Modelling of an Information Society in Transition - Slovenia's Position in the CE Countries

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Keywords: modelling of socieconomics data, visualisation, information society

Edited by: Cene Bavec and Matjaz Gams
Received: October 4, 1999 **Revised:** December 3, 1999 **Accepted:** December 14, 1999

This paper presents modelling and visualisation of information society development in the six Central European countries associated to the European Union. Modern approach for monitoring and evaluation of the transition processes is presented that enables comparison of the countries' successfulness and analysis of alternative development scenarios. The position of Slovenia, which also experiences gradual transformation to the information society, is shown.

1 Introduction

Slovenia, as well as the other Central European (CE) countries is facing intense transition processes necessary for incorporation to the European Union (EU) and the global information society. These transition processes are especially related to their system development and strategy-based development including the information society capability of these countries.

The change of the political, economic, and legal system of CE counties is the basis for a gradual transition to a modern society. The aim of this transition is to position those countries into the group of open and competitive countries with more effective economies. This will also facilitate their prospective integration within European Union.

It has been recognised the necessity of Slovenia to take an active part in these movements for a gradual transformation to the information society. During the period 1991-1997 a relatively smooth transition of Slovenian S&T institutions into the market-oriented system was made possible (Stanovnik 1997). However, in the last few years, the information society issues have been changing much faster than can be monitored by statistical tools. The penetration rates for PCs, mobile phones, and Internet usage are often growing with the rates larger than 100% annually (Vehovar 1999).

The conventional econometric methods and mathematical models, which have been used for selecting appropriate strategies and testing development alternatives no longer provide comprehensive answers. Consequently, different approaches and techniques are required for modelling various aspects of the information society development.

Here we present an approach, developed under the Copernicus project (INCO 1999) for monitoring and evaluation of the transition processes of our country and other CE countries, which enables data structuring, visualisation, exploration and discovery of regularities. We illustrate the power of the clustering and visualisation techniques applied on statistical data relevant for information society development. The data consists of a selection of statistical indicators for six CE countries associated to the European Union.

2 Sources and methods

In many studies countries are compared and analysed on the basis of selection of statistical indicators that are relevant for various aspects of society development. Indicators that are estimated as relevant for information society are selected from different sources. The International Data Corporation, IDC Company (IDC), is the one of the main sources for the key indicators in the field of Information and Communication Technologies (ICT, EITO 1999), particularly for the countries in transition. For some indictors the EU average is added as the reference level for an international comparison. Detail description of the data can be found in (Bavec 1999). Also OECD (OECD) provides comprehensive and comparative data in this field.

In order to facilitate and make more transparent the evaluation and comparison of countries successfulness we have used different tools and techniques that enable

data structuring, visualisation, exploration and discovery of regularities. The following tools and systems were primarily used during the modelling processes:

a) *An Information Society In Transition Data Analysis system*, (ISIT) developed for intelligent analysis of socio-economic data;

b) *S-PLUS* , a commercial product for Data Mining;

c) *See-5*, a commercial product for Machine Learning.

a) The ***ISIT Data Analysis*** *tool* (Krisper et. al. 1999) for data modelling enables expert system approach to construction of a knowledge base of the socio-economic domain. This approach in contrast to conventional econometrics or statistical methods and mathematical models gives clear insight into the internal structure of the domain. It enables a multi-dimensional treatment of socio-developmental problems from the viewpoint of the information society. The system offers high level of flexibility in modelling of development goals covering various aspects of development. In practice, ISIT system has shown that it is a useful tool, particularly suitable for comparison of successfulness of the countries in transition. Various comparisons facilitate the choice of suitable developmental scenarios.

b) ***S-PLUS*** (S-PLUS 1998) is a powerful tool for exploratory data analysis and statistical modelling. It is known as a tool for manual Data Mining.

c) ***See-5*** (Quinlan 1993) is a tool for machine learning. It enables discovering patterns in the data that are represented as decision trees or production rules.

The modern techniques for data analysis, especially clustering and machine learning are more powerful then the classical statistical tools since they enable:

- domain structuring,
- non-intuitive modelling,
- transparency,
- knowledge elicitation,
- better explanatory power.

In this paper we illustrate the power of those techniques applied on statistical data.

3 Modelling and visualisation

In our experiments, a set of statistical indicators that are relevant for information society development in the six CE countries associated to the European Union have been selected. The EU average is added as the reference level for an international comparison.

A common problem with all selected countries is a lack of official national indicators gathered by internationally compatible methodologies. Presented indicators are a subset of available national data (EITO 1999) that are reasonably comparable in all countries, and particularly with the EU data. Indicators are grouped as follows:

- Political background
- Economic background
- R&D and Technology
- Legal and Organisational background
- Information Technology
- Communications Infrastructure

Graphical representation of the expert developed hierarchical information society indicator model (Zrimec & Krisper 1999, IMD 1997, IMD 1998) is presented in Figure 1.

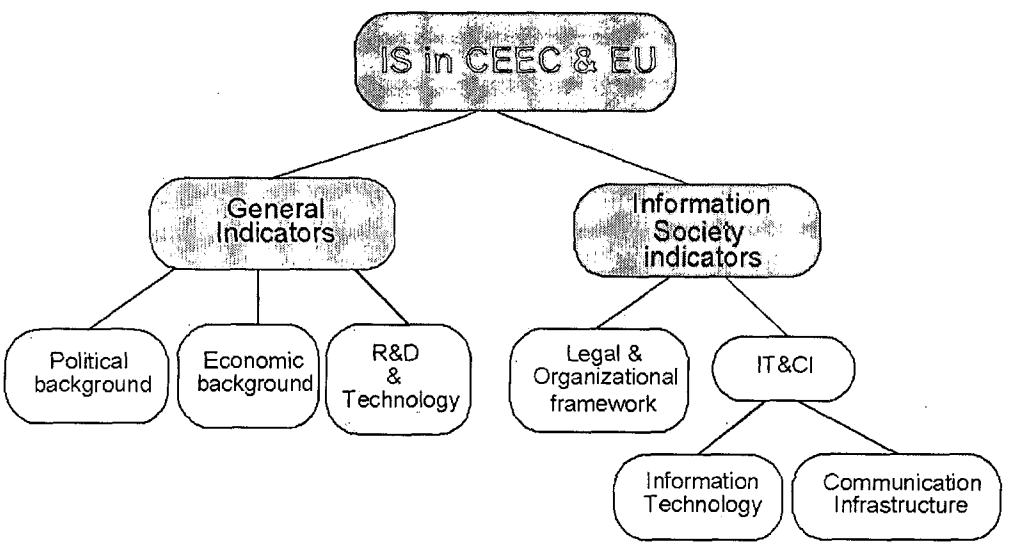


Figure 1: *Information society indicators model*

In order to provide better representation of the observed indicators and the influence of those positioning and grouping the countries, further modelling was performed. For each level of the model, the agglomerative hierarchical clustering method, one of many available S-PLUS methods, was applied. The observed countries were differently grouped together on the basis of self-similarity of the indicators of a particular group. S-PLUS provides a good graphical presentation of the data analysis results. The results of the clustering are represented by cluster trees - dendograms. This graphical presentation, in a form of a tree very clearly indicates the position of each country. The tree representation shows how the countries can be grouped and how well thy are positioned in comparison to EU.

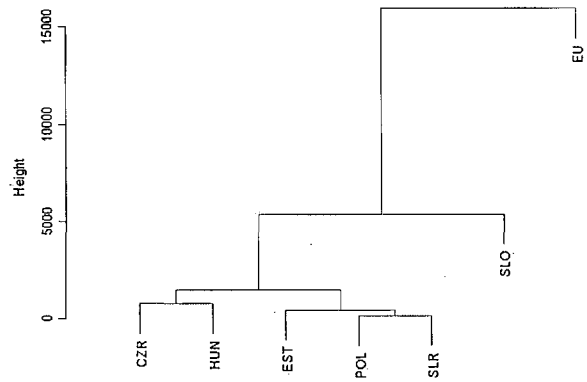


Figure 2: *Results of the clustering using the indicators for Economic Background*

3.1 Political background

A *political* awareness for a transition to the society in CE countries is presented by their membership in major international organisations. The membership indirectly represents their openness and attitude towards the global character of the information society (Krisper et. al. 1999a). These indicators are significant and show two groups of CE countries: Czech Republic, Hungary and Poland are member of all selected organisations, Estonia, Slovakia and Slovenia are not in OECD and NATO.

3.2 Economic background

Economic indicators show significant differences in general development level (clear lead of Slovenia). It is noticeably that economic development is not correlated with the direct foreign investments, which also represent the "openness" of the economy. It is interested that these indicators are correlated with a political "openness" presented in the *political background.* We have used the set of economic indicators and have applied clustering. The results are shown in Figure 2. It can be seen clearly the position of Slovenia and EU (Figure 2).

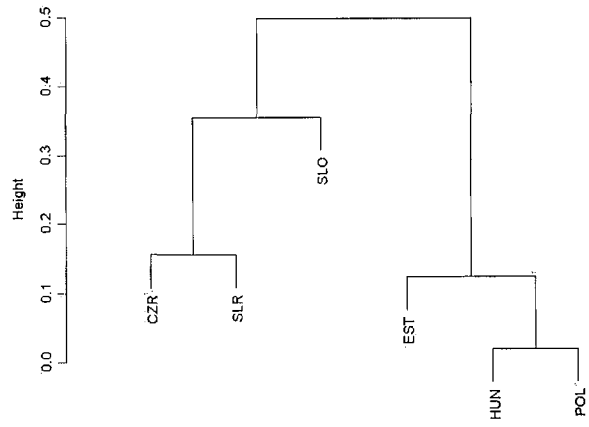


Figure 3: *Clustering of the domain: R&D Technology*

3.3 R&D and Technology

Investments into *R&D* and *Technology* represent a general attitude towards high technologies that could also reflect an absorption level for Information technologies in particular countries. To give better representation for comparison of the CE countries a tree representation, produced by clustering is shown in Figure 3. Because the indicators show a significant lower level than EU average in Figure 3 EU is excluded.

3.4 Legal and Organisational background

Legal and *organisational* framework is not represented by qualitative indicators but rather by qualitative descriptions. All CE countries are gradually implementing the EU "acquies" and face very similar problems concerning organisation and co-ordination of information society activities society (Krisper et. al. 1999a, Bavec 1999). Basic legislation concerning telecommunications is already prepared and will be harmonised with the EU in next three years. Legislation concerning electronic commerce is still in an early phase of preparation. Noticeable is a lack of government administrative structure that could support information society activities. The values of some indicators are given in Table 1.

3.5 Information Technology

Absolute CE countries investments into *Information Technology* are significantly lower than EU average is, but with the same growth rate as in the EU. Differences between individual countries are relatively small. Figure 4 shows a comparison of the GDP/pc (E1) indicator, and the indicator IT21, which represents % of PC connected to the Internet. Slovenia has a leading position in both categories.

More significant are differences in the quality and availability of *Communications Infrastructure.*

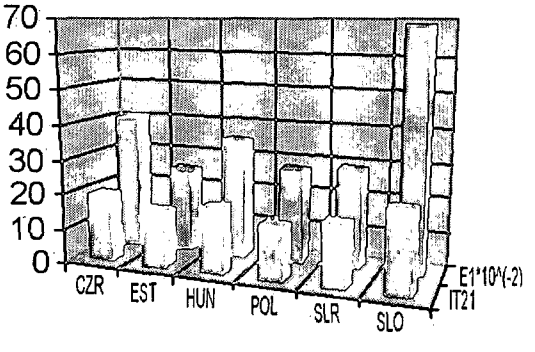
ID	DESCRIPTION	REMARKS	EU	Czech Republic	Estonia	Hungary	Poland	Slovak Republic	Slovenia
				INFORMATION SOCIETY INDICATORS					
	LEGAL AND ORGANIZATIONAL FRAMEWORK								
1	Monopoly on voice telecommunications		1.1.1998	1.1.2001	1.1.2001	1.1.2002	1.1.2003	1.1.2003	1.1.2001
3	Level of telecom. competition	Range 1-5	very high (5)	medium (3)	medium (3)	high (4)	medium (3)	low (2)	low (2)
5	Personal data protection law	Range 1-5	YES (5)	Draft law (2)	Draft law (2)	YES (5)	Draft law (2)	?	YES (5)
6	Digital signature law	Range 1-5	YES (5)	Draft law (2)	NO (1)	Draft law (2)	NO (1)	NO (1)	Draft law (2)
8	Government approved Action Plan on IS	Range 1-3	YES (3)	NO (1)	NO (1)	Governm ent only (2)	NO (1)	NO (1)	Governm ent only (2)
9	National ISPO	Range 1-3	YES	partially (2)	NO (1)	partially (2)	NO	NO (1)	partially (2)
11	Government coordinating body		YES	NO	NO	YES	YES	NO	YES
12	Import duties on IT	Range 1-5	very low (1)	low (2)	medium (3)	high (4)	medium (3)	high (4)	very low (1)

Table 1: *A selection of information society indicators for Legal and Organisational framework, source: Agenda 2000*

3.6 Communications Infrastructure

Recently *Information Technology* and *Communications Infrastructure* are converging. As a result of their convergence a synergetic effect is achieved. Communications Infrastructure is now of the same importance as Information Technology for information society development.

In Figure 5 the results of the clustering on the bases of the Communication Infrastructure indicators are shown. Figure 6 represents a two dimensional representation – portfolio of the relation between Telecom services growth in 1997/98 (IT21) and GDP per capita in EUR for 1997 (E1). The diagram clearly shows the position of the CE countries in comparison to EU. The portfolio representation was generated using the ISIT system (Krisper et. al. 1999) which offers alternative ways of good visualisation.



	CZR	EST	HUN	POL	SLR	SLO
IT21	19.8	16.1	18.7	15.2	17.4	23.1
E1*10^(-2)	40	24.67	34.71	27.37	28.52	69

Figure 4: *E1*10(-2) represends GPD/pc, IT21 represents percentage of PC connected to the internet*

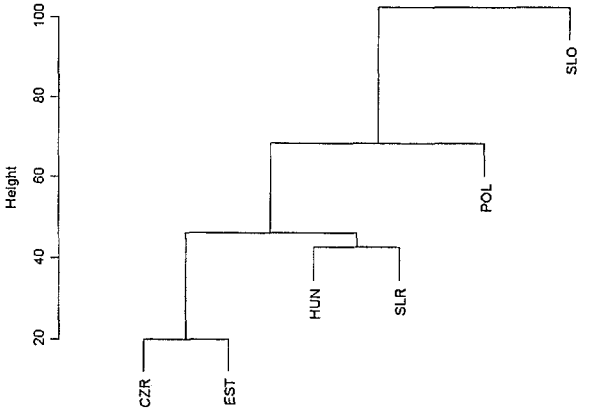


Figure 5: *Clustering using Communication Infrastructure indicators*

4 Conclusion

A common problem with the selected CE countries is a lack of official national indicators gathered by internationally compatible methodologies. We can use only a subset of the national data that is reasonably comparable in all countries, and particularly with the EU data. From the results presented in this paper the following conclusion can be made:

- Indicators on some areas are not correlated with economical power of the countries;
- Absolute investments are significantly lower then EU average;
- Administrative structure is still developing;
- Legal and organisational framework is rapidly improving;
- Level of capitalisation in telecommunication is improving although some monopolies still exits;
- ICT advanced development is beyond legal, organisational and administrative progress.

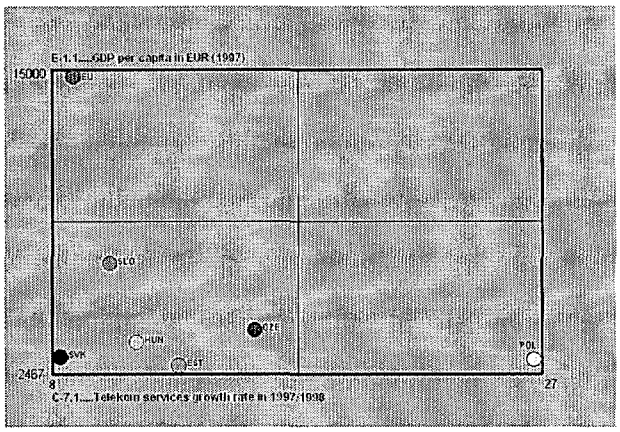


Figure 6: *Portfolio showing GDP/pc and Telecommunication growth rate in 1997/1998*

The proposed approach to data analysis and the developed tools are not only good for comprehensible modelling and presentation of the results, but also for permanent monitoring and studying of Slovenia and other CE countries' progress. Figure 7 shows a six dimensional diagram for CE countries comparison, based on the total values of six indicator's groups. Very clearly can be seen the leading position of Slovenia (SLO-white). This diagram and the diagram in the figure 6 were generated using our ISIT system.

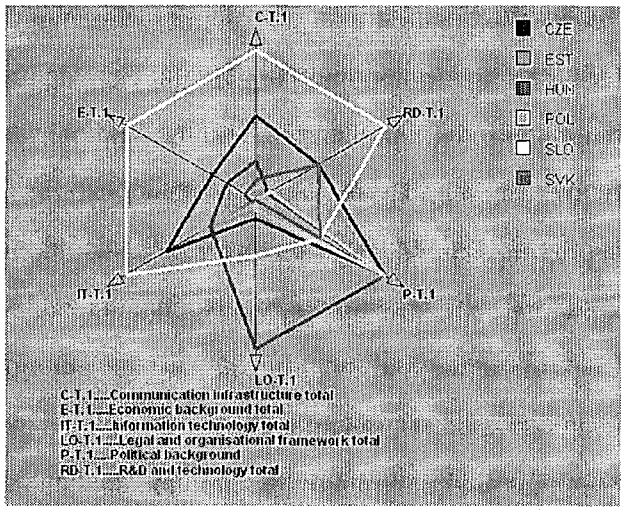


Figure 7: *Six dimensional diagram for CE countries comparison, based on the total values of six indicators groups (note position of SLO)*

5 Acknowledgement

The authors thank Cene Bavec for providing and preparing the data for the experiments. We would also like to thank Matej Grom for his help in using the ISIT system and Zoran Bosnić for the help in preparing the document.

6 References

[1] Stanovnik P. (1997) Some Characteristics of the RTD System in Slovenia with the Perspective to Co-operation within EU Programmes, (*IER, Ljubljana,* p. 12), *IER-CRII*, No. 6.

[2] Vehovar V (1999) Information society measurements - the usage of the Internet in Slovenia, (http://www.ris.org/), *CRII-TR6*, No. 7, p. 5.

[3] INCO (1999) The Role Of Information Society In Transition Processes, *Copernicus project 960154, CRII 1996-99,* (http://lpo.fri-uni-lj.si/crii/).

[4] Bavec C. (1999) Information society indicators in Central and Eastern European Countries: table of the indicators for CEEC and EU, *Report of CRII final workshop, CRII-TR6*, No.2, p.7-9.

[5] IDC, http://www.idc.com

[6] OECD, http://www.oecd.org/dsti/sti/it/index.htm

[7] Krisper M., Zrimec T., Grom M. (1999) ISIT-Information Society in Transition: software package and database with time series, *CRII-TR6*, July, No. 6, p. 16-19.

[8] S-PLUS (1998) Knowledge Discovery without Limitations, *MathSoft International, Statsci Europe,* Oxford.

[9] EITO (1999), EITO'99, http://www.fvit-eurobit.de/DEF-EITO.HTM

[10] Zrimec T., Krisper M. (1999) Intelligent data analysis using Clustering and Machine Learning techniques, *CRII-TR6*, No. 3, p. 1.

[11] IMD (1997) The World Competitiveness Yearbook, *International Institute for Management Development,* Switzerland.

[12] IMD (1998) The World Competitiveness Yearbook, *International Institute for Management Development,* Switzerland.

[13] Quinlan J.R., (1993) C4.5: Programs for Machine Learning, *Morgan Kafman Publishers*, San Mateo, CA.

[14] Krisper M., Zrimec T., Bavec C. (1999) Information Society In Transition Of Central European Countries - Position of Slovenia, *in* C. Bavec & M.Gams, eds, *Proc. Information Society Conference*, Ljubljana, p. 22-25.