

The multi-faceted nature of SDIs and their assessment - dealing with dilemmas

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Abstract. The proliferation of concrete SDI initiatives has brought with it the demand to assess what is going on, to learn from the developments and their impacts, and to see whether things can be done better. The process however, is problematic for various reasons. First, the concept is ambiguous and its understanding is still in its infancy and needs trans-disciplinary research. Moreover, SDI is multi-faceted and has a reciprocal relationship with the social context. Finally, assessment *itself* – including that of SDIs – is non-trivial and problematic as it follows not only that SDI is about situations at risk but that the development of concrete SDI initiatives *itself* is to cope with risks. Assessment of SDIs must reflect the evolving learning process of their development and should emphasise discussion and dialogue between practitioners and researchers in understanding and scoping an SDI. This chapter therefore proposes that assessment be around dilemmas that surround a concrete SDI initiative rather than follow a pre-given, general framework. Assessment in this way will challenge conventional approaches and paradigms that still dominate much of the contemporary SDI literature; notably that of techno-science, of hierarchical structure and of avoiding redundancy. This

chapter sketches possible ways to address the challenges that come with the assessment of SDIs by drawing on literature of concepts and practice that may fruitfully enrich the current SDI discourse.

2.1 INTRODUCTION

The last ten to fifteen years have witnessed an impressive diffusion and continuous development of the Spatial Data Infrastructure (SDI) concept worldwide which is reflected by a marked growth of professional and scholarly activities. It is beyond the scope of this chapter to even attempt to do justice to the vast literature that accompanies these developments. [Reference to the volumes by Groot and McLaughlin (2000), Williamson et al. (2003), and Masser (2005), as well as the Global Spatial Data Infrastructure Association (www.gsdi.org) may suffice here.]

The proliferation of concrete SDI initiatives has stimulated an undeniable demand for ‘stocktaking’ – a critical reflection on what is going on. There is the obvious need to learn from these developments and their impacts and to see whether things can be done better. There is also the question of whether control and regulation is needed. This chapter argues that the assessment of SDIs, however, is non-trivial for a number of reasons. First, the concept is ambiguous, as the literature shows, and its understanding needs cross-disciplinary research. Moreover, SDIs are multi-faceted and have a reciprocal (dual) relationship with their (societal) context. Finally, assessment *itself*, including that of SDIs, is non-trivial as the general evaluation and assessment discourse clearly demonstrates that the development of concrete SDI initiatives has to cope with risk (see also Axelrod, 2003). This chapter therefore proposes that the assessment of SDIs be around dilemmas that surround a concrete SDI initiative rather than follow a pre-given, general framework. In this respect, the chapter draws on literature that may fruitfully enrich the current SDI discourse.

SDI is a relatively new phenomenon. Masser (2005) suspects that many of the countries’ claims of being involved in some form of SDI development must be treated with some caution as there may be an element of wishful thinking in some of them. Masser also stresses the need to rigorously examine claims that SDIs will promote economic growth, better government, and improved environmental sustainability and that more attention should be given to possible negative impacts.

2.1.1 The ambiguity of the SDI concept

The demand to reflect drives the evaluation and assessment of SDI initiatives. Examples are Cromptvoets (2006); Cromptvoets et al. (2004), Delgado et al. (2005), Eelderink (2006) and Steudler (2003). Reflecting however, is problematic for at least two reasons. First, evaluation would presume clear and specific objectives for concrete SDI initiatives that are generally lacking and second, the concept of SDI is, at present, ambiguously understood which is reflected by the different ways SDI is described in the literature. For example, Cromptvoets et al. (2004) view SDI as *about* facilitation and coordination of the exchange and sharing of spatial data. Williamson (2003) speaks of SDI both as an *initiative* and as a *concept*. Nevertheless, he also speaks in terms of '*building SDIs*'. Groot and McLaughlin (2000) refer to SDIs as of certain *activities* and Rajabifard et al. (2002) recognise an emerging approach to SDI development as oriented towards the management of information assets instead of the linkage of available databases only.

2.1.2 Understanding SDI needs transdisciplinary research

Various factors contribute to the present ambiguity of the SDI concept. *Understanding* SDI is still in its infancy with many open questions. For example, the question whether or not SDIs are special and fundamentally different from other kinds of information infrastructure has only recently received wider attention in the SDI discourse (For instance, Bernard et al., 2005 and De Man, 2007a). Moreover, questions regarding the disciplinary framing of research in the SDI field have not been resolved yet. When SDI is understood as an essentially socio-technical assembly, such research must go beyond the scope of any one discipline and beyond the realm of traditional positivism (De Man, 2007b). Probably what is needed is integrative and participative, or trans-disciplinary research that also involves stakeholders who are not academics (see also Winder, 2003). Trans-disciplinary research acknowledges multiple realities, or as Nicolescu (2002 and 2007) puts it, different levels of multidimensional reality. The question whether research in the field of SDI would qualify as a legitimate discipline in its own right or might best be served by trans-disciplinary is relevant beyond academic politics and other scholarly interests. In the final analysis what matters is whether reflective, scientific work contributes to a *practice* of SDI that has a positive and societal value.

2.1.3 SDIs are multi-faceted

A second and more fundamental reason for the apparent ambiguity of the SDI concept is its multi-faceted nature. As different perspectives are possible, the SDI concept can mean quite different things to different people. These facets and perspectives may bring conflicts between different requirements, interests and values. Consequently, understanding concrete SDI initiatives requires a multi-faceted viewing approach that goes beyond only objective-oriented performance indicators to revolving around these dilemmas (De Man, 2006). This chapter groups the various facets of SDI into three categories. The first relates to different facets that are generally embodied in SDIs – independent of time and place, and is titled ‘Functionality of SDI’. The second relates to the content of any SDI: data about spatial objects, situations and processes. Because the resulting information matters in the final analysis only when risk is involved and beyond uncertainty, this category of facets is labelled ‘SDI in risk management’. The third is labelled ‘Beyond SDI’ and refers to its transformational rather than generational dynamics. SDI may lose its distinctiveness and its spatial functionalities may become an integral part of the information infrastructure in general. Moreover, information infrastructures, including SDIs, may become an institutional property of governance beyond the narrow and traditional limits of the state (see also De Man, 2007b).

2.1.4 Duality of SDI – a ‘moving target’

Assessing SDIs is problematic because they generally do not follow a straight and well-established development trajectory. On the one hand the development of a concrete SDI initiative is strongly influenced by the characteristics of the particular social system in which it is embedded (Rajabifard et al., 2002) and each SDI initiative is therefore unique to some extent. On the other, the emerging SDI has an impact on social practice at the same time (viz. on the exchange, sharing, accessibility, and use of spatial data). This ‘duality’ of being shaped takes place in a continuous process of negotiation and re-negotiation between many heterogeneous actors. In addition, ‘space’ – the ultimate object of any SDI – is socially produced as well (see also Lefebvre, 1991 and Smith, 2001). This double helix not only means that any SDI initiative will never be finished (a ‘moving target’) but also that its ongoing design is inevitably dominated by uncertainty from within and outside. Consequently, the ever-continuing development process itself requires a form of risk management if the

initiative is to produce a viable SDI that is flexible enough to adapt to changing and evolving circumstances, yet robust enough not to break down. (The chapter returns to this issue in a later section.)

2.1.5 Assessment of SDI is non-trivial

The inherent complexity of SDIs makes their evaluation and assessment non-trivial yet SDI initiatives are not unique in this complexity. For instance, Berghout and Remenyi (2005) reviewed literature on the evaluation of information technology (IT) in general and conclude that this is a very complex and wide ranging field. In a similar vein, Bannister (2005) suggests that IT evaluation be more engaged with current thinking in decision sciences and risk analysis. Hedman and Borell (2005) recognise the potential with narratives in information systems evaluation, in terms of their ability to convey meanings, interpretations, and knowledge about the system which can be used for further action. This parallels the view of Star (2002) that ethnographic practices offer the opportunity to examine both the formal and information aspects of communication and to understand the changes in the social orderings that are brought about by IT, along with reading the invisible layers of controlling and accessing information. Nevertheless, Brown (2005) concludes that IT evaluation in practice is slow to adopt new methodologies.

The apparent complexity in evaluating and assessing SDI initiatives, and other IT for that matter, corresponds with developments in the general evaluation field itself. Guba and Lincoln (1989 and 2001) describe the historical evolution of evaluation practice as four generations with increasing complexity: the first generation focus effort on measurement, the second on description, the third on judgment and the fourth on negotiation between the different stakeholders in its evaluation. This ‘fourth generation evaluation’ is responsive and constructivist in methodology. Guba and Lincoln (1989) argue that such evaluation addresses the major problems of the first three generations: the tendency toward ‘managerialism’ that favours the point of view of a limited number of powerful stakeholders, disempowering others, failing to accommodate value-pluralism, and is overcommitted to the positivist (‘scientific’) paradigm of inquiry. They admit, however, that constructivist evaluation is a difficult model to adopt (1989) as it is ever-recursive, case specific and in a sense never finished. On the other side of this coin, Guba and Lincoln argue (1989 and 2001) that ‘fourth generation evaluation’ is the best way to address viability and acceptability

claims, concerns and widely felt issues. In short, it is one of the more realistic and socially, and politically, sensitive approaches to performing useful, and utilised, evaluations. This chapter argues that evaluation and assessment of concrete SDI initiatives demands a 'fourth generational' approach that revolves around challenges and dilemmas that come with these complex and multi-faceted, socio-technical assemblies with a distinct societal dimension of governance.

The remainder of this chapter sketches the multi-faceted nature of the SDI concept. This property will be paramount in developing an assessment methodology for deliberative and reflective inquiry, if at all possible. Complexities are then explored to develop viable SDIs against the backdrop of double risk management. SDIs not only are to address situations at risk, but the development process itself is also a form of risk management in pursuing SDIs that are flexible enough to adapt to changing and evolving circumstances but robust enough not to break down. Complexity would not only challenge SDI development but may also be viewed as a necessary condition for its robustness.

Finally, the chapter will discuss the dilemmas in assessing concrete SDI initiatives, particularly whether dilemmas rather than any a priori framework will provide the basis of assessment.

2.2 SDI: A MULTI-FACETED CONCEPT

A major complexity in assessing SDIs is their multi-faceted nature. This section briefly portrays these facets and the challenges. Critical issues, and possibly dilemmas, can be borrowed from a series of perspectives in the literature that (it is assumed here) surrounds the concept of SDI (see also De Man, 2006 and 2007a). These facets will be grouped into three categories regarding the functionality of SDIs independent of time and place, the provision of information about situations at risk, and the transformational dynamics, or 'beyond SDI,' respectively. The institutionalisation of effective SDIs within their respective society appears as a recurrent theme.

2.2.1 Different facets of SDI functionality

SDIs generally share similar functionalities that are independent of their occurrence in time and place. First, SDI is about communication and the sharing of data and information. The ability to communicate is what SDI has in common with language. The politico-sociology of

language (e.g. De Swaan, 2001) helps to understand how means of communication can be perverted by powerful elites into exclusion and the continuous domination of others. Similarly, SDIs face similar conditions and barriers for communication and exchange, notably power positions. Second, SDIs share the characteristics of networked infrastructures generally and would have ‘network externalities’ where all users benefit when a new user joins the network (Monteiro et al., 1995 and North, 1990). However like other infrastructures, SDIs could also have fragmenting, discriminating, and exclusionary effects (Graham et al., 2001). This perspective calls attention to two opposite forces within SDIs – towards growth and towards collapse. Third, SDIs encompass both technical and social elements and are therefore socio-technical assemblies. The question of whether technology is primarily technical or social has been dealt with extensively in literature. For instance, from the perspective of socially constructing technology, it is primarily a product of human action under prevailing social conditions (see for instance Bijker, 1995; Bijker et al., 1992; Latour et al., 1979). The actor network theory views the process of developing networked assemblies as an interplay between heterogeneous actors – technical and non-technical elements tied together in actor networks (see for instance Callon, 1980; 1986; Latour, 1999; 2005; Law, 1992; 2000; 2002; 2003). As most actors pursue their own interests, actor networks develop in the potentially unstable process of negotiating and aligning various interests and expectations. The duality of technology perspective views technology as both the product of human action and providing the structure for human action (Orlikowski, 1992). These perspectives call attention to the dilemma of how to navigate between the needed authority and some form of central control and active involvement (participation) in developing SDI initiatives. Fourth, SDIs are supposed to support a wide group of stakeholders in the communication and sharing of spatial data. SDI can therefore also be viewed in terms of ‘commons’. Problems of abuse and misuse of common resources and possible solutions are dealt with by the tradition of ‘coping with tragedies of the commons’ (see for instance Ostrom, 1990; 1999; 2000; 2005). This perspective provides a repertoire of concepts and approaches to identify critical factors for the success and failure of SDIs. For example, the notion of ‘co-production’ would draw attention to the potential of synergy within SDIs. The notion of ‘polycentricity’ (Ostrom, 2005) may help in viewing SDIs as complex adaptive systems and in identifying conditions for sustainability. This perspective suggests that SDIs need a broader scope of analysis than

the one limited to narrowly define economic issues such as monopoly, markets and privatisation, (Onsrud, 1998). Fifth, SDIs generally operate within unstable environments. As a result the ability to adapt may be critical to their success and viability as adaptation to evolving circumstances, in turn, requires not only the ability to learn but also the ability of how to learn, in the sense of ‘double-loop learning’ (Argyris et al., 1978). This situated learning is essentially a social process and comes largely from day-to-day practice; in other words, participating in a ‘community of practice’ (Lave et al., 1991 and Lesser et al., 2001). Finally, SDIs may develop institutionalised properties in the ability to communicate, connect, and share between stakeholders once implemented. The institutionalisation perspective may help in understanding the conditions for viable SDIs and addressing the problems of obsolescence and irrelevance. [For institutionalization of geographic information technologies, see De Man (2000; 2003; 2006). For institutionalisation of IT in general, see Orlikowski (1992)].

In summary, all SDIs face similar challenges that come from the different facets of their functionality. Challenges include exclusion (access denial), fragmentation, technocracy (techno-centricity), isolation (from use), and discontinuity (obsolescence). As a result, the assessment of SDIs must address these different challenges.

2.2.2 SDI in situations at risk

Like any technology SDI implies context. Broadly speaking, SDIs are to facilitate the provision of spatial data that ultimately supports spatial decision making under uncertainty. Examples include urban and regional management, flood hazard management and transport management. Of prime importance are those uncertainties where “things can go badly wrong”; in other words, situations at risk. The main idea of (spatial) risk management is that agents can improve their performance by defusing risk in two ways — by changing the environment or by changing their opinions of it (Kostov et al., 2003). Risk is not just subjectively perceived but is rather socially constructed (see for instance Blaikie et al., 1994; Hilhorst, 2004; Kostov et al., 2003; Slovic, 2003). Therefore risky environments are conceived of differently by different actors, particularly at different social levels (like home, neighbourhood, community, and city). Various arguments can be found in the literature to support the view of differentiated conceptions of (risky) space. [For a review of some of the literature see De Man (2007a and 2007b)]. In short, the

argument is that firstly, space is subjectively conceived of as space (or environment) and activities (or behaviour) are intertwined into 'physical-behavioural units' (Smith, 2001). Secondly, space tends to be more integrated into wholes at higher spatial levels whereas behavioural conditions tend to be more specialised and fragmented at those levels. Moreover, physical-behavioural units tend to be less intimately connected to human and social conditions and values at, what can be conveniently called higher *socio-spatial* levels than at the local level. For example, managing various risks, like flooding, earthquakes, health hazards, and unemployment, seem to be integrated with livelihoods at the community level (Heijmans, 2004), whereas such risks are generally dealt with separately through specialised agencies at higher administrative levels. Thirdly, space is generally shared with others and is therefore a setting for social life. The intensity of social encounters and social life in general, can be characterised by the degree of 'social capital' (Putnam, 1995 and 2000). Social capital appears as either 'bonding' a network together (strong ties) or 'bridging' across networks (weak ties; see also Granovetter, 1973; Pigg et al., 2004; Woolcock et al., 2000). To the extent that social capital has a differentiated behavioural impact at different socio-spatial levels, space will be structured and conceived of differently at each level. Consequently, SDIs are likely to be different in terms of their contents, role and complexity. This would also challenge the hierarchical structure as the only possible, or most desirable, model for the SDI concept [as in Rajabifard et al. (2003) and De Man (2006 and 2007a)].

The provision of (spatial) data and the subsequent use of it however are problematic and may bring its own risk. For example, the storing of data inevitably implies choice and selection as with the definition and observation of data — what data is ignored and what is actually stored. However such selection may cause the generation of simplified, if not distorted, images of reality. The resulting information is confined to the assumptions and beliefs of how the data was collected and stored. It is the 'danger of self-evident truths' as Ostrom (2000) would have put it and, similarly, as Scott (1998) argues the modern statecraft inevitably relies on simplification by rationalisation and standardisation — "seeing like a state". However if simplification becomes a distorted perception of spatial reality, it would lead to a potentially dangerous situation in public decision making — counterproductive measures that "make things even worse". Scott therefore makes a case for the indispensable role of practical and

local knowledge, informal processes and improvisation in the face of unpredictability (Scott, 1998) to counteract these dangers. In order to do so would require specialised approaches that adequately capture such local, indigenous knowledge rather than taking refuge in only more advanced technology. SDI is therefore not only about situations at risk but that it is functioning and performance brings risk as well (this has SDI in common with literally all technologies; if not all human activity). In short, SDI is about double-risk management and this, in turn, has profound implications for its assessment. Above all, it can be argued that to be effective in risk management, SDIs need to be squarely located within the concerned 'risk communities'.

Finally, if SDI is about risk management it must be embedded within the locus of societal risk defusing operators. Kostov and Lingard (2003) argue that societal risk defusing operators is assembly of the institutional, organisational and network structures of society where different societal views and interests are coordinated. As a result, it means that the SDI initiative would gain an institutional (structural) property within the 'risk community' and will be different at different socio-spatial levels. (The chapter returns to the issue of risk management in the next section.)

2.2.3 Beyond SDI

Viable SDIs are flexible and able to learn and to adapt to ever changing circumstances. Masser (2005) distinguishes between the short-term processes needed to initially adapt the notion of an SDI to the existing context, and the processes that are involved in its evolution to respond to changing political, institutional, and technological circumstances. Given the extent to which SDIs can be expected to change, Masser also urges the establishment of research procedures that monitors their progress systematically (Masser, 2005). The SDI concept itself, however, is dynamic. For example, the last decade has witnessed an evolution from a 'product-based' approach to a 'process-based' approach in SDI development (Rajabifard et al., 2002). These and similar changes are generational, that is the SDI concept evolves but not fundamentally. Transformational dynamics are when the concept evolves 'beyond SDI' and at least analytically two stages can be distinguished (De Man, 2007b). First, SDI may lose its distinctiveness so its spatial functionalities become an integral part of the general information infrastructure. For instance, after impressive developments in specialised and complex tools for handling spatial data, over the past three decades or so, Reeve and

Petch (1999) assume that the convergence of computing towards open systems and interoperability may now lessen the justification for a separate status of GI technologies. Some attribute the convergence of geographic information technology and other ICTs to the widespread availability of the internet and the emergence of location-based services (e.g. Jiang et al., 2004). However this convergence is not clearly visible in the present geo-information discourse. As Reeve and Petch (1999) noticed almost a decade ago GIS has formed its own community and interactions with the broader sphere of information systems seem not to have always been strong. Indeed there seems to be a real danger of intellectual isolation for the professional and academic communities in the field of spatial information technology and of re-inventing the wheel. It would follow that the SDI community must engage itself in cross-pollination and learning with other relevant communities (Bernard et al., 2005).

The second stage of transformational dynamics is when information infrastructures, including SDIs, become an institutional property of governance that are beyond the narrow and traditional limits of the state. In short, the argument is that like any technology, information infrastructures would be the product of human agency under prevailing structural, institutional, properties within social systems and the assuming structural properties. Once applied technology tends to become refined and institutionalised (see also De Man, 2000; 2006; 2007a; 2007b; Orlikowski, 1992). The duality coin has therefore two sides. On the one hand information infrastructures emerge out of an unruly and inherently unstable process of continuous negotiations between heterogeneous actors that have diverse and often mutually conflicting interests. On the other hand the institutionalisation process would provide for some minimum stability and viability of the information structure. In the case of SDI, duality of the institutionalisation process means that it shapes behaviour regarding the exchange, sharing, accessibility, and use of spatial data within the spatial data community, and at the same time, this institutional property is developed by stakeholders continuously putting this behaviour recurrently and effectively into practice. Because IT in general, and information infrastructure in particular, is relevant to governing and decision making in society, it would follow that over time, effective information infrastructures tend to become an integral and characteristic part of the institutional aspects of the governance system in which they are implicated. A governance

system, in turn, is an institutional property of societal decision-making and governing beyond government.

2.3 SDI AS RISK MANAGEMENT – UNCERTAINTY, COMPLEXITY, AND ROBUSTNESS

SDIs are complex beyond just being complicated and difficult. This section argues that complexity is both a factor in the generation and management of risk. The uncertainties that surround the development of SDI greatly contribute to its complexity; specifically those in the never-finished social structuration process (in the sense of Giddens, 1984; and 'duality of technology' of Orlikowski, 1992). Design and implementation under uncertainty requires both flexibility and adaptation to changing circumstances along with robustness so as to not break down. This is a delicate balance because too much flexibility and adaptation may lead to chaos and robustness may easily degenerate into inflexibility. Developing viable SDIs is therefore a form of risk management to find a safe middle ground between various threads and is, as has been mentioned before, common to any technology. The remainder of this section briefly discusses complexity as a quality in its own right and not just 'complexified' simplicity (De Man, 2006). Furthermore this section proposes that, complexity as robustness is a major contribution to developing reliable and viable SDIs. In other words that such an SDI be embedded in its own social system with the very *processes* of its design and implementation.

2.3.1 Complexity, robustness and redundancy

The chapter understands complexity as “things relate but do not add up” and as “more than one and less than many” (Mol et al., 2002). Complexity does not necessarily develop into stability and higher-order unity, but must be viewed as a reciprocal reference of individual actors (Kwa, 2002). Instead of capturing and controlling complexity, the challenge then becomes to acknowledge multiple realities shaped by different and heterogeneous, reflective actors (Hilhorst, 2004). Often complexity can be associated with uncertainty and unpredictability, so it is difficult to manage. Under certain conditions, however, complexity will increase the reliability of systems subject to uncertainty – though within certain limits (Carlson et al., 2002). For instance, where older automobiles were simpler, new vehicles have elaborate control systems that make them safer, more robust, and require less maintenance. Nevertheless, these and similar systems can be catastrophically disabled by unforeseen circumstances and by

cascading failures initiated by tiny perturbations. Carlson and Doyle (2002) refer to this as to “robust, yet fragile”.

Complexity therefore must not be seen as “only a mask for simplicity” because of redundancy (Simon, 1981). To the contrary, redundancy and overlap may provide an essential contribution to diminishing uncertainty and maximising its reliability (Landau 1969). Functional redundancy provides reserve and security but above all, is the facilitator of change (Caiden et al., 1974). However some redundancy can be harmful. For example the suppression of redundancy in data collection frequently advocated in the literature, (the ‘collect-it-once-use-it-many-times’ principle) points to the possible waste of scarce resources. The point is to understand, however, that efficiency inevitably comes at some cost as with data collection.

2.3.2 Redundancy and robustness as risk management in developing SDIs

A major dilemma in designing and implementing socio-technical assemblies like an SDI is the conflict between an uncertain and complex reality and the conflicting views and interpretations that comes with it; and the need for simple decision-making criteria. Kostov and Lingard (2003) suggest that risk management proposes a way out of such a dilemma. The social capital paradigm can provide tools, specifically actor networks and institutions, to coordinate different views and interests and therefore contributing to manage conflicts and defusing risk. In any design process where there is substantial probability of error, built-in redundancy has been shown to have considerable advantage (Ostrom, 2005) or, as Landau (1973) has put it, the introduction of sufficient and appropriate redundancy makes any system “more reliable, more effective, more responsive, more able to withstand shock and damage than any of its parts”. In contrast to this, mainstream thinking in SDI and ICT in general, seems to be more concerned with diminishing and avoiding redundancy, admittedly in the guise of duplication (e.g. Crompvoets et al., 2004 and Nebert, 2004). Though some duplication in spatial data handling may certainly be avoided as was mentioned before, the lack of almost any positive connotation of redundancy in the SDI discourse is at least remarkable. [One of the few examples known to the author is the recent MSc thesis of Beatrice Nyemera (2008).]

The design and implementation of SDI is an ongoing process of negotiation between heterogeneous actors with diverse and often

conflicting views and interests. Moreover, the problems and desire justifying an SDI initiative arise from the *current* stage and form of a societal organisation and will certainly change. It follows that uncertainty is not just because of lack of information or cognitive ability to anticipate future developments but that these developments are literally *hidden in the future* and shaped by the possible future acts of others. These challenges are at the heart of the planning discourse over the last four decades and planning under uncertainty (e.g. Rosenhead, 1980a and 1980b). The future comes with new risks and uncertainties, adding to the ones which were perceived and where strategies, plans and designs were formulated (Hough, 2000). Uncertainty requires flexibility and changes the objective from one of performance maximisation to *survival* as put forward by Rosenheads (1980a). Planning under uncertainty is about accepting the uncertainty of future states and attempting to keep options open (Rosenhead, 1980b). Therefore the fundamental question designing and implementing information systems is therefore which decisions must be taken now and which decisions could be left open to permit more confident choices in the future (De Man, 1988). [This paradigm is also the essence of the so-called Strategic Choice Approach (Friend et al., 1987)].

The design and implementation of SDI must be 'robust' in the sense that it does not break down even if some of the underlying assumptions were to change quite drastically over time (see also Rosenhead, 1980a). Built-in redundancy contributes to robust and viable SDIs but the implementation of decisions, or options, which preserve as much useful flexibility as possible for the uncertain future will also contribute to its robustness. [The 'robustness' of an initial decision is the proportion of all acceptable system states which will still be attainable after the implementation of that decision (Rosenhead, 1980a)]. The necessary robustness in the design and implementation of an SDI clearly increases its complexity. The other side of the 'risk coin' is, as we have seen before, that embedding SDIs in their societal context will draw upon available social capital. Specifically, its institutionalisation within existing actor networks and institutional conditions will provide for redundancy and a robustness that contributes to a viable SDI (see also De Man, 2006). As Perri 6 (2003) points out, *viable* sets of institutions are not necessarily static but need to have the capability for being sustained within their dynamic environment through modest adaptation. Institutional viability, then, is a settlement of rival pressures for institutional

similarity and tolerance of dissimilarity (6, 2003) and will provide the locus of societal risk defusing operators (see also Kostov et al., 2003).

2.4 MULTI-FACETED ASSESSMENT OF SDIs – DEALING WITH DILEMMAS

The preceding sections suggest that the assessment of SDIs is about a ‘moving target’ in that it is multi-faceted – different things at the same time, dynamic and transformational, and constituted in a never-finished social process of negotiation. In turn, it would follow that the assessment of SDIs is also multi-faceted and that it must be responsive, deliberative and reflective. The assessment of SDIs, like any assessment, faces at least two major challenges. First, that the assessment is influenced by the choice of criteria. Or, as Mol (2002) states, “what we call success depends on the parameters of success”. Second is that when different phenomena are assessed as instances of a particular concept (viz. the SDI concept) it is necessary to maintain stability and an unambiguous meaning. It is however of equal importance to distinguish between a *concepts* and those *phenomena* which are conceptualised (see also Landau, 1973). In short, the assessment of SDIs is non-trivial and problematic.

This chapter has argued that the assessment of SDIs and other socio-technical assemblies is essentially a joint, collaborative and learning process amidst different and often conflicting values and interests that has unpredictable outcomes, and is emergent rather than following an a priori framework (see also Guba et al., 1989). Such infrequent and unruly processes generally tend to be convulsive and revolve around dilemmas, as pointed out by Argyris and Schön (1974). Dilemmas indicate and reflect value conflicts that are inherent in the design and implementation of SDI initiatives and bring with them the need for multi-faceted, if not multi-method, assessment. Different approaches with different underlying philosophies of inquiry can offer insightful perspectives on SDIs in this respect as, what is required is that the differentiated implications are understood (see also Chua, 1986 and Orlikowski et al., 1991). This final section therefore briefly explores some of the dilemmas that surround the assessment of SDIs. It must be understood, however, that this exploration is not exhaustive and the dilemmas are not, necessarily, mutually exclusive. As a consequence, the assessment of multi-faceted SDIs will not only be multi-faceted but may need an essentially multi-method approach. This final section remains somewhat open ended in that it does not

provide clear recipes instead it sketches possible ways to address the challenges that come with the assessment of SDIs by drawing on the literature of concepts and practice that, it is believed, may enrich the current SDI discourse.

2.4.1 Breadth versus depth in assessment of SDIs

An initial dilemma that faces any assessment of SDIs is the breadth and depth of the inquiry. Comparative studies of SDI initiatives require conceptual consistency and stability, often resulting in a framework of key indicators. However the alleged ambiguity of the SDI concept makes this problematic. Further, SDI initiatives are 'wicked' as Rittel and Webber (1973) would have put it as the problems which justify them are intertwined with the 'solution' that will be offered by the very initiative.. In other words, the never-finished development process of an SDI initiative inevitably adds its own problems, and, because every wicked problem is essentially unique (Rittel et al., 1973) it would follow that every SDI initiative is also to some extent unique.

In-depth case-studies may help to understand concrete SDI initiatives within their specific context, especially when the boundaries between the two are not clear as Yin (1994) would have put it. As the number of SDI case studies grows, one may attempt to integrate the various studies in order to deal with the inevitable limitation of its one-shot nature and, in this respect, case study research is exploratory (see also Frankfort-Nachmias et al., 1996).

2.4.2 Diffusion of SDI versus 'translation' and negotiation

The proliferation of SDIs indicates the viability of the concept and must therefore be an important aspect in assessing SDI development (see also Masser, 2005). The proliferation of technology is an undeniable social process while it is also a technical matter (Rogers, 1995). In the literature two alternative interpretations of the proliferation process can be found. First, some see SDI proliferation as the rate of adopting an innovation through a social system (e.g. Masser, 2005 and Nedovic-Budic, 1998). This view is based on Rogers' diffusion of the innovation model (Rogers, 1995). The rate of adoption would depend on the characteristics of the innovation itself and on the differentiated innovativeness and the communication channels within the social system. This 'pro innovation' view, however, does not acknowledge that differentiated power relations also determine the proliferation of technology through a social system quite independent from its characteristics.

An alternative view on the proliferation of SDI, or any technology for that matter, is that it emerges out of the interplay between human and non-human actors with different and generally conflicting interests. As Brey (1997) suggests, different social actors engage in strategies to win over the opposition and to shape technology according to their own plan. Technological change like SDI development therefore arises from technological controversies, disagreements, and difficulties that involve different actors (individuals or groups). Or, in terms of actor network theory, proliferation and adoption of SDI is ‘translated’ between these actors (see also the preceding section 2.1). Tatnall and Gilding (1999) contend that the actor network theory can be especially useful for IT studies where interaction of the social, technological and political are regarded as particularly important (see also Tatnall et al., 2001). This is not to say however that both views on the proliferation of SDI are necessarily opposing and mutually exclusive. For instance, Câmara et al. (2006) use Rogers’ diffusion of innovations model to study how GIS technology was introduced in Brazil and as GIS technology is non-neutral, they also use the actor network theory to explain the roles and importance of each of the main actors.

2.4.3 Generalisation versus particularisation

SDI assessment will inevitably face the question of whether the inquiry is about generalisations on the basis of the individual SDI cases or their particularities; in other words, the question whether the inquiry is about the SDI *concept* or about the individual SDI *initiatives*, about commonalities or about fringes and nuances – its uniqueness. This dilemma also brings the choice between different paradigms that would underpin the assessment: the choice between positivist and interpretive philosophies of IT research (e.g. Klein et al., 1999; Myers, 1997; Orlikowski et al., 1991). In brief, IT research can be classified as positivist if there is evidence of formal propositions and hypothesis testing. Such studies primarily attempt to increase the predictive understanding of phenomena as they are instantiations of an overarching concept. Interpretive studies assume that people create and associate their own subjective and inter-subjective meanings as they interact with the world around them.

Although the widely held shortcomings of the positivist approach to IT research, in particular its belief that the world operates according to immutable laws, by the end of the day many decision makers want to control developments by designing and implementing (policy)

instruments and measures. The underlying rationale of most of these interventions is the assumption that they target patterned and law-like behaviour. The point here is that this positivist assumption of decision making still exists, rather than whether it is correct. However it is not only that practice generally lags behind enlightened methodologies and theoretical insights (see also Brown, 2005), the dilemma is also because of different and conflicting rationalities. For instance, the tension between, as Ciborra (1999) would have put it, procedures and plans as abstract and distant though often necessary constructs on the one hand, and improvisation that is real and delivers on the other.

2.4.4 A single, dominant view versus multiple realities

A central tenet in the chapter is that SDIs are about double risk management. SDIs are not only *about* situations at risk but their *development itself* also has to cope with risk. Dealing with risk brings its own dilemmas, particularly the conflict between complex multidimensional reality and the need for simple decision-making criteria. Kostov and Lingard (2003) as we have seen, propose that the social capital paradigm offers a way out of this dilemma as it helps to coordinate different views and interests and therefore contributes to managing conflicts and defusing risk. In their view, social capital addresses the presence of heterogeneity and hinges on networks, institutions and synergy. Heterogeneity may bring the possibility that societal actors belong to different social domains at the same time. In disaster management, for example, scientists, managers, bureaucrats, politicians, local producers and vulnerable people have their own distinct stake with different domains of knowledge and action, and thereby constitute multiple realities (Hilhorst, 2004). The two forms of social capital – bonding and bridging (Pigg et al., 2004 and Woolcock et al., 2000) – are relevant here as bonding social capital within each social and knowledge domain may reinforce strong ties within each domain and develop parochial tendencies. Bridging social capital however may reinforce weak ties across domains and therefore stimulating synergy.

Risk in the development of socio-technical assemblies like SDIs may be reduced by built-in redundancy and robustness (see also Carlson et al., 2002). Embedding SDIs in their societal context, specifically their institutionalisation within existing actor networks and institutional conditions, will draw upon available social capital and will provide for redundancy and robustness that contributes to a viable SDI (see also De Man, 2006). It would follow that a viable SDI

is relevant both to the proponents of an SDI initiative and to other societal actors with otherwise diverse and often conflicting interests and values. A viable SDI, therefore, needs to balance a needed *diversity* in its contents and functioning on the one hand with an equally needed *standardisation* for technical, organisational and efficiency reasons on the other.

2.4.5 Objective (thin) observations versus rich insights - ethnography

Focus on the individual case alone does not necessarily specify a particular paradigm of inquiry, that is a positivist, interpretive or critical paradigm (following the classification of research epistemologies by Chua (1986); see also Orlikowski et al. (1991). Critical studies aim at a social critique whereby the restrictive and alienating conditions of the status quo are brought to light. Case studies, for example, can be positivist as well as interpretive (Klein et al., 1999 and Walsham, 1995). Positivist studies assume the existence of a priori of fixed and law-like relationships within phenomena which are typically investigated with structured instrumentation. Interpretive studies attempt to understand phenomena by accessing the meanings that participants assign to them. Generalisation from the setting is not sought; rather the intent is to understand the deeper structure of a phenomenon which it is believed can then be used to inform other settings (Orlikowski et al., 1991). In discussing the emerging field of interpretive case studies in IS research, Walsham (1995) relates its philosophical basis to the ethnographic research tradition (see also Myers, 1999).

Star (2002) argues for the relevance of ethnographic practices when studying information infrastructures. Ethnographic fieldwork focuses attention on fringes and nuances as well as the practical materialities (concreteness) of infrastructures. It helps to read the invisible layers of control and access and to understand the changes in the social ordering that result. Its strength is that it is capable of surfacing silenced voices, juggling disparate meanings and understanding the gap between words and deeds (Star, 1999). Myers (1999) contends that ethnography often challenges what we “take for granted” and provides IS researchers with the opportunity to get close to “the action”.

One of the distinguishing features of ethnographic research is *participant observation*. For example, in her study on the employment of computer-aided software engineering (CASE) tools in a large

consulting firm, Orlikowski used ethnographic techniques such as the observation of participants, researcher interaction with, and study of CASE tools, documentation review, social contact as well as unstructured and semi-structured interviews. The study was executed over eight months full-time within the firm, and in client sites where project teams were building application systems. Orlikowski employed a theoretical framework which focused her questions and observations; however, she used no structured instrumentation and conducted no statistical inference testing to analyse the data (Orlikowski et al., 1991). Hedman and Borell propose the use of narratives in IT evaluation because narratives can grasp the complexity of information systems better than traditional post-evaluation approaches (Hedman and Borell, 2005). Four features characterise a text or discourse as 'narratives' — the sequence in time, focal actor(s), an identifiable narrative voice, that they embody a sense of what is right and wrong, appropriate or inappropriate, and so on (see also Pentland, 1999). Narratives can be the stories told by actors that were, and are, involved in SDI development but Star (1999) understands that most information infrastructures themselves will also have an inscribed narrative. The task would then be its assessment to identify and surface the master and subsidiary narratives.

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