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DEALING WITH SOCIO-TECHNICAL COMPLEXITY: TOWARDS A TRANSDISCIPLINARY APPROACH TO IS RESEARCH

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Abstract

Research in the IS field has been characterised by the use of a variety of methods and theoretical underpinnings. This fact recently raised concerns about the rigour of the scientific results of IS research and about the legitimacy of the IS academic field. On the other hand, a number of IS researchers has argued for a view of diversity as a strength and necessity of the IS field. This paper supports this viewpoint and analyses the relation between IS research and concepts originating from theoretical debates around transdisciplinarity. We present results from a multidisciplinary group of researchers towards an integrative platform for the orientation of transdisciplinary IS research. The Mikropolis platform is intended to provide researchers with a common language, allowing the integration of different perspectives through exchange of experiences and mutual understanding. We also discuss some practical issues that arise from the transdisciplinary cooperation in IS research.

Keywords: transdisciplinarity, methodology, pluralism in IS research, information systems, integrative platform.

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1 INTRODUCTION

Research on Information Systems is constantly faced with the challenge of addressing the complexity of socio-technical systems. As a problem-oriented field of study, IS research is concerned with the interplay between information and communication technologies (ICTs) and the organisational and societal contexts in which technologies are used, generally under the assumption that the outcomes of technology use depend as much on characteristics of the technology as on organisational and social actions that shape them (Avgerou 2000).

While this common epistemic interest demarcates and to some extent unify the IS field, a great variety of research approaches and methods have been used in IS research. This theoretical and methodological diversity can be traced back to the manifold disciplinary origins of IS from computer science and applied social sciences like organisation studies, management science, and organisational psychology. Thus, in addition to the traditional theoretical paradigm of *organisational rationalism* originated from concepts of the management and organisational sciences (cf. Avgerou 2000), recent IS socio-technical research also builds upon theories from social sciences such as structuration theory (Orlikowski 2000), critical theory (Ngwenyama and Lee 1997) and actor-network theory (Monteiro and Hanseth 1996) – for a more comprehensive cover see (Avgerou et al. 2004), (Orlikowski and Baroudi 1991), (Myers 1997), and the on-line resource (Schneberger and Wade 2006). Several corresponding research methods from the social sciences are used in IS research, both of *quantitative* (e.g. surveys) and *qualitative* nature (e.g. case study, ethnomethodology). Indeed, a recent survey (Glass et al. 2004) supports the picture of IS as an applied discipline that applies concepts of other disciplines.

The diversity of approaches and methods and the consequent lack of a unified theoretical core has generated concerns about the legitimacy of IS as an academic discipline (Benbasat and Zmud 2003). Countering this viewpoint, a number of authors regard pluralism rather as necessary for the IS research to cope with the complex and multidimensional issues studied (Mingers 2001). Following this line, Lyytinen and King (2004) propose the metaphor for the IS discipline as a "*market of ideas in which scholars and practitioners exchange their views regarding the design and management of information and associated technologies in organized human enterprise*". As such, the theoretical and methodological diversity of IS is seen as a valuable resource for the plasticity of the research in response to changes in ICT and organisation forms (Lyytinen and King 2004).

Therefore, to fulfil its mission and address the complexity of IS and social practices, IS research should not harden and restrict itself to a theoretical 'core' orthodoxy (*pace* Benbasat and Zmud 2003), but rather dare the challenge of developing strategies for dealing with multiple research approaches, integrating different methods of inquiry, and articulating diverse theoretical backgrounds. Facing this challenge means replacing the hierarchical and homogeneous mode of scientific practice by a new form characterised by complexity, hybridity, non-linearity, reflexivity, heterogeneity, and transdisciplinarity—the Mode 2 knowledge production described by Gibbons et al. (1994). Thus, a transdisciplinary approach to IS does not strive for a one-dimensional synthesis of the object IS around a unified theory at the centre, but assumes that the complex and intertwined relations between ICTs and human practices must be approached in multiple ways. Each of these perspectives sheds a different light to the understanding of the multidimensional object studied.

This paper argues for the relevance of transdisciplinarity for IS research, by contrastively analysing the theoretical underpinnings of transdisciplinarity and IS, and thereafter reporting about practical experiences towards a transdisciplinary approach to IS research. This approach builds upon multi-disciplinary collaboration, in which a group of practitioners and researches with diverse disciplinary backgrounds (psychology, political science, IS, computer science, sociology) works together on related themes. To enable communication and articulation among the different perspectives involved, we use the *Mikropolis* platform (Krause et al. 2006, Simon et al. 2006) that provides us with a common exchange language and a unifying research concern, thereby allowing us to transpose disciplinary boundaries. Nevertheless, each researcher uses his/her own methods and has additional

particular research interests. We press the argument that this approach has the advantage of producing results enriched by the multiple perspectives, whilst also providing a critical feedback to the theoretical basis.

The rest of the paper is organised as follows. Firstly, we discuss the meaning of the interrelated terms interdisciplinarity and transdisciplinarity (Section 2), and their relation to IS research (Section 3). Section 4 thus briefly presents the main concepts and perspectives of the *Mikropolis* platform. Thereafter, we describe in Section 5 our experience of trandisciplinary work using Mikropolis, analysing difficulties, challenges, and lessons learned. Finally, Section 6 presents our concluding remarks and prospects for future work.

2 INTER- AND TRANSDISCIPLINARITY

Transdisciplinary and the related term interdisciplinarity are generally opposed to pluri- or crossdisciplinarity. The latter two refer to a form of cooperation among different scientific disciplines that does not change the existing disciplinary and theoretical structures. Thus, the result of pluri- or crossdisciplinary research can be characterised as a juxtaposition or uncoordinated collage of pieces stemming from diverse disciplinary traditions. Interdisciplinarity, in turn, involves collaboration and cross-fertilisation among disciplines, so that concepts and methods perceived as useful that originate from different disciplines are put together to achieve common problem definitions, terminologies and methods. The research results are thus a unified whole, and this process can indeed yield new disciplines (For more details about different forms of interdisciplinary practice and terminology variations see, for instance, Balsiger (2005) and Jantsch (1972)).

The term *trandisciplinarity* was coined in the 1970s, and it was defined in the first international seminar on interdisciplinarity as "a common system of axioms for a set of disciplines" (cf. Klein 2004). Meanwhile, the term has broadened its meaning and has been related to a new mode of knowledge production called *Mode 2*, which cut across disciplinary boundaries and is strongly oriented towards and driven by problem-solving (Gibbons et al. 1994). Transdisciplinarity is the privileged form of knowledge production in Mode 2, corresponding to "a movement beyond disciplinary structures in the constitution of the intellectual agenda, in the manner in which resources are deployed, and in the ways in which research is organised, results communicated and the outcome evaluated" (*op. cit.*, p.27).

In contrast with interdisciplinarity, a characteristic of transdisciplinary research is that the problems to be researched originate from non-scientific application contexts, and they are formulated in these contexts independently of scientific theories and disciplinary definitions (Balsiger 2005). In this manner, the philosopher Mittelstraß places transdisciplinarity in the interface between the two systems "science" and "society" (*apud* Balsiger 2005). Differently from a mere applied research though, transdisciplinarity does not proceed by segmenting a pre-defined problem into smaller parts each to be solved by a specific discipline or method (as usual in applied research), but involves a genuine integration and communication among researchers with different disciplinary perspectives, and among these and the people of the application context (Balsiger 2005).

Klein (2004) adds to these features of transdisciplinarity the acknowledgement of multidimensionality. Based on the works of the physicist Basarab Nicolescu, she argues that "transdisciplinarity requires deconstruction, which accepts that an object can pertain to different levels of reality, with attendant contradictions, paradoxes and conflicts" (Klein 2004, p. 524). According to this view, a transdisciplinary approach should not strive to achieve an one-dimensional theory or methodology – for such a procedure would imply the creation of yet another discipline. Instead, transdisciplinarity is capable of taking into account the "flow of information circulating between various branches of knowledge", and achieving a coherent whole that preserves the multidimensional aspect of the object of study (Klein 2004). Thus, transdisciplinarity call into question disciplinary thinking, while pluri-, cross-, and interdisciplinarity do not.

But what is the position of the IS field in this picture? The next section explores this relation.

3 IS RESEARCH AND TRANDISCIPLINARITY

As regards the definition of the object of study and the relation of IS to the so-called "reference" disciplines (Keen 1987), we may infer that IS has an interdisciplinary nature. Indeed, the IS field has drawn on concepts and methods from a number of different disciplines and research traditions, putting them together to address issues that arise in the interplay between ICTs and social and organisational practices. Were we to accept the demands of Benbasat and Zmud (2003) for the establishment of a well-defined and constant disciplinary "core" for IS, research in the IS field would be "disciplined"; i.e. fixed boundaries would be defined for the undertaking of IS research on the basis of a limited number of chosen concepts, methods, and concerns. We would see here the borne of a new interdisciplinary discipline, similar to what happened to other fields like for example socio-biology arising from sociology and biology.

Such unification could only be achieved at the expense of expurgating from the plural body of research in the IS field works that are not aligned with the proposed "core"—for Benbasat and Zmud the strict adherence to topics "closely related" to the IT artefact and to organisations—and preventing future research that uses alternative thematic, concepts and approaches to be accepted in the IS field. In fact, the proposal of a narrow focus for computing disciplines is not new and has a parallel in the positions of formalists like Dijkstra (1989), who defended the setting up of a firewall between the problems of formal *correctness*—to be explored by computing researchers—and that of *pleasantness* of use—to be addressed by other disciplines like psychology[2].

Nevertheless, there are many researchers that question the underlying premise of the argument of Benbasat and Zmud that sees diversity as a threat for the scientific rigour of the IS field—for instance, the earlier work of Keen (1987), and more recently, responding directly to Benbasat and Zmud, Lyytinen and King (2004) and Galliers (2003). For these authors, diversity of methods and topics is not only convenient to deal with the complex set of relations that arise from the encounters of technology and human practices, but also a real necessity for the field if it is going to stand the pace of the changes in the object of study.

As Galliers (2003) points out, accepting diversity implies moving from a concept of IS as a discipline with fixed boundaries and theoretical core to that of IS as a transdisciplinary field of studies. Indeed, the praxis-based core of IS (Lyytinen and King 2004) is directly related to the problem-solving orientation of transdisciplinary research mentioned in the previous section. And if we consider methods used in IS such as participatory approaches to IS design (e.g. Floyd 1993) and action research (e.g. Baskerville and Myers 2004), we can see that many of the problems addressed by IS research originate from practitioners' demands, and are solved in interaction with the views of people in the context of technology use. As claimed by Keen (1987), an important goal of IS research is to improve practice through research. That corresponds directly to the problem-solving orientation of research in Mode 2 described by Gibbons et al. (Sect. 2).

The multidimensional nature of the object of study of IS research—a main tenet of transdisciplinary research as explained in Section 2—is also acknowledged in a number of works in the IS community. For instance, Land and Kennedy-McGregor (1981) include in the notion of information systems:

> "1) the informal human system comprising the system of discourse and interaction between individuals and groups (…); 2) the formal, human system comprising the system of rules and regulations, of departmental boundaries and defined roles (…); 3) the formal computer system (…); 4) the informal computer system epitomised by personal computing and the possibility of using the formal systems and computer networks as means of holding unstructured information and passing informal messages (…); 5) the external system, formal and informal." (*apud* Galliers 2003; 341).

In this manner, the challenge for the IS field is considering diversity as a strength, and developing means for the integration of different approaches and perspectives in order to achieve an enrichment of

[2] The outcome of the debate in which the position of Dijkstra was presented has in the end broadened the field of computing, which includes today areas that explicitly address the human use of technologies like human-computer interaction.

the research results. Following the indications of theoretical works on transdisciplinarity mentioned in the previous section, this integration should not intend to reduce the object of inquiry to a particular theory nor to a certain type of causal principles (for instance, the precedence of technological issues over the social concerns or vice-versa). It rather implies acknowledging the multidimensionality of the object of study and the necessity of using diverse methods and approaches to deal with the different facets of an information system, while striving to achieve a dialogue among the different perspectives and theoretical constructs.

After analysing experiences of transdisciplinary research cooperation, Balsiger (2005) argues for the need of establishing an *integrative framework* for each transdisciplinary research project, adapting the idea of a "generalised axiomatic system" contained in the early work of Erich Jantsch (1972) on transdisciplinarity. This integrative framework should not only make clear the part of each different disciplinary perspective in the context of the research project as a whole, but also allow the different participants to communicate and to understand results and concerns from the other viewpoints in relation to their own research.

Due to the unique character of each transdisciplinary project, there can hardly be something like a universal approach that one would be able to use in all different projects. Nevertheless, we believe that a common conceptual platform for understanding socio-technical phenomena can be achieved on an appropriately high level of abstraction. This platform can in turn be used as a template in the establishment of an integrative framework for particular projects. The next section thus presents an approach towards the development of such a conceptual platform that can be used for transdisciplinary IS research.

4 THE MIKROPOLIS PLATFORM

The *Mikropolis* platform described here was originated as a didactical instrument in higher education aimed at explaining the interplay among computing activities, human beings and the global society within the same systemic context. As a didactical model, *Mikropolis* has been used in the last 10 years as an orientation model for students of Computer Science and Business Informatics courses at University of Hamburg. It has been also adopted by a number of scholars in Germany and was recently published by the German Federal Agency for Civic Education (Rolf, 2004). The name *Mikropolis* is derived from the German term "Mikroelektronik" (microelectronics) and the Greek word *polis*, thus emphasising the necessity to consider not only technical aspects of ICTs but the interplay between social and technological implications.

Based on the didactical model, the Mikropolis platform is being developed by a multidisciplinary network of researchers, which includes people with backgrounds in information systems, computer science, environmental and business informatics, political science, psychology, and sociology. We share a common understanding that designers and developers of software and information technology must take into account the social and organisational conditions as well as the consequences of technology use.

The Mikropolis platform does not have the explanatory power of a theory, nor is it meant to replace or complement existing theoretical approaches to socio-technical phenomena. It is rather to be understood as a heuristic framework that allows the integration of different disciplinary perspectives and theoretical approaches by providing a common language in which socio-technical phenomena may be described. As such, as argued above, this can only be achieved at a high level of abstraction.

The platform makes an analytical distinction between the *micro-* and *macro-context* of socio-technical interplay, referring to the societal and organisational level respectively. This affords a view of organisational aspects of computerisation and the wider societal influence, as well as the social relations that emerge from ICT-related organisational change in respect to economy, society, culture, and politics. Furthermore the platform distinguishes a *structural* and a *temporal* perspective from which we should interpret these contexts. The following sections examine each of these distinctions in turn.

4.1 Micro and Macro Contexts

At the micro-context we look at how the shaping of human behaviour and technological artefacts is interwoven, both in development and use of ICT. The focus here lies on the interplay between ICTs and their embedding into organisational contexts. At an inter-organisational level, we distinguish those organisations using and those developing ICT. This distinction is merely an analytical one, since many organisations using information technology develop or at least customise the products they use in-house, and those developing are themselves users of ICT. Therefore we accent the complex system of different actors that are involved in advancing information technology, for example globally operating software vendors, publicly funded research institutions, or ICT-related R&D-sections of larger organisations. The relation between these actors can be characterised as a sectional system of innovation (Malerba 2004). The interaction between organisations using ICT and the ICT-related sectoral innovation system is used for the analysis of the interplay between development and use of ICT, which can be characterised as either demand-driven or technology-driven.

Regarding the implications of ICT for the society at large, we take a look at the interplay between technological innovation and social change. Thus, at the societal level of analysis of computerisation the focus lies on the socio-political and socio-economic context in which the organisations are themselves embedded, comprehending social and political norms, cultural habits and values, and the economic pressures of a globalised world. At this level, social patterns, standards and guiding ideals and principles (*Leitbilder*) are thus considered, as well as social and cultural values, norms, and regulations. In this manner, the macro-context enables the description of specific factors and conditions that are relevant to the actor's actions in the micro-context, i.e. to ICT production and consumption. Further, the structures in the micro-context can thereby be observed in the perspective of their significance for bringing forth transformations to the social sphere as a whole.

4.2 Structural and Temporal Perspectives

The structural perspective used in our platform comprises the transformation processes from social actions to the technical information format. ICT is used and developed in specific contexts of interaction, where people work together and communicate, consisting of a specific set of rules, tradition, and history from which the previous elements emerged. In terms of individual ICT development and use, this involves, on the one hand, the interrelated processes of formalising human action, and of 'translating' it into computer executable routines. On the other hand, it means reintroducing those formalised routines into the organisational context, triggering social changes and unexpected uses of the technology produced. Since this process involves a generalised description of context-specific action, which is then somehow transferred back into a social context, we call it the interplay between *decontextualisation* and *recontextualisation*.

For the sake of better visualisation, Fig. 1—adapted from (Krause et al. 2006)—offers a pictorial representation of the platform elements presented so far. At the centre, the structural perspective is placed between the two systems of which the micro-context is composed: the organisations that use ICT (at the left-hand side) and the IT sectoral innovation system (at the right-hand side). These elements are then embedded in the wider social context of the macro-context, represented in the figure by the viewpoint of the global society.

The last element of the platform adds a temporal dimension to the previous ones by means of a historical analysis of technological developments based on the theory of path dependency (e.g. Schreyögg et al. 2003). These *technology utilisation paths* reflect paradigms, guiding principles, standards, methods, products, and tools that were developed in the lifetime of a technology in the society, in organisations and in the IT system. As such, the temporal perspective of our approach involves the historical development and establishment process of certain socio-technical structures until reaching their actual state; i.e. the history of the social interactions among the actors that were involved in and affected by the development of a technology, of the actors' conflicts and consequent power losses and wins, and of the guiding principles and the supporting technical paradigms. This

historical analysis thus adds value to the previous perspectives by examining the conditions that led to the success or failure of certain alternatives, and enabling one to use them as lessons for future technology development.

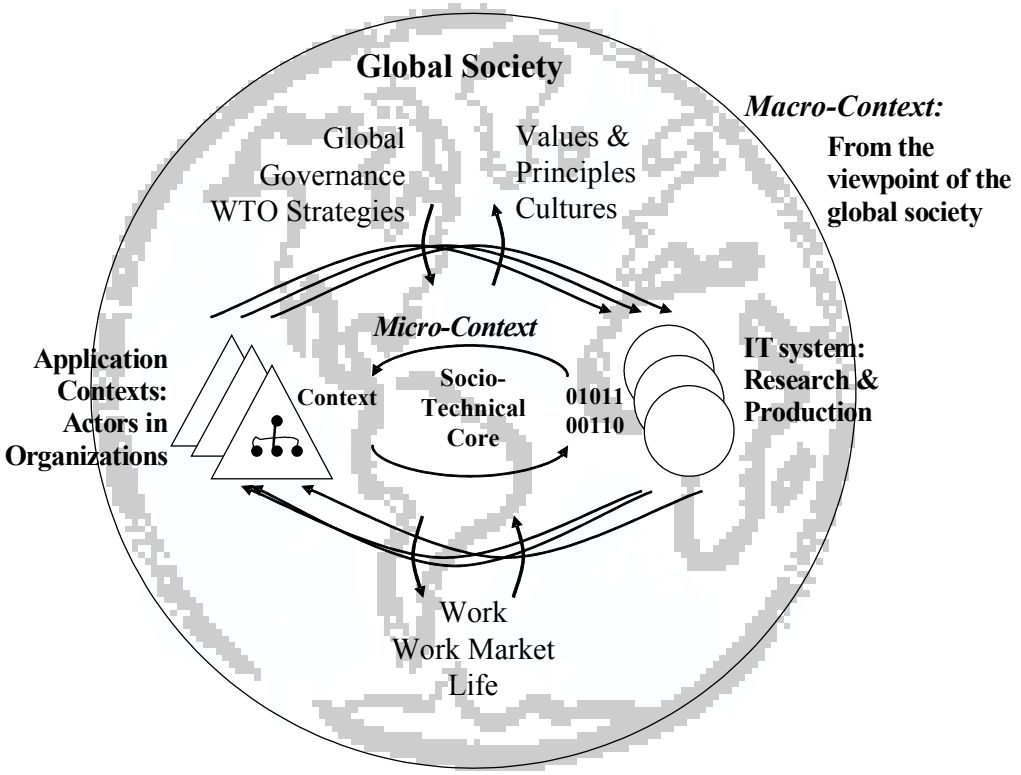

Figure 1. A pictorial representation of the elements of the Mikropolis platform

5 TRANSDISCIPLINARITY EXPERIENCES

The platform presented in the previous section is both the provisional result of and an enabling instrument for the cooperation of a group of researchers with different disciplinary backgrounds. As noted by Heintz and Origgi (2004), language is a major difficulty in the multidisciplinary collaboration. In this respect, the platform presented above offers a common language for the mutual understanding among researchers.

To offer a practical example, a difficulty has recently arisen in our group with the term *formalisation*. Whilst for researchers coming from the social sciences a formal artefact means an explicit representation (mostly in written form) of some social structure or agreement, computer scientists use normally a much stricter notion of formality—namely, the expression in a formal language with both semantic and syntaxes rigorously defined. With the aid of the structural view of the Mikropolis platform (Sect. 4.2), we could understand that these two definitions differ in fact by degree, i.e. they are successive steps in the formalisation process that are applied to actions of the original social and organisational context (*decontextualisation*).

The communication difficulties are not only related to terminology tough, but also to the understanding about the use of different research methods and approaches. In a recent project of our

group, the orientation platform Mikropolis was used to enable communication between researchers using a developers' perspective and those using an evaluative perspective. The project included the design, customisation, and evaluation of an IS for a virtual network of freelancers, a new and rapidly spreading from of virtual organisation—the following discussion is based on Janneck and Fink (2006) and Fink et al. (2006). Although the development was accomplished using participatory design with active involvement of members of the freelancer's community, the usage of the final system turned out to be unsatisfactorily low.

The analysis of the evaluation team indicated two factors for the low system usage. Firstly, they found out that decision-making processes in the development were clearly dominated by certain core members, unveiling informal hierarchical structures that could not be detected in the formal understanding of the organisation. As a consequence, members that have not taken part in the design decisions were less motivated to use the system. The second and more important factor was found in a tension between the declared intention of the virtual organisation and the socio-economic situation of its members (in the macro-context). Whilst the network had the official goal of providing collaboration among the freelancers, these were in fact competitors in the same market, so that resources shared through the system could give the others precious information that would cause the lost of a competitive edge for the well-intended collaborator.

Using the Mikropolis platform, designers were thus able to make sense of and draw consequences from the evaluation for future socio-technical development. One of these consequences was the importance of considering the diversity of interests of actors and groups of actors inside the organisation arenas in the micro-context. Regarding software support, they inferred the need to check whether functionalities supporting equal and intense cooperation are truly compatible with the organisation's structure and its insertion in the wider societal context.

During our experiences, one of the major advantages of our approach to transdisciplinarity perceived was the overcoming of the cognitive constraint difficulty mentioned by Heintz and Origgi (2004): it is indeed very difficult to become expert in more than one field. Through the multidisciplinary collaboration enabled by the Mikropolis platform though, each researcher contributes to the whole with her/his particular expertise on research methods and approaches according to her/his disciplinary background.

However, each researcher also uses his/her own methods and has additional particular research interests. The results of the common research process are thus brought back to question the original theories, avoiding in this way a mechanical application of theories from other disciplines to the IS context—as pointed out by Monteiro (2004) with respect to actor-network theory—by providing a critical feedback to the theoretical basis. As such, as pointed out by Gibbons et al. (1994) "some outputs of transdisciplinary knowledge production, particularly new instruments may enter into and fertilise any number of disciplinary sciences" (*op. cit.*, p. 9).

6 CONCLUDING REMARKS

In this paper, we argued for a transdisciplinary approach to IS research. The underlying assumptions of this argument are in consonance with a view of diversity in the IS field as beneficial and necessary to cope with the socio-technical imbrications in which ICT are involved in our society nowadays. Like other researchers, we see the IS field as a transdisciplinary forum—or *market of ideas* in the words of Lyytinen and King (2004) quoted in Section 1—where research results using different approaches, methods, and theoretical foundations come together in dialogue.

Furthermore, our approach extends the use of transdisciplinarity from the level of the IS community to particular research projects by means of multidisciplinary collaboration. This collaboration is enabled by means of the Mikropolis platform, which offers a common conceptual framework for the analysis of socio-technical phenomena.

The Mikropolis platform offers a socio-technical structural perspective of IS development, which is integrated into the micro-context of the relations between ICT producers and ICT consumers. These

two perspectives are also contrasted against the backdrop of the globalised society in the macro-context, and they are put into a historical perspective by means of the technological development paths. The analytical differentiation among these perspectives thus adds clarity to the different aspects of the ICT system design task that, in fact, always takes place simultaneously in the "seamless web" of socio-technical relations (Hughes 1983). In this manner, the platform affords a better understanding of the relations and dependencies among those different perspectives, thereby helping one to apprehend how complex and multifaceted the transformation process is that results from the interplay among ICT, organisations, individuals, and social actors in a globalised world.

As such, Mikropolis offers a common language for communication and articulation of perspectives from researchers with multiple disciplinary backgrounds. On the other hand, the platform reflects itself the provisional results of multidisciplinary interactions. For, as pointed out by Klein (1994), "interlanguages develop from acts of integration, not prior to them" (*op. cit*, p. 5). The learning platform so far obtained is to be taken neither as a theoretical instrument to substitute other socio-technical theories, nor as a fully-fledged universal construct. It is rather a provisional pidgin[3] to facilitate dialogue and cooperation of different perspectives, without striving to dissolve the particularities of the perspectives involved, but rather acknowledging multidimensionality and preserving idiosyncrasies.

The platform is thus in permanent evolution. One of the current enquiry directions is carried out in interaction with consulting activities in the public health sector. Also, work is in progress to relate the components of the platform more closely to different theoretical accounts, like, for instance, neo-institutionalism micro-politics and actor-network theory. By incorporating these new viewpoints we believe to step forward into the direction of improving dialogue with both scientific and non-scientific contexts and thus better addressing relevant issues for the society as a whole.

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[3] This metaphor was proposed by Klein (1994) in analogy with the term *pidgin* from linguistics, which means an interim language with simplified vocabulary and grammar, based in partial agreement on the meaning of shared terms.

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