Faculteit der Economische Wetenschappen en Econometrie

SERIE RESEARCH MEMORANDA

ICT and Urban Public Policy: Does Knowledge Meet Policy?

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Research Memorandum 1999-47

November 1999

vrije Universiteit amsterdam

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Prepared for Presentation at the conference on:
Cities in the Global Information Society
University of Newcastle. November 22-24, 1999

1. Introduction.

Urban areas have historically evolved as activity centres which were initially based on physical locational advantages, such as proximity to natural resources or transportation nodes. Among other factors, the costs of distance played a major role in determining a city's position vis-à-vis its surroundings, as well as its internal structure. The size of a city's hinterland was mainly defined by the quality of the transportation infrastructure and technology. Following the Industrial Revolution in the 19th century, cities started an unprecedented growth phase as a result of scale economies, alongside accessibility and agglomeration economies.

Transportation was clearly the most prevalent 'friction reducing technology' since early history, and continues to play a major role in the present and probably in the future too. It is therefore no surprise that local, regional and national decision-makers in the political arena have devised a variety of transportation policies in order to improve the position of their localities.

The dynamics of technological innovations in Information and Communications Technologies (ICT) over the last two or three decades and the consequent popularisation of these technologies, have given rise to a growing body of research on the wide range of expected, and desired impacts of ICT. Accompanying the rapid advances in ICT was an on-going transition into the 'information economy' in which information resources involve a growing share of the labour force.

A growing attention has been directed since the 1970's to the relationships between transport and ICT. As both technologies facilitate remote activities, there was much interest in the potential substitution of tele-activities for physical travel (Boghani et al., 199 1; Garrison and Deakin, 1988). But, there are many more similarities and differences in these phenomena which draw the attention not only of the scientific community. Just as the car has affected the shape of urban areas, there is an expectation that ICT will change cities. Horan and Jordan, (1998), and Coucelelis (1999), for example, have suggested to integrate and incorporate transport planning and ICT policy in urban policy , both being tools to enhance accessibility.

This paper focuses on the emerging public policy regarding transport and ICT. As transport policy was used to improve the spatial-economic position of particular locations, similar attempts to exploit ICT are widely evident. Of the various aspects of public policy that should be addressed (e.g., agenda setting, problem definition, implementation etc.), we raise in the present paper some questions about the utilisation of knowledge in the process.

We suggest that the public policy process, which is enacted in the discourse of both transportation and ICT, 'suffers' from similar but not identical problems. Specifically, we will argue that the knowledge upon which public policy decisions are (or should be) based, differ in two main aspects. First, the 'knowledge gap', namely the difference between what will happen and our ability to forecast it. There seem to be considerable differences in the cases of transport and ICT. Second, the 'communication gap', which suggests that even the knowledge that is available, is often mis-communicated, thus resulting in what may seem like unreasonable policies, many of which are doomed to fail, although some may still prove successful.

The motivation for this study is twofold. On the one hand, with the development of ICT there is a growing belief among urban officials that technology will remedy many urban problems. This is based, to a great extent on unchallenged assumptions. This paper takes a critical view on the process through which urban decision-makers obtain, and use knowledge about the potential contribution of ICT to ameliorate urban problems. Beyond this rather practical goal, lies a second objective that addresses a more general issue, of how scientific knowledge, produced mostly by public funds, serves the decision-making process in society.

Section 2 of the paper provides some background on ICT in general and ICT public policy at particular. Section 3 presents a conceptual model on the relationship between knowledge and policy-making, illustrating the process by which available knowledge in both transport and ICT is utilised in policy-making structure. Section 4 dwells on the communications gap and the knowledge gap, while the conclusions and some tentative policy implications are discussed in section 5.

2. Background

With the introduction of the 'knowledge' or 'information economy' during the second half of the 20th century, one is obliged to question whether this new era, with information and knowledge as important resources and with the world-wide introduction of the ICT's, will alter the 'old' rules of the 'transportation age'. If transport was the "maker and breaker of cities" (Clark, 1957), will ICT's inherit this role? Do virtual networks modify the role of cities?

Several authors have labelled the current or forthcoming ICT-dependent developments as the "Information Revolution" or the "Information Age" (see e.g., Castells, 1996; Slack and Fejes, 1987; Friendries, 1989). ICT has been identified (prematurely) as the cause for the 'Death of Distance' (The Economist, 1995). If the costs of distance are nullified, the whole notion of urban entities is likely to change. This view stands at the basis of many claims for the radical changes expected in urban areas, at two different scales. On the one hand, the emergence of 'global cities', which serve a non-contiguous hinterland scattered around the world (Castells and Hall 1994), and on the other hand, the dispersion of the urban area due to the growth in the phenomenon of urbanites living and working in exurban settings.

Clearly, the now completed transition into a service economy and further, into an information economy, in the presence of ICT, has brought about a new pattern of competition between cities (Alles and Esparaza, 1994; Graham, 1999). It seems as though cities are competing for opportunities for "positive" growth. Such growth is defined in terms of rising economic performance (i.e. rising income or wealth per capita). In recent years, cities have also been competing in providing clean environments and high quality amenities, which are part of the welfare expected by their residents and by business life. In this respect, ICT may play a prominent role as a potential substitute for environmental-non-benign activities.

The inter-city competition is also evident through many statements and documents produced by urban governments and Non-Governmental Organisations (NGO's), which suggest that ICT can, and will be an important policy tool to attract activities at a world-wide scale (Goddard, 1995; Graham 1992). Cities are increasingly operating as part of a global networks attempting to gain from the competition with other cities in remote, world-wide markets.

The economic success of Silicon Valley in California during the 1980's was a source for envy to many local decision-makers in the industrialised world'. Many have designed policies to replicate the success, but only a few have accomplished such objectives (e.g., Route 128 in the Boston area and route M4 in the UK). Analyses of some of the success and failure stories (see e.g., Saxenian, 1993) have revealed that the outcome is only in part a result of the directed policy. Several other factors, including chance, appear to have a crucial effect as well. If so, then one is obliged to question what makes some policies more successful than others, and what other basic conditions must be met in order to improve the likelihood of success.

Public polices (and even more so, urban public polices) do not act in a vacuum. Most actions in complex systems like cities and accessibility, require a balanced approach which takes into consideration the common and the conflicting views of many stakeholders, each with its own agenda. This is true for both transportation and ICT. In addition to various public agencies, the private sector accounts for important, yet different, developments in transport and ICT. Therefore, one should bear in mind the limited power of public policy and the crowded policy environment in which it is formed and implemented.

Transport and ICT, as noted above, display many similarities. One major difference, though, is the fact that they are being offered and implemented against a dis-similar backgrounds. The century of motorised transport has had a prominent role in shaping the horse-drawn city into the metropolis of the present. ICT, on the other hand, is introduced into a trenched automobile-dependent city. The substitution of the horse by the automobile presents a clear case of technological substitution. ICT is not a perfect substitute of the car, and consequently, its effects on cities cannot be expected to mirror the change brought by the automobile.

The main hypotheses put forward in this paper are related to the process that leads to public policy regarding ICT and transportation. It is suggested that there is a *knowledge gap* in our current understanding of what impacts ICT and transportation have on urban

[1] The "Silliconia" fashion is well represented in a web-site that had collected addresses of web-sites that are using the term Silicon outside the original Silicon Valley (http://www.tbtf.com/siliconia.html).

areas. In addition, there is a *communications gap* between the actors involved in the process, that may result in unmet expectations. In view of the uncertainty involved, it is an important question whether and how the gaps can be reduced to increase the likelihood of successful accomplishments.

Transportation is a mature technology and service system. Even though the uncertainty involved in policy making is still of significant magnitude, there is a sizeable body of knowledge in the field (e.g., Meyer and Miller, 1984, Altshuler, 1979, Dunn,1994). Conversely, ICT is a young concept, and ICT policy-making is still in its infant stage. Given the interactions between the two systems, a comparative perspective promises to explain some of the issues surrounding ICT and its emerging impacts. To that end, we need first to clarify some definitions.

2.1 Defining ICT

In order to examine the role of scientific knowledge in ICT policy-making, there is a need to define ICT and ICT policies. Thus far, no clear and unambiguous agreement on definition and measurement of the ICT sector has been generally accepted (for different definitions of ICT see for example Schwartz, 1990; Graham and Marvin, 1996; Malecki, 1991). At face value, ICT[2] is a collection of technologies and applications which enable the processing, storing and transfer of information to a wide variety of users or clients. The ICT sector has become a popular focal point of public policy because of its expected high economic benefits in an information age. However, the concept of ICT is somewhat dubious. Does an information technology that does not include a communications element still account as ICT? And does the information sector include also a broad array of "software" constituents such as research and development? We suggest therefore to take here a flexible approach and to view all information or (tele)communications technologies as elements of the ICT sector. Further more, we suggest that 'technologies' should be interpreted in a broad sense.

Technology, in general, and information technology in particular, is not merely a collection of hardware. Technology is a social construct (Salomon, 1998). This means that the use of the hardware is regulated, on the one hand, by the value it provides to the potential user and, on the other hand, by various rules and norms. Against this background it may be meaningful to offer some more characteristic features of ICT.

ICT is currently characterised by:

- very dynamic technological changes, with rapid adoption rates;
- a growing popularity and decreasing costs for new equipment;
- a rapidly increasing range of applications and penetration in many realms of professional and personal life;
- an intertwined institutional market place, with the private sector acting in a decreasingly regulated environment; and

[2] Also can be found in the literature as **IT** (Information Technology), NIT (New Information Technology) or telematics.

- production and services dependent on a range of qualities of skilled human resources.

Against the background of the previous section and for the purpose of the current discussion, we define ICT in this paper as:
A family of technologies used to process, store and disseminate information, facilitating the performance of information-related human activities, provided by, and serving both the public at-large as well us the institutional and business sectors.

2.2 **ICT Policy**

Policy can be regarded as consolidated actions aimed at defined target achievements. The term "policy" relates to both processes and actions. While often viewed as an action of an institution, a policy can be manifested in a set of changes within the policy-maker's structure or merely as a declaration (Dror, 1989). The variety of public policy forms suggests that there is more than one way to examine public policy in a specific field, its implications and achievements. A policy can also be viewed as a hypothesis, suggesting a relationship between an action and a result (if policy x would be implemented, then result y would happen). For the purpose of the current discussion, a policy always includes an action as well as a hypothesis, relating actions to results.

With this definition it is possible to define an ICT policy as any public-sector action taken to advance the development of ICT or the use of constituents that make up an ICT system. This policy may have two forms. Either it sees the ICT sector as a final goal in itself, which has to be achieved through the implementation of proper policy incentives (e.g., fiscal policy, land use policy or educational policy as instruments to achieve ICT goals). Or it sees ICT as a vehicle to achieve higher-order goals for the city (such as a strong international profile). Clearly, in a way we face here a system of goals and instruments at different hierarchical levels of policy formulation.

Such policies may be focussed on *technical* aspects (e.g., upgrading the telephone system to a digital one). They may also be focussed on non-technical aspects such as the regulation of ICT to promote universal services or to enhance competition among suppliers; they may include indirect long-term actions as well, such as investment in vocational education in order to improve the quality of future human capital. In the present context, our focus is on urban public policy, and hence public policies at the national and international level are taken as exogenous policies. Since many ICT public policies are generally made at the national level, the differences among cities relate to differences in indigenous local policies and local reactions patterns to exogenous policies.

The great diversity in action which comprise an ICT policy call for a systematic classification which will be useful in the discourse of the impacts of technology on urban areas. It also can give a possible explanation to the variety of ICT policies in different places: the way decision-makers interpret and define ICT policies may affect their policies in this field.

For the purpose of the current reflection on ICT we can define ICT public policies from three different, but complementary angles:

1. Direct *policy* are intended to promote the availability and use of ICT. Here, ICT is considered to be the target of the policy. Although the policy aimed to achieve broader goals (like economic growth or environmental protection), these goals are vaguely defined and there are no acceptable sets of indicators to measure the effectiveness of the suggested policy on such broad goals. On the other hand, there are also ICT indicators to evaluate the policy. Direct policies can be measured by the level of developing (or supporting the development) of ICT infrastructure, regulating the ICT market, supporting research on ICT applications and opportunities or building a web site to offer municipal services via the Internet.

Another direct policy relates to the goal of equal access to information. Since information itself is an important resource, access (or lack of access) to information may create income gaps and may feed a circular process in which lack of access to ICT widens the income gap and creates additional barriers to the acquisition of ICT (Servon and Horrigan, 1997). Since access to ICT requires both access to the technology and the ability to use it, this policy can contain both elements.

2. Indirect *policies* are intended to achieve non-ICT goals via the use of ICT. Examples for this type of policy are the use of ICT to disseminate rail timetables via the Internet to promote public transport usage, or using ICT in the planning process or adding computer classes to the education programs. Here, ICT is an instrument (in many cases, one of several) intended to accomplish defined goals, in an indirect manner. In such cases, the indicators to evaluate the policy are non-ICT measures.

In many cases, there is no clear distinction between direct and indirect policies, and the division depends on the context, the framing of the question or the researcher's views. When the discourse is more ICT-oriented and the emphasis is on ICT tools, a policy can be regarded as a direct policy. Nevertheless, the same policy can be evaluated with non-ICT indicators when the viewer is interested in the broader context. For example, one can investigate the performance of higher education and also include ICT implications within it, where the ICT policy here is indirect and the policy evaluation should include both ICT and non-ICT indicators. On the other hand, one may investigate utilisation of ICT to facilitate education and to concentrate on e.g. remote education via ICT. Here the policy under investigation would focus on ICT applications that are in use (in that case) to promote education.

3. *"By the way"* products or residual effects, are the effects of policies that are completely remote to ICT policy, and have diverse unrelated objectives, but still do affect ICT performance. For example, the defence industry is one of the main contributors to the development of ICT, although its goals are not related to the civilian use of these technologies. In the urban context, an example may be a

decrease in the social costs of traffic congestion, evolving from the increasing popularity of cellular phones. Another example is the development of a more efficient traffic system which as a by-product may lead to the design of a new telematics system. Of course, by definition a main characteristic of this group of policies is that these effects are not intended and can be seen just in an ex-post evaluation.

2.3 Transport and ICT: The comparative context

The relationships between transport and telecommunications have drawn much attention over the last two decades (Hepworth and Ducatel, 1992; Salomon 1986; Mokhtarian and Salomon, forthcoming). There are several obvious reasons for this: both belong to a class of 'friction reducing technologies', both have a network structure, and in some cases, there is a (much overstated) potential for substitution between physical travel and virtual travel.

There are also several differences that draw attention. The nature of virtual activities versus real physical activities is the most prominent difference from the users' perspective. The technical characteristics of synchronic vs. a-synchronic communications, or the ability to convey different types of information, also contribute to the differences. And, a major factor, which emphasises the above differences is formulated by economic actor, such as the organisational structure and division between the public and private sectors, the costs structure (both capital and use), and the billing mechanisms.

The latter is better known, given the exposure of automobility to decision-makers. The process through which knowledge is integrated in policy-making in the case of transport is reviewed in a previous paper (Salomon and Cohen, 1999; in other policy arena see Robinson, 1992). It suggested that elected decision-makers often abuse, misuse or ignore information, alongside the legitimate utilisation of knowledge. It also pointed to the fact that there seems to be a knowledge gap, i.e., a high level of uncertainty is inherent to the knowledge offered to decision- makers. Likewise, there is a communications gap, which negatively affects the quality of the information transferred.

In the forthcoming discussion of these two gaps in section 4, we will point out the differences and similarities between transport and ICT.

3. Incorporating Knowledge in Public Policy: A Communications Model

Knowledge is here defined as the accumulation of information, which facilitates choice. It is a widely accepted assumption that policies are designed with the expectation that they will introduce change, as public policy aims to address a wide array of social problems. This, in turn, is based on the assumption that policy making is a rational process based on knowledge, accumulated in the policy-maker's cognition.

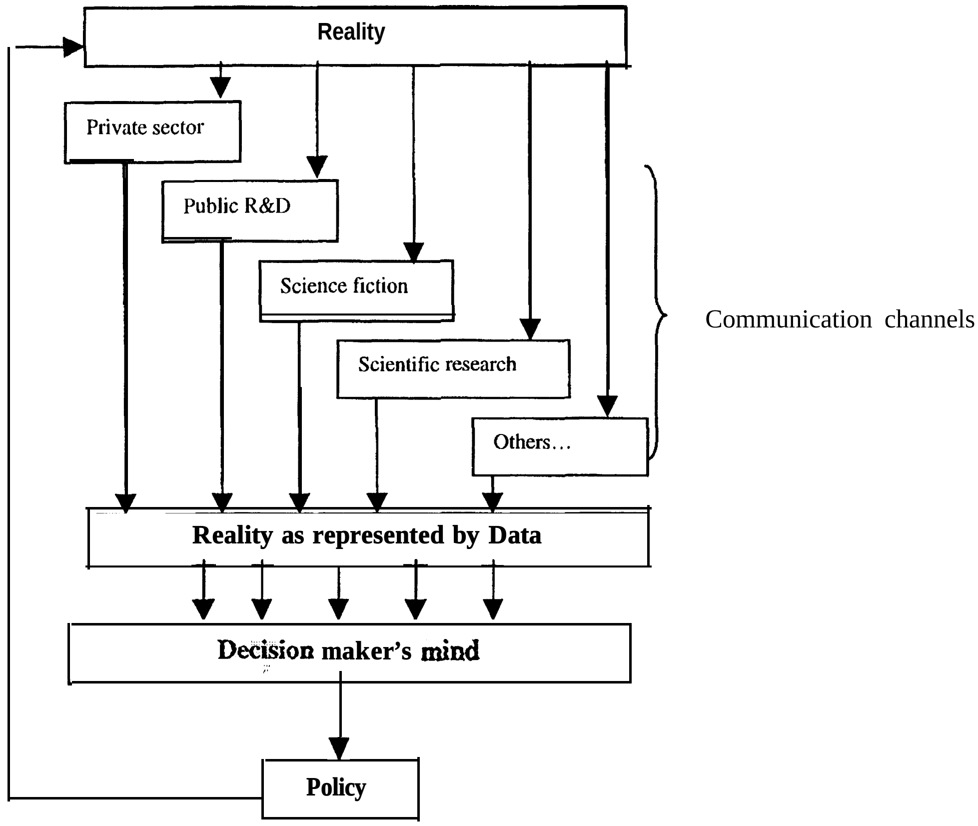
In an attempt to understand how policies evolve, we suggest to focus on the communications process through which reality is transformed to knowledge, which in turn is part of the input to decision making.

Figures I and 2 provide a schematic framework for this process. Decision makers are exposed to information (data) which is a partial representation of reality. This distinction is based on the assumption that 'real world attributes' of 'facts' are always viewed through the eye of the beholder. Hence, 'data' is a representation of 'facts' but cannot be assumed to be identical to facts.

There are two factors which distort the available data relative to the factual reality. The first is the ***knowledge gap*** and the second is the ***communications gap.*** These gaps seem to play a major role in explaining policy-making in the ICT and transportation areas.

The Data which represents reality, as shown in Figure 1, is a collection of information segments provided by various sources. Each of these sources is characterised by its own bias and perspective. It is also plausible to assume that users of the Data, assign, implicitly or explicitly, a reliability value for each source.

Figure 1: From Reality to Policy: A communications process



The box representing the decision-maker's mind is amplified in Figure 2. Its structure builds upon Rosenberg and Hovland (1960) who have suggested the Tripartite model of attitudes, applied here to the context of ICT and transport. The Tripartite model suggests that attitudes which are formed on the basis of stimuli, can be divided to three groups: Affective, Cognition and Behaviour, corresponding to Blocks II, III and IV in Figure 2.

Information, actively sought or passively observed, penetrates through some filters (Block I in Figure 2) into the human mind and is integrated in a perceptual map that includes numerous templates of sorted data that jointly constitute existing knowledge of a particular topic.

Block II in Figure 2 represents the attitudes and background knowledge that the individual decision-maker holds. It is based on experience, study and, to an extent, the beliefs he or she holds with respect to technology and vision. These affect the screening by the filters and the cognitive system (Block I and III, respectively).

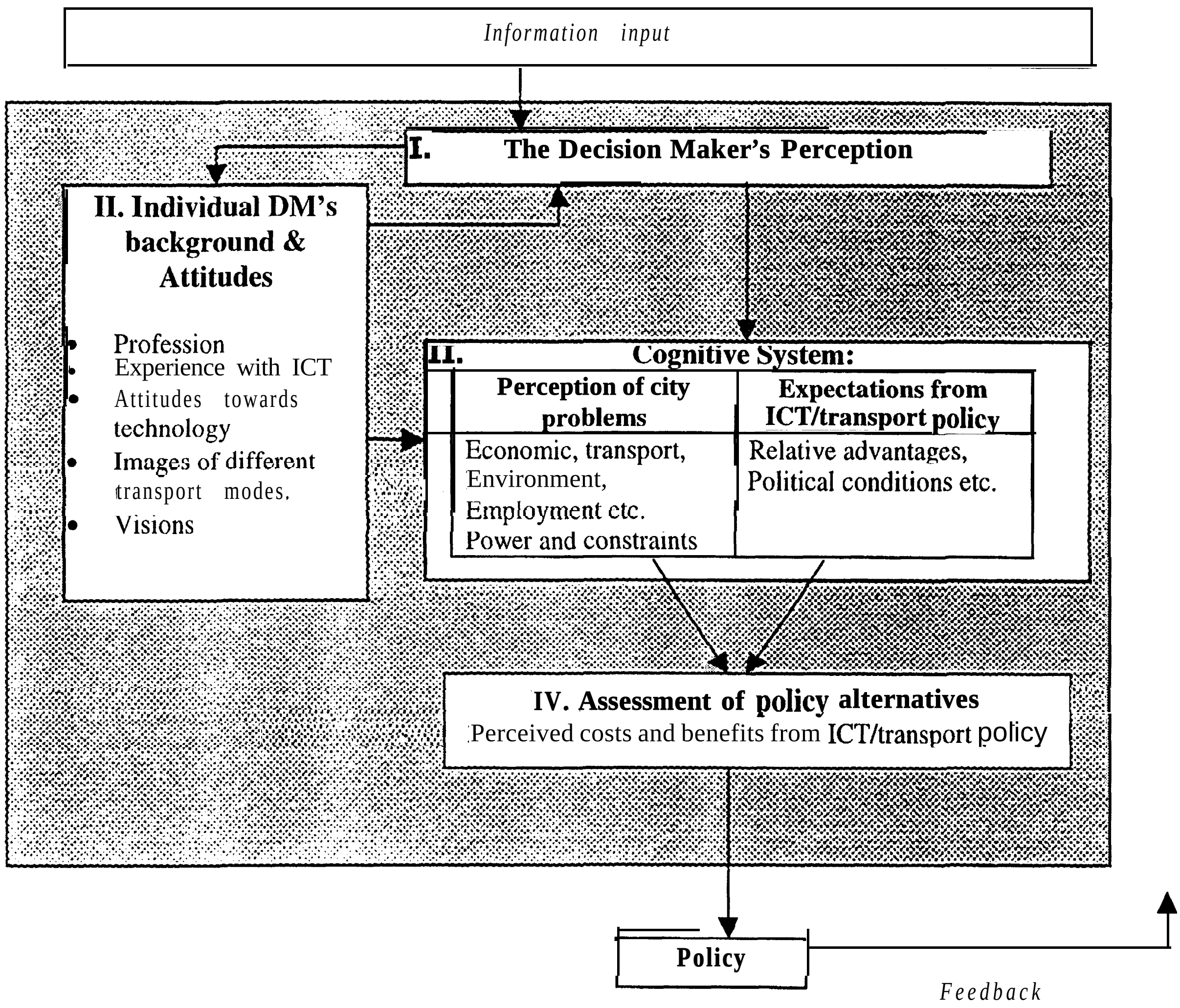
Two relevant templates of information can be assumed to exist in the mind: the perception of the city's problems and the perception of expectations from ICT and transport applications. Block IV represents the actions (assessment and decision on policy), which feeds back as shown in Figure 1.

Both the perception and the cognitive process are moderated by the individual decision maker's background, depicted at Block II. More specifically, a number of elements are at play. The professional background serves as a filter which may screen out, or inversely, allow the inclusion of information which seems pertinent to the person. It is likely that an engineer turned into politician is likely to view technological options differently from a law-educated politician.

When a decision-makers is committed to a certain agenda or political constrains, it may affect the way he or she is willing to accept information and make use of it. Decision-makers tend to reject data which contradicts policy that they are unwilling to change (Dery, 1989). Past experience with ICT will also affect both perception and the tendency to adopt ICT policies. A more general view of technology that may reside within a person will likewise affect her or his perception of the choice set. The same can be applied to the image of different transport mode and the way the decision-maker perceive its effects and benefits. The extent to which the decision-maker hold a visionary view of the city and the world seems to be relevant too, but very difficult to identify and measure.

The information input originates in a number of sources and reaches the decision maker through one or more channels of communications. These different channels create the communication and knowledge gaps that are discussed in the next section. The quality of the information that the decision-makers face depends on these two gaps. As we hypothesised that these gaps differ between transportation knowledge and ICT knowledge, we suggest that there are also differences in the quality and accurateness of the knowledge that serves as input in the policy making process.

Figure 1: The process of information utilisation and translation into policy



4. The Knowledge Gap and the Communications Gap

The knowledge gap is defined as the mismatch between our ability to fully understand the entity that is labelled Reality and the box labelled Data in Figure 1. The latter is a partial representation of the real world complexity or reality.

As knowledge accumulates through the communication of tentative explanations about reality, the communications gap relates to that part of the knowledge gap which can be attributed to miscommunications between the parties involved.

The rational model of policy making assumes that decision-makers base their actions on knowledge (Simon, 1957; Dror, 1989) . However, the notion of what constitutes knowledge is dubious. Certainly it is not just what the scientific community regards as legitimate knowledge. Knowledge is, as noted earlier, the accumulation of information that facilitates decision making or choice, marked as Box III in Figure 2.

But knowledge is not a monolithic entity. The objective of identifying the rules which explain "reality", is often characterised by competing explanations for complex situations, which emphasise the presence of uncertainty. This is particularly evident in the discourse about the relationship between technology and society at large, as well as between technology and various interfaces with the individual's daily life.

One of the costs of the existence of different and diverse bodies of knowledge, is sometimes the reduction in the interest of decision-makers in such knowledge and in the research generating it. Keynes (cited in Sharpe, 1975) suggested that governments "hate to be well informed", as it complicates decision-making. Obviously, when the scientific community suggests more than one answer or prediction to a socio-economic problem, it leaves more space for accepting other views or other (perhaps equally important) considerations. Hence, the concept of the "knowledge gap" involves the uncertainty and fragmented nature, of our current knowledge of ICT's and transport's social impacts.

4.1 The Knowledge Gap

4.1.1 Sources of Uncertainty

It seems that at present we still have a collection of fragmented elements of knowledge on ICT and transport systems, although experience with and exposure to the latter has resulted in a better understanding of what can be accomplished with policy tools. Our ability to forecast ICT impacts for urban areas, a precondition for devising public policies, suffers from a knowledge gap. Various aspects of the relationships between ICT and its impacts still, and for some time to come, involve high levels of uncertainty.

Forecasts are always made within some level of uncertainty. But, we argue, that in the case of ICT, the knowledge gap belongs to a class of technology-society interactions that are more complex than many other fields. There are a number of reasons for this complexity.

First, the *dynamic* technological developments of ICT curtails much of the forecasting ability. We fail to know what tomorrow's IC technologies will be like in terms of their features, their costs or even their usefulness for different potential users (Crandall, 1997). This is further complicated by the fact that social and institutional processes, which are involved in the adoption and assimilation of ICT, work at a very different pace compared to the pace of technological advances.

Second, with all the research aimed at understanding (and forecasting) the process of technological penetration and adoption, *behavioural modelling* is still limited in its ability to produce sound forecasts. ICT may involve many different facets of human life, like residential patterns, work patterns, learning, leisure activities. At present, we are, at best able to accomplish some partial forecasts for simple, single applications. However, the complexity of the possible interactions is far from being understood.

There is another characteristic of ICT which makes it difficult to study in comparison to transportation. While queues of congested traffic, accidents and even some pollution are very visible, ICT is largely *invisible* (Batty, 1990; Graham and Marvin, 1996). Neither the technological elements, nor the traffic upon them can be seen. Given that much of the information constituting the traffic is private in nature and not measurable. There is also a lack in measurement tools compared to the case of transport. Researchers are barred from studying much of what is going on and its implications.

Paucity of empirical research in this field (as one possible consequence of the invisible nature of ICT) is another obstacle to reduce uncertainty. As a relatively young field of research, ICT research is often grounded on theoretical and conceptual work (as well as speculations and anecdotes) and it would benefit much from contributions to the empirical testing of a wide diversity of hypotheses (Atkinson, 1998;)

Yet another factor that contributes to relatively high uncertainty in ICT as compare with transport is the lack in *institutional* data and knowledge. Much of the data is in the hands of the private sector, and hence not visible. But, there is an additional implications. It enables analyses which are based on inconsistent definitions and measurement methods. Consider, for example, data about tele-workers (or telecommuters, in the American language). Entirely different estimates about the number (or share) of tele-workers surface in the literature, depending among others on the interest of the data supplier (Salomon, 1998; Mokhtarian, 1991).

One can estimate the number of actual tele-workers, based on a wide definition which includes all those not working in a traditional workplace. This approach will include all workers who are mobile and may use advanced mobile ICT's. Others, who define tele-workers as those using ICT and work at home, often do not distinguish between occasional tele-work and regular tele-work. Each approach, using inconsistent definitions, leads to different conclusions about the extent of telework. In the present context, it implies that "Reality" (the real number of telecommuters on any particular day) is represented in the Data box by very diverse figures.

Two types of 'knowledge gaps' may be in effect. The first is the obvious case in which a phenomenon is only partially understood, due to its complexity or novelty. There is only one way to reduce this type of gap: more research. This gap exists mainly among members of the research community, who naturally, aspire to reduce it.

In summary, the current scientific knowledge of ICT's social, economic and spatial impacts is still scarce and much of it is anecdotal. We still fail to explain, within an empirically supported theoretical framework such issues as penetration pace, future costs, patterns of adoption, the interactions with other technologies and with other socio-demographic, economic and cultural trends. An often cited and valid critique of forecasts is that present day forecasters tend to apply incumbent norms and values, which may well be altered as today's children mature (Warren et al., 1999).

The scientific community, of course, is not the only source of legitimate knowledge, especially in the ICT field, in which the private sector plays a major role in technological progress and promotion. Other sources of knowledge (promotion drives, literary and journalistic stories) are substituting and complementing for science, as decision-makers adopt views that are presented to them by various types of experts. The scientific community does not have a monopoly on knowledge. At best, its 'monopoly' is limited to the scientific method and the transparency of assumptions and models, and consequently it is less likely to generate or support myths (Graham, 1997; Salomon, 1998). However, in the case of ICT research it seems that the scientific community itself contributed to number of myths, especially those which belong to the utopianism-futurism approaches (Graham and Marvin, 1996).

Knowledge about transportation is also far from being comprehensive. The wide range of externalities, both positive and negative, still challenge the transport planning profession. Although behavioural modelling is quite advanced in transportation, still the is much room for improvement. Also, the relationships between transport infrastructure investment, economic growth and urban development are not completely clear. On the one hand, history provides us with evidence that relate transportation development and urban (or regional) growth. On the other hand, it is doubtful whether a marginal transport development (in an already developed system) will contribute to further growth (Banister and Berechman, forthcoming). Much more needs to be understood before a comprehensive transport policy can be devised and successfully implemented (Meyer and Miller, 1984).

However, in contrast to I-CT, technological development, at present, seem to affect transport system only at the margin. In this respect, knowledge gaps are not as wide in the case of transport.

4.1.2 Who are the "experts"?

Information is supplied by a variety of sources (forming the so-called communication-gap described below). But, it is noteworthy to identify the type of expertise required to produce knowledge in the field. ICT carry a range of different meanings for both users and non-users. For some, it is a set of technologies. For others, it may mean a set of services and still others may see in it a tool for enhancing social cohesion of a community (or vice versa). The view one holds depends very much on the discipline practised or acquired by the individual and the degree of exposure to other, competing perspectives. It also depends very much on the basic perception and attitudes toward technology.

Various disciplines address ICT issues. Engineers play a major role in the technological development and are generally less aware of the social and economic facets of the technologies they develop. On the other hand, social scientists, in various fields (economics, sociology, geography, psychology etc.), naturally tend to focus on those aspects in which their discipline reigns. It seems not to be erroneous to claim that ICT-related interdisciplinary or multidisciplinary studies are still at their infancy. In many cases the aspiration to engage in cross-disciplinary research falls short of integration and synthesis and tends to remain at a level in which 'the other' perspective is introduced at a very rudimentary level. Those who are concerned about urban and regional development, find that telecommunications policy research usually contains very specialised group with just a few links to the implications of ICT on urban development (Goddard, 1995; Graham and Marvin, 1996). It is not clear yet (especially in the light of our definition of ICT policy) who are the relevant experts to develop ICT policy and what is the appropriate balance between the different disciplines. As will be shown in the next section, communication problems play a major role in slowing multidisciplinary collaboration.

Transportation systems also embrace more than one discipline. As in the case of ICT, there are experts on infrastructure, traffic and technology (mostly engineers) as well as economists, geographers and urban planners who investigate the social effects of transport systems. However, in contrast to ICT planning, there is a considerable level of co-operation among the different groups, probably a result of the fact that transport systems are more mature.

Historically, three phases of transport policy can be discerned, and with each, a broadening of the scope of analyses and knowledge were introduced. Until the 1960's transportation policy meant almost exclusively investment in infrastructure. It was devised through a mutual understanding of highway engineers and economists, who believed that more infrastructure will lead to less congestion. During the 1970's, transportation systems management (TSM) emerged as a policy goal. During the 1980's , transportation demand management (TDM) surfaced as the new approach to address the ills of transport systems. This transition reflects the growing adjustments among the different facets of transportation systems and the necessity to combine different aspects of transport measures in order to achieve desired goals. Furthermore, transport planning seems to be associated with a certain profession, with agreeable education or knowledge.

ICT professionals still do not have the same "professional label" and their education and knowledge is considerably different than those dealing with transport. With ICT infrastructure being much less obtrusive to the environment and urban cohesion, than the case of transport, there is less of a need to contain the engineers' actions.

4.2 The Communications Gap

4.2.1. Channels of communication

Much of the knowledge gap that lies between "reality" and "data" in Figure 1, is a result of the limited understanding of the complex phenomena of the merging of a new technology into society. The complexity, as noted earlier, is due to the diverse interactions between technological elements and human adoption and regulation patterns. The rapid technological developments leave the research and analyses well behind. This seems to be true for the new ICT, but also for the more mature field of transportation.

Another source of the knowledge gap is the communications gap. Information and expectations of what ICT "can do better" is communicated to the decision-makes through numerous channels, some of which were identified in Figure 1 above.

Communications channels are characterised by certain inherent noise levels, which lead to loss of accuracy in transmission. This is particularly true when the channels are human beings who are liable to introduce different types of 'noise'.
The scientific on the one extreme, tends to use "unfriendly" data through scientific reports and articles. On the other extreme, we can find advertising materials which use visual demonstrations, Buzz-words and an easy-to-catch logic. Between these extremes there are scientific policy-oriented reports, executive summaries, journalist writing, non-profit organisation reports and publications, and so on. In the case of ICT, also science fiction literature may be regarded as information channel.

When comparing the communications channels and the information providers in ICT and in the transportation arenas, it seems that ICT knowledge is available though more channels than the transportation knowledge. The latter is based to a great extent on the personal experience and 'institutional' knowledge, whereas the former, in the lack of experience, relies more heavily on various types of literature and promotion material. As more channels are active in the case of ICT, the relative weight of the scientific knowledge tends to be lower. This not to say that the other channels are not important or providing false knowledge, but it can explain the relative importance of scientific knowledge in policy-making.

Since scientific knowledge is not the only data provider for the decision-makers, it seems that a-priori its potential to affect them its limited. However, even when the scientific channel is dominate, we suggests that the immanent differences between the scientific world and the policy-making arena adds additional difficulties to the communications among the different groups. The next section deals with this communication gap.

We suggest that the communications gap arise from two main intertwined factors: language and culture. The basic argument is that decision-makers, in particular elected politicians, act in an environment which is quite divorced from that used by scientists, in particular those who serve in academic (as opposed to Research & Development) institutions.

4.2.2 Language differences

Different groups in society adopt languages or jargons which best serve their needs, but will often result in communication problems between groups. Nowhere is this more evident than in the case of scientists and politicians.

The 'language' barrier can be attributed to the following issues:
Dealing with *Uncertainty* is the bread and butter of scientific forecasting, and as such is embedded in a series of *assumptions* which are integral qualifiers of any forecast. By contrast, politicians expect science to deliver unqualified forecasts and they seem to have a problem dealing with qualifying assumptions. Thus, forecasting future passenger kilometres, demand for rail service or number of tele-workers is given with defined assumptions and subject to corrections when the assumptions are changes. Some of the assumption that are needed for such forecasts can be controversial, and the forecasts

receivers should be aware of them. While the scientific practice questions these assumption as part of the scientific process, Decision-makers not always aware to its importance.

Technical terms often create a gap. Decision-makers are not always sufficiently knowledgeable in the technical concepts and jargon. Consequently, they may perceive a concept in very different ways from the meaning intended by the scientist. In the case of ICT, the technical terms and variety of technologies are still not widely adopted.

The *time gaps* between a scientific innovation and its dissemination and introduction are also a contributing Factor to the knowledge and communication gaps. It is often the case that years go by between the innovation which makes some headlines and the time its off-spring technology is introduced to the market place. Policy-makers often operate with an election terms clock, and expect solution to be implemented within an election term.

The use of *metaphors* is another problematic issue. The language which describes new technologies is often relying on concepts with which the audience is more familiar. The ICT arena is blessed with exceptional amount of metaphors. It seems that the more the subject under discussion is hidden and invisible, the more we need metaphors as a bridge to understand the concepts. Hence we are talking about 'information superhighways' that are connecting 'telecottages' in a 'wireless neighbourhoods' and 'intelligent environments'. The gateways to such 'virtual cities' are the 'teleports' .

The use of such metaphors is useful for introducing new concepts without requiring a deep understanding of them. Still, quite some coition should be taken in an uncritical use of metaphors since they can be misleading. The case of teleports can demonstrate it. If the size and centrality of an airport or a seaport earned the relative positioning of a city in the industrial age, it follows, according to some viewers, that a teleport is a necessity in the information age, as the information age port. A few cities adopted this view, prompted among others, by a World Teleport Association. We hypothesise that the adoption of a teleport concept seems to have made sense to decision makers who had unknowingly, suffered from a knowledge gap. ICT developed in directions which relied on technologies which gave the teleport no advantage. Nevertheless, for a while, at least, some cities could market themselves as information age cities given the availability of a teleport.

Clearly, among the language differences, the most significant contrast between transportation and ICT is the use of metaphors. Since the transport system is well known and highly visible, the use of metaphors is low. On the other hand, the invisibility of ICT and difficulties to understand its mechanisms, encourages the use of metaphors, as demonstrated above.

4.2.3 . Cultural differences

Cultural factors provide further explanation for the disparity between professionals and policy-makers. Perhaps the most evident underlying cultural factor is the fact that academics generally are educated to take a ***sceptic perspective*** on knowledge whereas policy maker are educated to think in an *action-oriented* mode. This explains why scientists tend to emphasise limiting assumptions while politicians prefer an assumption-free statements about facts.

Another related cultural factor is the degree of social commitment that each arty carries. In its ideal form, scientists are committed to increasing knowledge and are motivated by curiosity, not by the commitment to solve social problems. Political decision-makers have a social commitment, and scientific understanding is not their prime objective. The social commitment emphasises the need to act even when the uncertainty is high. Scientist, on the other hand, would prefer to continue the investigation to reduce the uncertainty and delay the action.

Assuming that both scientists and decision-maker are rational players, still the rational is not identical and guided by different criteria. Scientists are tend to be quite naive with regard to how the real world operates, comparing to the politicians, who tend to live (and manipulate) the real world. Hence, criteria that seem highly important to the scientist can be irrelevant to the decision-makers and vice versa. This gap often rests in an emphasis of the seemingly irrelevance of the ivory towers. Occasionally, this gap gives rise to a legitimisation of ignorance and a de-legitimisation of academic research.

Vision in contrast to *rational thinking* is another cultural difference. Scientists are often blamed, by politicians and others, for a lack of vision. Vision seems to be a view of a desired future, which is not a products of a rational analysis-planning procedure. By contrast, it is a product of a synthesis driven more by intuition (and wishful thinking) than by scientific tools. Political elected officials are sometimes able to define and advance certain visions, that may be useful in the political domain but rarely gain the support of scientists. This does not mean that the politicians are wrong, but it is certainly a source of cultural tension.

Both transport and ICT policies discourse seems to have the same problems regarding to the culture differences. The culture differences are inherit in the relationships of science and policy and tend to characterise most (if not all) the policy areas.

5. Policy implications

The future impacts of ICT on the city depends on variety of trends, actions and developments. One of them is the ICT urban policy. In order to understand different ICT policies employed in different cities, this paper examined the role of scientific knowledge in the process of decision-making and offered a conceptual framework explaining the process. Although the knowledge and communications gaps are not unique to the ICT case, it seems that the ICT discourse suffers from relatively wide gaps.

There is a general agreement among scientists that ICT will have important implication for the society as whole, and for the city in particular. However, the tools to accomplish desired goals or to understand the TCT possible impacts are less clear. When science cannot deliver concrete usable knowledge, it is not surprising to find decision-makers who resort to alternative channels of knowledge acquisition and misusing available scientific knowledge.

The comparison between ICT and transport can shed some light on the nature of the ICT discourse. In contrast to transport policies, ICT policies do not (yet) play an important role in public debate. While transport-related political comments (and criticism) are frequently heard, (both in urban and national levels), ICT related commentary appear to be less critical in nature. ICT policy, at present, face less scrutiny and criticism, but also entertain less public support. Moreover, in many cases the responsibility for ICT is perceive to lay on the private sector, implying less activist public policy.

Vision, in ICT policy has an important role. Alongside the accumulated knowledge (transferred via the different channels), the image of the future city and the "information society" seems to have important role in formulating policies. Where the "vision" is dominates, there is less place to "dry" knowledge. As Melody puts it, "so *far, the preparation of information* society statements *has* not been a costly proposition. *However, if and when these 'visions' lead countries to make major commitments of resources and/or adopt fundamental changes in public policies, they will become extremely important"* (Melody, 1996 page 244).

One important conclusion with regard to the practical implication of this paper, is the desirability of educating professionals (and decision-makers) to communicate. While this sounds like a very simple and trivial conclusion, this paper has shed light to the specific importance of 'cross-cultural' discourse and to the importance of reducing the knowledge gap.

However, we should keep in mind the limited role of sciences in policy-making process. As Weiss puts it, science can serve as *". ..a background of data, empirical generalizations and ideas that affect the way that policy-makers think about problems. It influences their conceptualization of the issues with which they deal...Often it helps them to make sense of what they have been doing after the fact.. .some times it makes them aware of the over-optimistic grandiosity of their objectives in light of the meagerness of program resources. At time it helps them reconsider the entire strategies of action for achieving wanted ends.. ."(Weiss, quoted in Lindblom, 1990: 270).*

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