A Taxonomy for Networked Working Environments (NWEs)

Katarina STANOEVSKA-SLABEVA[1], Torsten BRODT[2], Roman HOEGG[3]
[1] *mcm Institute, Blumenbergplatz 9, St. Gallen, 9000, Switzerland*
Tel: +41 71 224 2793, Fax: +41 71 224 2771, Email: katarina.stanoevska@unisg.ch
[2] *mcm Institute, Blumenbergplatz 9, St. Gallen, 9000, Switzerland*
Tel: +41 71 224 2772, Fax: +41 71 224 2771, Email: torsten.brodt@unisg.ch
[3] *mcm Institute, Blumenbergplatz 9, St. Gallen, 9000, Switzerland*
Tel: +41 71 224 3439, Fax: +41 71 224 2771, Email: roman.hoegg@unisg.ch

Abstract: This paper presents a taxonomy for networked working environments (NWEs). It describes a matrix consisting of two axes: "level of human interaction" and "collaboration context" of different NWEs. Based on twelve brief cases, it illustrates the different categories of NWEs and elaborates on potential implications.

1. Introduction

New ways of working require various changes in intra- and inter-organisational processes and structures (including employees' skills, decision making, legal arrangements, communication and controlling). The current study "Sustainable Value Creation in Networked Working Environments" (or short "Network4Value N4V"), funded by the European Commission (EC) analyses what kind of changes are required by which type of new working environment, their specific impacts on a technical, organizational and social level as well as how their performance can be measured. The aim of the study is to develop a roadmap for research in the area of networked working environments (NWEs) based on a systematic classification of NWEs, the analysis of their actual and future impacts. Furthermore, the study yields the development of meaningful aggregated NWE-indicators and a revisit of NWE visions in various industries.

1. Objectives

The present article provides insight into the results of the first phase of the N4V project. In particular it provides a new taxonomy of working environments and illustrates different types of NWEs by describing specific cases for each type. The taxonomy takes into account earlier approaches to categorise and describe the emerging phenomenon of new ways of working and attempts to capture aspects of the types of knowledge involved in the working environment which have not been utilised in the earlier approaches. The taxonomy is based on specific NWE case studies which allow for a first validation of its structure and coherence .

The presented taxonomy provides the basis for the N4V project which aims to find the common drivers for sustainable growth in NWEs. N4V provides a sound basis for continuous development of the EC's Information Society research policy and supports capacity building to respond to future needs for evidence by providing structured, referenced material and an analytical framework. Results of the study will be used to adjust the definition of Strategic Objectives within the EC's 7th Framework Programme for Research. Potential users of the taxonomy and derived results are therefore mainly policy

making institutions. It can however also be used by individual organisations for benchmarking purposes.

2. Methodology - Existing analyses of ICT-driven change in work environments

Work environments are considered in various research disciplines. The following brief literature review probes into work environment research from three major research streams: First, the review includes general management research, second, specialised research of work organisation and third, research into automation of work processes which has so far been neglected by NWE research.

2.1 General management driven concepts

Driven by the need to address increasing globalisation, management research investigated new opportunities to organise work by the extensive use of new ICTs. As such, a network view of the firm started to develop [1]. Under the paradigms of the resource-based view [2], the management research perspective brings NWEs into the broader context of strategic management [3] and organisational science [4]. From early on, researchers in this field draw their attention to changes in the work environments of employees [e.g. 5,6]. Typical functions that have been researched under the network view are knowledge-centred functions of research and development [e.g. 7,8] and the process-oriented functions of operations [9]. As a consequence researchers have defined the "networkability" of organisations as a source for competitive advantage [10-13]. In the view of the authors it appears sensible to utilise the process-oriented and the knowledge-oriented perspectives for the categorisation of NWEs.

2.2 Specialised work-oriented concepts

The concept of work environments is closer examined by a specialised research stream comprising aspects of tele-, e-, mobile and virtual work. As the prefixes already indicate this research has been stimulated by the use of technologies to change work concepts.

Telework is usually understood as individual workplaces which have been made locationally flexible by the use of ICT. Often a relocation of the work from a centralised office environment to a decentral workplace in the home of the worker, or a mobile workplace (anytime, anywhere) is implied [14,15].

The term eWork takes a step onwards from previous notions of telework. While telework in the traditional sense is mostly focussing on individual changes of work location, most prominently at home, eWork also includes remote work in shared office premises, such as call-centres and (other) remote back offices [16]. In addition to traditional telework, eWork is understood to cover tele-collaboration as well, i.e. telemediated work forms carried out by workers located in traditional office environments, as in the case of virtual teams which stretch across the boundaries of single organisations [17].

Following the developments of mobile communication technology, the research on telework and eWork got extended to mobile work environments [18]. Locational mobility, linked to the possibilities of increased connectivity anytime, anywhere, has been the first focus of emerging research [19]. The growing technological capabilities steered a discussion on further aspects of mobility, including virtual mobility [20], operational and interactional mobility [21]. Consequently, the aspect of networking/collaboration grew more important [22].

A common denominator of the first two research concepts is the focus on the human as the core element of the work environment. Given the obvious technology push, the authors

argue that aspects of automation of work processes should not be neglected in the analysis of NWEs.

2.3 Research on automation of work

The concept of automation aims for a new level of integration. Its goal is to automatically connect the real world with ICT. It thereby bypasses human labour as a cost intensive, error prone and time consuming factor when feeding data to the computer. These are important aspects in so-called real time enterprises [23]. Recent research in automation is looking at the benefits of ubiquitous computing in preventing media breaks [24]. Amongst other areas, technologies such as radio frequency identification (RFID) that support automation have the potential to create considerable benefits in supply chains and help to close the gap between the real world and ICT [25].

3. Technology description - Taxonomy of Networked Working Environments

As shown in the previous section, existing taxonomies of NWEs are strongly bound to depict existing human centric work environments, ignoring the manifest trend of increasing automation of work processes on the one hand and the extension and augmentation of work environments into more peripheral and stakeholder-oriented realms on the other hand.

Therefore, the authors have developed a taxonomy that utilises two key dimensions of NWEs to categories new phenomena of networked working. The taxonomy is depicted in the figure below. The matrix shows the level of human interaction on the y-axis and the collaboration context of NWEs on the x-axis.

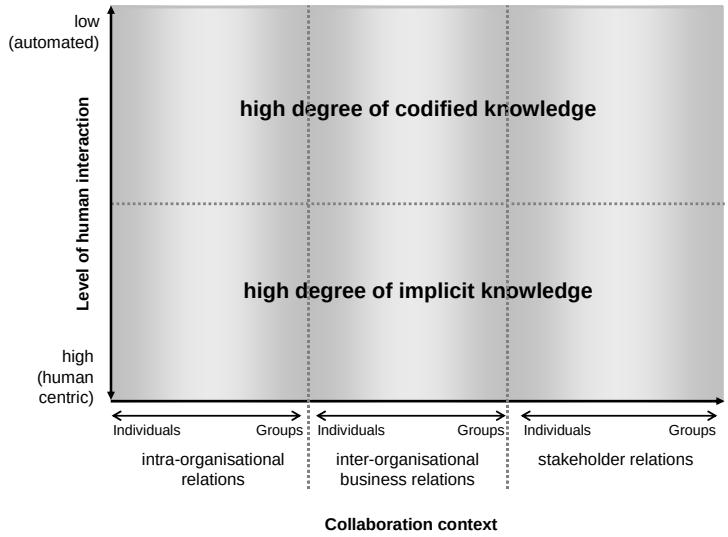

Figure 1: Taxonomy of Networked Working Environments (NWEs)

The level of human interaction describes whether a NWE is human centric (i.e. displays high degrees of human interaction) and primarily deals with implicit knowledge or whether it is highly automated (i.e. displays low degrees of human interaction) and focuses on codified knowledge and work processes.

The collaboration context shows whether a NWE is placed within organisational boundaries or whether it goes beyond organisational boundaries, involving external partners and stakeholders and including them into the work process. Thus, the dimension is split into three segments: Intra-organisational relations, inter-organisational business relations and relations to stakeholder to whom no direct business relation exists. These three contexts can be split up further and labelled according to the number of core participants in the

networked environment. Each sub-context differentiates if a NWE focuses on the collaboration of individuals or groups within organisations. Similar definitions have been used to describe e-Work settings [16, 26]. For simplification purposes the differentiation is set between collaboration with an individual partner (company or actual individual person) and collaboration with a group (which can either be a closed circle or a completely public and open collaboration).

4. Case capsules

This section introduces selected cases of networked working based on the study of extant literature. The taxonomy is then populated with the cases. For this purpose each case is numbered and the number is depicted in Figure 2. We aim to show that the taxonomy allows for clusters to be built which describe typical instantiations of working environments and provide insights on NWE's implications for practitioners and researchers.

4.1 Aerospace engineer supported by wearable computer systems (Case 1)

The term wearable computing describes a movement in hard- and software engineering towards a seamless integration of computing power and software applications into clothes and fashion accessories. In business contexts, the main objective is to support complex work processes without limiting a worker in its physical moves and actions. One case example is the use of wearable computing equipment for aerospace maintenance engineers. The engineers, while controlling and repairing aeroplanes need to use their hands for the repairs and for example need to be able to reach engines without being bound to a computer at a fixed location. As such, this case represents individual support in an intra-organisational setting. The work environment is networked in so far as the individual engineer is connected to a central database. The provisioning of knowledge at the right time and the right place and the reduction of physical limitations by computer equipment are in the foreground of the human centric work environment design. The level of human interaction is high and the work process is highly knowledge dependent [27].

4.2 Mobile sales force solutions (Case 2)

Mobile sales force solutions are used to support sales representatives in their daily routines of meeting customers, presenting products and closing deals as well as taking orders. The sales representatives usually use PDAs or tablet-PCs as a device. Wireless or fixed line connectivity is used to synchronise the devices with the central customer and product data base [28]. The data-sets can be personalised to individuals or groups of sales people. Certain solutions provide the sales personnel with contextual data such as location-specific information about (potential) clients [refer to 29]. Hence, mobile sales force support groups or individuals within one organisation to conduct their business more efficiently. The level of human interaction is high in sales relationships and the work process is highly knowledge dependent.

4.3 Freelance graphic designer (Case 3)

Freelance graphic designers operate as self-employed businesses. They work for several clients at the same time or in tight sequence. Usually, they belong to a lose network of friendly designers, who might share common rooms for their work or help each other with contacts and knowledge sharing. Their work is strongly computer-based and deliverables can be 100% digitally delivered. The work environment of freelance designers changed in so far as ICT support them in operating their business from remote (cheap) locations and

having strong remote interactions with clients which in certain cases leads to the fact that work is accomplished without any physical client meeting [refer to 21].

This work environment describes a case of individual inter-organisational collaboration which is highly knowledge driven, requiring high levels of human interactions.

4.4 Automotive CAD interface for product development (Case 4)

Product development processes (e.g. in the automotive industry) are highly complex in terms of the components to be developed, the engineering and design skills required and by the fact, that teams are often geographically dispersed. These determinants require a strong ICT-infrastructure to support collaboration and the exchange of complex information. Design and Computer Aided Engineering (CAE) solutions support intra- and inter-organisational teams and individuals in pursuing their tasks. Key components of a collaborative CAE-solution are (1) a common engineering database, (2) tools and environments for remote collaborative sessions regarding common examination of hypotheses and modifications and (3) the possibility to choose the best adequate environment (from the desktop to the virtual room) [30]. The work environment is inter-organisational, integrates entire groups of participants and is highly knowledge centric.

4.5 Forum Nokia (Case 5)

Forum Nokia is - with more than two million individual developers - the world's largest application developer platform for mobile applications. It is separated the two levels "Forum Nokia", an open and free to the public forum and "Forum Nokia PRO", a fee-based membership developer community. By offering technical development guidelines as well as marketing and sales support, Nokia orchestrates the decentralized development activities to increase the number of mobile applications available in the market [31].

4.6 Health expert circles (Case 6)

Health expert circles are platforms initiated by the health industry to pool experts and their knowledge. Various companies have set up such platforms, e.g. Pfizer [32], Sanofi [33] or Wyeth [34]. The key component of these circles is a web-platform used for information purposes, offering certain community features and a knowledge repository. The platform is initiated by a core organisation which invites experts to participate in the platform. In a variation the wider public can be invited to either actively participate or consume the information generated on the platform.

The circle can be used for communication purposes (e.g. public relations, product promotion) or the stakeholder involvement can be used as a tool for idea generation for new products (co-creation strategies) [35]. As such, online communities are an extension of companies' core marketing and development activities and impact working environments like corporate communication specialists, product engineers and marketing planners. Online community managers can actually evolve as a new job description requiring an integrated set of skills. The work environment is stakeholder related, integrates entire groups of participants and is highly knowledge centric.

4.7 Self check-out (Case 7)

To test customer acceptance the supermarket chain Spar Austria installed two self-scanning check-outs in their store in Mattinghofen near Salzburg. Instead of having a cashier the customers take their purchases out of their trolleys, scan and pack them. Afterwards they pay for the goods at a machine either by cash or by card. The company states that there will

remain human assistance at the check-out. However, it has to be stated that the traditional tasks of cashiers have been taken over by the machine. It is a working environment which focuses on a single employee, is intra-organisational and the check-out process was automated in a way that it was possible to have the customers to do it on their own [36].

4.8 eLearning (Case 8)

"envole" is the official eLearning teaching material for French at schools in several Swiss cantons. It uses computer technology to allow the students to do self-assessments as well as teaching correct pronunciations by playing recordings of native speakers. Teachers are still needed but with the advancements of eLearning their job profile may be transformed radically. Many repetitive tasks (such as training the correct pronunciation) are taken over by computer programs. The NWE (for the teachers) is intra-organisational, integrates entire groups of participants (students) and is highly automated [37].

4.9 Industry supply chains (Case 9)

DaimlerChrysler established the Internet-based Information Control Tool (IC-Tool) for the production of their cars. Each supplier knows the gross requirements, assets and capacities in the entire supply chain and can - in the ideal case - deliver his goods just in sequence of the assembly line. The work environment is inter-organisational and highly automated [38].

4.10 Public procurement (Case 10)

simap.ch (Système d'information sur les marchés publics en Suisse) is an association of nearly all Swiss cantons, many big cities as well as the federal government. Its ambition is to establish one single platform for the exchange of information on public procurement. The platform is to promote competition and transparency in the public procurement process, to grant access to all relevant information and to minimize administrative costs. It generates an inter-organizational working environment for groups, automates the processes and therefore reduces the need for human interaction [39].

4.11 Individualized information from a website (Case 11)

The Swiss federal railways SBB offer individualized time table information on their websites. Through a simple interface queries about travel routes, times and costs can be sent to the web server to be automatically processed. This NWE is highly automated and collaboration takes part with customers as well as non-business partners [40].

4.12 Content feeds (Case 12)

DW-WORLD, the online-branch of Deutsche Welle in Germany, offers news feeds of its own content to other websites. Their feed system customizes the content to the individual profiles of their customers and automatically offers the news in different XML formats or HTML. Available topics are politics, business, culture, multimedia or sports. Apart from a webmaster who sets up the system, this service allows its customers to offer news without the need of an own editorial team. This NWE is highly automated and incorporates a potentially open group of stakeholders [41].

5. Results - Summary of implications

As demonstrated in the previous section, typical examples for all sectors of the taxonomy matrix can be identified.

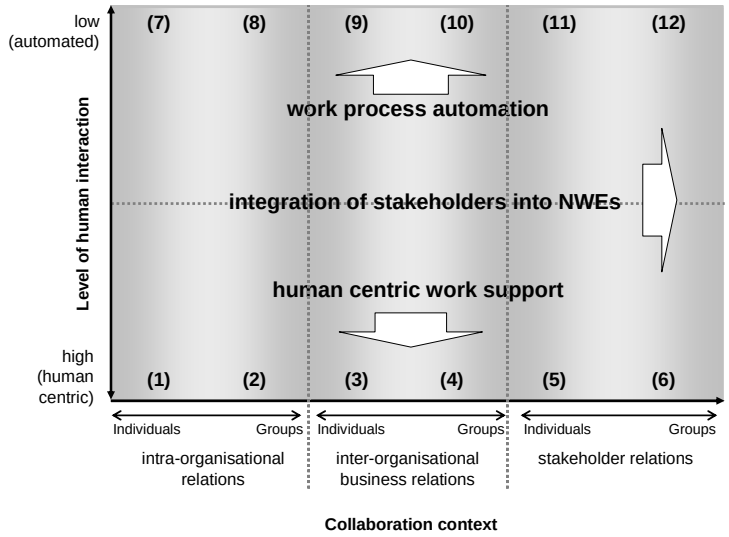

Figure 2: Selected cases

Generally, three main trends become visible when analysing the NWEs based on the suggested taxonomy:

1. Increasing automation of Working Environments which are based on codified knowledge about processes
2. ICT as a context aware support technology for Working Environments that base on implicit knowledge support
3. Increasing active extension of corporate networks (and the respective work environments) to comprising various groups of stakeholders that are not in a business relation with the company. Examples of such stakeholders are NGOs, consumer organizations, regulatory authorities and similar.

From each of these trends we can identify critical implications for the design of NWEs: (1) NWEs with increased automation tend to a reduced need for human work for highly structured routine activities. On the other hand existing job profiles change profoundly. The tasks require different - typically more advanced - sets of skills as routine work is taken over by machines. (2) NWEs with a strongly human-centric dimension can be seen as augmented working environments as they allow for interactions that would never have been possible before. This allows for greater efficiency but also for new types of bundling of resources. With the advances of ICT and further codification of implicit knowledge they may be automated over time too. (3) Networking technologies and activities allow the active inclusion of non-business partners.

6. Conclusions

The taxonomy presented in this paper has evolved from an extensive research and analysis of emerging networked working environments in various industries and application domains. By populating the taxonomy with selected case studies of NWEs it proved useful to cluster and describe NWEs and their impacts in business and social contexts. The paper also illustrates implications which need to be addressed in the future. Further validation is part of ongoing research. Apart from the examination of literature based case studies, several in-depth case studies of NWEs have already been conducted in the context of the N4V project. A distinct set of value drivers with an aggregation of the key challenges for further promoting NWEs in Europe's ICT industry are being derived.

References

[1] G. Easton, Industrial Networks: A Review. In: Industrial Networks: A New View of Reality, B. Axelsson and G. Easton (Eds.), Routledge, London, 1992, pp. 3-27.
[2] G. Hamel and C.K. Prahalad, Competing for the future. Harvard Business School Press, 1994.
[3] R. Gulati, N. Nohria and A. Zaheer, Strategic Networks. Strategic Management Journal, 21 (2000).
[4] J. Sydow, Strategische Netzwerke Evolution und Organisation. Gabler, 1992.
[5] S.L. Jarvenpaa and B. Ives, The Global Network Organization of the Future: Information Management Opportunities and Challenges. Journal of Management Information Systems,, 4, 1994, pp 25-47.
[6] W. H. Davidow and M.S. Malone, Das virtuelle Unternehmen. Campus, Frankfurt/Main, 1993.
[7] A. Arundel and C. Bordoy, In-House vs. Ex-House: The Sourcing of Knowledge for Innovation. In: Networks, Alliances and Partnerships in the Innovation Process, J. De la Mothe and A. Link (Eds.), Kluwer Academic Publishers, Dordrecht, 2002, pp. 67-90.
[8] J. Birkinshaw, Managing Internal R&D Networks in Global Firms: What Sort of Knowledge is Involved? Long Range Planning, 35 (2002), pp. 245-267.
[9] M. Christopher, Logistics and Supply Chain Management, London, 1998.
[10] H. G. Gemünden, T. Ritter and P. Heydebreck, Network Configuration and Innovation Success: An Empirical Analyis in German High-Tech Industries. International Journal of Research in Marketing, 13 (1996), pp. 449-462.
[11] T. Ritter, The Networking Company: Antecedents for Coping with Relationships and Networks Effectively. Industrial Marketing Management, 28 (1999), pp. 467-479.
[12] T. Ritter and H.G. Gemünden, Network competence: Its impact on innovation success and its antecedents. Journal of Business Research, 56 (2003), pp. 745-755.
[13] R. Klueber, R. Alt and H. Österle, Implementing Virtual Organising in Business Networks: A Method of Inter-Business Networking. In: Knowledge Management and Virtual Organisations, Y. Malhorta (Ed.), Idea Group Publishing, Hershey, USA, 2000.
[14] Empirica, Work, Employment and Skills, SIBIS Topic Report No.5, European Comm., Brussels, 2002.
[15] Empirica, SIBIS Pocket Book 2002/3, empirica GmbH, Bonn, 2003.
[16] U. Huws and S. O'Regan, eWork in Europe: The EMERGENCE 18-Country Employer Survey, IES Report No. 380, Brighton: Institute for Employment Studies, 2001.
[17] H. Eichmann, B. Saupe and M. Schwarz-Wölzl, Critical Issues Pertaining to the Code of Practice for Global E-work, Centre for Social Innovation, Vienna, 2002.
[18] R. Reichwald, K. Möslein and F. Piller, Taking Stock of Distributed Work: The Past, Present and Future of Telecooperation, Proceedings of the ASAC-IFSAM 2000 Conference, Montreal, 2000.
[19] S. Lilischkis, More Yo-yos, Pendulums and Nomads: Trends of Mobile and Multi-location Work in the Information Society, STAR Issue Report No. 36, 2003.
[20] M. Vartiainen, Mobile Virtual Work - Concept, Challenges and Scenarios. In: Mobile Virtual Work, J.H.E. Andriessen and M. Vartiainen (Eds.), Springer, London, 2005 (forthcoming).
[21] M. Kakihara and C. Sørensen, Practicing Mobile Professional Work: Tales of Locational, Operational, and Interactional Mobility. INFO: The Journal of Policy, Regulation and Strategy for Telecommunication, Information and Media, 6, 2004, pp. 180-187.
[22] P. Luff and C. Heath, Mobility in Collaboration, Proceedings of CSCW'98, ACM Pre, Seattle, 1998.
[23] R. Alt and H. Österle, Real-time Business, Spring, Berlin, Heidelberg, New York 2004.
[24] E. Fleisch, Betriebswirtschaftliche Perspektiven des Ubiquitous Computing, 2001.
[25] M. Kärkkäinen and J. Holmström, Wireless product identification: enabler for handling efficiency, customisation and information sharing, in Supply Chain Management: An International Journal, 7(4), 2002.
[26] T. Hanhike and K. Gareis, Modelling eWork - Towards a Better Understanding of Information Technology's Impact on Workplaces and Work Locations, 22nd Annual International Labour Process Conference, Amsterdam, 2004.
[27] T. Nicolai, T. Sindt, H. Kenn and H Witt, Case Study of Wearable Computing for Aircraft Maintenance, Proceedings of IFAWC'05, Zürich, 2005, pp. 97-111.
[28] Frost & Sullivan, Mobile Sales Force Automation (SFA) Markets, Report # F114-65, Palo Alto,, 2004.
[29] T. Brodt et al., Best Practise and Success Factors of Mobile Work, Information Society Technologies programme of the European Commission, Brussels, 2005 , pp. 83.
[30] T. Fernando et al., A Strategic Roadmanp for Defining Distributed Engineering Workspaces of the Future, European Commission, Brussels, 2003.
[31] Forum Nokia - Developer Resources, 2005, http://www.forum.nokia.com/
[32] Pfizer, 2005, www.der-gesunde-mann.de
[33] Sanofi, 2005, www.schilddruese.de
[34] Wyeth, (2005), www.denkepositiv.com.

[35] M. Sawnhey and E. Prandelli, Beyond Customer Knowledge Management: Customers as Knowledge Co-Creators. In: Knowledge Management and Virtual Organisations, Y. Malhorta (Ed.), Idea Group Publishing, Hershey, PA, USA, 2000, pp. 258-282.
[36] SPAR Österreich, 2005, Premiere im österreichischen Lebensmittelhandel in Mattighofen: SPAR setzt auf Self-Check-Out (Pressrelease), http://www.spar.at
[37] envol, 2005, http://www.envol.ch/
[38] D. Corsten and C. Gabriel, Supply Chain Management erfolgreich umsetzen, Springer, Berlin, 2002.
[39] SIMAP.CH, 2005, http://www.simap.ch
[40] SBB, 2005, http://www.sbb.ch
[41] Deutsche Welle, 2005, http://www.dw-world.de/dw/article/0,1564,306767,00.html