Information Technology for Sustainable Societies-Public Policy Perspectives in Japan: The Case of Telework

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Issue: Telework and telecommuting (T/T) enable the reduction of environmental problems resulting from transport. In the case of Japan it is estimated that the net effect of T/T will be a reduction of about 2% of the Japanese carbon dioxide emission reduction target by 2008, as agreed in the Kyoto Protocol. The net impact of all IT-related activities as a whole will be about 7%. T/T will also benefit individuals by reducing public transport congestion - a positive externality irrespective of sustainability impacts.

Relevance: Apart from sustainability considerations, the fact that T/T is able to contribute towards benefits (from a 'public good' point of view) is sufficient justification for policies designed to support it. For instance, adequately designed tax instruments could be used to influence T/T behaviour.

IT can contribute to sustainability in several ways

Roles of Information Technology for Sustainability

Information technology (IT) is expected to play a wide range of important roles in societies pursuing sustainability. These roles may be classified into three groups:

- direct technological effects
- indirect contributions through changes in the behaviour of individuals and organizations
- promotion of the overall decision-making capability of a society.

First, direct effects arise from the increased efficiency of manufacturing and other activities through the use of various information systems. Examples include IT control of air conditioning equipment to reduce energy consumption, energy savings in transport by the use of intelligent transport systems (ITS), etc.

Indirect contributions may arise through changes in lifestyle and working patterns enabled by use of IT. For example, telework/telecommuting (T/T) not only saves workers' daily commuting time but also the energy consumed in commuting. Other examples are the development of remote-sensing devices to monitor the state of the global environment, and the use of computerized bidding mechanisms for trading the right to emit carbon-dioxide (CO_2). These are but a few of the many examples of possible ways in which IT can contribute to sustainability.

There is one more way; ICTs can improve society's overall decision-making capacity to

implement public policies for sustainability. Collective decision making on public policies, however, is subject to political factors. In a democratic society, a collective choice which influences the majority can be sustained only with its consent. This means that the majority needs to understand the consequences of selfish patterns of behaviour in order to accept the consequences of public policies which are useful for the global community as a whole in the long-run, but may go against the direct short-term interests of individuals and communities (including the majority). In this sense the knowledge society is a prerequisite for sustainability, and IT can play a role in building such a society quickly; hopefully before it becomes too late to get on the path to sustainability.

Complex Relationships

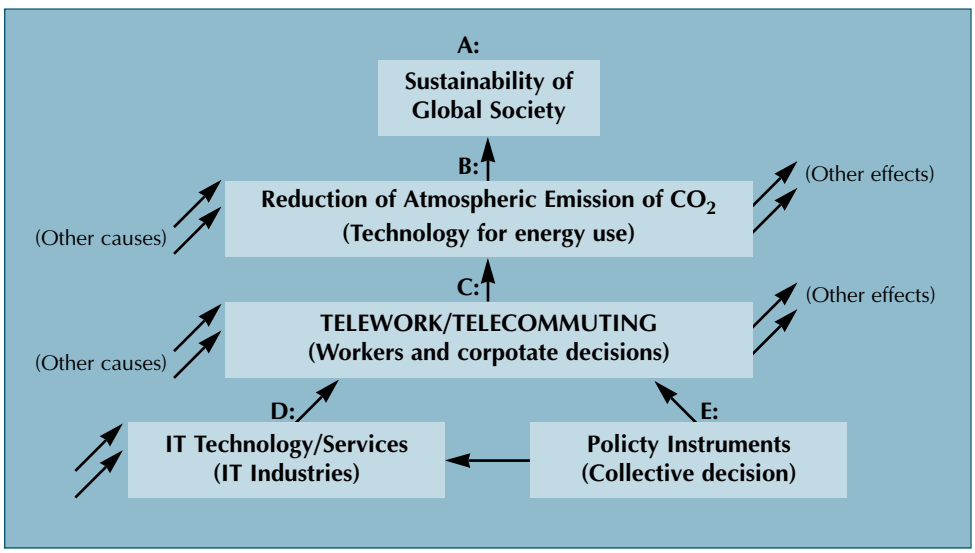
When considering IT's contribution to sustainability, we need to take note of its causal relations. Take the case of T/T for example. The development of IT helps people telework, thus relieving them of physical commuting and decreasing atmospheric emissions of CO_2. This is easy to understand at a glance, but the causal relations involved may be complicated, calling for careful attention when public T/T policies are formulated (see Figure 1).

The boxes and the arrows in Figure 1 describe schematically the causes and effects surrounding T/T. Each of the five boxes (marked A through E) represents an activity related to T/T, box C being T/T itself. The arrows in Figure 1 indicate the presence of the causes and/or the effects between activities. Observe that the arrow from C to B indicates that the promotion of T/T contributes to the reduction of atmospheric emission of CO_2, and the arrow from B to A indicates the effects of CO_2 reduction on sustainability.

The lower half of Figure 1 explains the socio-economic factors affecting T/T. First, the penetration of T/T depends on IT technology and services together with policy instruments (such as government subsidies), as indicated by the arrows from D to C and E to C, respectively. In addition, the arrow from E to D shows possible effects of policy instruments on IT technology and services.

ICTs can enhance decision making capability by ensuring access to information – essential if the public is to understand the need to change towards sustainability

Figure 1. Causes and Effects Involved in "Telework/Telecommuting"



The causal relationships involved are complex. Government can influence T/T, but only indirectly

The COP3 climate change convention held in Kyoto had a significant impact on public awareness of the need for sustainability

Boxes B, C, and D have incoming arrows representing other causes. Consider box C, for example. The decision to take up T/T is made by workers and corporate management for private benefits, not for global sustainability. Likewise, the development of IT technology and services is a consequence of decisions made by IT industries, seeking corporate objectives. The government (or society as a whole) can influence T/T by means of various policy instruments, but it can do so only indirectly. Thus the government, in planning and implementing public policies for the promotion of T/T, needs to estimate the effects of its policies on the behaviour of workers and management.

Not shown in the figure is the fact that IT and T/T may contribute towards unsustainability, i.e. have a negative impact on the environment. There are several ways in which this can happen. For instance, the actual reduction in transport due to T/T is less than expected due an increase in other, non-commuting, travel, such as personal trips during the day, later trips to the office, increase in customized delivery to T/T personnel, and so on. This negative effect is more general for ICT than only for T/T, say through the increase of customized transport due to Internet shopping. When considering actual estimates of IT and T/T on sustainability, it is therefore important to consider the *net effects*, not only the positive effects (see more below).

The complexity of causes and effects of T/T explained above indicates the scale of the issue of IT and sustainability. One can imagine hundreds of interconnected diagrams each of which looks like the one in Figure 1. We can only look at a small part of the issue here. The following sections introduce an attempt by the Japanese government toward formulating a policy for T/T, and research work toward estimating the behaviour of individuals in relation to T/T.

Policies for Sustainability in Japan: the Case of Telework/Telecommuting

In the summer of 1997 the COP3 meeting (a United Nations Climate Change Convention) was held in Kyoto, Japan. This had a significant effect on promoting the Japanese people's understanding of the need for sustainability. In the Kyoto meeting, it was agreed that Japan, together with other advanced countries, would by the year 2008 decrease atmospheric emissions of CO_2 and other greenhouse gases to levels 6% lower than those in 1990. This translates into a decrease in emissions of 56.5 MTC (million tons of carbon) in a year in Japan.

The Japanese government recently formulated a set of policies for achieving this goal. As part of these initiatives, the Telecommunications Council in the Ministry of Posts and Telecommunications (MPT) submitted a Report in May 1998 toward this target in relation to the possible contributions of IT (MPT [1998], pp.74-76).

The MPT report gives a breakdown of Japan's target of 56.5 MTC into subcategories; T/T is projected to contribute by a decrease of 1.29 MTC, 2.28% of the total projected decrease. The report attempts to provide an explanation of this projected contribution by T/T in two steps: (a) a projection of T/T participation in the year of 2008 (which corresponds to box C in Figure 1), and (b) a projected reduction of CO_2 emissions in 2008 (which corresponds to box B). (See Tables 1 and 2).

As Table 1 shows, the report classifies the total workforce of Japan into four categories: managers and office workers, professionals and engineers, sales transport and communication workers, and others, the total workforce in 2008 being 63.38 million. The ratio of T/T participation to the total workforce is highest

(20%) among managers and office workers, and lowest (1 or 0%) among sales, transportation and communication workers and other workers. On the basis of these figures total T/T in 2008 is projected to be 4.19 million man/years, i.e. 6.6% of total work. Furthermore, 35% of these T/T man/years correspond to work at home, 15% to work at satellite offices, and the remaining 50% to work at spot offices (i.e. offices available on a temporary rental basis).

By using the data in Table 1, the Report calculated, as shown in Table 2, the gross and the net decrease in CO_2 emissions brought about by the introduction of T/T and the use of remote video meetings. As discussed above, although T/T will save energy otherwise expended in commuting it will nevertheless increase the consumption of energy at home and at satellite offices. The Report estimated the parameters needed to calculate the gross and net decreases in

Table 1

Estimated T/T Participation in 2008: Japan (by MPT) (Million Man/years)

Workers Occupation	Total Man/hours	Composition (%)	T/T Man/hours Percent of T/T		Composition (%)
Managers and Office workers	14.79	23.3	20	2.96	
Professionals and Engineers	11.13	17.6	10	1.11	
Sales, Transportation, and Communication	11.80	18.6	1	0.12	
Others	25.66	40.5	0	0	
Total	**63.38**	**100.0**	**6.6**	**4.19**	**100**
T/T Work at Home				1.47	35
Work at Satellite Offices				0.63	15
Work at Spot Offices				2.09	50

Table 2

Projected Change in CO_2 Emission due to T/T in 2008: Japan (by MPT) (1,000 tons of Carbon per Year)

Source of Change: T/T	Change in CO_2 Emission		
	Decrease	Increase	Net Total
Telework at Home	530	190	-390
Satellite Offices	20	0	
Sport Offices	30	0	
Video Meetings	940	40	-900
Total	**1520**	**230**	**-1290**

CO_2 emissions as the average distance of commuting per person (3100 kilometres per year for the case of commuting by train), and the amount of CO_2 emitted as a result of commuting (4.8 tons of carbon per million person kilometres in the case of trains). The figures shown in Table 2 have been obtained by combining the data in Table 1 with the projected parameters. The total decrease in CO_2 emissions have been calculated to be 1.29 MTC per year.

Box 1

Impacts of ICT on Sustainability: The Japanese case

The Telecommunications Council, an advisory body of the Ministry of Posts and Telecommunications (MPT), released a report entitled "Addressing Global Environmental Preservation through Info-Communications Systems" on May 27, 1998. The report predicts the CO_2 reductions that might be attained through the use of information systems with the potential to reduce CO_2 emissions.

System (converted to equivalent CO_2 amounts)	CO_2 Reduction
1☐ Telework	1.29 million tons
2☐ Intelligent Transport Systems	1.10 million tons
3☐ Reduction of paper consumption by using LANs	0.53 million tons
4☐ Internet, etc.	0.50 million tons
5☐ Building management systems	0.36 million tons
6☐ Electronic publishing and electronic newspapers	0.25 million tons
7☐ Distance learning, home education systems	0.03 million tons
Total reduction per year	**4.06 million tons**

Notes

1☐ Estimated by taking into account the reduction in CO_2 emissions achieved by reducing commuting, business trips and travel and the increase in CO_2 emissions resulting from the construction and operation of information/communications networks. The teleworking population (total number of people engaged in telework two or more times a month) in 2010 is estimated at 20.80 million people. Expressed in percentages, 4.2% of total aggregate working time takes the form of telework.

2☐ Estimated reductions achieved by the diffusion of enhanced car navigation systems, electronic toll collection systems and optimized traffic management systems, among the various subsystems making up Intelligent Transport Systems (ITS).

3☐ Estimated reductions achieved by reducing paper consumption, including the consumption of slips, forms and printer paper, through the installation of LANs.

4☐ Estimated through alternative access to work, reducing amounts of waste paper, decentralization of cities, etc.

5☐ Estimated reduction in energy consumption as a result of expanding the introduction of building management systems and associated introduction of heat-recovery air-conditioning systems and automatic lighting adjustment and on/off control systems by 2010.

6☐ Estimated on the assumption that 10% of the total volume of books, newspapers, etc. published the 1990 financial year will be switched to electronic publishing and electronic newspapers.

7☐ Estimated reduction in energy consumption as a result of reducing the use of transportation systems through substitution for travel.

Note: Only the seven activities above were estimated. Activities such as electronic commerce and other IT-activities will further reinforce sustainability.

Source: Compiled by the author based on
http://www.mpt.go.jp/policyreports/english/telecouncil/global_env_index.html
and MPT News Vol 8, No 19, Dec 29, 1997

The contribution of T/T explained above is only a small part of the Report; it contains other contributions of IT such as those brought about by the introduction of ITS (intelligent transport systems), high-performance displays for television and computers, etc. The main contribution to sustainability can be summarized as shown in inset Box 1.

Analysis of Telework/Telecommuting Behaviour in Japan

One of the important policy issues left unanswered in the Report is the actual choice of policy instruments. The Report presents a set of preconditions needed to achieve the target set in COP3; it does not deal with whether the preconditions will become reality, or, if not, what policy instruments should be used to put them into practice.

To deal with this issue systematically is a formidable task and something which can only really be tackled stepwise. Recently, H. Mitomo and T. Jitsuzumi [H. Mitomo and T. Jitsuzumi, 1998] made an attempt to approach this issue in relation to T/T. Their paper gives a forecast of telecommuters in Japan in three scenarios for the period from 1995 to 2020 by using assumptions based on the growth curve represented by logistic functions (See Table 3). Scenario 1 is a conservative case, scenario 2 an intermediate case, and scenario 3 an optimistic case. For the conservative case, the percentage of telecommuters in the total workforce in 2005 is 9.16%, which is greater than the percentage used in the Report for 2008. The difference between the two estimates comes from the fact that different assumptions have been used. No estimate of telecommuters can avoid forecast errors so we should not be surprised at seeing differences of this kind.

In the second half of H. Mitomo and T. Jitsuzumi's paper, an attempt is made to estimate the value of T/T for telecommuters, and the value for non-telecommuters, in relation to train transportation in the metropolitan Tokyo area. Telecommuters receive direct benefits from T/T in terms of shorter commuting time (often zero) and avoidance of traffic congestion (in the Tokyo metropolitan area the underground is so crowded during the rush hour that passengers

Table 3

Estimated Number of Telecommuters in Japan (by Mitomo & Jitsuzumi) (Thousands)

Year	Scenario 1	(1)	Scenario 2	(1)	Scenario 3	(1)
1995	814	1.20	848	1.25	862	1.27
2000	2,943	4.24	2,934	4.23	2,931	4.22
2005	6,367	9.16	7,199	10.35	7,656	11.01
2010	8,490	12.47	11,290	16.58	13,400	19.68
2015	9,152	13.86	13,200	20.00	16,850	25.53
2020	9,421	14.52	13,970	21.54	18,370	28.31

Note (1): Percentage of telecommuters in the total workforce.

The direct personal benefit is a motivation for workers to become telecommuters. However, their action reduces congestion and so also favours non-telecommuters. This fact justifies the use of public policy instruments to provide further incentives to telecommute

are often packed into carriages with little space to move even their arms). Non-telecommuters (i.e. ordinary commuters) also benefit from the reduction in congestion brought about by T/T. Thus, T/T gives direct benefits to telecommuters, and indirect benefits to non-telecommuters; a clear case of positive externalities.

H. Mitomo and T. Jitsuzumi's article estimates the benefits of T/T with the aid of an assumption regarding the marginal elasticity of substitution between the level of congestion and the commuting time. As Table 4 shows, the direct benefit of T/T to telecommuters is somewhere between 197 and 253 yen per working day, whereas the indirect benefit of T/T to non-telecommuters for the intermediate scenario lies between 37 and 99 yens per working day.

These estimates give us some idea about the magnitudes of the *private benefit* of T/T to telecommuters and non-telecommuters. (Observe that these benefits do not include that of achieving global sustainability.) The estimated private benefit obtained in the Paper can be used for choosing policy instruments to promote T/T for sustainability. The direct private benefit is a motivation for workers to become telecommuters. The indirect benefit is an external impact of T/T enjoyed by non-telecommuters. It is conceivable therefore that the government could impose a tax on non-telecommuters for not becoming telecommuters (e.g., in the form of environmental tax on transport), and to use the revenue from such taxes as a subsidy to telecommuters for becoming telecommuters, irrespective on impacts upon sustainability.

Conclusion

In this article we have discussed the possible contributions of IT to global sustainability, and considered a framework for formulating public policies promoting T/T. We have also looked at forecasts for T/T, and an analysis of how it may affect individual behaviour, in relation to possible contributions of T/T to sustainability.

In reality, needless to say, there are hundreds of such causes and effects generating direct and indirect benefits/costs in relation to an activity for promoting sustainability. To formulate a system of wide-ranging policies for sustainability is a difficult task. The work presented by the Report and H. Mitomo and T. Jitsuzumi's paper opens up a path towards such a system.

Table 4

Estimated Value of Telecommuting to Telecommuters and Non-telecommuters: Japan, Tokyo Metropolitan Area (by Mitomo and Jitsuzumi) (Yen per workday)

Area Average	Telecommuters		Non-telecommuters	
	Model 1	Model 1	Model 2	Model 2
Scenario 1	197	253	29	77
Scenario 2			37	99
Scenario 3			44	115

Keywords

telework, CO_2 emissions, externalities, Kyoto protocol, incentives, sustainability

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