact with existing clients
☐ Maintaining contacts with existing suppliers
☐ Communicating with family and friends
☐ Meeting new people
☐ Entertainment
☐ Playing games
☐ Downloading music & video
☐ On-line shopping
☐ Research
☐ Studies
☐ Other, what: ____

17. **Have you tried to find a solution to a computer related problem with the help of the Internet?**
☐ Yes ☐ No

17a. If yes, how did you go about it? Did you find a solution, and where?
Can you describe some good or bad experiences?

____

17b. If no, can you name some reasons for that?

____

[Questions 18-19 have been omitted]

20a. Do you use the following applications?
5 = Daily **4**= Every week **3**= A couple of times a month **2**= I have tried it **1**= I have never used

[Question 20b. Future usage of the applications has been omitted]

	Do you use the service?
Internet for seeking information	**5 4 3 2 1**

Internet buying (ordering / buying books, CDs, or other products)	**5**	**4**	**3**	**2**	**1**
Internet for reservation and / or purchase of airplanes, boats and / or traintickets	**5**	**4**	**3**	**2**	**1**
Internet IP telephony , eg Skype or MSN	**5**	**4**	**3**	**2**	**1**
Internet (video) calls via eg . Skype	**5**	**4**	**3**	**2**	**1**
Internet for reading / listening to the news and weather	**5**	**4**	**3**	**2**	**1**
Internet for explaining the company's products / services	**5**	**4**	**3**	**2**	**1**
Internet sales of company products / services	**5**	**4**	**3**	**2**	**1**
Internet for routine banking transactions (bill payments, etc.)	**5**	**4**	**3**	**2**	**1**
Internet to create video casts (YouTube or similar)	**5**	**4**	**3**	**2**	**1**
Internet to look at video casts (YouTube or similar)	**5**	**4**	**3**	**2**	**1**
Internet to create podcasts	**5**	**4**	**3**	**2**	**1**
Internet to listen to podcasts	**5**	**4**	**3**	**2**	**1**
Internet to write in chats	**5**	**4**	**3**	**2**	**1**
Internet to view the chats	**5**	**4**	**3**	**2**	**1**
Internet to write blogs	**5**	**4**	**3**	**2**	**1**
Internet to read blogs	**5**	**4**	**3**	**2**	**1**
Internet to post in forums	**5**	**4**	**3**	**2**	**1**
Internet to read forums	**5**	**4**	**3**	**2**	**1**
Applications for direct messages (Instant messaging, Skype, MSN or ICQ)	**5**	**4**	**3**	**2**	**1**
Social networking (Facebook, LinkedIn, etc.)	**5**	**4**	**3**	**2**	**1**
Google maps	**5**	**4**	**3**	**2**	**1**
Excel	**5**	**4**	**3**	**2**	**1**
Power Point	**5**	**4**	**3**	**2**	**1**
Word	**5**	**4**	**3**	**2**	**1**
Other, what:____	**5**	**4**	**3**	**2**	**1**
Other, what:____	**5**	**4**	**3**	**2**	**1**

21. Below are listed some statements about different applications. Please select the most appropriate option for each statement.

5 = Agree **4** = Somewhat agree **3** = Neither agree or disagree
2 = Somewhat disagree **1** = Disagree

APPLICATIONS

I can use Word effectively, hanging indents	**5**	**4**	**3**	**2**	**1**
I can use Word effectively, sorting	**5**	**4**	**3**	**2**	**1**
I can use Word effectively, mail merge	**5**	**4**	**3**	**2**	**1**
I can use Word effectively, document templates	**5**	**4**	**3**	**2**	**1**
I can use Excel effectively, relative and absolute references	**5**	**4**	**3**	**2**	**1**
I can use Excel effectively, insert and delete rows and columns	**5**	**4**	**3**	**2**	**1**
I can use Excel effectively, insert a chart of the specified data	**5**	**4**	**3**	**2**	**1**
I can use PowerPoint effectively, change the background color and image	**5**	**4**	**3**	**2**	**1**
I can use PowerPoint effectively, select, cut, copy and paste a picture	**5**	**4**	**3**	**2**	**1**
I can use PowerPoint effectively, automate the presentation	**5**	**4**	**3**	**2**	**1**
I can use effectively:	**5**	**4**	**3**	**2**	**1**

Appendix B – Survey Instrument for Survey 2

This section presents the questions used to gather data for Survey2 in Publication 2 and the data collected was subsequently used in the analysis for Piublciation3. The survey was used to collect data for other purposes than this research, so those questions not relevant here have been omitted. The survey present here is translated from the original Swedish into English. A full instrument might be available from the author at request.

Survey sent to Åland island archipelago organisations

The company's industry

☐ Agriculture, forestry
☐ Fishing
☐ Manufacturing
☐ Construction
☐ Wholesale, retail
☐ Hospitality
☐ Transport, storage, communication

The organisation employs

☐ 1 person
☐ 2 – 5 people
☐ 5 – 10 people
☐ 10 – 15 people
☐ 15 – 20 people
☐ 25 – 30 people
☐ over 30 people

☐ Other (department if municipal organisation), what: __________________

1. Name:____________

2. Age:
☐ ≤20 ☐ 21-25 ☐ 26-30 ☐ 31-35 ☐ 36-40 ☐ 41-45 ☐ 46-50 ☐ 51-55 ☐ 56+

3. Level of education.
☐ Elementary school ☐ High school ☐ Bachelor degree ☐ Masters level degree

4. Affiliation (more than one choice is possible)
☐ Entrepreneur ☐ Municipal worker ☐Potential entrepreneur

[Questions 5-10 have been omitted.]

11. Which method(s) do you use to solve a work related problem?
Mark one or more alternatives.

☐ I look in books for a solution
☐ I contact someone I think has a solution
☐ I try various alternatives to find a solution
☐ I search the Internet for a solution
☐ I use an Internet forum to find a solution
☐ Other, what: _____________

12. Which method(s) do you use to solve a computer related problem?
Mark one or more alternatives.

☐ I look in books for a solution
☐ I contact someone I think has a solution
☐ I try various alternatives to find a solution
☐ I search the Internet for a solution
☐ I use an Internet forum to find a solution
☐ Other, what: _____________
☐ I use the Windows or application help function

13. Do you use the following applications?

5 = Daily **4**= Every week **3**= A couple of times a month
2= I have tried it **1**= I have never used

	Do you use the service?				
Internet for seeking information	**5**	**4**	**3**	**2**	**1**
Internet for seeking information in my private life	**5**	**4**	**3**	**2**	**1**
Internet for seeking information to work related problems	**5**	**4**	**3**	**2**	**1**
Internet buying (ordering / buying books, CDs, or other products)	**5**	**4**	**3**	**2**	**1**
Internet for reservation or purchase of airplanes, boats and traintickets	**5**	**4**	**3**	**2**	**1**
Internet IP telephony, eg Skype or MSN	**5**	**4**	**3**	**2**	**1**
Internet (video) calls via eg . Skype	**5**	**4**	**3**	**2**	**1**
Internet for reading / listening to the news and weather	**5**	**4**	**3**	**2**	**1**
Internet for informing/marketing the organisation’s products/services	**5**	**4**	**3**	**2**	**1**
Internet for sales of organisation’s products/services	**5**	**4**	**3**	**2**	**1**
Internet for routine banking transactions (bill payments, etc.)	**5**	**4**	**3**	**2**	**1**
Internet to create video casts (YouTube or similar)	**5**	**4**	**3**	**2**	**1**
Internet to look at video casts (YouTube or similar)	**5**	**4**	**3**	**2**	**1**
Internet to create podcasts (off-line radio)	**5**	**4**	**3**	**2**	**1**
Internet to listen to podcasts	**5**	**4**	**3**	**2**	**1**
Internet to write in chats	**5**	**4**	**3**	**2**	**1**
Internet to view the chats	**5**	**4**	**3**	**2**	**1**
Internet to write blogs	**5**	**4**	**3**	**2**	**1**
Internet to read blogs	**5**	**4**	**3**	**2**	**1**
Internet to write micro blogs (eg Twitter)	**5**	**4**	**3**	**2**	**1**
Internet to read micro blogs (eg Twitter)	**5**	**4**	**3**	**2**	**1**
Internet to post in forums	**5**	**4**	**3**	**2**	**1**
Internet to read forums	**5**	**4**	**3**	**2**	**1**
Applications for direct messages (Instant messaging, Skype, MSN or ICQ)	**5**	**4**	**3**	**2**	**1**
Social networking (Facebook, LinkedIn, etc.)	**5**	**4**	**3**	**2**	**1**
Google maps or other chart service	**5**	**4**	**3**	**2**	**1**
Adobe photoshop or similar graphics program	**5**	**4**	**3**	**2**	**1**
Outlook or similar e-mail application	**5**	**4**	**3**	**2**	**1**
Database software, e.g. Access	**5**	**4**	**3**	**2**	**1**
Other, what:______________________________________	**5**	**4**	**3**	**2**	**1**
Other, what:______________________________________	**5**	**4**	**3**	**2**	**1**

14. Below are listed some statements about different applications. Please select the most appropriate option for each statement.

5 = Agree **4** = Somewhat agree **3** = Neither agree or disagree
2 = Somewhat disagree **1** = Disagree

APPLICATIONS

I can use Word effectively in general	**5**	**4**	**3**	**2**	**1**
I can use Word effectively, eg hanging indents	**5**	**4**	**3**	**2**	**1**
I can use Word effectively, eg mail merge					
I can use Word effectively, eg document templates	**5**	**4**	**3**	**2**	**1**
I can use Excel effectively in general	**5**	**4**	**3**	**2**	**1**
I can use Excel effectively, eg relative and absolute references	**5**	**4**	**3**	**2**	**1**
I can use Excel effectively, eg insert and delete rows and columns	**5**	**4**	**3**	**2**	**1**
I can use Excel effectively, eg insert a chart of the specified data	**5**	**4**	**3**	**2**	**1**
I can use PowerPoint effectively in general					
I can use PowerPoint effectively, eg change the background color and image	**5**	**4**	**3**	**2**	**1**
I can use PowerPoint effectively, eg select, cut, copy and paste a picture	**5**	**4**	**3**	**2**	**1**
I can use PowerPoint effectively, eg automate the presentation	**5**	**4**	**3**	**2**	**1**
I can use Adobe Acrobat effectively, eg change a Word doc to a locked pdf					
I can use Adobe Acrobat effectively, eg create a form with editable fields					
I can use graphics program (eg. Photoshop) effectively, eg edit pictures	**5**	**4**	**3**	**2**	**1**
I can use e-mail effectively, eg sending e-mail without showing recipients	**5**	**4**	**3**	**2**	**1**
I can use e-mail effectively, eg creating mail lists	**5**	**4**	**3**	**2**	**1**
I can use e-mail effectively, eg create and use e-mail templates	**5**	**4**	**3**	**2**	**1**
I can use anti-virus effectively, eg check if a disk or CD-rom is infected	**5**	**4**	**3**	**2**	**1**
I can use anti-virus effectively, eg how to remove viruses	**5**	**4**	**3**	**2**	**1**
I can use spam-filters effectively, eg how to define e-mails as junk	**5**	**4**	**3**	**2**	**1**
I can use effectively:	**5**	**4**	**3**	**2**	**1**
I can use effectively:	**5**	**4**	**3**	**2**	**1**

Appendix C – Survey Instrument for Survey 3

In this section the entire instrument distributed on an internet forum for Survey3 is presented. The survey was done using web-based survey system. The survey was distributed in English to an international audience. Some of the layout has been adapted to fit this paper format.

Survey on knowledge sharing in a virtual community

Most experienced users are aware of dos and don'ts on-line. There is a lot of anecdotal evidence of ways to better reach the experts. I am trying to confirm that empirically. There are two main goals with the survey, to investigate the knowledge sharing in a virtual community compared to similar studies in other organisations and settings and what impact can someone seeking help have on the process.

The results of the survey will be published in a research outlet and will be part of my (eventual) PhD thesis. I have also promised to give a report to the MrExcel administration. The important thing is that it will all be completely anonymous and no one will be able to identify anyone. So be as frank and honest as you can!

All replies are completely anonymous. There will be no follow-up or reminders sent and I will not contact anyone further, unless you want me to (PM me on the forums). If there are any questions please post them or PM me, I can also be reached by e-mail.

The survey contains the following sections:

- **Demographic information**
- Questions on your **Forum reading habits**
- Questions regarding your **Perception of the community**
- Questions regarding your **Knowledge management** activities
- Questions regarding the **Influence of thread topic, contents and poster's actions** on your participation in the community and helping process.
- Questions regarding your **Self-efficacy and expertise**
- Questions regarding **Motivations** that impact on your decision to participate.
- Questions regarding **Attitude, Intention and subjective norms to share knowledge**

This is a somewhat long survey, and should take about 30-45 minutes to complete.

It is possible to save a partial survey and continue filling it out later. Scroll to the bottom of the survey and click the checkbox, provide an e-mail address and click "save". The system will send you a link that will allow you to access the saved incomplete survey. Please remember to save the incomplete survey when you have filled it out so it registers as completed. I will not be able to remind or prompt people to do this so it is important you remember to do it yourself.

Demographics

The following questions are standard set of questions asking for demographic information to control for any potential group bias in basic demographics.

Please indicate gender

	Male	**Female**
Gender	○	○

Please provide your age (in years): ☐

In what country are you currently residing (the majority of your time)? ☐

Please indicate the highest level of education completed

Education
○ Primary/Elementary school
○ High School
○ B.Sc (or other bachelor level degree)
○ M.Sc (or other master level degree)
○ Ph.D. (or other equivalent degree)

Please indicate your working experience (years in total)

	0-3	>3-6	>6-9	>9-12	>12-
Work experience (in years):	○	○	○	○	○

Please provide your experience with spreadsheets/Excel

	0-3	>3-6	>6-9	>9-12	>12-
How long have you used spreadsheets? (years)	○	○	○	○	○
How long have you used Microsoft Excel? (years)	○	○	○	○	○

What percentage of your work-week is devoted to Excel or Excel related functions? (percentage of work-week) ☐

Is your Excel related work on a
○ Professional paid basis
○ Volunteer/hobby basis
○ Both

Are you an MrExcel / Microsoft Excel MVP?
○ Neither
○ MrExcel MVP
○ Microsoft Excel MVP
○ Both, first a MrExcel MVP then I became a Microsoft Excel MVP
○ Both, first a Microsoft Excel MVP then I became a MrExcel MVP

Pleased indicate the main industry/industries you are currently working in/for

☐ Mining
☐ Utilities
☐ Construction
☐ Manufacturing
☐ Wholesale Trade
☐ Retail Trade
☐ Information
☐ Finance and Insurance
☐ Educational Services
☐ Public Administration
☐ Other (please explain below)

☐ Agriculture, Forestry, Fishing and Hunting
☐ Transportation and Warehousing
☐ Health Care and Social Assistance
☐ Arts, Entertainment, and Recreation
☐ Accommodation and Food Services
☐ Real Estate Rental and Leasing
☐ Other Services (except Public Administration)
☐ Professional, Scientific, and Technical Services
☐ Management of Companies and Enterprises
☐ Administrative and Support and Waste Management and Remediation Services
☐ Non-profit organisation

Forum reading habits

The following questions concern your forum reading habits.

Why did you originally join the MrExcel forums?

Please indicate your agreement with the following **reasons for reading** the MrExcel forums (1—strongly disagree to 7—strongly agree)

	1	2	3	4	5	6	7
I browse MrExcel forums to find and learn from message threads that contain potentially relevant information.	○	○	○	○	○	○	○
I browse MrExcel forums to find posted questions that I want to answer.	○	○	○	○	○	○	○
I browse MrExcel forums because it is fun.	○	○	○	○	○	○	○
I browse MrExcel forums as a break from other work.	○	○	○	○	○	○	○
I browse MrExcel forums to be part of the community.	○	○	○	○	○	○	○

Are there any other **reasons for reading** the MrExcel forums not mentioned above?

How often do you read the MrExcel forums?

○ Constantly/3+ times/day

○ Daily (1-2 times/day)

○ Weekly (1-3 times/week)

○ Monthly (1-2 times/month)

○ Only when I have an Excel related problem

What is your approximate average time per session on MrExcel forums?

○ <10 minutes

○ 10 - < 30 minutes

○ 30- <60 minutes

○ 1-2 hours

○ 2+ hours

How much time does it take you to answer a question on average?

○ <10 minutes

○ 10 - < 30 minutes

○ 30- <60 minutes

○ 1-2 hours

○ 2+ hours

Do you budget or otherwise limit your time spent on the forums?

○ Yes ○ No

If yes, how do you decide how much time to spend?

What do you do if answering questions/problem solving starts to take too much of your time?

Perception of the community

A virtual community such as MrExcel is constructed from both technical and social aspects. The following questions ask about your opinions related to different parts of the community.

Please indicate your agreement with the following statements about **community commitment** (1—strongly disagree to 7—strongly agree)

	1	**2**	**3**	**4**	**5**	**6**	**7**
I would feel a loss if the MrExcel forums were no longer available.	○	○	○	○	○	○	○
I really care about the fate of the MrExcel forums.	○	○	○	○	○	○	○
I feel a great deal of loyalty to the MrExcel forums.	○	○	○	○	○	○	○

Other aspects of **community commitment** not mentioned above that you would like to add.

Please indicate your agreement with the following statements about **help process commitment** (1—strongly disagree to 7—strongly agree)

	1	**2**	**3**	**4**	**5**	**6**	**7**
I usually follow up questions I answer.	○	○	○	○	○	○	○
I feel obliged to follow up threads I answer.	○	○	○	○	○	○	○
I avoid answering questions because I do not want to be responsible.	○	○	○	○	○	○	○

Other aspects of **help process commitment** not mentioned above that you would like to add.

Please indicate your agreement with the following statements about **sociability** (1—strongly disagree to 7—strongly agree)

	1	**2**	**3**	**4**	**5**	**6**	**7**
I help people I do not know.	○	○	○	○	○	○	○
I spend more time helping someone I have helped before.	○	○	○	○	○	○	○
I spend more time helping someone who is a long time community member.	○	○	○	○	○	○	○
I spend more time helping someone I recognize as a valuable community member.	○	○	○	○	○	○	○
I avoid answering questions from some persons.	○	○	○	○	○	○	○
I enjoy communicating with other community members.	○	○	○	○	○	○	○
The social connections I make are important to me personally.	○	○	○	○	○	○	○
The social connections I have made are an important part of why I continue to contribute.	○	○	○	○	○	○	○

Other aspects of **sociability** not mentioned above that you would like to add.

Please indicate your agreement with the following statements about **system use and reliability** (1—strongly disagree to 7—strongly agree)

	1	**2**	**3**	**4**	**5**	**6**	**7**

It is easy to understand how the message boards operate.	○	○	○	○	○	○	○
It is easy to understand how to use the message boards.	○	○	○	○	○	○	○
It is easy to learn how to use the message boards.	○	○	○	○	○	○	○
The system is always available.	○	○	○	○	○	○	○
The system is stable.	○	○	○	○	○	○	○
The system is robust enough for my use.	○	○	○	○	○	○	○

Other aspects of **system use and reliability** not mentioned above that you would like to add.

Please indicate your agreement with the following statements about **your perception of moderation** (1—strongly disagree to 7—strongly agree)

	1	**2**	**3**	**4**	**5**	**6**	**7**
The administration/moderators' presence encourages my knowledge sharing.	○	○	○	○	○	○	○
The administration/moderators are taking a too active role.	○	○	○	○	○	○	○
The boards would function properly with less moderation.	○	○	○	○	○	○	○

Other aspects of **your perception of moderation** not mentioned above that you would like to add.

Knowledge management

The ability to keep track of your knowledge and actions influence the perception of a community and knowledge exchange. The following questions ask about your opinions related to knowledge management.

Do you save links/bookmarks to interesting discussions/solutions?

Yes ○ No ○

If yes, where and how do you organise your saved links/bookmarks?

Do you save solutions to problems you've solved?

Yes ○ No ○

If yes, where and how do you organise your saved solutions?

How do you find references to previous discussions?

Please indicate your agreement with the following statements on **what you do to answer a post/question?** (1—strongly disagree to 7—strongly agree)

	1	**2**	**3**	**4**	**5**	**6**	**7**
I mainly provide information I already have.	○	○	○	○	○	○	○
I search for additional information that would be useful for the poster.	○	○	○	○	○	○	○
I do some problem-solving to help the poster.	○	○	○	○	○	○	○
I create a complete solution for the poster based on	○	○	○	○	○	○	○

information/sample data (if any) provided.

Other aspects of **what you do to answer a post/question** not mentioned above that you would like to add.

Please indicate your agreement with the following statements on **knowledge management** (1—strongly disagree to 7—strongly agree)

	1	2	3	4	5	6	7
I often answer with “ready made” solutions.	○	○	○	○	○	○	○
I often write new formulas/code for each problem, even though I've answered a similar question previously.	○	○	○	○	○	○	○
It is easier to create a new solution than to find an old one.	○	○	○	○	○	○	○
Reusing knowledge makes me more likely to answer questions.	○	○	○	○	○	○	○
I maintain sample formulas/code for posting answers.	○	○	○	○	○	○	○
I use the function to subscribe to threads to keep track of my knowledge.	○	○	○	○	○	○	○
The forum enables me to track knowledge provided by others.	○	○	○	○	○	○	○
The forum enables me to track the knowledge I provided.	○	○	○	○	○	○	○

Other aspects of **knowledge management** not mentioned above that you would like to add.

Influence of thread topic, contents and poster's actions.

There are hundreds of threads posted every day on MrExcel. Assume you can't or don't want to look at or answer each and every one, how do you pick what threads to look at and answer? This section asks about your opinions on threads and what makes you choose to answer one question/thread over another.

How do you decide which threads to look at?

Please indicate your agreement with the following statements on the impact of **thread visibility** (1—strongly disagree to 7—strongly agree)

	1	2	3	4	5	6	7
I often use the "Zero Reply Posts" function to pick threads.	○	○	○	○	○	○	○
I often use the "Subscribed Threads" function to see if there are any updates to threads I've participated in.	○	○	○	○	○	○	○
I mainly look at the first one or two pages of threads.	○	○	○	○	○	○	○
I often read through several pages (more than the first two) of threads.	○	○	○	○	○	○	○
I use the search function to find threads containing keywords I'm interested in.	○	○	○	○	○	○	○

Other aspects of **thread visibility** you would like to add.

Do you look at the number of posts in a thread before you answer?
Please indicate your agreement with the following statements on the impact of **post counts** (1—strongly disagree to 7—strongly agree)

	1	**2**	**3**	**4**	**5**	**6**	**7**
I actively look in threads with many answers.	○	○	○	○	○	○	○
I actively look in threads with few answers.	○	○	○	○	○	○	○
I prefer to answer threads with many answers.	○	○	○	○	○	○	○
I prefer to answer threads with few answers.	○	○	○	○	○	○	○
I try to be the first one answering a thread.	○	○	○	○	○	○	○
I check which other posters have replied before answering a question.	○	○	○	○	○	○	○

Other aspects of **post counts** you would like to add.

Do you try and determine the topic of thread before you read or answer?
Please indicate your agreement with the following statements on **role of thread topic** (1—strongly disagree to 7—strongly agree)

	1	**2**	**3**	**4**	**5**	**6**	**7**
I read the “mouse over” description before opening a thread.	○	○	○	○	○	○	○
I decide which thread to answer based on the topic title.	○	○	○	○	○	○	○
I actively look in threads with a vague or generic title, e.g. "urgent help needed".	○	○	○	○	○	○	○
I avoid looking at threads with a vague or generic title, e.g. "urgent help needed".	○	○	○	○	○	○	○
I actively look in threads with and/or complicated/specific topic title.	○	○	○	○	○	○	○
I avoid looking at threads with long and/or complicated/specific topics.	○	○	○	○	○	○	○
I mainly reply to threads I know the topic of (e.g. by reading the title, description etc).	○	○	○	○	○	○	○
I always open and read the contents of threads before deciding to reply.	○	○	○	○	○	○	○

Other aspects of **role of thread topic** you would like to add.

Do you only answer some types of questions?
Please indicate your agreement with the following statements on **problem scope**
(1—strongly disagree to 7—strongly agree)

	1	**2**	**3**	**4**	**5**	**6**	**7**
I mainly solve limited problems.	○	○	○	○	○	○	○
I prefer to solve complex problems.	○	○	○	○	○	○	○
I prefer to have a complex problem broken down into smaller individual problems.	○	○	○	○	○	○	○
I prefer to have the whole problem presented at the beginning.	○	○	○	○	○	○	○

If I find that the same poster is asking for small parts of a larger question I'm less likely to keep answering.	○	○	○	○	○	○	○
There is a limit to the complexity of problems I will answer, but I know I could still solve them.	○	○	○	○	○	○	○

Other aspects of **problem scope** you would like to add.

Please indicate your agreement with the following statements on **the content of the post** (1—strongly disagree to 7—strongly agree)

	1	**2**	**3**	**4**	**5**	**6**	**7**
I help when the amount of information on the problem provided is large	○	○	○	○	○	○	○
I help when the quality of information about the problem is good.	○	○	○	○	○	○	○
I help when the poster included sample data.	○	○	○	○	○	○	○
I help when the poster included sample screen shots.	○	○	○	○	○	○	○
I help when the poster included sample code/formulas.	○	○	○	○	○	○	○
I help when the poster has shown effort in solving the problem themselves first.	○	○	○	○	○	○	○
I help when the poster has complicated/extensive demands.	○	○	○	○	○	○	○
I help when the poster has illogical demands.	○	○	○	○	○	○	○
I help when the poster has posted too much information, i.e. a "wall of text".	○	○	○	○	○	○	○
I help when the poster has posted formulas/code that is hard to read, messy, non-functional or similar.	○	○	○	○	○	○	○
I help when the poster has provided unclear/incomplete examples of the problem/data.	○	○	○	○	○	○	○
I help when the poster has provided little information.	○	○	○	○	○	○	○

Other aspects of **content of the post** you would like to add.

Please indicate your agreement with the following statements on **poster actions**
(1—strongly disagree to 7—strongly agree)
A thread starter would improve the chances of further answers from me by...

	1	**2**	**3**	**4**	**5**	**6**	**7**
... thanking for the help.	○	○	○	○	○	○	○
... showing appreciation for my or others' efforts.	○	○	○	○	○	○	○
... providing acknowledgement of efforts in their subsequent work.	○	○	○	○	○	○	○
... projecting a positive attitude towards the help.	○	○	○	○	○	○	○

Other aspects of **poster actions** you would like to add.

Please indicate your agreement with the following statements on **complexity of the provided answer**
(1—strongly disagree to 7—strongly agree)

	1	**2**	**3**	**4**	**5**	**6**	**7**
I try to discern the expertise level of the poster before answering.	○	○	○	○	○	○	○
I adapt my answer to the expertise level of the poster.	○	○	○	○	○	○	○
I answer with a less optimal solution that seems within the understanding of the person asking.	○	○	○	○	○	○	○
I keep the solution as close to the original formulas/code as possible even if there is a better way.	○	○	○	○	○	○	○
I explain what the formula/code I provided does.	○	○	○	○	○	○	○
I assume the information posted is accurate.	○	○	○	○	○	○	○
I assume formulas/code posted works unless stated otherwise.	○	○	○	○	○	○	○
I assume that the problem has been accurately defined by the poster.	○	○	○	○	○	○	○
I try to discern what the actual problem the poster is trying to solve is.	○	○	○	○	○	○	○

Other aspects of **complexity of the provided answer** you would like to add.

Self-efficacy and expertise

Please indicate your agreement with the following statements on **expertise and answering** (1—strongly disagree to 7—strongly agree)

	1	**2**	**3**	**4**	**5**	**6**	**7**
I would describe myself a generalist expert in Excel.	○	○	○	○	○	○	○
I would describe myself as specialist in some functions/areas of Excel.	○	○	○	○	○	○	○
I would describe myself as moderate Excel user in general.	○	○	○	○	○	○	○
I would describe myself as novice Excel user in general.	○	○	○	○	○	○	○
I only answer posts about specific topics I am knowledgeable in.	○	○	○	○	○	○	○
I try to answer many different types of topics.	○	○	○	○	○	○	○
I avoid answering if I am unsure of the answer.	○	○	○	○	○	○	○
I attempt to answer questions even if I'm not certain of the answer.	○	○	○	○	○	○	○
I answer questions with partial solutions.	○	○	○	○	○	○	○

Other aspects of **expertise and answering** you would like to add.

Generally, when you **know the solution** to a post/question, why did you know it?
(1—strongly disagree to 7—strongly agree)

	1	**2**	**3**	**4**	**5**	**6**	**7**
I have experienced the same problem and solved it.	○	○	○	○	○	○	○
I knew on the basis of general knowledge about Excel.	○	○	○	○	○	○	○

Other reasons for **knowing the solution** you would like to add.

Generally, when you know the solution to the post/question, **how many other readers of MrExcel forums do you think also know a solution?**

- ○ many
- ○ few, only people with good general expertise in Excel
- ○ few, only people who have encountered a very similar problem
- ○ few, only people with very specific expertise in Excel

Please indicate your agreement with the following statements on **answered/solved threads** (1—strongly disagree to 7—strongly agree)

	1	2	3	4	5	6	7
I provide answers to a question that is already answered to correct a solution.	○	○	○	○	○	○	○
I provide answers to a question that is already answered to improve on a correct solution.	○	○	○	○	○	○	○
I provide answers to a question that is already answered to show a better solution.	○	○	○	○	○	○	○
I provide answers to a question that is already answered to add my knowledge to the community.	○	○	○	○	○	○	○
I provide answers to a question that is already answered to further the discussion.	○	○	○	○	○	○	○
I provide answers to a question that is already answered to showcase my competency.	○	○	○	○	○	○	○
I provide answers to a question that is already answered to improve my reputation.	○	○	○	○	○	○	○
I look in threads I think are "solved".	○	○	○	○	○	○	○
I would not look in a thread clearly marked as "solved".	○	○	○	○	○	○	○
I would look in threads that seem interesting regardless if marked "solved" or not.	○	○	○	○	○	○	○

If you look at threads which are "solved", how do you determine whether it is solved or not?

Other aspects of **answered/solved threads** you would like to add.

Motivations

Please indicate your agreement with the following statements on **reciprocity** (1—strongly disagree to 7—strongly agree)

	1	2	3	4	5	6	7
If I answer questions on MrExcel forums, others are more likely to help me when I post a question in the future.	○	○	○	○	○	○	○
Others have helped me in the past on MrExcel forums and I feel an obligation to reciprocate.	○	○	○	○	○	○	○
Others have helped me in the past on other on-line forums and I feel an obligation to reciprocate.	○	○	○	○	○	○	○
Others have helped me in the past and by answering questions I	○	○	○	○	○	○	○

reciprocate *in general*.

I know that other members will help me, so it's only fair to help other members	○	○	○	○	○	○	○
I trust that someone would help me if I were in a similar situation.	○	○	○	○	○	○	○

Other aspects of **reciprocity** you would like to add.

Please indicate your agreement with the following statements on **reputation**
(1—strongly disagree to 7—strongly agree)

	1	2	3	4	5	6	7
Participating/answering questions on MrExcel enhances my career prospects/professional status.	○	○	○	○	○	○	○
Participating/answering questions on MrExcel can enhance my reputation in the Excel/MrExcel community.	○	○	○	○	○	○	○
Participating/answering questions on MrExcel earns me respect from others.	○	○	○	○	○	○	○
I have an area(s) of expertise within Excel and try to answer all questions that come up in that area(s).	○	○	○	○	○	○	○
I answer questions because I thought the poster might not get a good answer if I didn't.	○	○	○	○	○	○	○
I would be more likely to answer questions if there was a feedback system that visualizes my contribution.	○	○	○	○	○	○	○
I get many private requests for help.	○	○	○	○	○	○	○
I prefer to answer questions "in public".	○	○	○	○	○	○	○
Generally, I answer a private request by reposting it publicly.	○	○	○	○	○	○	○
Generally, I ask that the request be reposted in a public thread instead.	○	○	○	○	○	○	○
Generally, I answer private requests privately.	○	○	○	○	○	○	○

Other aspects of **reputation** you would like to add.

Please indicate your agreement with the following statements on **enjoyment**
(1—strongly disagree to 7—strongly agree)

	1	2	3	4	5	6	7
I answer questions on MrExcel for fun.	○	○	○	○	○	○	○
I answer questions on MrExcel because I enjoy the challenge of problem solving.	○	○	○	○	○	○	○
I answer questions on MrExcel because I learn new things by doing so.	○	○	○	○	○	○	○
I answer questions on MrExcel as a break from other work/tasks.	○	○	○	○	○	○	○
I answer questions on MrExcel because I like to help.	○	○	○	○	○	○	○
I answer questions on MrExcel because I enjoy the social/community aspects.	○	○	○	○	○	○	○

Other aspects of **enjoyment** you would like to add.

Attitude, Intention and subjective norms to share knowledge

Please indicate your agreement with the following statements on **subjective norm** (1—strongly disagree to 7—strongly agree)

	1	2	3	4	5	6	7
Knowledge sharing is something I associate with MrExcel.	○	○	○	○	○	○	○
The board administration/moderators think that I should share my knowledge with other members of the community.	○	○	○	○	○	○	○
Other community members think I should share my knowledge with the members of the community.	○	○	○	○	○	○	○
Generally speaking, I try to follow the general spirit of knowledge sharing.	○	○	○	○	○	○	○
Generally speaking, I try to follow the rules and decisions given by the board administration/moderators.	○	○	○	○	○	○	○
Generally speaking, I respect and put in practice the wishes of other community members.	○	○	○	○	○	○	○

Other aspects of **subjective norm** you would like to add.

Please indicate your agreement with the following statements on **attitude toward knowledge sharing**(1—strongly disagree to 7—strongly agree)

	1	2	3	4	5	6	7
My knowledge sharing with other community members is good.	○	○	○	○	○	○	○
My knowledge sharing with other community members is harmful.	○	○	○	○	○	○	○
My knowledge sharing with other community members is an enjoyable experience.	○	○	○	○	○	○	○
My knowledge sharing with other community members is valuable to me.	○	○	○	○	○	○	○
My knowledge sharing with other community members is a wise move.	○	○	○	○	○	○	○

Other aspects of **attitude toward knowledge sharing** you would like to add.

Please indicate your agreement with the following statements on **intention to share knowledge**(1—strongly disagree to 7—strongly agree)

	1	2	3	4	5	6	7
I intend to share my experience or know-how of Excel with other community members more frequently in the future.	○	○	○	○	○	○	○
I will always provide my know-how at the request of other community members.	○	○	○	○	○	○	○
I will share my workbooks/VBA modules and documentation with members of the community more frequently in the future.	○	○	○	○	○	○	○
I will always provide my workbooks/VBA modules, documentation and models for members of the community.	○	○	○	○	○	○	○

Other aspects of **intention to share knowledge** you would like to add.

Part II

Original research papers

Publication 1

Korvela, Henri and Packalén, Kristian, "On-line support - a virtual treasure trove for end-user developers in small organisations?" (2009). *AMCIS 2009 Proceedings*. Paper 630. http://aisel.aisnet.org/amcis2009/630

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1-1-2009

On-line support - a virtual treasure trove for end-user developers in small organisations?

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Recommended Citation

Korvela, Henri and Packalen, Kristian, "On-line support - a virtual treasure trove for end-user developers in small organisations?" (2009). *AMCIS 2009 Proceedings.* Paper 630.
http://aisel.aisnet.org/amcis2009/630

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On-line support - a virtual treasure trove for end-user developers in small organisations?

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ABSTRACT

End-user development of spreadsheet applications or models is both a problem and opportunity for small organisations. In an educational programme aimed at small-business owners, we have observed the problems end-user developers in small organisations are facing. They lack essential basic computer skills, yet when they have been taught these they will soon find that their ideas for further development outstrip their actual skills. The problems are similar to those that other end-user developers face with one additional factor: in small organisations access to the traditional sources of support are limited or even nonexistent. In an explorative study we try to pinpoint what, if anything, the participants feel about on-line support and if they use it to solve problems. It seems that in this case while Internet is recognized as a source of information for work related problems this does not extend to computer related problems.

Keywords

End-user development, support, community of practice, SME.

INTRODUCTION

Small-business owners (SBOs) need access to information systems to support their daily work allowing them to focus more on important tasks, such as developing their businesses (Packalén, 2008). Often there are no suitable solutions, or they are not aware of any so they will adapt something they know to do the job instead. In most cases SBOs will have access to basic software such as office suites e.g. Microsoft Office or similar packages. Thus SBOs need support that would allow them to utilize these better, e.g. learning to create templates for billing or simple analysis models for budgeting or inventories. How can SBOs get help with the creation of such templates and tools? SBOs do not have the same access to traditional support methods as employees of larger organisations do. One solution is going to the SBOs and teaching them how to use the tools. This is very resource intensive and support cannot be made available indefinitely this way.

In the fall of 2007 a research institute at a Finnish university conducted an educational programme (the Project) aimed at SBOs and municipal employees, in two municipalities in the Finnish archipelago. The original objective was to give the participants insights into and practical skills in new mobile and web-based technologies. However, it was found that they lacked basic computer skills, so the objective was altered and instead focused on teaching the participants to use the Microsoft Office package. Additionally further instruction concerning specific software was made available. The majority of the inquiries regarded Microsoft Excel, which suggests that enhanced spreadsheet knowledge and skills are important to SBOs. All in all, there were 17 SBOs taught as well as 18 municipal employees. The SBOs were from various industries ranging from farming to graphic development. Most however, were from the tourism industry, as it is a major part of the economy in the Finnish archipelago.

During the Project we noted how SBOs would quickly outstrip their development skills in seeing possibilities for improvement in efficiency and automation. E.g. having created templates for invoices and bills in Excel SBOs wanted to connect these together instead of copying or manually typing the information from one into the other. This shows how incremental development can turn a simple idea into fairly advanced information systems. Often without the developers realising how advanced what they are trying to accomplish actually is. However, the (now) end-user developer will just as quickly run into stumbling blocks. Creating an interface and some basic calculations in Excel is easy; trying to take the next step can be insurmountable. There is a need for a method where the SBOs can access the knowledge they need in a cost and time effective manner. We believe on-line support can be a solution.

The aim of this paper is to explore how these potential developers viewed different sources of support. We also want to investigate whether the possibilities of Internet support was recognized among this segment of users. Our basic assumption is that users would turn to the Internet, but it seems lack of computer knowledge can be a key limiting factor. People would need to be comfortable with computers and using the Internet and search engines (Liaw, 2002). As was show in the Project, the participants had a limited computer literacy. We wanted to find out if the participants recognized that the Internet was a source for information they could use. Our research questions are as follows: what are the current modes of support among SBOs, do they recognize Internet as a potential source of support? If not, what issues need to be solved?

While we refer to end-users in a wider more general setting in some instances, the emphasis in this paper is on SBOs and members of small organisations working as end-user developers. For the purpose of this paper the end-user developers (EUDs) are considered novices in the chosen tools, often also to computing in general. While no assumption was originally made in regards to development tools used, in practice in this paper end-user development (EUD) means creating spreadsheets in Microsoft Excel.

The structure of the paper is as follows: next we will describe EUD support briefly, and then we discuss Communities of Practice, followed by a section on EUD and Internet. After that we describe our study and discuss the results and some implications for on-line support which are then summarized in the concluding section.

SUPPORT FOR END-USER DEVELOPMENT

Traditionally support for end-users is divided into two categories: formal and informal support. Formal support consists mainly of help from an IT department and the helpdesk. Other formal support include manuals or vendors. Informal support usually consists of a user's social network in the form of colleagues or friends and family. Additionally one should consider local IS/IT staff, a practice sometimes referred to as super users, power users or similar connotations. This form of support can be formalised to various degrees, often combining some of the best aspects of formal and informal support. Local IS/IT staff are people from the IS/IT departments placed in various other departments or business functions to provide local support. The so called super users are people who as part of their work tasks provide support for other people, as they are recognized experts e.g. on certain applications (Nardi, 1993).

The main problem in the context of SBOs is that they have few formal support methods to turn to and what little they have is not always suitable. There is usually no helpdesk available for micro enterprises or other small organisations. And the availability of vendor support tends to be limited, mainly as manuals and in-system/application help. While in a wider context colleagues or local IS/IT support has had some success from a satisfaction perspective few small organisations have the mass or resources to support either.

Manuals and in-system help can be technically oriented and can require an understanding of programming to correctly apply, e.g. the VBA language help found in Microsoft Office. Also in-system help function examples are often generic and brief. End-users may have troubles adapting examples for their own use, something we noticed during the Project. As does Ko and Myers (2005) regarding end-users' adaptation of example code.

It cannot be expected that SBOs will be able to rely on their social network for technically reliable advice in all situations. It is likely that it will be on par with the user in terms of knowledge. This is an important issue as the social network can be their only source of support.

The requirements for support seem to vary by the characteristics of the users themselves. Some users, presumably less knowledgeable users, will emphasize friendliness and good communication skills while others, possibly the more experienced users seem to favour a high degree of knowledge. This seemed to be the case in (Mitrusevska and Pettersson, 2005). Also such factors as gender and computer self efficacy are likely to influence the choices of support source (Nilsen and Sein 2004). Proximity, both mentally and physically, to the user is also an important factor (Mitrusevska and Pettersson, 2005; Nilsen and Sein, 2004). Considering formal support requirements differ according to characteristics of users these requirements will be important for determining the effectiveness and desirability of on-line sources of support.

COMMUNITIES OF PRACTICE

A definition of Community of Practice (CoP) is, according to Lave and Wenger (1991) an activity system that brings together individuals who are united in action and in the meaning the action has for them and for the larger collective. A CoP is described as an entity having an informal structure, based on the connections that exist between the members. Lave and Wenger highlights shared problems and areas of interest as key to a CoP. This also corresponds in great detail to definitions of Virtual Communities, which usually mention a common objective or background as the basis for the Virtual Community, see e.g. (Rheingold, 1993; Hagel and Armstrong, 1997). Success factors of a CoP are, according to Ardichvili, Page and Wentling (2003) its members' willingness to both contribute to the community and its knowledge base and their willingness also to use it as a source for information and knowledge.

In this paper we will use the term CoP as the general term for communication and collaboration utilizing the Internet, whatever communication media or tool used. A CoP can be formed in the real world as well as virtually. We do not propose either way as the norm, other than suggest the suitability of CoPs. However, the virtual CoP has potential of being an effective way of reaching experts, as SBOs are affected by various boundaries. E.g. in the Project physical boundaries were important due to the geography of the archipelago.

The participants of the CoP will have a common interest as the definition of CoP states. However, the participants usually have slightly different approaches, as a result of having different backgrounds and possessing different knowledge, connections and expertise. This interplay of competences is essential to CoPs (Wenger, 2000). Another potential with CoP include that a knowledge base, highly accurate and rich of information, presumably can be produced when a critical mass collaborates in the creation. In a utopian CoP, everybody should be able to focus on what they know best, and contribute with this knowledge, while receiving help with other, less familiar topics.

Ardichvili et al. (2003) mention that people, experienced with a CoP, have learned who is knowledgeable about what and can pinpoint questions to that expert. This increases the chance of getting accurate answers by relatively short notice.

END-USER DEVELOPMENT & INTERNET

We believe the potential of the Internet sources in providing help for end-user development are considerable. Especially on-line discussion forums can have a significant impact on the end-user development, by providing accurate and adequate support for EUDs. Such on-line discussion forums, focused around a specific topic are CoPs. The CoP has several characteristics that are suitable for EUDs especially in the SBO context. It can also compensate to some degree for the education that we found SBOs needed during the Project.

Internet as a source of support

Many people use the Internet for help and information (Estabrook, Witt and Rainie, 2007). Thus it should form a recognized source for information and even support on various topics. This is suggested by the many Internet forums where a variety of people come to together to discuss a multitude of subjects. EUDs will probably not differ from other people in this regard and Ko and Myers (2005) mention EUDs using the Internet as a source of support. Thus we expect that EUDs will look to the Internet for help, whether they are SBOs or part of a larger organisation.

Internet as a source of support can be important in bridging the gulf of knowledge separating many end-users from what they need to know. Research within end-user spreadsheet development shows a lack of knowledge and understanding about the dangers and problems inherent in this activity among many EUDs, e.g. (Panko, 2007). Since search engines range far and wide users are bound to find information they didn’t know they needed. However, recognizing it and actually applying it remains an issue.

All traditional sources of support in one form or another can be found on-line. Formal support would include software libraries and vendor sites, while informal support is mainly represented by the different kinds of CoPs. Manuals and technical information as well as software (if applicable), are increasingly found on-line. The helpdesk can be found on-line in many companies. And finally family/friends/colleagues can be reached on-line or take the form of a virtual community. Part of the strength of the Internet as a medium for support is that it contains something for nearly everyone.

The first and probably the most important step of getting support through the Internet is usually the search engine which forms a natural starting point for any information retrieval. As EUDs need to find information this most likely means involving a search engine.

For the end-user, context is important as often the grasp of the development environment can be lacking. EUDs often know what they want to do, but are constrained by the how. As the development effort is often a secondary activity to the end-user, attention is not focused on the specific implementation used by the environment (Ko and Myers, 2005; Nardi, 1993). Formal support methods, foremost manuals and software help functions, rarely provide context to the help, when they explain how to implement a function to print text it will be done as an isolated example. Some formal support methods can require a fair amount of previous knowledge to apply correctly. Any example code will most likely need to be modified to fit into an user developed application, which is something EUDs are not very good at (Ko and Myers, 2005). Context is also important as a motivating factor. An end-user developer will need to be able to recognize a future benefit so as to motivate the development effort (Blackwell and Green, 1999). Another aspect of context is that creating the application has little value in of itself; the end-user exerts the effort primarily for whatever value can be gleaned from its use.

Nardi, in conjunction with other researchers, presents the importance of cooperation for successful development in spreadsheets and other EUD. These findings show that developing spreadsheets is often a collaborative work effort rather than individual effort. (Gantt and Nardi, 1992; Nardi and Miller, 1990; Nardi, 1993)

In both (Nardi, 1993) and (Ko and Myers, 2005) the importance of interactivity in end-user development is mentioned. The developer can see what happens as they are not very good at anticipating actions occurring in the future. Arias, Eden, Fischer, Gorman, and Scharff (2000) note the importance of the ability to act for EUDs. Also in (Ko and Myers, 2005) the users' wish to act or react to the situation at hand is mentioned. These factors (listed in table 1) are all in one form or another available in various support sources found on-line. However we have found that one source seems to show more promise than the others: Internet forums, a form of Community of Practice.

Factors important in end-user development	Papers discussing the factors
Context	(Blackwell and Green, 1999)
Cooperation	(Ko and Myers, 2005; Nardi, 1993)
Interactivity	(Ko and Myers, 2005; Nardi, 1993)
Immediacy	(Arias et al., 2000)

Table 1. Important factors for EUD where Internet sources can be especially influential

METHODS AND RESULTS

The study was conducted as a questionnaire with both open-ended and multiple-choice questions and sent to all participants in the Project. Two sets of questionnaires were sent, one to entrepreneurs and the other to the employees in municipalities. They were functionally identical only certain wordings were changed to reflect the difference in recipients. In total 35 questionnaires were sent, 17 to SBOs and 18 to municipal employees. The initial response rate was 53% for SBOs and 61% for municipal employees. One response from a municipal employee was discarded so the final response rate was 56%.

We asked respondents to mark sources they use for solving work-related problems, and the same question was asked with regards to computer-related problems, results listed in table 2.

For problems related to work/computers, I…	Work-related problems*	Computer-related problems*	Factors supported†
…ask someone I think can help	79%	79%	C,Co,In,Im
…search the Internet	58%	21%	C
…use trial and error	26%	47%	In,Im
…look on an Internet forum	16%	16%	C,Co,In,Im
…look in books	11%	16%	Im
…use the windows/application help function	N/A**	26%	In,Im

*percentage adds to more than 100% as multiple answers were possible; **question was not asked in conjunction to work-related problems; †C=context, Co=cooperation, In=Interactivity, Im=Immediacy

Table 2. Percentage of users that said they used a certain source of support

Personal contact was the most popular source of support with 79% mentioning it. Though one weakness is that we can't say how often personal contact is used compared to others, as respondents were only asked if they use a certain mode of support or not. This needs to be accounted for in the future. The other problem is helpdesks. We did not know that some of our sample included employees of a small local branch of a national bank. These all mentioned contacting the bank's helpdesk for computer related questions. Nor did we expect these small municipalities to have a helpdesk. Yet it seems that the employees at least one of the municipalities may have had access to some sort of tech support/helpdesk function as at least three persons mentioned calling "this person who knows everything and helps us". Thus at least some of the personal contacts are helpdesk related. Personal contacts have aspects of all the factors in table 1. They are cooperative and interactive, and answers can be gotten immediately. It is also possible to apply context to the problem at hand when explaining it in person. In that light it is unsurprising personal contacts are so popular.

We find it encouraging that 58% used Internet for work-related problems, as it suggests they at least recognize that various types of information can be found on-line. It is however interesting that so few rated Internet the same for computer-related problems. It seems trial and error and the system/application help is used instead of checking on-line and presumably the existence of helpdesks explains much of this for those that had one available. Perhaps some explanation can be found in trial and error being an immediate and interactive approach whereas searching the Internet is more time consuming and static. The responses indicating time and effort as limitations certainly indicate this. One respondent mentioned not knowing how to find help on the Internet, and expecting it to take too much time to figure it out would call someone who could help instead. On the other hand one of the most computer skilled respondents was instead very Internet savvy and used forums and search engines frequently to solve problems, mentioning the following: "on forums you can find someone who has had the same problem and usually a solution". While Internet searches would provide context it seems other factors have more weight in this situation. On the other hand it cannot be said trial and error lacks context as any trial and error will be performed on the artefact being developed.

Clearly factors are influencing the user's choice to find support for a computer related problem from other sources than those on the Internet. This could be a result of the users' generally low to average computer skills. In (Mitrusevska and Pettersson, 2005; Nilsen and Sein, 2004) it seemed less experienced user favoured personal contact. Some respondents indicated a lack of skill as a reason for not using Internet sources.

The existence of a helpdesk for many of the respondents clearly is an incentive not to try and solve problems for themselves. Six persons stated they had used Internet for solving computer related problems, but didn't say anything beyond mentioning that they had managed to solve their problems. 12 reported they had not used Internet for this and of these, one respondent mentioned the helpdesk while three mentioned lack of interest, knowledge and especially lack of time as a reason for not using the Internet. These three respondents made the connection between time spent finding solutions versus the ease of calling someone they expected to solve the problem. Thus it is likely municipal and bank employees had less incentive to find other methods of support. Indeed, only 1/14 did search the Internet for computer related problems whereas 4/5 SBOs had used a search engine or Internet forum to find a solution. This suggests that EUDs could be more likely to turning to Internet sources as they lack formal sources.

Interpreting the survey results in light of the factors in table 1 we suggest the following. The popularity of personal contact indicates that cooperation and interactivity in the support process is important. It also ties in with context. Several responses expressed the sentiment that it was "easier to explain things to someone". The importance of timeliness to some respondents suggests immediacy will be important.

Answering our research questions we find that SBOs use personal contacts to a large degree for all types of problems. The other common support sources were the Internet and trial and error, though used in an unexpected way. Internet is not used for computer problems and it seems SBOs fall back on trial and error instead.

COMMUNITIES OF PRACTICE – POSSIBILITIES FOR END-USER DEVELOPERS

Our view is that CoPs, i.e. Internet forums, by supporting the factors important to end-user development, can be a very important source of support, both in general and in the context of SBOs. CoPs can be an effective tool for problem solving, enabling, in theory, anyone to receive help from experts specialised in specific areas (Ardichvili et al., 2003). CoPs come with the benefit of being interactive and potentially intelligent. As they are formed by actual humans the CoP will be able to interact with the EUDs in need of support. This helps counteract one of the biggest problems with many support methods, applying knowledge in the context appropriate for EUDs.

One of the strengths of a CoP is the interactivity which means EUDs can go through several iterations to solve the problem or refine the solution often while still working on a spreadsheet. The interactivity also enables a form of cooperative development, which is considered a key activity in end-user development (Gantt and Nardi, 1992; Nardi and Miller, 1990).

This interactivity also support immediacy, EUDs can get help and feedback almost immediately, at least in theory, to their specific problem. Personal contacts and timeliness both seemed to be important to our respondents.

Nardi and Miller (1991) mention more advanced users contributing code to less experienced users, thus teaching less experienced users. In their example this happens inside the same organisation. However the CoP extends this behaviour outside the boundaries of the EUDs' immediate environment allowing a much broader base of experts to be contacted easily. Ko and Myers (2005) mention these "informal apprenticeships", and suggest that systems could help users and experts to come together. The CoP performs exactly this function, yet it avoids the need for specialised software and agents, allowing for an easier and more anonymous first contact with a CoP.

A CoP is also able to provide context, working with the EUDs real problem which was important to the Project's participants. As one respondent noted, it is possible to find someone who has already experienced the same problem on-line. Also, during the Project problems were usually framed in the context of the developer. While the EUDs vocabulary might not be the same as that used on the CoP, at least initially, the interactive aspect allows the EUDs and CoP to work towards a common understanding of the problem (Arias et al., 2000). Unlike some formal support methods, e.g. books and manuals, that are static in their information content, the CoP has a living knowledge content (Wenger, 1998), which can also adapt to the EUDs specific context. In this way context is very much present and this task specific help will likely be very useful for EUDs. The CoP has features which support all four important factors, i.e. context, cooperation, interactivity, and immediacy. It also supports them concurrently, providing much of the same benefits as having an actual co-developer present.

LIMITATIONS

Limiting factors include the small sample size and that all participants live in the same geographic area which limits generalization of our findings. In the archipelago means of communication, both physical and telecommunication (including Internet) are less developed than on the mainland. This means the usage of Internet is potentially lessened due to technical barriers.

We didn't explicitly ask for end-user development related problems as at this stage we wanted to explore how well people connect problem searching and computer related problem searching to on-line sources. Also for many of our respondents this would have been their first contact with any kind of end-user development activities.

DISCUSSION

There are many end-user developers (EUDs) who are in need of support. We believe that Communities of Practices (CoPs) found on the Internet have the potential to play an important part in providing support for EUDs. Examining the literature on end-user support and development we have identified several factors important to EUDs. We propose that CoPs fit many of these aspects and should thus be well suited to providing support.

Having worked with several rather inexperienced computer users, who nonetheless were working hard at development activities, we conducted a survey. It suggests that despite using Internet for some problem situations this does not extend to computer related problems. We have some possible explanations for this, namely helpdesks and the low skill level of the users. Among the small-business owners, who did not have a helpdesk, Internet was used more often for support. However, there are other potential barriers as well, such as language and the vocabulary problem.

It is puzzling that the seemingly well suited CoPs were not used more for support by the respondents. We intend to further investigate the link between users' characteristics and ability to use on-line sources of support to determine why some use on-line support and others do not. And more specifically what CoPs can and can't bring to the equation.

ACKNOWLEDGEMENTS

The authors wish to thank the Institute for Advanced Management Systems Research and Department of Information Technologies at Åbo Akademi University, TUCS graduate school for their support and especially Joanna Carlsson for help administering the survey. We also gratefully acknowledge the comments of the anonymous reviewers.

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Publication 2

Korvela, Henri and Packalén, Kristian, "Looking beyond the veil – what makes the micro organisation end-user developers tick?" (2010). *AMCIS 2010 Proceedings.* Paper 360. http://aisel.aisnet.org/amcis2010/360

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Looking beyond the veil – what makes the micro organisation end-user developers tick?

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Korvela, Henri and Packalén, Kristian, "Looking beyond the veil – what makes the micro organisation end-user developers tick?" (2010). *AMCIS 2010 Proceedings*. Paper 360.
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ABSTRACT

Information and communication technology offers the opportunity to make current work more effective and enable new developments. This is in particular needed in micro-organisations, who have to cope with very limited resources. End-user development could be a solution for these problems. However, supporting the heterogeneous user population is problematic. On-line sources could possibly bridge this gap, but are they suitable for all end-user developers? What, if any, are the characteristics of potential end-user developers and how are they connected to the current use of support. What can we say about the future?

Keywords

ICT, SME, end-user development, on-line support, small organisations

INTRODUCTION

Many Finnish municipal organisations face diminishing resources and are struggling to keep up with their current service level. The problem is in particular critical in the smallest municipalities located in the archipelago. The Åland Islands have 16 municipalities, of which six are regarded as archipelago municipalities. These archipelago municipalities are very small, having from circa 100 inhabitants in the smallest to about 600 in the largest of the municipalities. However, the smallest islands' municipalities shoulder the same responsibility as their bigger and more affluent neighbours to give high-standard service to their citizens. This is a challenge in particular for the municipalities that have the least resources. Still, they are required by law to provide full service in the social sector, education and other areas.

In a similar manner, the private enterprises in the archipelago also face challenges. Small businesses in the archipelago face additional challenges that their mainland colleagues and competitors usually do not. Small and medium enterprises (SMEs) and entrepreneurs in the archipelago spend more resources at finding solutions to communication and logistics problems. Communication problems might exist between the businesses and their customers, in a worst case scenario leading to lost business opportunities.

Both these groups share some similarities. For example, they have limited monetary resources and knowledge resources. The persons working in the organisations usually have to do a lot of different, diverse work, often in fields that would require unique expertise. As the organisations are small they have less access to traditional support in-house and have limited capabilities to hire outside expertise. By experience, they manage to cope with the present situation. However, it leaves little or no room for improvements of the service level.

Information and communication technology (ICT) offers the potential to improve the situation for both these groups of small organisations by enabling improvements in current work methods and new possibilities. End-user development (EUD) is an alternative for the resource poor small organisations which might not be able to procure traditional ICT systems. However, to take full advantage of EUD SMEs need to be able to support their activities, which can be a major problem. Small organisations, in particular micro organisations, cannot maintain the same level of support staff as a large organisation can. Many SMEs will therefore be completely without a traditional computer support. We believe the Internet can help alleviate some of the problems SMEs would have in finding support for their particular problems.

This paper is structured as follows: next we will describe the background and theory in brief. Then we describe the aim, research questions and methodology. The next section is an analysis of our results and we end with some concluding remarks.

BACKGROUND, FACTORS AFFECTING CHOICE OF SUPPORT SOURCE

We know little of the people using Internet as a source of support. While there are some studies about support in open-source software (OSS), e.g. (Lakhani and von Hippel, 2003), it is likely that they are a much more homogenous population as OSS requires a level of computer skill above most regular users. End-user developers are a very heterogeneous population (Klann, Paternò and Wulf, 2006). It is possible that some SMEs lack the skills, knowledge or self-efficacy to use the Internet sources of support such as Internet forums which seem to be well suited for support (Korvela and Packalén, 2009).

To be able to use Internet sources people would need to be comfortable with computers and using the Internet and search engines (Liaw, 2002). Liaw also shows that skill is related to usage as better computer skills increases confidence in using computers. Gender could also be a factor in using Internet sources, either directly or indirectly. There are studies that show that males are more comfortable with computers and the web (Liaw, 2002) and that gender impact areas of end-user development such as debugging (Beckwith, Kissinger, Burnett, Wiedenbeck, Lawrance, Blackwell and Cook, 2006) and self-efficacy in end-user developers (Beckwith, Inman, Rector and Burnett 2007).

Thus, previous research suggests that gender, self-efficacy and computer skills all impact the use of computers and Internet (Beckwith et al., 2006, 2007; Liaw, 2002). Additionally we have decided to look at education and whether the person is a self-employed small-business owner (SBO) or a public worker. We speculate there is a possibility for these two groups to differ. SBOs do not have access to all the same sources of support as those in the public-sector do who invariably work in larger organisations where e.g. colleagues and formal support are more readily available. Age might also be a factor. It is much more common with computer education in younger people where it has been part of the syllabus whereas older persons are more likely to have been trained on and specifically for that job, if at all. In our experience this is common and computer skills are often constrained to using those applications needed for their job. Our study showed a clear advantage (albeit self-reported) for the younger groups in computer skills and Internet use. Age also matters as people who have grown up with technology are more familiar and comfortable with its use (Brown, 2002). Young people use the Internet more frequently according to Statistics and Research Åland (2001).

AIM AND METHODOLOGY

The aim of this paper is to investigate what support sources are used and what connections, if any, there are to demographics. Figure 1 shows our research model. End-user developers are all very different in demographics and perform a multitude of different tasks. In Korvela and Packalén (2009) we investigated which sources of support were used by end-user developers in small organisations, but could not look at demographics and if there were any patterns to the people who used the different sources of support available.

We therefore ask:

- Are there any particular groups who are more/less likely to use Internet based support?
- Are there any particular groups who are more/less likely to use other support?
- What impact do the demographic factors have?

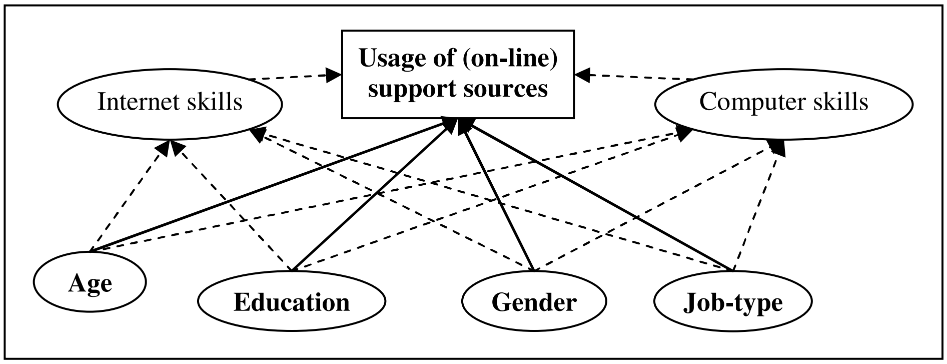

Figure 1. Preliminary research model

In order to fulfil the aim and answer the research questions empirical data was used. The empirical data for our study were collected within a project that gathered background information through a questionnaire about the present ICT situation of micro- and small organisations in the Åland Island archipelago, of skills and technologies used, and to identify need and wishes for improvements of skills. In this paper we use part of that data: namely, the questions on their current use of support and the current/future usage of applications and corresponding questions related to Internet services. The respondents were asked to rate their computer knowledge and indicate their usage of different applications or services, both on a scale of 1-5.

Aiming at practicality at the same time as remaining academic means that trade-offs needs to be made which provide limitations to the research. For example the language of the researcher should be adapted to the skills and knowledge of the respondents, which is not always easy. Using too complex or advanced language can lead to misunderstandings, and using too simplistic language can lead to poor measurable results. Since we expected many of the respondents not to have direct experience of EUD, or might not recognize if they had it, we asked people to list the support sources used for "work-related problems" and "computer-related problems". This would give us some idea of how they might behave when performing EUD activities which combines the more familiar domain (work) knowledge with the potentially less familiar computer knowledge.

The questionnaires were sent to all municipal offices for distribution among the employees of all segments including schools, day-care and elderly care as well as to all firms in the Åland Island archipelago using the regional post office's services. We thus have answers from a full sample of firms registered in any of the six municipalities constituting the Åland Island archipelago. The number of firms according to the regional post office was 209 of which we got responses from 36. Hence, the response rate among private enterprises was 17.2%. In addition to this, we have results from 41 municipal employees. Here the sampling was random, as all employees were encouraged to fill in the questionnaire. According to Statistics and Research Åland (2001) there are a total of 232 employees in the public-sectors in the Åland Island Archipelago, giving a response rate of 17.6%.

RESULTS

Basic demographics

We received 77 responses of which 60 reported what support sources were currently in use. In Table 1 we show the basic demographic breakdown among these according to the groups we have chosen to analyse, namely: gender, SBO or public-sector worker, age group and the levels of education.

Gender		**Job-type**		**Age**		**Education**	
Male	43 %	SBO	45 %	25-35	17 %	Elementary	7 %
Female	57 %	Public	55 %	36-45	27 %	High-school	38 %
				46-55	43 %	Lower academic	22 %
				56+	13 %	Higher academic	33 %

Table 1. Basic demographics of respondents

	Current study				**(Korvela and Packalén, 2009)**			
Source of support used	*Work problems (n=60)*		*Computer problems (n=60)*		*Work problems (n=19)*		*Computer problems (n=19)*	
Personal contacts	47	78 %	51	85 %	15	79 %	15	79 %
Trial and error	18	30 %	28	47 %	5	26 %	9	47 %
Internet searches	41	68 %	21	35 %	11	58 %	4	21 %
Internet forums	8	13 %	6	10 %	3	16 %	3	16 %
Windows/application help function	-	N/A*	16	27 %	-	N/A*	5	26 %
Helpdesk	-	N/A*	6	10 %	-	-**	-	-**
Books	19	32 %	1	2 %	2	11 %	3	16 %

* not applicable to work-related problems; ** was not included in previous

Table 2. Comparing our current study with previous one in (Korvela and Packalén, 2009)

SOURCES OF SUPPORT

Table 2 shows how the respondents used the different sources of support. The same themes from (Korvela and Packalén, 2009) are repeated where personal contacts, searching the Internet and trial and error are the main sources of support. And these sources are consulted in much the same way, trial and error for computer problems and Internet searches for work problems. Books as a source are problematic. Though ranking as the third most popular source for work problems in this study, much more popular than the previous study, only one response indicated use for computer problem. We therefore note that books do not seem to be a choice for the computer problems and choose to exclude them from the analysis to save space.

Usage of personal contacts

Table 3 shows that more females than males choose personal contacts for both work related and computer related types of problems. One possibility is that the females are more likely to be in a position where they have colleagues to contact for support. As mentioned a higher percentage worked in public-sector. Also the men in the public-sector are more often in management positions and do not have as many colleagues in the normal sense. For computer questions where the users might be more equal the differences is less, despite men in the public-sector having a self-reported higher level of skill. Looking at the numbers broken down by job-type, however, there is little difference between SBOs and public-sector. So it seems that gender impacts usage of personal contacts. The age groups show little variation in using personal contacts though looking at work problems the 46-55 groups uses them somewhat less than could be expected, this groups has more males and more SBOs so it makes sense that they have less opportunities to ask colleagues for help. Personal contacts are somewhat more prevalent in the high-school group which is strongly populated by females, a likely explanation. The higher academics are often found in management positions and potentially have less inclination to ask colleagues. It would seem gender and job-type impact on the use of personal contacts.

Total	(n)	%	Computer problems (n)	% of question	% of total	Work problems(n)	% of question	% of total
Gender	**60**	**100 %**	**51**	**100 %**	**85 %**	**47**	**100 %**	**78 %**
Male	26	43 %	19	37 %	73 %	16	34 %	62 %
Female	34	57 %	32	63 %	94 %	31	66 %	91 %
Job-type	**60**	**100 %**	**51**	**100 %**	**85 %**	**47**	**100 %**	**78 %**
SBO	27	45 %	23	45 %	85 %	23	49 %	85 %
Public	33	55 %	28	55 %	85 %	24	51 %	73 %
Age	**60**	**100 %**	**51**	**100 %**	**85 %**	**47**	**100 %**	**78 %**
25-35	10	17 %	10	20 %	100 %	8	17 %	80 %
36-45	16	27 %	14	27 %	88 %	15	32 %	94 %
46-55	26	43 %	20	39 %	77 %	17	36 %	65 %
56+	8	13 %	7	14 %	88 %	7	15 %	88 %
Education	**60**	**100 %**	**51**	**100 %**	**85 %**	**47**	**100 %**	**78 %**
Elementary	4	7 %	2	4 %	50 %	3	6 %	75 %
High-school	23	38 %	21	41 %	91 %	21	45 %	91 %
Lower academic	13	22 %	12	24 %	92 %	11	23 %	85 %
Higher academic	20	33 %	16	31 %	80 %	12	26 %	60 %

Table 3. Breakdown of the usage of personal contacts, computer vs. work problems

Usage of trial and error

Table 4 summarises the usage of trial and error. There is a slight bias to males with computers, possibly an indication of the higher self-efficacy in males and computers. Beckwith et al. (2006) showed that males tinker more than females and trial and error is a form of tinkering. The higher skill reported by males in our study indicates (at least) higher self-efficacy by males and support the expectation that they tinker more. However for work there are many more women using trial and error than men. We do not have an explanation for this.

The use of trial and error does not seem to be affected by the job-type; the distribution follows it almost exactly. For computer problems just under half of the respondents use trial and error regardless of category. However for work problems this changes. The number of SBOs and public-sector that use trial and error for work is much lower than for computer problems but the distribution is essentially the same. As such job-type does not seem to affect the use of support source for computer-related problems. If we look at age then there's a clear edge to the youngest users, both for computers and work problems. The only exception is the 46-55 age group who uses trial and error with computers slightly more than could be expected. As noted earlier this group leans towards SBOs and males which could be the explanation. The highest educated group use trial and error more, as the most skilled users they are more likely to have the confidence to experiment with computers. It seems trial and error is an activity mainly associated with males and younger people, as well as skill and confidence.

Total	(n)	%	Computer problems (n)	% of question	% of total	Work problems(n)	% of question	% of total
Gender	**60**	**100 %**	**28**	**100 %**	**47 %**	**18**	**100 %**	**30 %**
Male	26	43 %	14	50 %	54 %	5	28 %	19 %
Female	34	57 %	14	50 %	41 %	13	72 %	38 %
Job-type	**60**	**100 %**	**28**	**100 %**	**47 %**	**18**	**100 %**	**30 %**
SBO	27	45 %	13	46 %	48 %	8	44 %	30 %
Public	33	55 %	15	54 %	45 %	10	56 %	30 %
Age	**60**	**100 %**	**28**	**100 %**	**47 %**	**18**	**100 %**	**30 %**
25-35	10	17 %	9	32 %	90 %	5	28 %	50 %
36-45	16	27 %	4	14 %	25 %	4	22 %	25 %
46-55	26	43 %	13	46 %	50 %	7	39 %	27 %
56+	8	13 %	2	7 %	25 %	2	11 %	25 %
Education	**60**	**100 %**	**28**	**100 %**	**47 %**	**18**	**100 %**	**30 %**
Elementary	4	7 %	2	7 %	50 %	1	6 %	25 %
High-school	23	38 %	9	32 %	39 %	6	33 %	26 %
Lower academic	13	22 %	5	18 %	38 %	4	22 %	31 %
Higher academic	20	33 %	12	43 %	60 %	7	39 %	35 %

Table 4. Breakdown trial and error, computer vs. work problems

Usage of Internet searches

Table 5 shows the use of internet searches. With almost twice the number of people searching for work problems compared to computer problems this is an interesting question. More males search with a search engine for computer problems. But more females searched for work-related problems. Males had a self-reported Internet skill of 2.74/5.0 with females reporting 2.3/5.0. This could be an indication of higher male self-efficacy with regards to computers. Males also had higher computer skills (2.83/5.0) than females (2.42/5.0) in this study. The higher number of females searching for work problems cannot be explained this way. It could possibly be explained by the types of functions and the breakdown of males/females with regards to type of jobs, as 63% of the public-sector respondents are women to only 37% males. The nature of the job-tasks in the public-sector e.g. healthcare and education lends itself towards finding support in existing sources, problems and solutions are well defined. However, this does not bear over to the breakdown into job-types. Interestingly a higher percentage of SBOs search the Internet for computer problems, which is not surprising considering it is likely one of their main sources of support. This also ties in with the previous figures; more males are SBOs so that likely increases the number of males using Internet as support for computers. However, the numbers for computer and work-related problems are inverse, male and SBO seems to indicate using the Internet for computer problems while females and public workers are more strongly associated with using the Internet with work problems. It is not clear why this is so.

Contrary to what we had expected the use of the Internet for computer problems is higher in the 46-55 group than the 25-35 and 36-45 groups. Though the 46-55 group had slight overweight of SBOs which are also more likely to use the Internet to solve computer problems. The numbers are more even for work problems. However, few of the oldest group are using the Internet, possibly due to lack of skills. Internet searches follow the education groups quite closely. Only for work problems are the high-school group underrepresented and the highest educated group overrepresented. This is odd since the high-school group has more females which used the Internet searches more. Usage of Internet searches poses an interesting dilemma. For computer problems males and SBOs seem to indicate use, while for work problems it is females and public-sector.

Total	**(n)**	**%**	**Computer problems (n)**	**% of question**	**% of total**	**Work problems(n)**	**% of question**	**% of total**
Gender	**60**	**100 %**	**21**	**100 %**	**35 %**	**41**	**100 %**	**68 %**
Male	26	43 %	11	52 %	42 %	16	39 %	62 %
Female	34	57 %	10	48 %	29 %	25	61 %	74 %
Job-type	**60**	**100 %**	**21**	**100 %**	**35 %**	**41**	**100 %**	**68 %**
SBO	27	45 %	13	62 %	48 %	18	44 %	67 %
Public	33	55 %	8	38 %	24 %	23	56 %	70 %
Age	**60**	**100 %**	**21**	**100 %**	**35 %**	**41**	**100 %**	**68 %**
25-35	10	17 %	3	14 %	30 %	9	22 %	90 %
36-45	16	27 %	3	14 %	19 %	10	24 %	63 %
46-55	26	43 %	14	67 %	54 %	19	46 %	73 %
56+	8	13 %	1	5 %	13 %	3	7 %	38 %
Education	**60**	**100 %**	**21**	**100 %**	**35 %**	**41**	**100 %**	**68 %**
Elementary	4	7 %	2	10 %	50 %	3	7 %	75 %
High-school	23	38 %	7	33 %	30 %	11	27 %	48 %
Lower academic	13	22 %	5	24 %	38 %	10	24 %	77 %
Higher academic	20	33 %	7	33 %	35 %	17	41 %	85 %

Table 5. Breakdown Internet search usage, computer vs. work problems

Total	**(n)**	**%**	**Computer problems (n)**	**% of question**	**% of total**	**Work problems(n)**	**% of question**	**% of total**
Gender	**60**	**100 %**	**6**	**100 %**	**10 %**	**8**	**100 %**	**13 %**
Male	26	43 %	4	67 %	15 %	5	63 %	19 %
Female	34	57 %	2	33 %	6 %	3	38 %	9 %
Job-type	**60**	**100 %**	**6**	**100 %**	**10 %**	**8**	**100 %**	**13 %**
SBO	27	45 %	4	67 %	15 %	4	50 %	15 %
Public	33	55 %	2	33 %	6 %	4	50 %	12 %
Age	**60**	**100 %**	**6**	**100 %**	**10 %**	**8**	**100 %**	**13 %**
25-35	10	17 %	1	17 %	10 %	1	13 %	10 %
36-45	16	27 %	0	0 %	0 %	1	13 %	6 %
46-55	26	43 %	5	83 %	19 %	5	63 %	19 %
56+	8	13 %	0	0 %	0 %	1	13 %	13 %
Education	**60**	**100 %**	**6**	**100 %**	**10 %**	**8**	**100 %**	**13 %**
Elementary	4	7 %	1	17 %	25 %	2	25 %	50 %
High-school	23	38 %	0	0 %	0 %	2	25 %	9 %
Lower academic	13	22 %	2	33 %	15 %	2	25 %	15 %
Higher academic	20	33 %	3	50 %	15 %	2	25 %	10 %

Table 6. Breakdown of the Internet forum usage, computer vs. work problems

Usage of Internet forums

The use of Internet forums is displayed in Table 6. It seems more common among males for both types of problems. This could possibly be due to a higher self-efficacy with computers and technology as more people are using forums for work questions where they would likely be more confident, i.e. have domain familiarity. The numbers are much the same when breaking it down by job-type. More SBOs report using forums, only in work related questions is the numbers more even. Internet forums and searching the Internet seems related, as females were more often searching for work related problems and this seems to be the case with Internet forums as well. Again interestingly the use of an internet forum is mainly in an older age group. The indication seems to be that males and SBOs are driving this. Comparing to searching the Internet this seems to be a trend in this population. The higher education group is more likely to use internet forums for computer problems. That males and SBOs are using forums the most is something we would expect as they have higher skills and less options. That the more educated people are also overrepresented is not surprising as the higher education is associated with more skill.

Usage of windows/application help function & helpdesks

Table 7 shows the breakdown of the system/application help function and helpdesks. There is little difference between usage for males and females, both groups being equally likely to consult this source. However, slightly more SBOs use it than public-sector workers. One probable explanation is that organisations in the public-sector fairly generally have some kind of official computer support. Looking at age groups the 25-35 group seem less inclined to use the help function while the 46-55 groups uses it more. The job-type explanation seems to fit. The young group has less SBOs while the older group have more SBOs. In education the differences are small, only the highest educated, who are also the most skilled use the help function. This often requires some understanding so greater skill helps with understanding and using the help functions. However, the youngest are the most skilled but also less likely to use the help function. It seems skill and job-type are the most likely explanations for help function usage.

Regarding helpdesks it is somewhat more common for males to use them for computer problems, but with so few respondents it is difficult to generalise. Helpdesks are only available to public-sector workers as no larger private companies were part of the questionnaire. The SBO with a helpdesk is a person who works as both a SBO and in the public-sector. The same 46-55 group is also the one using the helpdesk the most. There's no obvious reason to why one group should use the helpdesk more than another. The answer is likely that these groups are more often found in administrative/higher functions where more computer tasks are performed. This interpretation is also supported when looking at the groups broken down by education where the majority of helpdesk users fall in among the highest educated.

	Total (n)	**%**	**Help function (n)**	**% of question**	**% of total**	**Helpdesks (n)**	**% of question**	**% of total**
Gender	**60**	**100 %**	**16**	**100 %**	**27 %**	**6**	**100 %**	**10 %**
Male	26	43 %	7	44 %	27 %	3	50 %	12 %
Female	34	57 %	9	56 %	26 %	3	50 %	9 %
Job-type	**60**	**100 %**	**16**	**100 %**	**27 %**	**6**	**100 %**	**10 %**
SBO	27	45 %	8	50 %	30 %	1	17 %	4 %
Public	33	55 %	8	50 %	24 %	5	83 %	15 %
Age	**60**	**100 %**	**16**	**100 %**	**27 %**	**6**	**100 %**	**10 %**
25-35	10	17 %	1	6 %	10 %	1	17 %	10 %
36-45	16	27 %	4	25 %	25 %	1	17 %	6 %
46-55	26	43 %	9	56 %	35 %	4	67 %	15 %
56+	8	13 %	2	13 %	25 %	0	0 %	0 %
Education	**60**	**100 %**	**16**	**100 %**	**27 %**	**6**	**100 %**	**10 %**
Elementary	4	7 %	0	0 %	0 %	0	0 %	0 %
High-school	23	38 %	6	38 %	26 %	1	17 %	4 %
Lower academic	13	22 %	3	19 %	23 %	1	17 %	8 %
Higher academic	20	33 %	7	44 %	35 %	4	67 %	20 %

Table 7. Breakdown of the use of the help function and helpdesk

LIMITATIONS

We acknowledge limitations of the sampling, as the objective of the questionnaire also was to gather interested participants to an educational programme, where the entrepreneurs were given the possibility to participate in ICT-training. As such there is a potential non-response bias among people not interested in gaining more ICT skills. This focus also potentially impairs generalisation as we are targeting a very specific group of respondents both geographically and in interests, though many of the challenges remain the same regardless of the SBOs' immediate environment.

Regarding small firms, which often consist of only one worker, the owner, it can be difficult to differentiate between the firm and the owner as these are closely inter-related. This means that it can be difficult to know if the person speak on his own or his company's behalf. Also the owner / manager's opinions, values, and competence affect the firm (Johannisson and Lindmark, 1996).

The respondents were asked to do a self-evaluation of their current ICT skills. Self-evaluation is subjective, and there is no common baseline to determine own skills. This potential overconfidence was something we considered when looking at the skill levels in the analysis.

CONCLUSIONS

In this study we looked at a set of potential and actual end-user developers (EUDs). We found that a minority are currently using Internet sources for computer-related problems, but we believe this will increase in the future as peoples' skills and comfort with computers and the Internet increases. Looking at demographics we found that there are indeed differences between groups, though they are seldom large. However, the differences may not always be those we would expect. For example, age was not a determining factor in using Internet searches, but it was for helpdesks and Internet forums. In most cases when differences existed there was a corresponding increase in skill for the group.

It seems skills are more important than demographic factors. We find this reassuring, as skills can be improved. We add the caveat though that we cannot say this with certainty as the survey and subsequent analysis was not fully built to facilitate this type of analysis. We have yet to analyse the data on skills compared to the use of support sources in depth, yet none of the demographic factors seemed able to explain all the variation.

Currently there seems to be barriers and knowledge gaps preventing users from taking advantage of on-line sources. When we know who the EUDs are we can then compare them to those already using on-line sources and hopefully determine something of what is needed for EUDs to choose to go on-line to find support.

ACKNOWLEDGEMENTS

The authors thank the support from the department of IT at Åbo Akademi University, financial support from the Academy of Finland (project nr. 280000861), TUCS, European Social Fund, Ålands Landskapsregering and Företagssam skärgård (r.f.). We also gratefully acknowledge the comments of supervising Professor Barbro Back and the anonymous reviewers.

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Publication 3

Korvela, Henri and Back, Barbro, "The impact of skills and demographics on end-user developers' use of support" (2012). *AMCIS 2012 Proceedings*. Paper 14. http://aisel.aisnet.org/amcis2012/proceedings/EndUserIS/14

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The impact of skills and demographics on end-user developers' use of support

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Recommneded Citation

Henri Korvela and Barbro Back, "The impact of skills and demographics on end-user developers' use of support" (July 29, 2012). *AMCIS 2012 Proceedings.* Paper 14.
http://aisel.aisnet.org/amcis2012/proceedings/EndUserIS/14

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The impact of skills and demographics on end-user developers' use of support

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ABSTRACT

There are many end-user developers but they are quite often left to their own devices when it comes to finding support for development tasks, particularly those who belong to small organisations. With less access to formal support sources we would expect them to turn to more informal as well as on-line sources. However, the use of on-line sources requires skill and confidence in using computers and the Internet. In this paper, we look at a group of small organisations and what impact the skill and demographic factors have on the use of different support sources among existing and potential end-user developers. The analysis was performed using the self-organizing map. It suggests that personal contacts form a default source for people and that increased skills leads to less reliance on these. Computer and Internet skill are the most important factors influencing support use, enabling some end-user developers to "self-help".

Keywords

End-user development, on-line support, SME, small organisations self-organizing map.

INTRODUCTION

The practice of end-user development (EUD) is very common. According to Scaffidi, Shaw and Myers (2005) there are more end-user developers than professional programmers. Extrapolating the estimate in Scaffidi et al. for computer usage suggests that around 55 million, potential and actual, end-user developers exists in the United States alone. In addition to the more traditional areas of EUD, such as spreadsheets and databases considered in the Scaffidi et al. study, web design and related activities are relatively new areas where many more end-user developers can be found. Increasingly, regular software also allows for extensive customisation that is pushing the envelope towards being out-right EUD, e.g. through the introduction of macros and scripting. In all of these cases users are gradually taking on the role of developers and consequently facing a growing need to support these new tasks.

These end-user developers generally lack the training a professional developer would have, in fact, the definition of an end-user developer and associated development usually revolves around the lack of formal training in programming or development activities. E.g. Lieberman, Paternò and Wulf (2006) formulates it thus: "*EUD can be defined as a set of methods, techniques, and tools that allow users of software systems, who are acting as non-professional software developers, at some point to create, modify, or extend a software artifact*".

End-user developers are found in organisations of all types and sizes, but particularly interesting are those end-user developers who are part of very small organisations. In small organisations, many of the traditional forms of support, such as helpdesks, are limited or non-existent. Furthermore, a small-organisation emphasizes one of the main EUD issues, which is that it does not form the main focal point for the effort (Nardi, 1993). In smaller organisations each member will have more responsibilities, which is likely increased further by incorporating information technology in the organisation, all culminating in the single business proprietor, who has sole responsibility for not only the core business but also all ancillary tasks.

For these developers the possibilities afforded by support from sources on the Internet could be important in replacing or supplementing the traditional forms of support. In our experience many people are not taking full advantage of this. We therefore ask: why is this so? Can we identify the reasons why this potential is not fully explored?

Shaw, DeLone and Niederman (2002) investigated factors impacting end-user support satisfaction and concluded that contextual factors are important for determining satisfaction with support and that they vary among different groups. Cross and Sproull (2004) note that some factors are prevalent for all types of information seeking such as gender, job type and relation to the source. Previous research has focused on the use of computer support *in general*, (e.g. Govindarajulu, 2002; Nilsen and Sein, 2004; Shaw et al., 2002) often within one organisation.

Like Cross and Sproull (2004) we attempt a more holistic modelling of information seeking by analyzing contextual factors and groups. Our study differs from previous studies by using the self-organizing map in building the model and analyzing the results. This enables a multi-dimensional analysis without prior determination of potential groups. We also take a slightly different view in analysing support from the end-user developers' perspective. Demographic and computer/Internet skill were picked as potential contextual factors based on Cross and Sproull (2004), Nilsen and Sein (2004) and Shaw et al. (2002).

The dual aims of this study are 1) to explore if any groupings can be identified in the use of support despite the very heterogeneous nature of end-user developers and 2) to examine the impact of demographic factors as well as computer skill and Internet skill on support source usage. To achieve this, self-organising maps (SOMs) (Kohonen, 2001) are used, which should assist in analysing the complex connections of the very heterogeneous end-user developer population (Klann, Paternò and Wulf, 2006). From the dual aims we have derived the following research questions (RQ):

- RQ1: With no prior assumptions on possible groupings, can we still find commonality among users of support sources?
- RQ2: What is the impact of gender, age, education and job-type contra those of skills?
- RQ3: Are there any connections between groups, demographics/skill and support use?

The rest of the paper is organized as follows. The next section deals with the methodology, presents the data set used and discusses the reasoning behind the factors included and training the map. This is followed by an analysis of the results. Finally, we summarize and conclude this research.

METHODOLOGY AND DATA

The research methodology builds on the design science and empirical research paradigm. We build an artefact, a self-organising map (SOM). This data-mining technique is used in determining potential groups of users and relationships between the different factors and support sources. A central ingredient when using SOM is the choice and pre-processing of relevant input variables for it. The input variables were derived from a questionnaire as described below.

Self-organising maps

The SOM is a neural network using unsupervised, competitive learning. It uses a two-layer (input/output) design where multi-dimensional data is mapped onto a two-dimensional plane (i.e. the map) through the training process. One feature of the SOM is that items of data are placed on the map in manner where the items resemble those around them, creating clusters of similar data items.

Even the relatively small sample we maintain is ponderous to examine for each attribute (demographic/skill factors and support sources), especially, since relationships are likely to be fairly complex. The SOM software package used, in this case "Viscovery SOMine 5.2", allows for analysis and visualisation of the data in multiple ways. An important feature was the relative ease with which categorical data could be handled. In addition the software provides us with basic statistical information/tools that have been used in the analysis, e.g. correlations between attributes.

Data

Our data originated from a larger questionnaire that concerned a proposed teaching project for developing ICT skills in small-organisations in a region in Finland. That project was mainly focused on potential participants' skill levels and current usage of ICT. This gave us the demographic and skill data. The other part we used in this research was designed for this study to answer the RQs. Respondents were asked to indicate which support sources they currently used for solving work and computer problems respectively (see Table 2). Aiming at practicality while remaining academic leads to some trade-offs, which may limit the research somewhat. The questions on support sources are one such compromise. Based on previous experience and knowledge of the population targeted, we expected many of the respondents to not have direct experience of end-user development (fairly novice users) or to not recognize it as such (end-users often do not recognize their efforts as software development). Therefore, we asked people for example to list the support sources used for "problems in your work" and the sources used for "computer-related work-problems". This would give us some idea of how developers might behave when performing development activities which combines the more familiar domain (work) knowledge with the potentially less familiar computer knowledge.

The questionnaires were sent to all municipal offices for distribution among the employees and to all firms registered in the six municipalities constituting the Åland Island archipelago. The number of firms the survey was sent to was 209 and the response rate 17.2%. For municipal employees sampling was random, as all employees were encouraged, but not required, to fill in the questionnaire. According to Statistics and Research Åland (2009) there are a total of 148 employees in the public-sectors in the Åland Island Archipelago, giving an approximate response rate of 27.7%. Of the 77 total responses 60 were usable for this analysis. The demographic breakdown of these are summarised in Table 1.

Gender		Job-type		Age		Education	
Male	43 %	SBO	32 %	25-35	17 %	Elementary	7 %
Female	57 %	Public	55 %	36-45	27 %	High-school	38 %
		Both	13 %	46-55	43 %	Lower academic	22 %
				56+	13 %	Higher academic	33 %

Table 1. Basic demographics of respondents

Support Sources used	**Work problems (n=60)**		**Computer problems (n=60)**	
Personal contacts	47	78 %	51	85 %
Trial and error	18	30 %	28	47 %
Internet searches	41	68 %	21	35 %
Internet forums	8	13 %	6	10 %
Help function	-	N/A*	16	27 %
Helpdesk	-	N/A*	6	10 %
Books	19	32 %	1	2 %
	* not applicable to work-related problems			

Table 2. Use of different support sources

Chosen attributes and data preparation

Our analysis included 19 attributes compiled from the original raw data of 60 respondents. Seven attributes represented different factors likely to impact use of support sources and the remaining 12 represented each type of support source for respective type of problem. The independent variables consists of the demographic and skill attributes, and thus included in the map's training, whereas the sources used are dependent variables and given zero priority in training, i.e. they are visible to aid analysis, but did not affect the result of the map. The attributes are listed in Table 3.

Demographic and skill attributes (independent variables)

Gender	Job	Industry	Age	Education	Computer skill	Internet skill

Work-problem support source attributes (dependent variables)

Books	Personal contacts	Trial and error	Internet search	Internet forum

Computer-problem support source attributes (dependent variables)

Books	Personal contacts	Trial and error	Internet search	Internet forum	Help function	Helpdesk

Table 3. Breakdown of the 19 attributes used in the analysis.

Gender has been important in many cases. Males are more comfortable with computers and the web (Liaw, 2002). Nilsen and Sein (2004) mention gender and self-efficacy as influencing factors. Gender impacts areas of end-user development such as, debugging and self-efficacy in end-user developers (Ko, Abraham, Beckwith, Blackwell, Burnett, Erwig, Scaffidi, Lawrance, Lieberman, Myers, Rosson, Rothermel, Shaw and Wiedenbeck, 2011). Burnett, Wiedenbeck, Grigoreanu and Subrahmaniyan (2008) note that gender is a factor that determines how software features are used.

Job type affects what sources are available for the end-user. Small business owners (SBOs) do not have access to all the same support sources as those in the public-sector do. In comparatively larger organisations colleagues and formal support are more easily available, whereas SBOs are less likely to have access to personal contacts and other sources. Different work tasks will also lead to differing support needs. We also separated out those who worked partly as SBOs and partly in the public sector as they have a rather special position between the normally mutually exclusive job categories. Thus “Job type” is a nominal attribute with three categories, “Job:Public”, “Job:SBO” and Job:Both”.

The Industry attribute is closely related to “Job type” and was included to provide a better granularity. Specific job tasks might be part of the explanation for why a source was chosen. Task focus and use of computers differs between public administration where computers are the main tool of the trade and public service, such as schools and other social services, where computers play a lesser role and the main task is the service provided, similarly different types of SBOs may be different in their use of computers.

Initially all industry data items were considered individually, but the items in the attribute were gradually consolidated into 4 major groups by grouping the items which mapped in nodes close together. In this way the categories “public office”, “public service” (schools, child- and elderly care) were formed. Similarly, the 19 separate industries named by the respondents were consolidated into two categories, “SBO combine1” and “SBO combine2”. This was done as a compromise as the many industries with a single entry creates a visual overload in the map. There was no discernible similarity to these industries like there was for the public sector “industries”. Having two attributes with similar basic information strengthens the clustering effect of this information, but we argue the benefits of the improved visualisations outweigh this. Maps were created with either and both attributes present and there is no impact on the analysis and results.

Age was included as some age effect could be expected. People who have grown up with technology are more familiar and comfortable using it (Brown, 2002). While we have encountered both old and young users of Internet and on-line sources, our experience suggest younger people are more likely to use Internet sources. Young people use the Internet more frequently (Statistics and Research Åland, 2001). Age was treated as a numerical attribute.

Education was picked as an attribute because it gives an opportunity for gaining computer knowledge through computer courses which are now common in syllabuses. Education is an ordinal attribute scaled from 1 to 5 representing different levels of education. A low education in this population means having a secondary level education, i.e. low only in the sense that it is possible to achieve further educational degrees at a university or college.

People need to be comfortable with computers, the Internet and search engines to use them and skill increases confidence (Liaw, 2002). The computer skill attribute is an average based on the respondents reported skill in among others, office-, graphics- and e-mail applications. The Internet skill attribute is based on the respondents reported Internet usage for different tasks. Both attributes are scored from 1 to 5 where 1 represents little/no skill/use and 5 represents high skill and extensive use.

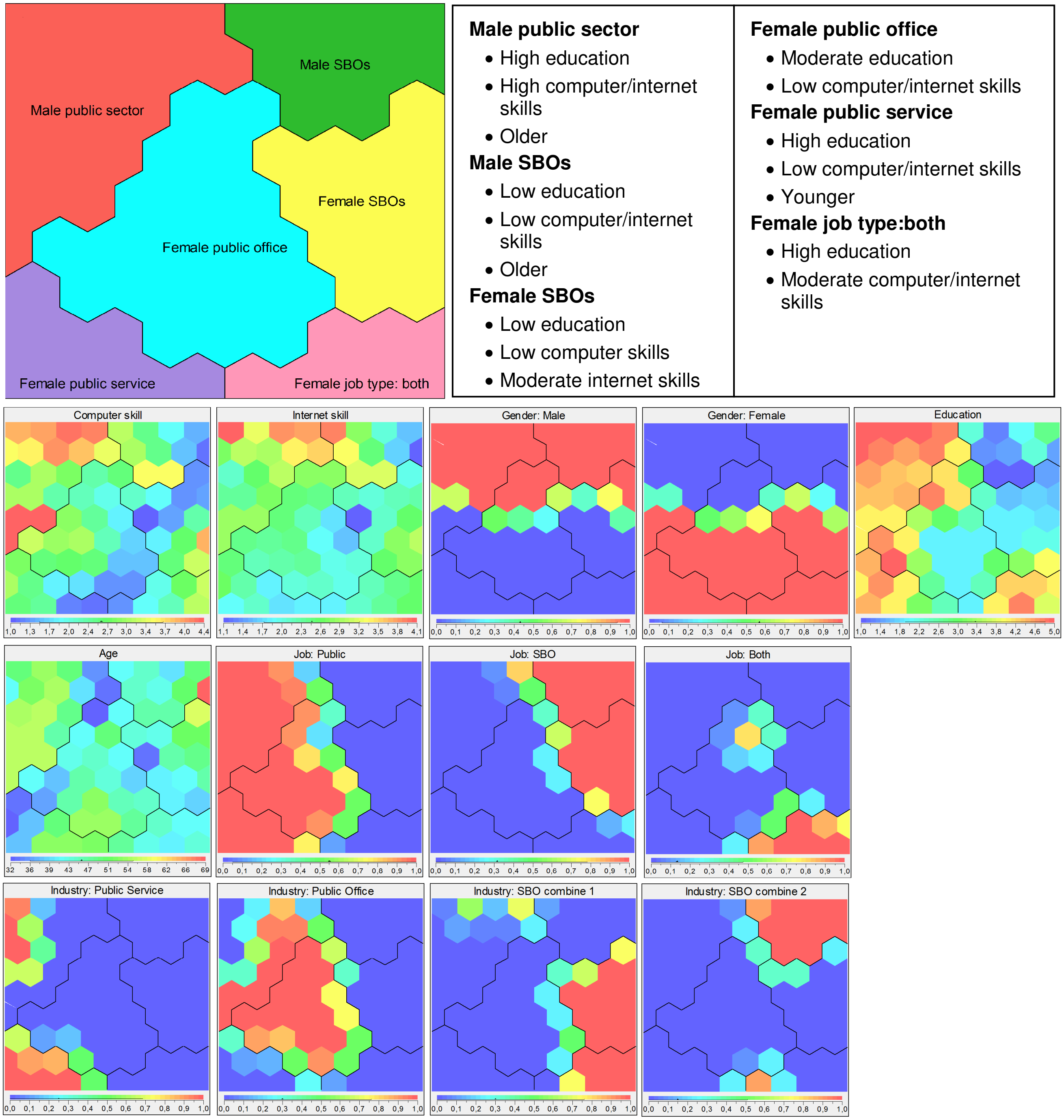
Training of the maps

The SOM will usually be adapted to the data to be analysed and certain degree of adjustment is usually necessary. In this case most of the parameters were left at the software package’s default values. The main adjustments were map-size and the attributes included in training the map. This differs somewhat from the suggested map-size (e.g. Kohonen 2001), but it seems to fit the data better. The target size was set at 100 nodes, but as suggested by the software’s heuristics the map-size eventually used in training was 72 nodes (8x9). Although comparatively large for a small dataset of 60 items, the smaller map-sizes seemed to lose explanatory power, when otherwise mutually exclusive items were stacking in the same nodes.

RESULTS AND ANALYSIS

We identified six (6) clusters, namely*, male public sector*, *male SBOs*, *female public office*, *female SBOs*, *female public service*, *female job type: both*. These groups and their main distinguishing attributes are illustrated in Figure 1.

The interpretation to the six clusters is given by analyzing the feature planes (Figures 1 and 2) where the weight for each neuron is visualized by colour imaging, warm colours representing high values and cold colour representing low values. The education attribute’s value e.g. is high for the neurons on the left-hand side of the map and low for the neurons on the right-hand side (mostly). Hence, persons that are mapped onto the neurons on the left-hand side of a self-organizing map have a higher educational level than the persons on the right hand side. This is most clearly seen with binary type variables like gender where males are on the top half of the map and females on the bottom half. Therefore, males with high education are mapped on the upper half and left-hand side of the SOM, while high education females map to the lower half right-hand side and so on. A visual representation of the clusters and the main distinguishing attributes as displayed in the software package is found in Figure 1 and Figure 2.



Male public sector
- High education
- High computer/internet skills
- Older

Male SBOs
- Low education
- Low computer/internet skills
- Older

Female SBOs
- Low education
- Low computer skills
- Moderate internet skills

Female public office
- Moderate education
- Low computer/internet skills

Female public service
- High education
- Low computer/internet skills
- Younger

Female job type:both
- High education
- Moderate computer/internet skills

Figure 1. The clusters and feature planes for the demographic/skill attributes in the SOM software.

Demographic and skill attributes

The clusters (Figure 1) are formed based on the demographic and skill attributes. There are some strong connections between these that we may need to be aware of for the analysis. Gender and job type/industry are the main clustering factors with the other attributes further refining them. E.g. public sector jobs require certain levels of formal education resulting in higher education naturally being related to some types of jobs, whereas anyone can start up their own business. While the labour market is largely gender neutral there is still a tendency for males to be overrepresented in managerial positions. We see this here with the 'male public sector' cluster where public sector males are brought together by the requirements of broadly similar managerial positions, whereas females in the public sector are divided into two clusters depending on the particularities of their work.

Education associates with higher computer skill. Those with more education have had more exposure to computer courses. Higher computer skill is also found in public sector clusters, where computer courses may be available to workers and also where people have more education and likely more exposure to computer training.

Internet skill and computer skill are closely connected. It seems in this case Internet skills can be considered as a continuation of computer skills. In the survey males scored themselves higher with regard to computer skills, this may to some degree represent overconfidence. This could lead to less reliance on other support sources, but does not seem to be the case as higher skill increases use of most support sources except personal contacts Overconfidence may not be a problem when seeking support if it gives the confidence to actually go out and ask questions.

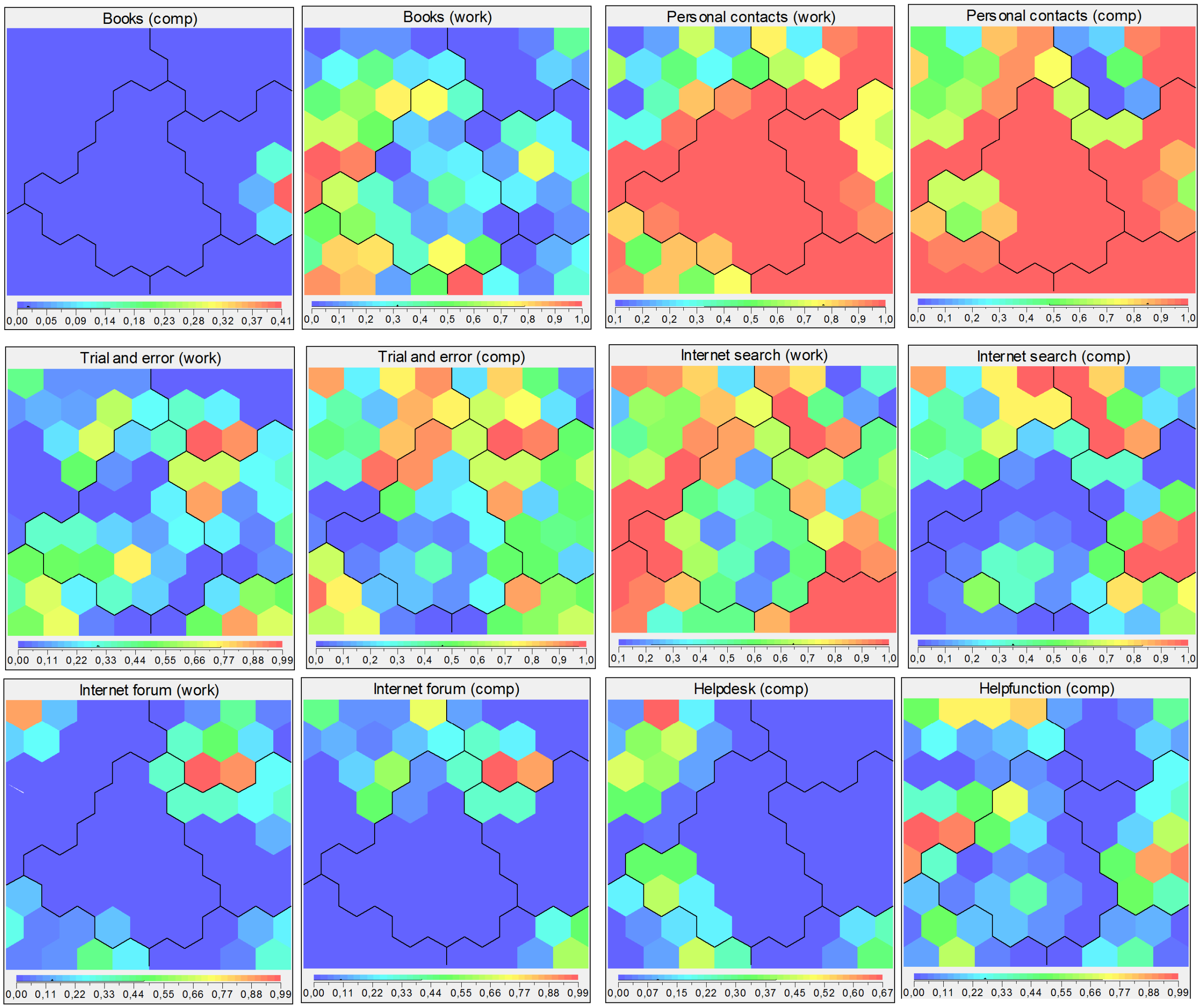


Figure 2. The feature planes for the support sources in the SOM software.

Support sources

Books The SOM indicates that books are mainly used by females and in the public sector for work problems. Only one responder used books for computer problems so that particular item cannot be adequately examined.

Personal contacts are widely used by respondents. In Figure 2 some areas show less usage, the "male public sector" cluster is one. Also in the SBO clusters there are some who do not use this source. One plausible explanation is that these are respondents who feel their work tasks cannot easily be supported by other people, e.g. lack of domain knowledge. That SBOs do not use personal contacts is fairly intuitive, most of these are sole proprietors and would not have any colleagues to ask. In that sense it is perhaps somewhat surprising that so many in the SBO clusters do still report using personal contacts as support. It seems the need to communicate is strong and that those who do not have colleagues as such find other personal contacts to support them in their efforts.

Gender seems to influence personal contact use. Males use them less than females do. Interestingly this is less prevalent for computer problems than work problems. So even though males are less disposed to using personal contacts they do use them to some degree for computer problems. This suggests that personal contacts are somewhat influenced by gender which is in-line with Nielsen and Sein (2004). More skilled people are also less reliant on personal contacts as support.

Figure 2 shows where areas of non-use largely correspond to each other. People using personal contacts are also somewhat less likely to use other forms of support, especially for computer questions and as many as 35% use personal contacts as the sole support source for computer problems. While generally popular among all groups it seems personal contacts are used more by females and those less skilled.

Trial and error (T&A) was used by roughly half the population (see Table 2). The absence of any strong connections suggests T&A is another default response to problem solving. T&A for computer problems connects to Internet skill, but not computer skills. Since Internet skill seems a continuation of computer skills a probable interpretation is that skilled individuals attempt solutions by applying their knowledge in a T&A process. T&A seems associated more with males and SBOs. Males are more likely to experiment by tinkering (Ko et al. 2011) and SBOs would need to be more flexible in their work.

Internet searches for computer problems relate to Internet and computer skill as well as Internet forums and using the help function. Searchers also seem to be less reliant on personal contacts. Taken together this could possibly be an indication of the more skilled users supporting themselves.

Searches for work problems are used more by younger and educated people. While the searches are used (occasionally) in most clusters there is a distinct lack in the ‘female public office’ cluster, possibly due to the administrative tasks’ nature as fixed processes that need to be followed. By contrast the ‘female job type:both’ extensively use searches, it is not farfetched to assume their dual role requires more flexibility in performing tasks.

Although Internet searches for computer problems and work problems are generally both used by people, they differ when regarding the other attributes. Mostly in the public sector clusters there are many who simply do not, possibly due to better access to formal support. The SBOs use searches more, probably because they have fewer options available.

Internet forums were used by few so some caution is needed in interpreting the results. Internet forums are used by the most skilled respondents, again those with high Internet skill. It seems safe to say that familiarity with the Internet is an important factor for using forums, more so than computer skill and that using forums for one purpose means you are open to using it for another.

Helpdesks is somewhat used instead of personal contacts. This seems intuitive as people using the helpdesk would probably not need to ask another colleague for help. The helpdesk should not require any particular level of skill to use and should be approachable by all users. This source was used by very few people though, so should be treated with some caution. This lends support to the question if helpdesks actually help people as noted by Govindarajulu (2002).

Help function use corresponds to nodes with higher computer skill. Higher skill enables better understanding of the help information. There is also a connection to Internet searches. It seems logical that users would use these information sources together. This supports the idea that existing help functions are not compatible with the end-users’ needs. Better computer skill, whether actual or simply perceived, increases the end-user’s ability or willingness to make use of “self-help” computer support sources.

SUMMARY AND CONCLUSION

In this paper, we have explored the existence of groupings and examined the impact of the demographic and skill attributes on support sources in a population of actual and potential end-user developers. Using self-organising maps allowed us to analyse the data in a slightly different manner. This has some interesting potential, however, a larger dataset and preferably one where all sources are used somewhat extensively would potentially increase the generalisation of the results. The clearest results were found among those sources with higher number of users, i.e. personal contacts, Internet searches and Trial and error. With such a diverse population as end-user developers it may not be surprising that there is little commonality to the use of support sources and that the connections are fairly complex.

Attempting to answer RQ1 we found that, in this population, there is a very strong connection to work with groups forming more along types of tasks performed rather than traditional demographic factors. This fits the task centeredness and heterogeneous nature of end-user development (Klann et al., 2006; Nardi 1993). Like Shaw et al. (2002) we find differences across groups, most clearly in the non-use of some sources. RQ1 ties in with RQ3 as some of these differences can be explained by the groups, but some can not. It is fairly clear that the "male public sector" is not using personal contacts and that the females in the public sector do not generally use trial and error or Internet searches, whereas these are more prevalent in SBO clusters. It was also surprising to find so many SBOs using personal contacts. Initially we did not expect SBOs to have ready access to such.

As for RQ2, in some cases support usage seems mainly tied to certain attributes instead of groups. Cross and Sproull (2004) list factors that impact information seeking such as gender, job type and relation to the source and we see some of these effects in the use of support, however, not in the degree that was expected. The general lack of impact of the demographic factors is somewhat surprising. Gender has less impact than was expected considering the effect it has had on other areas of end-user development (Ko et al. 2011; Sein and Nielsen 2004). Job types influence somewhat what support sources are available, but not necessary what support is used. Age was expected to influence skill and computers use more (Brown 2002), but it seems this working population is not yet "computer/Internet savvy". Only the education attribute seems to have a broader impact on the use of support, directly or indirectly through the skill attributes. This factor has a larger impact than expected. It would seem education provides opportunities for expanding computer and Internet skills.

Further, in answering RQ2 and RQ3 we find the clearest impact on support use come from computer and Internet skills. In of itself this is not surprising, however, when combined with an almost complete lack of impact from other factors this warrants some further consideration. Computer skill is strongly connected to the use of support methods for computer problems; higher skill seems to indicate more use. The same is true for Internet skill, to an even higher degree. The central importance of Internet skill is rather interesting. The strong connection to Internet sources is expected, yet the connection to the other computer sources less so. The answer seemingly lies in the strong tie between computer and Internet skill as those with the highest computer skill also have good Internet skill. This is a two-edged sword. While the importance of skill means that people can with training and experience become better at using Internet based sources, in the short term it is problematic if it forms a barrier for end-user developers and solidifies their reliance on usually less reliable support, such as personal contacts.

When creating the survey the questions were split into the computer problems and work problems parts, as a substitute for asking about end-user development problems. This led to some uncertainty as to the validity of doing this. However, we found a strong connection between the corresponding work and computer problem support sources suggesting that this may be at least an adequate substitute. People using a source for one type of problem often use it for the other. While we used factors based on the literature it may be that they are not suitable for the end-user developer context.

While not the focus in this paper we found that formal sources either need skill to use (helpfunction) or was not utilized much by the users (helpdesk and books). This can be problematic and would help explain why personal contacts are so widely used.

When providing or considering support it will not be as important who people are, but rather what they do. The important thing is not the constitution of these groups, as that will vary over different populations, but that there are indeed groupings which can be found. You can still target groups despite a population that is heterogeneous, but groups will be more eclectic and less distinct.

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Publication 4

Korvela, Henri, Forums and Blogs and Wikis, Oh My! – An analysis of On-line Sources of Support for End-User Development. In: Jan Devos, Hendrik van Landeghem, Dirk Deschoolmeester (Eds.), *Information Systems for Small and Medium-sized Enterprises, State of Art of IS Research in SMEs*, Progress in IS, 353–373, Springer, 2014.

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Publication 5

Korvela, Henri, Plz urgent help needed!1!!–Aspects of on-line knowledge sharing in end-user development support. (2013).*AMCIS 2013 Proceedings*
http://aisel.aisnet.org/amcis2013/EndUserIS/GeneralPresentations/17/

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Plz Urgent Help Needed!1!! – Aspects of On-line Knowledge Sharing in End-user Development Support

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ABSTRACT

In this paper the knowledge sharing and contributing in on-line communities, specifically one for providing end-user development support is examined. The focus is on the knowledge seeker/contributor interactions and how the seeker can impact on the quality of support. Knowledge seekers post threads asking questions and contributors answer them. Knowledge contributors were asked their attitude towards the support interaction, e.g. the impact of the topic, the importance of presentation and content and knowledge seeker actions. From the answers a set of guidelines for best practice knowledge seeker actions is constructed that outlines what a knowledge seeker can do to improve the chance of getting help.

Keywords

Knowledge sharing, knowledge contribution, end-user development, on-line communities.

INTRODUCTION

The issue of knowledge sharing has garnered wide attention as it is a fundamental force for creating and maintaining information systems. Organisations struggle to promote, collect and share knowledge among its members. These problems would seem to be even more pronounced when taking the knowledge sharing outside a single organisation where many motivational factors or norms may no longer apply, such as extrinsic rewards and institutional structures.

When looking at knowledge sharing in the on-line world, specifically the case of supporting end-user development, we find both similarities and differences from inter-organisational knowledge sharing. Bock, Zmud, Kim and Lee (2005) note the difficulty of changing behaviours from hoarding to sharing, so how can sharing be promoted in ad-hoc situations where organisational structures are diffuse, where relationships are weak and people invisible? Wasko and Faraj (2005) note how paradoxical this sharing is and one can only agree bearing in mind how difficult formal sharing seems to be in organisations.

The knowledge sharing on on-line communities seems mainly to be characterised by a question-answer type support relationship. Anecdotal evidence suggests the process is usually that someone asks the question and others post the answer. This is the case of those end-user development communities author has experience of. This means that in this knowledge contribution processes there is an opportunity for the knowledge seeker to impact on the process in the way questions are asked and by making oneself more attractive to help, ostensibly by making the process easier for the knowledge contributor. In cases where there is a large demand of support this becomes vital, since the knowledge seeker's cost is generally lower than the provider's in this situation (Lakhani and Von Hippel, 2003). In essence the suggestion is to reduce the attention cost of knowledge contributors, at some additional cost to the seeker. There is some anecdotal evidence of general guidelines, such as the so called "netiquette", and some communities have rules or other informal guidelines of behaviour. In this paper, we more formally examine what actions a knowledge seeker can take to improve the possibility of getting help.

The focus in this paper is on the direct sharing of knowledge where a direct social interaction occurs, i.e. a question is asked and someone answers it, as opposed to an exchange where knowledge was contributed earlier to a repository and was simply used by the knowledge seeker. Knowledge sharing in an on-line community differs from other cases as the act of helping is in essence interactive. How can someone seeking help best make use of the social and technical facilities of the on-line community? There are two problems for someone seeking help, 1) how to get noticed and 2) how to ensure people will invest the effort of solving your problem. Thus the research questions (RQ) are:

- RQ1: What can the knowledge seeker do to be noticed?
- RQ2: What can the knowledge seeker do to increase the likelihood and quality of support?

The rest of the paper is structured as follows. The next section discusses knowledge sharing. Then we present the research model and data used. After that the analysis is presented and then a discussion of the results with some guidelines for best practice knowledge seeking. The paper ends with a concluding section.

KNOWLEDGE SHARING IN ON-LINE COMMUNITIES

To use an on-line community for support is a form of knowledge sharing and knowledge management process between a knowledge seeker and one (or more) knowledge contributors. Davenport and Prusak (1998) define knowledge management as capturing, storing, sharing and using knowledge. The on-line community provides a platform for doing this by connecting knowledge seekers and contributors.

Contributing knowledge to an on-line community takes time and effort from the contributor, it follows then that there must be powerful motivating forces influencing the decision to participate. Bock et al. (2005) suggest that increasing knowledge-sharing and contribution in organisations is challenging. Their behavioural intention model, as shown in Figure 1, focuses on this in the form of intention to share knowledge and provides a number of motivational factors to help explain the intention to share knowledge. Wasko and Faraj (2005) discuss the impact of social capital and social exchange theory (Blau, 1964) on knowledge contribution where there is the expectation of some benefit from the exchange. They look at how various individual motivations, structural capital, cognitive capital and relational capital impact knowledge contribution. An online community is the sum of its social interactions as facilitated by the system it runs on. Since all knowledge management happens through the system, its function i.e. usability, will have an impact on the social interaction, sociability. This is the socio-technical perspective (Maloney-Krichmar and Preece, 2005). Phang, Kankanhalli and Sabherwal (2009) adopt this socio-technical perspective and examine how ease of use, system reliability, knowledge tracking, social interactivity and moderator perception impact on knowledge seeking/contribution in an on-line community.

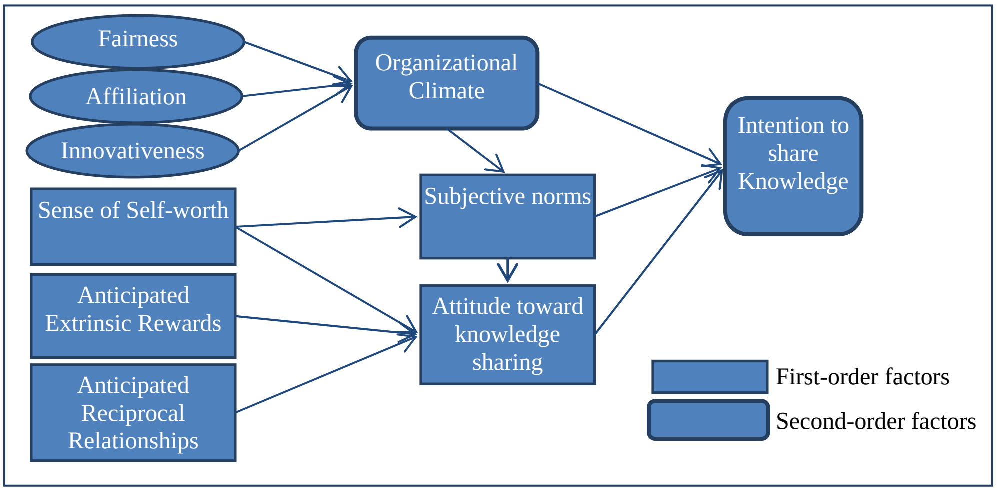

Figure 1. Bock et al. (2005) research model

Social interaction is particular for on-line communities compared to other electronic knowledge repositories (Phang et al., 2009). While Phang et al. (2009) and Wasko and Faraj (2005) acknowledge the social interaction and look at aspects such as social interactivity and relational capital respectively, neither directly examines the direct interaction between a knowledge seeker and contributor that happens in the on-line community knowledge sharing activity. These studies do not account for motivational factors, or only in a limited way. On the other hand Bock et al. (2005) do not consider socio-technical aspects in their model. Thus, previous studies have largely focused only on one aspect of knowledge sharing, e.g. contributing knowledge (Bock et al., 2005; Lakhani and Von Hippel, 2003) or not included aspects that may impact on knowledge contributions (Phang et al., 2009; Wasko and Faraj, 2005).

RESEARCH MODEL AND DATA

Research model

For knowledge seekers' actions to impact on the sharing of knowledge both parties need to get some benefit from the exchange (social exchange theory) creating social capital. This is mediated through the socio-technical system of the on-line community where hopefully a balanced knowledge-sharing market exists. Phang et al. (2009) suggest there will be differences in factors that are important for knowledge seekers and contributors. A number of motivating factors will impact on the knowledge-contributors' willingness to engage in the knowledge-sharing activities, e.g. reputation, reciprocity, altruism, usefulness of the software platform, moderation and many others (Bock et al., 2005; Lakhani and Von Hippel, 2003; Phang et al., 2009; Wasko and Faraj, 2005). Only a few of these are actually within the control of the knowledge seeker, mainly how one formulates the request for help. As the focus of this research stream is on the end-user developer and his/her needs the focus has been on the specific issues where the seeker can impact the knowledge sharing. This paper takes a broader view by bringing together both socio-technical aspects, as well as the seeker/contributor relationship in knowledge sharing with previous models of knowledge contribution.

The research model applied here is based on Bock et al.’s (2005) behavioural intention model (Figure 1), but expanded to include socio-technical aspects which affect the on-line community setting as well as the knowledge seeker’s impact (Figure 2a). Bock et al.’s model employed partial least squares (PLS) as an analysis method. The PLS method is often used where sample sizes are small and some flexibility with regards to data is needed (Ringle, Sarstedt and Straub, 2012). The questionnaire was constructed to collect data for this modified research model (Figure 2a). However, the large number of questionnaire items compared to so few data points made PLS untenable and a more basic frequency and statistical analysis was used instead. For space considerations this paper also focuses only on the relationship between knowledge seeker and provider and how the actions of the former can influence the latter to contribute their knowledge. This limited research model used for analysing this part of the data is pictured in Figure 2b.

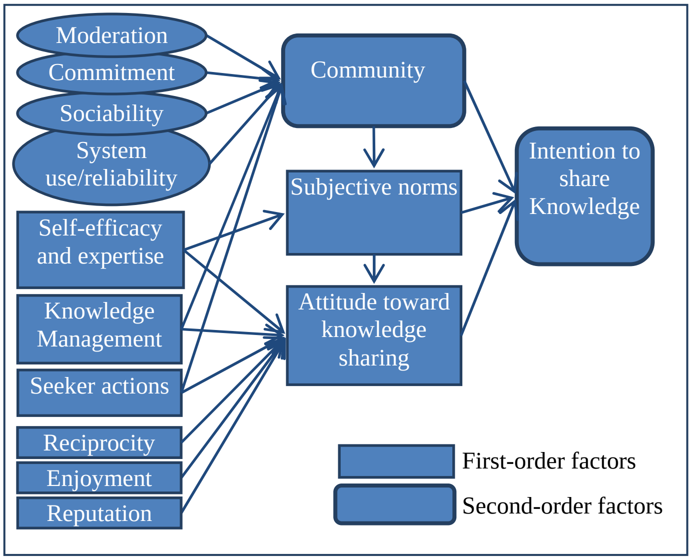

Figure 2a. Original research model

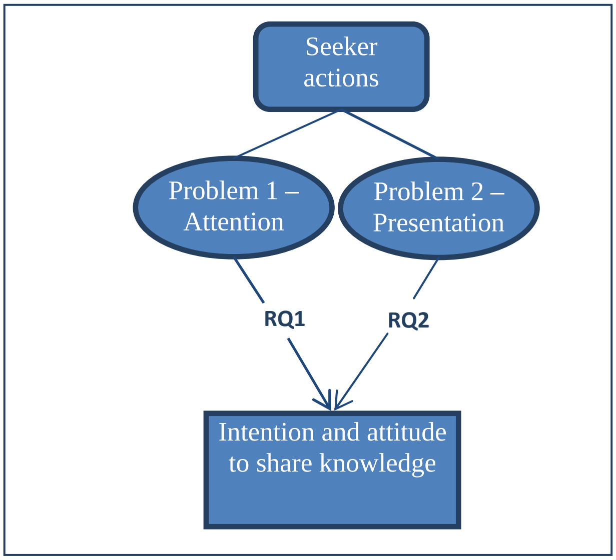

Figure 2b. Research model used in the paper

There are two problems giving rise to RQ1 and RQ2. While a functioning community has a balanced market of supply and demand (Davenport and Prusak, 1998), it is usually not feasible to read everything in a large forum so we usually have a situation of excess demand. Problem 1 (RQ1) stems from the traffic and turnover and the knowledge provider’s attention limit, e.g. time may limit reading to the first page or so. Being on the first page largely equals being visible. Sometimes technical solutions are implemented to overcome this. In the community studied there is a function to find questions with zero replies, which poses an interesting dilemma for a knowledge seeker. Do I push my question to the top or hope that someone seeks it out anyway? What is more likely to be an effective strategy? Since the topic title is the main way to get attention it will be key in drawing attention to your problem. But, how do you effectively do this without potentially alienating knowledge contributors? Again there are conflicting priorities, describing your problem accurately versus being terse so as not to cause information overflow. Problem 2 (RQ2) relates to the investment in time and effort by knowledge contributors. If you post a short informative thread with lots of example data, are you more likely to get replies? Can there be too much information? Are there other actions of the information seeker that can improve odds of getting answers? This creates a conflicting situation where the knowledge seeker may find it difficult and requiring effort to define the question/problem, but ultimately worth it to get higher quality support.

Data collection and research instrument

Data was collected by means of a quantitative and qualitative on-line questionnaire. The items in the questionnaire were adapted from studies of knowledge contribution in electronic knowledge repositories and on-line communities, namely from Bock et al. (2005), Constant, Sproull and Kiesler (1996), Lakhani and Von Hippel (2003), Phang et al. (2009), Wasko and Faraj (2005) and self-developed. Particularly the items that attempt to examine the social-interaction, the impact of seekers’ actions analysed in this paper, are largely self-developed. Viewing the community as a social-technical system it becomes important to know what the features available to members are and the interactions among them, since this is a particular feature of an on-line community (Phang et al., 2009). Taking inspiration from the so called netnography method (Kozinets, 2002), experiences from participation observation in the on-line community were used to create new items as well as modify those from literature. The author has spent time over the past years participating in the knowledge contribution process, both as seeker and provider. The items examining RQ1 ask respondents about their knowledge contributor reading/searching habits and the impact of number of replies and thread title on those. The specific items used for RQ1 can be seen in Tables 2-5 in the next section. The items for RQ2 focus on the impact of problem complexity, post quality and completeness and poster's social actions. The specific items for RQ2 are found in Tables 6-8 in the next section.

The on-line community where the study was performed is a community built around discussion/support for Microsoft Excel run by a third party. It has over 233,000 members (at the time of writing). The community is very active with hundreds of messages every day. A request for participation was posted in the off-topic section of the boards, containing an explanation of the questionnaire and a link. The questionnaire was also promoted by the administration among the group of community recognized experts in a section not publicly accessible. These people include many prolific contributors.

The questionnaire was open from late September through December 2012. A total of 41 responses were given, of which 36 were sufficiently complete and included in the analysis. As any members can potentially be knowledge-contributors there is no way of properly defining the group, consequently a rate of response cannot be calculated. With regards to the large number of potential respondents the response rate looks extremely low. However, the community's activity is highly skewed and the 90 most prolific posters (3940 or more posts each) contribute 30% of the community's total volume of posts despite representing only 0.04% of the total membership. We cannot directly tie this group to the respondents, but many of the respondents will belong to this group who contribute a disproportionate amount to the community. The problems with knowledge sharing on-line described earlier likely affected this research due to 1) attention limits for the survey request (it was posted in the lesser trafficked off-topic section and was thus less visible) and 2) the time and effort required from respondents. It should be noted that the small number of respondents and taking account of the particulars of a specific on-line community makes this in some aspects a case study with all the limitations that apply when trying to generalize. The addition of many qualitative items to some degree gives the study an explorative dimension as well.

ANALYSIS AND RESULTS

Demographics

Table 1 shows the basic demographics. Respondents are fairly similar as a group. Most respondents were male, have a bachelor degree, are experienced in spreadsheet use and live in the UK or US.

Gender	**Percentage**	**Education**	**Percentage**	**Country**	**Percentage**
Male	94%	Primary/Elementary school	3%	UK	25%
Female	6%	High School	14%	South Africa	3%
Total	100%	B.Sc (or other bachelor level degree)	67%	USA	42%
		M.Sc (or other master level degree)	11%	Colombia	3%
		Ph.D. (or other equivalent degree)	6%	Germany	3%
		Total	100%	New Zealand	3%
				Australia	6%
				India	6%
				Canada	3%
				N/a	8%
				Total	100%

Respondents experience in years, percentage of respondents						
	0-3 years	**3-6 years**	**6-9 years**	**9-12**	**12- years**	**Total**
Work experience	0%	3%	11%	8%	78%	100%
Time used spreadsheets	3%	11%	6%	19%	61%	100%
Time used Microsoft Excel	3%	11%	9%	23%	54%	100%

Table 1. Demographic factors

Impact of thread visibility and number of replies

The first or top page of a forum is usually what people see first, a constantly changing list of topics. On a very active forum a topic may only be visible a short time so new or newly replied to topics vie for the top position. In a competitive environment like this visibility is important, or is it? The first step a knowledge contributor takes is to decide from the long list of topics, which deserve their attention. We consider the actions and attitudes of knowledge providers when deciding which threads to answer. Referring to Table 2 there is relatively strong support for the idea that only the first few pages are considered.

I mainly look at the first one or two pages of threads

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	5.00	5.00	1.66	2.743	1.0	7.0

I often read through several pages (more than the first two) of threads

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	3.81	3.50	1.64	2.675	1.0	7.0

I use the search function to find threads containing keywords I'm interested in

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
35	1	2.09	1.00	1.60	2.551	1.0	7.0

I often use the "Zero Reply Posts" function to pick threads

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	5.22	6.00	1.96	3.835	1.0	7.0

I often use the "Subscribed Threads" function to see if there are any updates

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	4.97	6.00	2.42	5.856	1.0	7.0

Table 2. Knowledge contributor reading/searching habits

Furthermore, Table 2 shows how some board specific search features are used. The keyword search function is little used to find threads. However, the special search functions are highly used, especially the one finding threads with no replies. This poses an interesting problem, while it would be a good idea to reply to one’s own thread to keep it on the first page it means people looking for questions may not find it. Several respondents mentioned different strategies aiming at finding unanswered posts through searching or sorting. This tendency towards answering unanswered posts is also shown strongly in Table 3. This lends further support to the idea that replying to one’s own posts to bump them can backfire. Knowledge contributors seem to prefer unsolved problems and to some degree avoid threads they can assume have been dealt with.

I try to be the first one answering a thread

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	5.00	5.00	1.43	2.057	1.0	7.0

I actively look in threads with few answers

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	5.58	6.00	1.11	1.221	2.0	7.0

I prefer to answer threads with few answers

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	5.64	6.00	1.29	1.666	1.0	7.0

Table 3. Impact of number of replies

Impact of thread title

The other key determinant of which thread is picked is the thread title. After all, this is the first thing knowledge contributors see. Logic would suggest being informative, descriptive and specific in the topic title would mean it is easier for knowledge contributors to determine whether they are interested in helping, improving odds of getting replies. A short, uninformative title could mean people are not inclined to look at it, as they cannot be sure it is something that they are interested in or can help with. Table 4 lists the responses to question regarding the thread title. While most respondents do not actively look at threads with “bad” titles, they also do not avoid looking at them. Conversely, people do not avoid verbose titles, and to some degree look in them. This suggests it is better to err on the side of too much information rather than too little, though neither extreme will result in total lack of help.

I actively look in threads with a vague or generic title, e.g. "urgent help needed"

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
34	2	2.94	2.00	1.77	3.148	1.0	6.0

I avoid looking at threads with a vague or generic title, e.g. "urgent help needed"

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
34	2	4.21	4.00	1.89	3.562	1.0	7.0

I actively look in threads with long and/or complicated/specific topic title

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
34	2	5.06	5.00	1.41	1.996	2.0	7.0

I avoid looking at threads with long and/or complicated/specific topic title

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
34	2	2.94	3.00	1.32	1.754	1.0	6.0

Table 4. Impact of thread title

That the topic is important can also be seen in Table 5, a decision is made based on the thread title, using it to gauge the content. Several comments from responders alluded to topic titles sparking interests or being red flags for problems they simply choose not to solve. However, interestingly a strong agreement is found to the statement that people will read the content of a post before deciding whether to reply. A good title will promote views, but a bad one will not eliminate them. The title helps in sorting out some threads, but the final decision on helping is taken after looking at the post content.

I decide which thread to answer based on the topic title

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
35	1	5.17	5.00	1.20	1.440	2.0	7.0

I mainly reply to threads I know the topic of (e.g. by reading the title, description etc)

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
34	2	5.00	5.00	1.33	1.758	2.0	7.0

I always open and read the contents of threads before deciding to reply

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
34	2	5.53	6.50	2.00	4.014	1.0	7.0

Table 5. Impact of thread title

Impact of problem complexity

As noted above, knowledge contributors will usually look at the contents of a post to make a final decision on whether to answer a question. What can the knowledge seeker do to improve and facilitate knowledge sharing? Part of the question is about problem scope. A complex problem provides a more interesting challenge, but at the same time represents a larger investment of effort. As such, it can be tempting to try to dissemble a complex problem into smaller pieces. But as several responders noted they prefer to see the entire problem from the start. Table 6 shows the strong agreement with this idea and summarizes the responses on statements regarding problem complexity. One respondent pointed out that seeing the entire problem allows them to provide a more appropriate solution. The solution to a complex problem may differ from the solutions to many smaller problems. It might not fit together since the solutions were based on another set of requirements. A complex problem may also be somewhat beyond the scope of a help forum. Respondents agreed that complexity may limit answering. One respondent suggested that if it looks like someone is asking for help that is more along the lines of software development requests they will avoid answering. In fact half the respondents agree that it reduces willingness to help if they notice this behaviour.

I prefer to solve complex problems

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	4.86	5.00	1.29	1.666	2.0	7.0

I prefer to have a complex problem broken down into smaller individual problems

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	4.33	4.00	1.57	2.457	1.0	7.0

I prefer to have the whole problem presented at the beginning

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	5.75	6.00	1.13	1.279	3.0	7.0

If I find that the same poster is asking for small parts of a larger question I'm less likely to keep answering

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	4.44	4.50	1.83	3.340	1.0	7.0

Table 6. Impact of problem complexity

Impact of the content and quality of a post

Providing sample data and a d problem description should make answering questions easier for knowledge contributors. Table 7 shows this is largely confirmed. Unsurprisingly, respondents agree with being presented with good posts and are less interested in bad posts. The most important things to note are that more information is better than too little, too much being better than too little information. And that regardless of how bad a post is it seems someone will still answer, even if, as many respondents noted, it will be with "more information needed". Sample data/code and presenting prior effort are appreciated.

I help when the amount of information on the problem provided is large

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	4.83	5.00	1.21	1.457	2.0	7.0

I help when the quality of information about the problem is good

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	6.11	6.00	0.85	0.730	4.0	7.0

I help when the poster included sample data

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	5.97	6.00	0.81	0.656	4.0	7.0

I help when the poster included sample code/formulas

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	5.92	6.00	0.87	0.764	4.0	7.0

I help when the poster has shown effort in solving the problem themselves first

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	5.89	6.00	1.43	2.044	2.0	7.0

I help when the poster has complicated/extensive demands

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	3.50	3.50	1.23	1.514	1.0	7.0

I help when the poster has illogical demands

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	2.42	2.00	1.46	2.136	1.0	7.0

I help when the poster has posted too much information, i.e. a "wall of text"

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	3.14	3.00	1.59	2.523	1.0	7.0

I help when the poster has posted formulas/code that is hard to read, messy, non-functional or similar

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	3.03	3.00	1.34	1.799	1.0	5.0

I help when the poster has provided unclear/incomplete examples of the problem/data

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	3.06	3.00	1.45	2.111	1.0	6.0

I help when the poster has provided little information

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	2.92	3.00	1.46	2.136	1.0	6.0

Table 7. Impact of post quality and completeness

Impact of knowledge seeker's actions

Table 8 presents the attitudes towards a number of statements regarding knowledge seekers' actions. Again these "good" behaviours are appreciated by respondents. One respondent specifically noted that the reverse was also true. Behaving the opposite way would likely reduce willingness to help. Finally, it was found that respondents did not appreciate being contacted directly for help through the community's internal messaging system. It was felt to be contrary to the idea of public knowledge sharing that the community represents.

A thread starter would improve the chances of further answers from me by...

... thanking for the help

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	5.22	5.50	1.85	3.435	1.0	7.0

... showing appreciation for my or others' efforts

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	5.42	6.00	1.73	2.993	1.0	7.0

... providing acknowledgement of efforts in their subsequent work

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	4.86	5.00	1.74	3.037	1.0	7.0

... projecting a positive attitude towards the help

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	5.94	6.00	1.33	1.768	2.0	7.0

I prefer to answer questions in public

Valid	Missing	Mean	Median	Std.Dev.	Variance	Minimum	Maximum
36	0	6.47	7	1.11	1.228	2	7.0

Table 8. Impact of poster's social actions

DISCUSSION

What can we learn from the data and how does it impact the research questions? First and foremost, the overwhelming enthusiasm to help, even under adverse conditions is apparent. Strong dedication to helping and problem solving means that almost regardless of the transgression a knowledge seeker makes there will be someone who will help, eventually. The key consideration seems to be time. Respondents gave many references to being limited by availability of time to help, and that when time was available even less preferred threads would be considered. The other notable issue is the conflicting problems a seeker has to consider. Increased visibility may make the topic harder to find by other means. Providing adequate information is advisable, but a point of too much information will eventually be reached. Similarly, being too descriptive can make the post confusing and difficult to read. Posting prior work is encouraged, but messy formulas and code should be avoided. Taking this into consideration we propose the following guidelines for knowledge seekers on on-line communities to help reduce the information processing load on contributors and improve the likelihood of a comprehensive answer and solution:

- **Try to make the topic relevant to the question asked.** It will be easier to determine whether someone can solve the problem at hand. It increases the chance of someone with specific knowledge or interest to find it. In addition, the thread has subsequent value as it will show up in subsequent keyword searches adding to the knowledge base of the community.
- **Patience is a virtue.** Do not reply to your own question simply to keep it on the first page. Contributors specifically look for unanswered posts. If there is no reply within 24 hours then reply and try to add additional information on the problem.
- **Simple and complex problems are both fine.** But for a complex problem be sure to outline the entire problem at hand. This allows helpers to see the problem in its entirety and work on that. Do not try and parcel it out in small pieces in many threads to hide a massive software development request.
- **Define the problem clearly by outlining requirements and expectations.** There is nothing gained by trying to be brief or post quickly. Spend the effort to write a clear post. Illogical demands and unclear posts reduce willingness to answer.
- **It is usually better with more information than less.** Providing sample data and any attempted solution helps defining the problem. If you have tried something that did not work, include that. Showing previous efforts also indicates commitment. People are glad to help, but may not want to do all your work for you.
- **A little courtesy goes a long way.** Remember that helpers are volunteers, giving away their time and effort for free. Thanking for the help or somehow acknowledge the efforts will improve chances of help in the future. While a forum can be a big place the number of “top” responders is often relatively small. Be nice to them.
- **Do not contact people privately.** It is probably only a waste of everyone’s time. The community is a public knowledge repository and discussion space. Thus, knowledge contributors prefer to answer publicly as others can then also benefit and participate. It also allows the contributor to answer questions they know. There is no guarantee the person you contact privately can actually solve the problem.

An ideal post according to the respondents should have an informative topic, include sample data and information on what was attempted and the desired and/or undesired result of that.

CONCLUSION

This paper has looked at the actions a knowledge seeker can take to improve their chances of getting an answer in an on-line community by looking at two problems. The first is *attention*, how to be noticed in the flow, and the second is how to *present* yourself and your problem. A solution to the first issue is to provide a descriptive topic to ensure knowledge contributors can easily find questions they are interested in and able to answer. Constantly striving to be on the first page can be counter-productive, as there are specific tools for contributors to find unanswered questions and these are heavily utilized. The second solution is more complex. The poster should strive to provide enough information and data about the problem to make it easier for the contributor to solve the problem. Providing examples of prior work shows the knowledge seeker has put in some effort before asking others to do the same. Being courteous and positive encourages helpers to continue helping.

Engaging in on-line support can be a positive experience for both knowledge seeker and contributor. Seekers are helped and contributors learn and enjoy solving problems. Following the guidelines will probably result in more engaged contributors and thus better and faster help in the long run, and a better experience with using on-line support for end-user development.

ACKNOWLEDGEMENTS

The financial support from the Academy of Finland (grant No 127592) and TUCS is gratefully acknowledged. The author also gratefully acknowledge the comments of supervising professor Barbro Back and the anonymous reviewers, as well as the valuable input from my colleagues and the management of the Mr Excel forum for their support with the survey.

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ISBN 978-952-12-3060-8
ISSN 1239-1883

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