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**Digital Information Network Technologies,  
Organizational Performance and Productivity**

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# **Digital Information Network Technologies, Organisational Performance and Productivity**

## **An Exploratory Study of the Public Sector in Europe**

By

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## EXECUTIVE SUMMARY

### The study and its organisation

The changing extent of adoption and the modes of utilising networked informational technologies within the public sectors of modern economies, and the ways in which these developments affect the performance of public organisations are matters of obvious importance from the economic standpoint, as well as for the political and social consequences that may follow. Yet, the economic aspects of the uptake and utilisation of digital network technologies by organisations, and the effects these have had upon both their internal operations, and their interactions with citizens and private sector organisations, have begun to be studied only recently. A significant advance in systematic quantitative research on this subject has become possible recently, due to the availability of a remarkable dataset. That material was gathered in a survey of more than a thousand public sector organisations located in eight European countries, which was conducted during 2003 by the Momentum Research Group for the *Net Impact 2004* report sponsored by the Cisco Corporation.

This Report presents selected results from the Oxford Internet Institute's exploratory study of this remarkably body of data. The research and its findings in this phase focused on three distinct but interrelated sets of empirical phenomena:

(1) ***Aggregate diffusion patterns and trends:*** The macro-level extent of e-network technology adoption in the public sector as of the beginning of 2004, and the projected near-term and planned adoption rates, across the region represented by the seven western European countries and Poland from which survey data was gathered.

(2) ***Technology acquisition and deployment by individual organisations:*** The main patterns in the adoption of specific e-network technologies by individual organisations, and the resulting overall "profiles" that can be identified as characteristic of distinct stages of advance in the acquisition and deployment of digital information network technologies (DINT) by each of the different types of (government and health) organisations in the public sector.

(3) ***Performance "impacts":*** The relationship between micro-level estimates of changes occurring in selected aspects of organisational performance (with respect to "productivity" and customer/client satisfaction) that were gathered from a sub-sample of the survey population, on the one hand, and, on the other hand, the status of the organisations' respective DINT facilities of the reporting organisations and the particular business practices they were following in utilizing their network infrastructures and networked applications.

The organisation of this presentation is straightforward. Issues motivating our study of each of the foregoing topics, and the connections among them, are discussed in Part I. Part II takes up the questions of diffusion at both the macro- and micro-levels. Part III tackles the third topic, presenting the findings of a preliminary approach to quantifying the differential “impacts” on organisational performance that are associated with differences in the configuration of e-network technologies and accompanying business practices. The text concludes with a number of necessary qualifications that point to both the need for caution in interpreting the findings we present, and the yet unexhausted potentialities for further, more refined analysis of the existing data and supplementary material that may be gathered in future surveys. In the interest of conciseness, and to avoid unduly burdening readers with technicalities, discussions of the underlying survey data, methodological problems, statistical procedures, and selected details of the results have been placed in addenda for each of the three Parts which are grouped following the text.

## **Key findings on the extent and pattern of technology diffusion**

### ***At the macro-level: the public sector in Europe in 2003 and after***

Estimates of the macro-level extent of adoption of the main classes of network services and networked applications by public organisations across the 8 European countries covered by the NI 2004 survey point to the existence of something resembling a “digital divide”. Quite large proportions among these “connected” organisations (well above two-thirds) had equipped themselves with these technologies at basic levels, such as network virus detection, security and recovery services, and back-office organisational control applications (for financial accounting and human resources management). A much smaller faction among these organisations had rolled out more sophisticated network infrastructures and provided their employees with access to web portals and customer/client relations management systems – thereby supporting more than basic business functions.

The larger organisations -- particularly those having 500 or more employees and the national government organisations in the northern European region -- generally have been fastest off the mark in introducing the more advanced technologies and deploying them more extensively. The projections we have been able to make of future trends in technology adoption on the basis of survey responses, however, suggest that the presently existing “divide” is not likely to persist long into the future. Rather, it appears to be a transient result of lags in the inter-organisational diffusion of these e-network technologies associated with differences in region, size and type. The substantial convergence that is observed in adoption plans for the entire array of services and applications points to a relative fast phase of “catch-up” by the laggards in the near-term – which we envisage as occurring during the 2003-2008 interval.

### ***At the micro-level: technology profiles of the organisations***

More detailed examination of patterns of technology adoption at the micro-level lends further support to the impressions gained from the macro-level data. By applying the statistical technique of cluster analysis to the full set of observations in the TDM survey on network services, networked applications and the extent of intra-organisation deployment of those applications, it is possible to distinguish a small number of technology-adoption configurations (clusters) in each of those three dimensions. The clusters in each dimension can be ranked in ascending order from a "basic profile" to more extensive and sophisticated technology profiles. Examination of the cross-section distribution of organisations among the profiles thus defined reinforces the two suppositions drawn from the macro-level indicators. The first is that public sector organisations in Europe have tended to follow similar dynamic paths of technology acquisition and deployment, and the second is that those who have been slower to start on this ascent will be catching up with the leaders before very long.

### ***The distribution of organisations by level of "technology profile"***

An overall profile, combining the indicators of the relative technological positions of individual organisations in the three separate dimensions just noted has been constructed by performing a "meta-cluster" analysis. This procedure assigns each organisation to one or another of a distinct number of "technology profiles" that are associated with the constituent "cluster-assignments" and two other (binary) classifications. The latter capture distinguishing features of their network infrastructures and of the range of business functions that are supported by their networked applications. This method of "data reduction" yields meta-clusters that have a rank-order, and it reveals that the large organisations are systematically under-represented among those observed at the lowest level of these summary technology profiles. While this suggests that organisation size may well be correlated with access to budgetary and technical resources that have advantageously affected the advance on the part of the large organisations, organisation size *per se* may be not exercising independent effects upon the rates at which these organisations are able to improve their performance.

The meta-cluster analysis of the patterns of technology acquisition and deployment reveals that there are differences among the various types of organisations in their distributions among the levels of the ascending scale of technology profiles that we have identified. This is seen clearly from the variation in the locus of relative concentration across the array of organisation types. Whereas regional government organisations are significantly concentrated at the lowest level, and local clinics and health care organisations tend to be clumped together at the level just above that, national government organisations and other entities in the health sector (particularly those dealing with health insurance) are disproportionately concentrated at the highest level of our technology profiles. Hospital and laboratories, clinics and other units of

the government sector occupy intermediate positions among which the differences in the rank ordering technology profiles is not clear-cut. Whether the future will witness a tendency toward technological convergence by the different public organisations at the upper end of the scale remains an open question. Their distinctive range of functions makes it more likely that the substantial differences now present will persist for some time to come.

### **The pace of technology diffusion and aggregate productivity growth in public sector organisations**

The projected macro-level trends in the adoption of these e-network technologies carry some implications as to the likely growth of average productivity among employees in public sector organisations. To bring these out, the quantitative trends in the sector-wide extent of diffusion can be considered in conjunction with the what has been learned (in Part III of the Report) from analysis for a sub-sample of these organisation of the relationship between their adoption and mode of utilisation of e-network technologies, on the one hand, and, on the other hand, the proportionate rates of improvement that their business managers' perceived had occurred in the average number of cases resolved per employee. By combining the two types of empirical information within a formal (mathematical) model one can obtain approximate estimates of the implied rate of growth in the sector-wide average number of "cases resolved per employee" during the period 2003-2008.

Our estimates of the aggregate annual growth rates obtained for this generic "task productivity" measure span in the range between 2.2 percentage points and 5.6 percentage points. The lower rate refers to the direct effects of the projected diffusion of digital information technologies whose adoption was associated with increases in average labour productivity at the organisation level; the higher of the pair of growth rates reflects the inclusion of an estimate of indirect "learning effects" and network externality spillovers associated with the accumulation of experience in the use of those technologies.

Rather strikingly, the foregoing magnitudes closely resemble the pace of advances of aggregate labour productivity in the U.S. private domestic economy during the period beginning in the late 1990's. This era has seen a very substantial resurgence of the rate of growth of labour productivity, a development that has been attributed by macroeconomists to the cumulative effects of ICT-embodied capital formation, worker retraining, and the associated reorganisation of production and distribution operations within the U.S. private domestic business economy. Although the broadly parallel results presented here for the European public sector are indirect forecasts based upon a narrow indicator of task productivity, they lend a plausible degree of concreteness to the view that industrially advanced economies during the years ahead will see a similar surge of improvement in at least some dimensions of public sector organisations' "productivity performance."

## **Key findings about e-network technology impacts on selected aspects of organisational performance**

Four salient findings emerged from our investigation of the factors that appear to systematically affect the organisational performance gains in Europe's public sector organisations. These relate to the differential impacts upon productivity improvements and increased client and customer satisfaction that are associated with differences among organisations in the following respects: (1) their networked technology "profiles," (2) their adoption of "best practices" in deployment and utilisation of the new technologies, (3) their use of particular combinations of technology and "best practice" approaches in implementation and application, and (4) national differences vs. differences between government and health-sector organisations.

1) The main significant difference is that between the marked of performance improvements perceived by managers in organisations that had attained a minimal overall technology profile and the *smaller* proportionate gains reported by organisations that were considerably more advanced in their acquisition of e-network technologies. The "minimal" or basic technology profiles simply affords clients and customers online access, provides employees with virus-free email, and networks the organisation's on-line back-office applications for managing accounting and finance, and human resources management and training. By contrast, the technologically "more advanced organisations" in this comparison were those that had gone beyond the "basic profile" by adding internal and external web portals and moved toward having the complete array of networked applications.

1a) The pattern of associated performance payoffs in the reported rates of increase in average cases resolved per employee, and in measures of customer and citizen satisfaction, is consistent with the existence of rapidly diminishing marginal payoffs to further technology acquisition without accompanying organisational changes. The former group of organisations may well have experienced (and therefore report) bigger percentage gains during the preceding year than was the case among their counterparts whose technology profiles had advanced beyond that basic level during the same time interval. But, because the available data are cross-section observations of percentage changes in performance metrics, rather than time-series data for the organisations in question, the "diminishing marginal returns" interpretation is merely an inference.

1b) A second, rather different interpretation can be given to the foregoing findings. Business decision managers in organisations that are still at low levels in terms of their digital networked technology adoption/deployment may tend to over-estimate the pure, technology-driven effects on performance of having become "Internet-connected" at that basic level. The first stage of the transition to complete network connectivity could well be accompanied by strong performance improvements arising from induced changes in employee motivation and morale that are associated with



the introduction of new equipment, altered working conditions, and greater managerial attention. Effects of that kind – so-called “Hawthorne effects” – are found to be strongest during the initial introduction phase of improvements in working facilities and altered routines; and Hawthorne effects on worker productivity in industrial establishments typically are observed to wear off with the passage of time, unless renewed by recurring major changes accompanied by continued managerial and supervisory interest and attention.

1c) Of course, it also remains possible that the business decision managers in organisations that are still at very early stages in their use of network services and networked applications may have been particularly concerned to encourage the allocation of resources that would enable continuation of the process. That might have led them to be particularly disposed to offer overly enthusiastic estimates of the performance gains that accompanied the initial steps.

2) Some among the purported “best practices” in the implementation of digital network technologies are found to matter quite a lot, but most of the items in the long list of such business process practices and features of organisation culture affecting IT that were examined in the context of our statistical framework do not significantly affect the estimated rates of performance improvement. In our final results, only 2 of the 13 supposedly significant “best practices” that the *NI 2004 Report* cited in the case of customer and citizen satisfaction remained as having a statistically significant positive effect on improvements reported by organisations that tracked the metric in question. These two were “integration of business processes” and whether a “strategic IT plan was communicated throughout the organisation.” There is some evidence that a third, closely related practice also contributes to boosting performance: the existence of network wide applications that support data-mining and analysis.

2a) In the case of the conventional productivity improvement metric (based on cases resolved per employee), none of the supposed “best practices” had statistically significant impacts when allowance was made for the effects of differences between government and health organisations and national differences. Only the “integration of business processes” was found to contribute significantly to shortening the average case resolution time. Thus, it appears that it is the latter practice – entailing the consistent alignment of business processes with networked applications and the organisation’s network infrastructure -- that appears to be the most robustly pervasive, and hence reliably “best” in its positive association with increased performance with regard to productivity and customer and client satisfaction.

3) The results of our regression analysis studies clearly indicate the existence of generally higher payoffs – in terms of rates of performance improvement -- where public sector organisations at higher technology profile levels also adopt key “best practices” in technology application. The markedly greater magnitudes of the resulting impact effects on the productivity metrics are quite

striking, especially in comparison with the average performance improvements described by the *NI 2004 Report*

3a) Whereas the *NI 2004 Report* found estimated impacts in the 20-45% range for improvements in average time to case resolution where “best business process practices” were followed, same range of impacts appear from our analysis to be obtained *when none of the so-called “best practices” in business process and organisation management are present*. Moreover, where there is “integration of the business process” with network services and applications, the range of impacts is seen to be raised by a factor of more than three-quarters.

3b) Still more impressive results emerge in regard to the estimated impacts on average number of cases resolved per employee, the most reliable of the pair of productivity metrics we studied. Organisations that had deployed internal and external web portals among their network services, were providing more than the minimum profile of networked applications (finance and accounting, and human resource management and training), and had also attained an above-median extent of deployment of customer or citizen relationship management applications on their network, appear to benefit greatly when they consistently align these technologies with their business processes. The addition of just that form of “best practice” alone is associated with a more than four-fold increase in the annual percentage growth rate in cases resolved per employee. This is found to be the case across the entire range of organisational types and countries when explicit allowance was made for such variations.

3c) Thus, it appears justified to surmise that if there is an incipient tendency towards diminishing marginal returns to technology acquisition investments alone, it can be more than overcome by commitment to consistent integration of business processes in these public sector organisations.

4) Inter-country variations in manager’s estimates of performance payoffs from ICT investments generally are not found to be statistically significant *where any of the other explanatory factors are present*.

4a) Despite the emphasis placed on national differences by the presentation of finding in the *NI 2004 Report*, our results do not show many significant inter-country differences in changes in the average number of cases resolved per employee. In the case of changes in customer and citizen satisfaction, we have found that the average rates of performance improvement are markedly lower among both government and health sector organisations in Germany. Similarly, the impacts on the average speed of case resolution in both Germany and Sweden exhibit significantly smaller improvement percentages than the groups including the U.K., Italy, Holland and France.

4b) The findings just noticed, however, may reflect the existence of certain systematic inter-country differences in the configurations of networked information technologies that are distinctive among public organisations in the generally more advanced northern European region, but is not adequately captured by our simple cluster analysis approach to characterizing "technology profiles." It thus remains a possibility that because the nationality effects are capturing differences that would be identified by more sophisticated controls for technology deployment profiles, the results give the appearance of a tendency towards smaller incremental improvement of organisational performance in the countries that were farthest advanced in integrating their business processes with a full array of e-network technologies.