Information Technology in Selected Countries

Reports from Ireland, Ethiopia, Nigeria, and Tanzania

Edited by Eileen P. Drew and F. Gordon Foster

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University**
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Contents

Introduction

F. G. Foster, Project Director

The country reports constituting this publication were prepared as an integral part of the activities of a third-world informatics research and training project carried out, in cooperation with the United Nations University (UNU), at Trinity College, Dublin (TCD), the participants on which were UNU fellows.

The Project Philosophy

The UNU/TCD project had its origins in the conviction that there was an urgent need for developing countries to build up their capabilities in information technology and self-reliance in informatics development and that the prime requirement was the development of a broad understanding of the significance of informatics. Transfer of technological know-how, as opposed to technological products, was primary. This was the philosophy behind the project, whose aim was to train individuals who would act as multipliers on their return to their countries and promote institutional informatics development.

With this in mind, the emphasis in the project was on issues of policy for informatics development, while at the same time the training was provided to enable academics and administrators to acquire practical skills and to apply them, together with their Irish-based experience, to the needs of their institutions in an innovative way.

A Definition of Informatics

It is useful to make a distinction between the terms *information technology* and *informatics*. Information technology (IT) means the group of technologies that is revolutionizing the handling of information. In a report that I prepared for UNIDO on their policy for IT,[1] the term *informatics* was defined as the study, not of IT, but of the consequences of IT, including the variety of ways in which information flows, is processed, is utilized, affects productivity and efficiency, is used for monitoring and control purposes, and, lastly, influences socio-economic development and society itself. This is analogous to the use of the term "economics," which refers to the study, not of the production and distribution processes and procedures themselves, but of how they are deployed to provide goods and services from scarce resources to meet human needs.

The Informatics Project

The project was planned as a pilot investigation that would establish the most effective research and training procedures at a global level and provide a baseline for a further more comprehensive, well-planned and well-structured second-stage informatics project. To this end, in the latter years of the project, a research study was initiated whose aim was to investigate the processes of IT innovation and the mechanisms for development relevant to differing sets of circumstances in different countries.

The Country Reports

The country reports were intended to form a part of the baseline information required. Each was intended to be a survey of the state of IT development at the national level. Of the nine countries represented on the project, seven were African. It was decided therefore to confine the reports to Africa, apart from a report on Ireland, which was written in advance of the others by my colleague Dr. Eileen Drew, Project Research Coordinator, and was intended to provide guidelines for the other reports. Together with the report on Ireland, this publication comprises country reports on Ethiopia, Nigeria, and Tanzania. (Country reports were also sought from Egypt and Zambia, but these did not materialize.)

 Attention is drawn to the fact that the authors who were commissioned to write the African reports are all former UNU fellows on the project. Thus they were all aware of the basic aims of the project, had in common the same basic informatics training, and had participated in the same discussions on policy issues. It was anticipated that this common background, together with the provision of the Irish paradigm, would result in some overall uniformity of presentation.

 Mr. Teferi Kebede, Ethiopian Science and Technology Commission,

Addis Ababa, joined us at TCD as a UNU fellow in 1985. His work while with us involved an examination of the ways and means of developing a computer-based library and information centre for his organization. He returned again to TCD at a later date to read for the degree of M.Sc.

Dr. Michael Nwachuku, Department of Electronic Engineering, University of Nigeria, was a UNU fellow at TCD during 1987–1988, and worked on a plan for the establishment of a microprocessor application laboratory at his university, with a view to fostering the growth of an indigenous IT industry focusing on the needs of agricultural and industrial enterprises.

Mr. Klodwig Mgaya, Faculty of Commerce and Management, University of Dar es Salaam, Tanzania, was also a UNU fellow at TCD during 1987–1988. He worked on the development of certain aspects of the technical expertise required to strengthen the consulting capability of his university in the area of the use of microcomputers in business.

Dr. Eileen Drew, Lecturer in Systems, Department of Statistics, TCD, coordinated the training of all UNU fellows. She also led the team that was later set up to research IT innovation and was responsible for coordinating and writing up the results.

Close study of the four reports, of which two describe market economies and two centrally planned ones, reveals many useful comparisons and contrasts. While these reports were the result of desk research only, taken together they would provide the basis now for asking many questions.

Take, for example, the IT policy sector. Of the four countries, only Ethiopia has evidenced a sustained commitment to IT planning at the national level. (Whether the economy is a market one or centrally planned is not the overriding factor, as is evident also elsewhere if one compares, say, the United States and France.) The withering of national IT planning in the 1970s, after a promising start, did, in my view, delay IT development in Ireland; and the absence of IT policy in Nigeria and the early negative IT policy in Tanzania certainly delayed developments in these two countries.

Again, consider the telecommunications sector. All four reports make it clear that it is now accepted that this is an indispensable infrastructure for industrial development. Ireland, relatively late for a developed country and relatively early for a developing country, modernized rapidly at the national level. The other market economy, Nigeria, has not. It was left to the oil companies to install private systems, a packet switched data network (PSDN) using leased lines and an all-digital network using optical fibre cables, said to be the largest network in Africa. Again, Ethiopia modernized early but Tanzania has only recently begun to install digital exchanges.

To investigate these differences across the IT sectors would be useful, and these reports could form a basis for constructing relevant nationwide surveys of each of the important sectors of IT development.

It was felt that these reports would be of interest to a wider audience and warranted publication on their own account, independently of the overall project report. The type of information provided by them is not otherwise readily available.

These country reports are a start in providing a baseline for the further re-

search and training project referred to above. It is my belief that the production of country-wide reports on individual IT sectors (such as is done by the OECD for industrialized countries) on an ongoing, systematic basis would be of substantial value. Regular updating is also essential. As the author, some 20 years ago, of the first IT report on Ireland,[2] I am acutely aware of the speed of change in this area, and indeed of the acceleration in this speed.

The UNU/TCD Project Report

A comprehensive final report on the UNU/TCD project, of which these country reports constituted one part, is available.[3] The structure of the project was, we believe, unique; readers may therefore be interested in the following very brief summary of it.

The Training Programme

The project ran at Trinity College, Dublin, from 1985 to 1990. Over this period, there were 36 participants in the training and research activities. These participants were fellows selected by the UNU from scholars and policy makers in research institutions, universities, state bodies, and the private sector. The institutions were invited to propose candidates whose studies would contribute directly and in specifically defined ways to already agreed institutional development objectives. The training project was not discipline oriented or designed to enable participants to read for higher degrees or to further their own personal research interests.

The lengths of the fellowships of the 36 participants on the project varied from a few weeks to 15 months, according to their differing requirements and circumstances. In all, 9 countries were represented: Nigeria, Ethiopia, Zambia, Iraq, Tanzania, Egypt, Sudan, China, and Zimbabwe. Most of the fellows were drawn from the university sector, but a number came from other types of institutions and state bodies.

The study areas undertaken by fellows covered:
- informatics education/training/research planning;
- information systems development;
- library/information systems services;
- applications software development;
- health care/epidemiology/population applications;
- microprocessor technology research;
- geographical/geological applications;
- horticulture applications.

To accommodate this wide range of studies, a very flexible training programme was arranged. Each fellow was assigned to an adviser (usually an expert in the relevant field) prior to arrival. Some of the advisers were drawn from within TCD while others were based in external Irish institutions. The range of activities of the fellows included:

- "hands-on" computer laboratory sessions;
- optional lecture courses;
- seminars;
- external courses/seminars/conferences;
- study visits to other European institutions.

The aim was to provide sound training in all relevant technologies and to expose fellows to state-of-the-art systems, hardware, and software. In this way, fellows would acquire a full understanding of IT potentialities and develop an innovative approach and a broad vision. The "tailor-made" approach geared to the needs of individual fellows was central, and it also involved an in-depth study on an institutional development project in the fellow's home institution. Study visits to other European institutions were important for some participants in facilitating contact with experts in their field.

Achievements of the Informatics Project

Considerable institution-wide impact, in terms of the multiplier effect, has taken place since fellows returned to their institutions. Developments under the following headings have occurred:
- consultancy assignments;
- production of reports/research papers/teaching manuals;
- organizing training programmes/conferences/seminars;
- implementation of research projects;
- software evaluation studies;
- systems development;
- appointments to key IT decision-making committees.

Lessons Learned and Future Plans

One of the most important lessons from the project is that, to be successful in selecting candidates who will be good multipliers, it is highly desirable for the host institution to have established links with the institutions from which trainees are to be selected. These linkages could involve cooperation on institutional development projects. During the course of the project we eventually reached this position of working with colleagues in their own institutions whom we already knew well through their having been amongst us at TCD, but this was not the case at the start.

The project has demonstrated the very important role of linkages. Our future plans include the development of already established linkages. Assistance with ongoing institutional development projects in these linked institutions will be essential to their success. This implies that we need to build up our consultancy and advisory capability at TCD in order to fulfil this requirement.

Costly mistakes in the selection of trainees should not occur if, from the start, training services are fully integrated with consultancy and advisory ser-

vices. The strategy in any follow-on training programme should be first to identify appropriate project areas of prime importance in contributing to development in the countries concerned, and, only following on from that, to identify appropriate prospective fellows.

It has also emerged clearly from the project that indigenous consultancy capability hardly exists in developing country universities. We regard the general development of consultancy capabilities as of fundamental importance, and this development will require very careful planning.

As a result of many years' previous experience in third-world development, the TCD team was well aware from the start of the project of the inadequacies and frustrations of communicating in situations where electronic mail (email), telex, fax, and telephone may all be non-existent and where postal services are slow or erratic. Both for routine administration and also for all the information activities routinely carried out by researchers in the industrialized countries, better communications between ourselves and the linked institutions are essential. For this reason, we were motivated during the course of the project to focus on communication itself as a vitally important informatics research problem. As a result, an investigation was set up into the application to communications with and between developing country institutions of small-scale, low-earth orbiting (LEO) satellites.

As a result of this investigation, and thanks to close cooperation with the US development agency Volunteers in Technical Assistance, a satellite ground station is now set up and running at TCD. This provides the potential means to communicate swiftly and reliably, by a form of email, with colleagues in any part of the globe. We are currently investigating the modalities and operational development of this new infrastructure and evaluating its impact on institutional development in facilitating an ongoing dialogue by computer, and thus the transfer of information, among the participating institutions and ourselves. It also provides an invaluable infrastructure for our continuing research into the processes of innovation, with special reference to appropriate adaptations of Western technology to third-world conditions.

Conclusion

This publication provides reports on IT developments in four very different countries. It would be desirable to continue the research thus initiated on a wider international, cooperative basis. Valid approaches to such a study have to take into account the particular environment – social organization, economic structure, and other prevailing conditions – of each country, and the research protocol would need careful and detailed consideration. The main focus in IT developments has now shifted completely away from purely technical computer processes to the social and work processes being supported. The deepest informatics problems reside in the complex processes of information flow that to an ever-increasing extent affect society. On valid approaches to these problems depend the control and management of IT developments for the benefit of humanity.

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Development of Information Technology in Ireland

Eileen P. Drew

1. Introduction

Background to the Report

This study forms the first of a series of country reports commissioned under the auspices of the United Nations University/Trinity College Dublin informatics research project. It was envisaged that the Irish country report would lead to the production of guidelines that could be used in all the other reports.

The selection of Ireland for study was not in order to provide a model for information technology (IT) development. Rather the objective of the study was to investigate what lessons could be learned about the processes of innovation from recent Irish experiences.

In examining the Irish situation it is important to emphasize that no assumptions are being made on the likely effectiveness of any technology transfer. Ireland's membership of the European Community has brought unique advantages that would not be shared by the vast majority of developing countries. This has allowed companies located in Ireland to avail themselves of a potentially large European market, a particular attraction for North American companies. This positive locational advantage has to be balanced against Ireland's peripheral status within Europe, both geographically and economically.

As a relatively late entrant to the process of industrialization, the Irish economy has many features in common with newly industrializing countries. This makes the study of IT adoption and innovation in Ireland an interesting example of some of the range of problems that all developing countries have

experienced or will encounter: a shortage of IT skilled manpower, a non-technocratic culture, relatively scarce resources for IT investment, a low level of awareness among managers and public servants regarding IT applications, and a reliance on bought-in technology transfer through multi-nationals. However, there is no way that Ireland should be seen as a "model" for developing countries. This report draws together the main features of IT innovation that have occurred over the last two decades, and this may provide some insights for developing countries.

Definition of Terms

Innovation

The term "innovation" is used to indicate both a new object, idea, or practice and the process by which that object, idea, or practice comes to be adopted by an individual, group, or organization. In considering the process of innovation, it is useful to consider it as a continuum:

$$\vdash\!\!\text{------------- INNOVATION -------------}\!\dashv$$
Invention   Development   Diffusion   Adoption

The *invention* stage would apply to new types of hardware or potential software tools for information processing that have not been "developed" for any specific procedures and applications. The *development* phase in IT, as in any other manufacturing process, converts the invention into a market-able product or service to potential users. *Diffusion* is the spread of a new idea from its source of invention to its ultimate users or adopters. The diffusion process can be passively or actively pursued in that it may rely on market forces or a trickle-down effect to reach users, or it can be actively promoted through political intervention (at national, institutional, or local level).

Research into diffusion of innovations indicates that this is a critical stage and that certain patterns can be discerned.[1] In summary:
(1) Plotted over time, adoption of an innovation conforms almost always to an S-shaped curve, indicating a lag period before take-off occurs.
(2) Individuals react differently in terms of response to an innovation, ranging from "innovators," "adopters" through to "laggards."
(3) The usual stages are awareness, interest, evaluation, trial, adoption (or rejection), although not all innovation follows these stages.
(4) Certain characteristics of an innovation that make it more likely to be adopted are:
   (a) advantage over existing practice;
   (b) compatibility with existing values;
   (c) low level of complexity as perceived by potential adopters;
   (d) degree to which innovation can be tested on a limited basis.
(5) Early adopters are more likely to be younger, perform more specialized

functions, respond to impersonal sources of information, and be leaders of opinion.

(6) Personal influence from peers is more important for relatively late adopters.

These patterns are important in considering the probability of adoption of innovation within institutions in Ireland and developing countries. In the context of IT innovation, they are also relevant in relation to decision makers and the formation of IT policy at national and institutional level.

Adoption is defined as the acceptance, over time, of a specific idea or practice, by individuals, groups, or other adopting units, through channels of communication (formal or informal) within a social structure by a system of values or subculture. The importance of values and culture cannot be ignored in considering innovation, in Ireland or in developing countries. The general conclusion is that diffusion and adoption are more likely to occur where there is congruence between the innovation and the dominant values of the social system.

Information Technology

The term "information technology" embodies a convergence of interest between electronics, computing, and communications, all of which are leading to the rapid development of micro-electronics.[2] These technologies are being utilized to restructure and reorganize the spheres of production, distribution, and circulation.

According to Wad, it is "the low cost, high-speed and versatile processing and control capacity of the microprocessor and the tremendous information storage capacity of silicon chips that are the significant features of micro-electronic technology."[3] Allied to the technological innovations in the semi-conductor and telecommunication industries, there has been a parallel growth in the supply of and demand for information as a major industry in its own right.[4] Hence the emphasis on "information technology."

The applications for these technological developments have been grouped into four main areas:

(1) The introduction of computing power into the industrial process, thereby extending the level of automation in sectors such as automobile, chemicals, textiles, and engineering manufacture. New developments in information technology have transformed not only the equipment and machinery of the factory but also the role of human labour in production itself.

(2) The substitution of digital for analogue techniques of message transmission and switching has transformed the telecommunications process. "The speed and capacity of new transmission media (such as satellites at a global, and optical fibres at a local, level) are such that vast amounts of data are capable of being transmitted across the world in seconds." This has given rise to the issue of "transborder data flow," especially in many developing countries.

(3) The development of office automation, to support functions ranging

from word processing to highly complex distributed processing systems such as are evident in the banking environment.

(4) Consumer products based on micro-electronics, which relate mainly to the "leisure" industry. These include video games and recorders, videotext services, and personal computer systems.[5]

These main areas, with a lesser emphasis on those listed in category 4, represent the developments and innovative applications under consideration in this report.

Report Outline

In the next section, innovations in IT are charted for Ireland to establish the milestones and trends in IT development.

Section 3 concentrates on the national and institutional context in which IT policy and developments have occurred. It traces the involvement and responsibilities of key institutions in Ireland.

In sections 4 and 5, major developments in the electronics (hardware) industry and software sector are examined. These will be considered against the expectations and projected growth for the Irish hardware and software industry.

The telecommunications infrastructure is dealt with in section 6, in terms of how it has enhanced developments in IT in Ireland and its potential in promoting the transfer of information.

Applications of IT in manufacturing and services are examined in sections 7 and 8, to trace the degree to which IT has penetrated into these sectors and the future expectations for further applications.

In sections 9 and 10, the human side of IT is reviewed in terms of employment trends in the electronics and IT-related industries and the IT-related education/training programmes and initiatives.

The final section draws some conclusions about Irish experience of innovation in IT to highlight some lessons that could be relevant to developing countries in the 1990s.

2. Historical Perspective

The advent of information technology in Ireland coincided with a shift in emphasis in industrial policy. In the post-Independence decades, and most particularly from the 1930s to the 1950s, the emphasis was on promoting import-substituting native industries by the use of tariffs and controls on foreign investment through the Control of Manufacturers Acts (1932, 1934), which were not repealed until 1958.

By the 1960s this policy was altered to (a) actively promoting export growth and (b) attracting direct foreign investment by the availability of capital grants and tax concessions. This significant change in emphasis was due to the lack of sustained growth in Irish industry, a rising balance of pay-

Table 1.1. Survey of computer usage in Ireland, 1986/87

Industrial sector	Technology users					Total	(Total bureaus)
	CPU in 1986	Plan to in 1987	Plan beyond 1987	Bureau only	None		
1. Energy & Water	8	—	—	—	1	9	(6)
2. Extraction & Processing of Non-Energy Metals	32	1	2	—	5	40	
3. Metal Manufacturing Mechanical, Electrical & Instrument Engineering							
– Data processing Machine Mfg.	9	1	—	—	—	10	(12)
– Other	54	1	2	1	12	70	(12)
4. Other Manufacturing	81	5	—	1	10	97	
5. Building & Civil Engineering	15	1	2	—	8	26	(—)
6. Distributive Trades, Hotels, Catering & Repairs							
– Wholesale	61	6	5	2	34	108	(11)
– Retail	15	1	2	—	9	27	(3)
– Hotels & Catering	8	—	—	—	8	16	(1)
– Other	10	—	—	—	8	18	(2)
7. Transport & Communication	37	1	3	1	21	63	(7)
8. Banking & Finance, Insurance, Business Services							
– Banking	8	—	—	—	1	9	(1)