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

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Issue: Telework and telecommuting (T/T) enables the reduction of environmental problems due to transport. It is estimated that the net effect of T/T is about 2% of Japan's total reduction of carbon dioxide emissions by 2008, as agreed in the Kyoto Protocol, while the overall net impact of all IT-related activities is about 7%. T/T will also contribute to private benefits and less public transport congestion - a positive externality irrespective of sustainability impacts.

Relevance: Since T/T will contribute towards private and social benefits above sustainability, policies should be designed to support T/T. For instance, the tax instrument can be used to influence T/T behavior.

I. Roles of Information Technology for Sustainability

Information technology (IT) is expected to play important and wide-ranged roles in pursuing sustainable societies. The roles may be classified into three groups:

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

First, direct effects arise from the increase in the efficiency of facility operations or human activities through the use of various information systems. Examples are the saving of energy with air conditioners through controlling them by information devices, and the saving of energy for transportation by means of intelligent transport systems (ITS).

Indirect contributions come from changes in the style of living and work with the use of IT. For example, telework/telecommuting (T/T) saves not only the daily commuting time of workers but also the energy consumed for commuting. Other examples are the development of remote-sensing devices to monitor the state of global environment, and the use of computerized bidding mechanism for trading the right to emit carbon-dioxide (CO_2). These are but a few of the many examples of possible ways through which IT contributes to sustainability.

There is one more way; IT improves the overall decision-making capability of a society to implement public policies for sustainability. Collective decision making on public policies, however, are subject to political factors. In a democratic society, a collective choice which influences the majority of the people can be supported only with the approval by them. This means that, in order to accept the consequences of public policies which are useful for the global community as a whole in the long-run but often go against the direct and short-run interests of individuals and communities, the majority needs to understand the consequences of selfish decisions to the world as a whole, and eventually to each of them. Knowledge society is a prerequisite for sustainability in this sense, and IT can help one built as quickly as possible and hopefully before it becomes too late to get on the track of sustainability.

II. Complex Causal Relationships

In considering the contribution of IT for sustainability, we need to take note of the causal relations of IT. Take the case of T/T for example. The development of IT helps people telework, thus relieving them of physical commuting and decreasing the atmospheric emission 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 policies are formulated for T/T. See Figure 1.

The boxes and the arrows in Figure 1 summarize the causes and the effects of 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 the reduction of CO_2 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 and also on policy instruments (such as government subsidies), as indicated respectively by the arrows from D to C and E to C. In addition, the arrow from E to D shows possible effects of policy instruments on IT technology and services.

It is noted that boxes B, C, and D have incoming arrows representing other causes. Consider box C, for example. The decision on 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 the 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 behavior 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 reasons for this effect. For instance, the actual reduction of transport due to T/T is less than expected due to a number of other transports taking place, such as personal transports during the day, transports at a later time to the offices, increase in customized delivery to the 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 netshopping. 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 vastness of the issue of IT and sustainability. One can imagine hundreds of interconnected diagrams each of which looks like the one in Figure 1. A research work such as this paper can consider only a small portion of this issue. The following sections introduce an attempt by the Japanese government toward formulating a policy for T/T, and a research work toward estimating the behavior of individuals on T/T.

III. 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; the understanding of the need for sustainability by the Japanese people was promoted greatly around this meeting. In the Kyoto meeting, it was agreed upon that Japan, together with other advanced countries, decrease by the year of 2008 the atmospheric emission of CO_2 and other greenhouse gases to the level that is lower by 6% than the emission level in 1990. This means a decrease of the emission by 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 Report*).

The Report presents a decomposition 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 the CO_2 emission 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 clerks, professionals and engineers, sales transportation 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 the highest (20%) with managers and office clerks, and the lowest (1 or 0%) with sales transportation and communication workers, or with other workers. From these settings a total T/T in 2008 is projected to be 4.19 million manyears, 6.6% of the total workforce. Furthermore, 35% of this T/T manyears is attributed to work at home, 15% to work at satellite offices, and the remaining 50% to work at spot offices (offices available at rental bases).

By using the data in Table 1, the Report calculated, as shown in Table 2, the gross and the net decrease in the emission of CO_2 brought about by the introduction of T/T and the use of remote video meetings. As discussed above, T/T will save energy for commuting on one hand, but will increase the consumption of energy at home and at satellite offices on the other. The Report estimated such parameters needed to calculate the gross and the net decrease in CO_2 emission as the average distance of commuting per person (3100 kilometers per year for the case of commuting by train), and the amount of CO_2 emitted from commuting (4.8 tons of carbon per million person kilometers for the case of trains). The figures shown in Table 2 are obtained by assembling the data in Table 1 together with the projected parameters. The total decrease in CO_2 emission is calculated to be 1.29 MTC per year.

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 in the box below.

Box

Impacts of ICT on Sustainability: The Japanese case

The Telecommunications Council, an advisory body of the Ministry of Posts and Telecommunications (MPT), released an "Interim Report Concerning Global Warming" on November 20, 1997. The report presents predictions of the CO_2 reductions that might be attained through the use of information systems, which have the potential to reduce CO_2 emissions.

System	**CO_2 Reduction**
(converted to equivalent CO_2 amounts)	
1. Telework	1.29

million tons

2.	ITS	1.10 million tons
3.	Reduction of paper consumption by using LANs	0.72 million tons
4.	Building management Systems	0.40 million tons
5.	Electronic publishing and electronic newspapers	0.26 million tons
6.	Distance learning, home education systems	0.04 million tons
Total reduction per year		**3.81 million tons**

Explanations

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 info-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 the total aggregate work time is devoted to telework.
2. Estimated reduction 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 reduction achieved by reducing paper consumption, including the consumption of slips, forms and printer paper, through the installation of LANs.
4. 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.
5. Estimated on the assumption that 10% of the total volume of books, newspapers, etc. published in FY 1990 will be switched to electronic publishing and electronic newspapers.
6. Estimated reduction in energy consumption as a result of reducing the use of transportation systems through substitution for travel.

Source: MPT News, Vol. 8, No. 19, Dec 29, 1997

IV. Analysis of the Behavior on Telework/Telecommuting 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 have them become reality.

To deal with this issue systematically is a formidable task; we can only proceed step by step. Recently, H. Mitomo and T. Jitsuzumi [1998] (the Paper) made an attempt to approach this issue in relation to T/T.

The 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 the year of 2008. The difference between the two estimates comes from the difference of the assumptions used in the Report and in the Paper. No estimate of telecommuters can avoid forecast errors, and we are not surprised at seeing such a difference.

In the second half of the 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 on shorter commuting time (often zero) and no traffic congestion (in the Tokyo metropolitan area, the traffic condition during the rush hour period is so bad that passengers are often packed into a train car with little space to move even their arms). To non-telecommuters (i.e., ordinary commuters), T/T still gives the benefit of having less congestion. Thus, T/T gives direct benefits to telecommuters, and indirect benefits to non-telecommuters; this is a case of positive externalities.

The Paper estimates the benefit of T/T, with the aid of an assumption on 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 yens per workday, whereas the indirect benefit of T/T to non-telecommuters for the intermediate scenario lies between 37 and 99 yens per workday.

Such estimates as obtained in the Paper gives 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 the one of achieving global sustainability.) The estimate of the 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 telecommuters to become telecommuters. The indirect benefit is an external impact of T/T enjoyed by non-telecommuters. It is possible, therefore, for the government to impose a tax on non-telecommuters for not becoming telecommuters (e.g., in the form of environmental tax on train fares), and to use the revenue from such taxes as a subsidy to telecommuters for becoming telecommuters, irrespective on impacts upon sustainability.

IV. Conclusion

In this short paper, we discussed about possible contributions of IT to global sustainability, and considered a framework for formulating public policies promoting T/T. This paper then introduced, a projection of T/T by the Japanese government, and an analysis of the (private) behavior on T/T, in relation to possible contributions of T/T to sustainability.

In the 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-ranged policies for sustainability is a difficult task. The work presented by the Report and the Paper breaks an path leading to such a system.

References

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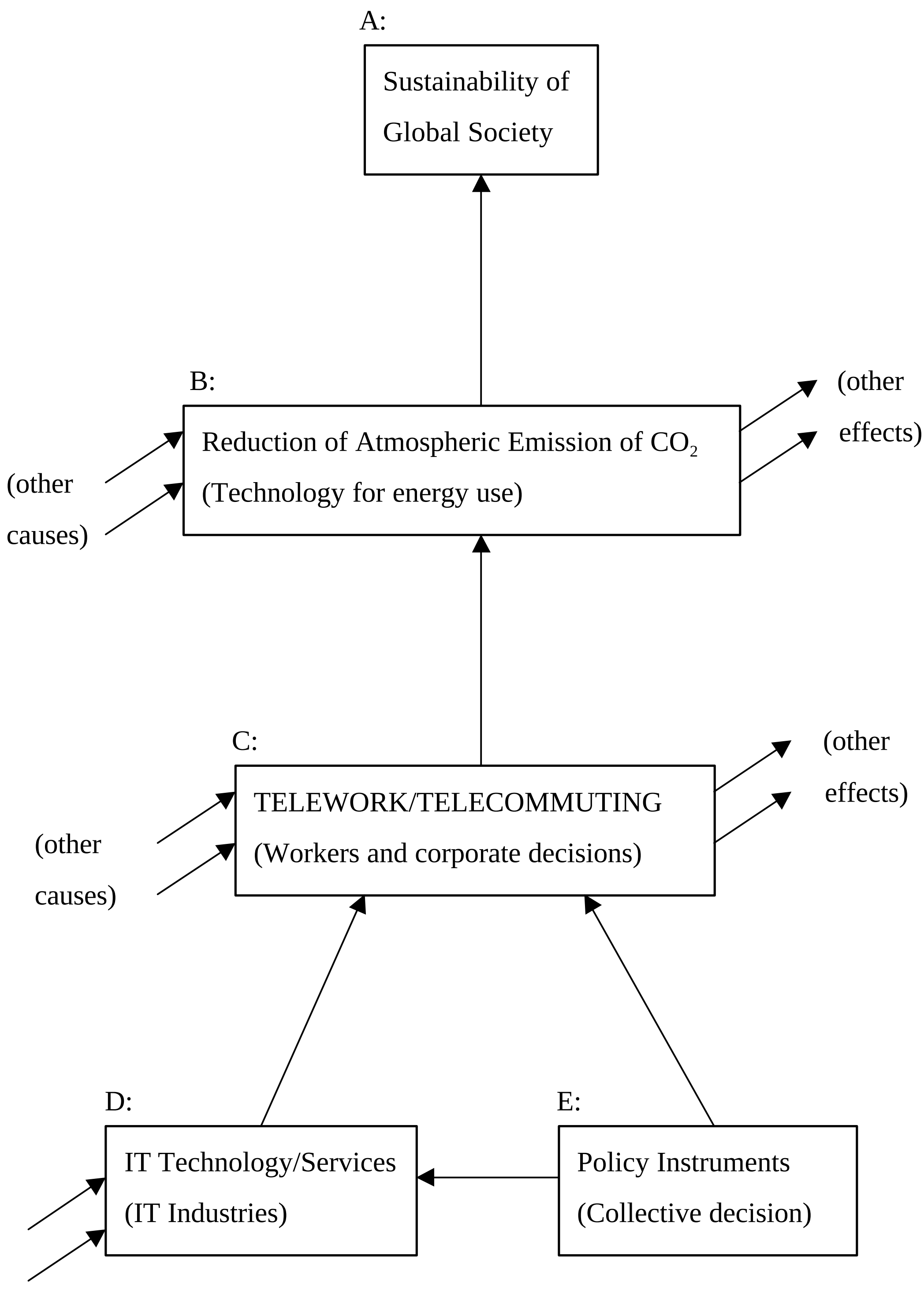

Figure 1: Causes and Effects Involved in "Telework/Telecommuting"

Workers Occupation		Total Manhours	Total Manhours Composition (%)	T/T Manhours Percent of T/T	T/T Manhours	T/T Manhours Composition (%)
	Managers and Office Clerks	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
T/T	Work at Satellite Offices				0.63	15
T/T	Work at Spot Offices				2.09	50

Table 1: Estimated T/T Participation in 2008: Japan (by MPT)

(Million Manyears)

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

Table 2: Projected Change in CO_2 Emission due to T/T in 2008: Japan (by MPT)
(1,000 tons of Carbon per Year)

Year	Scenario 1		Scenario 2		Scenario 3	
		(1)		(1)		(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.

Table 3: Estimated Number of Telecommuters in Japan
(by Mitomo & Jitsuzumi)
(Thousand)

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

Table 4: Estimated Value of Telecommuting to Telecommuters and Non-telecommuters: Japan, Tokyo Metropolitan Area (by Mitomo and Jitsuzumi) (Yen per workday)

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"Information Technology for Sustainable Societies--Public Policy Perspectives in Japan: A Case of Telework" (co-authored with Hitoshi Mitomo), *The IPTS Report* (edited by the Institute for Prospective Technological Studies (IPTS), published by the European Commission, Joint Research Centre), No.39, March 1999, pp.24-31. An outline was presented by Hajime Oniki at the PLATO Seminar of the FWSymposium, Poitier, France, March 1-5, 1999.

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