Evaluating Iran's progress in ICT sector using e-Readiness Index, A system Dynamics Approach

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Abstract*: In the modern era, Advancement in information technology needs advancements in many areas including communications, human resources, business environment, legal background, and so on. Current information technology growth indicators such as e-readiness indicator spotted this fact too. National legislators are always seeking a way to improve this sector and use it as an enabler industry. In some developing countries, a considerable effort has been devoted to this field but they have not reached their expected result. Iran is also attempting to engage in similar activities in recent years, but it made one of the worst results among others. In this study a system dynamics approach is used to model changes of information technology state in Iran. By implementation and simulation of this model we found some reasons of this problem in Iran. Then we tried to introduce some policies to make steady growth in the future.*

Keywords:

- Iran ICT Condition
- Information Technology Growth Model
- E-readiness Index
- System Dynamics
- System Thinking

1. Introduction

Information and Communication Technologies have transformed the way we live, learn, work and entertain ourselves. Advances in computing and communication technologies create new infrastructures for business, scientific research, social interaction and public services.

ICTs with their increasing growth are one of recent decade's benefits and have played a significant role in development and extol as an infrastructure in development of countries. Development and employment of ICT as an economic sector may cause glory for knowledge and wisdom in production fields – including software, hardware, and so forth.

From other point of view, ICT can be seen from two perspectives. First, using ICT as an enabler, empowering other parts of economy- industry and services- work effectively. Second, it can be seen itself, as a part of industry. [1], [2]

In the fast globalizing world economy of today, governments have recognized the importance of ICT in development. Whether ICTs, considered as an enabler or an industry itself, effective decision making, policy formulation and policy implementation, in the field of ICT and e-business, with regard to either public policies or business competitive strategies, requires a sound understanding of the principles and dynamics that govern interaction between technologies and the economics, legal and social environments of countries in which those policies are implemented. [1]

Government has an important role in improving the ICTs progress in a country. Government's policy can either discourage or incentivize competition, and thus have an impact on availability, prices, business environment, legal environment and so forth.

During the last decade, many governments have started programs which targeted the developments in the ICT area. There were of course, remarkable growth in some countries (such as Bulgaria); but despite this growth, there were failures in development programs in other countries (for example, Iran). [1], [3]

Albadavi [7] formulated national information technology strategies for Iran, using a preference ranking model. Sharifi and Zarei [8] reviewed the history of e-government in Iran and analyzed its related concepts. Shin and Park [9] proposed a new, systematic and integrated way of building national information and communication technology frontier for countries specialized

in ICT for exports. They also exemplify Korea ICT industry to make their model clear. Urumban and Jong [10] studied the differences between countries in ICT adoption using Hofstede cultural framework, from a cultural perspective.

Today a vast number of ICT rankings between countries, have been formulated through research by many governments, and public or private institutions. This ranking system diversity is consequences of differences in data gathering, methodologies and also divergent definitions of e-readiness concept. As a result, findings from different institutions may differ and seems to be inconsistent with each other. [6]

Iranian researchers have been studying this field .They have been working on a national information technology index. Unfortunately because it is not completed up to this time, we didn't use it in this study. In this study we use e-readiness index as an indicator for information technology, because we believe it is one of the most comprehensive indexes in information technology field. Also we use EIU e-readiness ranking because they gathered Iran information and for more years than other rankings.

The approach of system dynamics is adopted for this study so as to demonstrate how the proposed model can be beneficial for decision makers and national legislators to deal with current ICT status and to make steady growth in the future.

2. An Introduction to e-readiness Index

The Economist Intelligence Unit (EIU) has been publishing an annual e-readiness ranking of the world's largest economies since 2000. The ranking evaluates the technological, economic, political and social assets of 68 countries and their cumulative impact on their respective information economies.

The e-readiness rankings are a weighted collection of nearly 100 quantitative and qualitative criteria, organized into six distinct categories measuring the various components of a country's social, political, economic and of course technological development. The underlying principle behind the rankings is that digital business is at its heart business, and that for digital transactions to be widely adopted and efficient they have to thrive in a holistically supportive environment. E-readiness is not simply a matter of the number of computers, broadband connections and mobile phones in the country (although these naturally form a core component

of the rankings); it also depends on such things as citizens' ability to utilize technology skillfully, the transparency of the business and legal systems, and the extent to which governments encourage the use of digital technologies.

The ranking methodology and definitions are continuously updated in order that the rankings remain relevant measures of e-readiness. The parameters of e-readiness are slowly changing, based on two developments. First, there is increasing convergence within the top tier of countries around a basic level of e-readiness, and many countries in the lower tiers are progressing towards this level as well, in some cases narrowing the gap between them and the "e-leaders". Second, the migration of countries at different development stages towards next-generation connectivity is under way.

Mathematically, e-readiness score is a weighted average between six distinct different categories which scaled from zero to ten. These are, in turn, weighted according to their assumed importance as influencing factors. Major data sources include the Economist Intelligence Unit, Pyramid Research, the World Bank and The World Information Technology and Services Alliance (WITSA), among others.[3(2006)]

These six categories are listed below. [3(2006)]

1. Connectivity and technology infrastructure

Weight in overall score: 25%

Category description: Connectivity measures the access that individuals and businesses have to fixed and mobile telephony services, personal computers and the Internet. The affordability, quality and reliability of service—all functions of the level of competition in the telecoms market—also figure as determinants, as does the security of content delivered and transactions conducted via the Internet. In recent years they have increased the weighting of broadband penetration, and added measures of wireless "hotspot" penetration and Internet affordability, the latter measured by the percentage of income per head that a month's worth of Internet access represents.

Category criteria: Narrowband penetration; broadband penetration; mobile-phone penetration; Internet penetration; PC penetration; WiFi hotspot penetration; Internet affordability; security of telecoms infrastructure.

2. Business environment

Weight in overall score: 20%

Category description: In evaluating the general business climate, the Economist Intelligence Unit screens 70 indicators covering criteria such as the strength of the economy, political stability, the regulatory environment, taxation, competition policy, the labor market, the quality of infrastructure, and openness to trade and investment. The resulting business environment rankings measure the expected attractiveness of the general business environment over the next five years. Calculated regularly as part of the Economist Intelligence Unit Country Forecasts, these rankings have long offered investors an invaluable comparative index for 60 major economies.

3. Consumer and business adoption

Weight in overall score: 20%

Category description: The e-readiness rankings assess how prevalent e-business practices are in each country. What share of retail commerce is conducted online? To what extent is the Internet used to overhaul and automate traditional business processes? And how are companies helped in this effort by the development of logistics and online payment systems, the availability of finance and government investment in ICT?

Category criteria: Government spending on information and communications technology as a proportion of GDP; level of e-business development; degree of online commerce; quality of logistics and delivery systems; availability of corporate finance.

4. Legal and policy environment

Weight in overall score: 15%

Category description: E-business development depends both on a country's overall legal framework and specific laws governing Internet use. How easy is it to register a new business, and how strong is protection of private property, in particular intellectual property, which can easily fall victim to digital-age piracy? Governments that

support the creation of an Internet-conducive legal environment—both through policy and enforcement—receive high scores. Those more concerned with censoring content and controlling the web score lower.

Category criteria: Overall political environment; policy towards private property; government vision regarding digital-age advances; government financial support of Internet infrastructure projects; effectiveness of traditional legal framework; laws covering the Internet; level of censorship; ease of registering a new business

5. Social and cultural environment

Weight in overall score: 15%

Category description: Literacy and basic education are preconditions to being able to utilize Internet services, but this category also considers a population's "e-literacy"—its experience using the Internet and its receptivity to it—and the technical skills of the workforce. E-business, at some level, usually requires some amount of risk-taking, and the fruits of that risk-taking often culminate in the creation of intellectual property. In fact, policymakers often use e-business development as a catalyst for innovation. Thus, the rankings attempt to measure each country's ability to foster new products and industries, by assessing entrepreneurship and innovation levels, the latter measured by the number of patents registered. The two have been included as separate criteria for ratings in the category.

Category criteria: Level of education and literacy; level of Internet literacy; degree of entrepreneurship; technical skills of workforce; degree of innovation.

6. Supporting e-services

Weight in overall score: 5%

Category description: No business or industry can function efficiently without intermediaries and ancillary services to support it. For e-business, these include

consulting and IT services, and back-office solutions. The rankings also take into account whether there are consistent, industry-wide technology standards for platforms and programming languages.

Category criteria: Availability of e-business consulting and technical support services; availability of back-office support; industry-wide standards for platforms and programming languages.

3. Problem Definition

In order to clarify the problem with Iran, we have studied some other countries which their scores were very close to each other by 2001. [3(2006),(2005),(2004),(2003)][4]

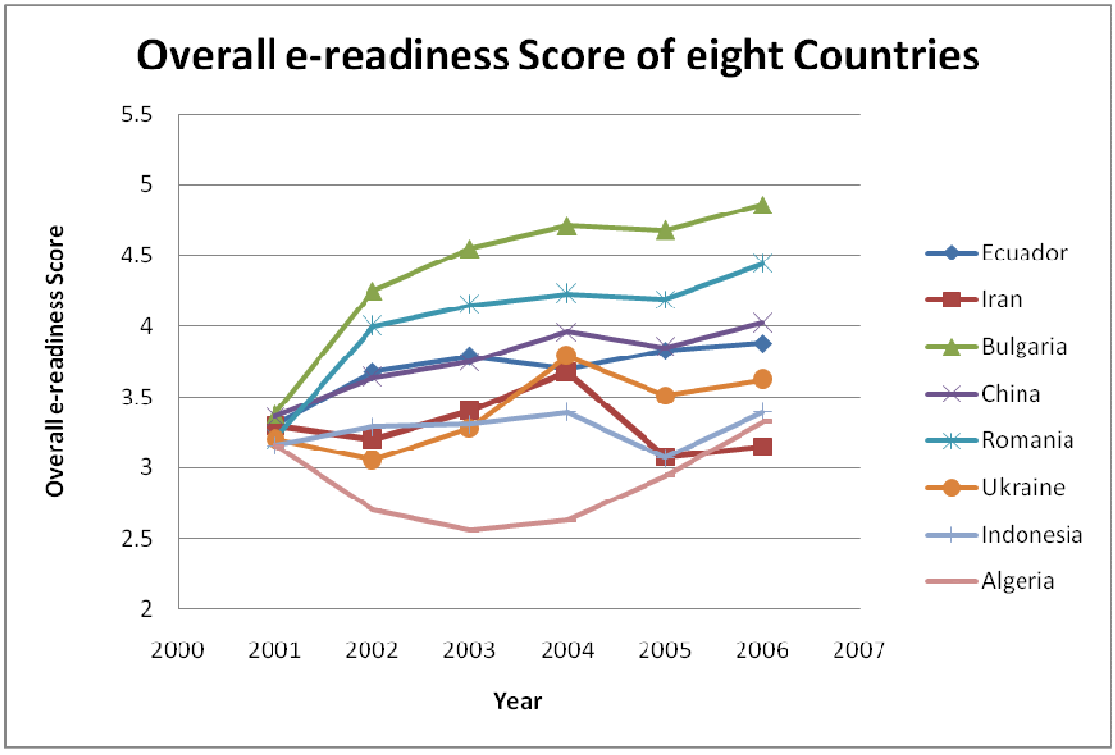


Figure 1: overall e-readiness score of eight countries which their score is near Iran's in year 2001

As it's obvious from the figure 1, Iran's overall score begins to rise from 2002, till it reaches at its maximum in 2004. After this year, its overall score begins to fall. Also it's

understandable from the figure that, the possible successful policies result in a goal seeking behavior as it's noticed by EIU.

One noticeable point is that, Overall score of Iran in 2006 is close to its value in 2001. We can't see any advancement, with the same index, even after 6 years. Iran is placed in the lowest rank between eight studied countries after six years of allotting budget and resource, as shown in figure 2.

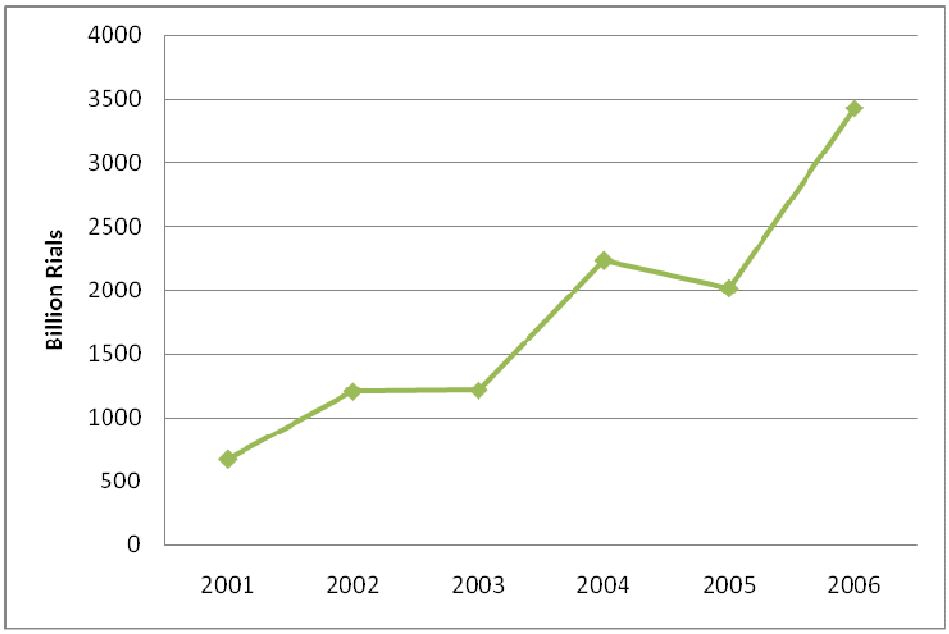


Figure 2: governmental budget on ICT development

Based on [5] statistics a large percent of budget has been used for improving connectivity infrastructures. In average this percent in 2002-2006 is about 60% of whole budget.

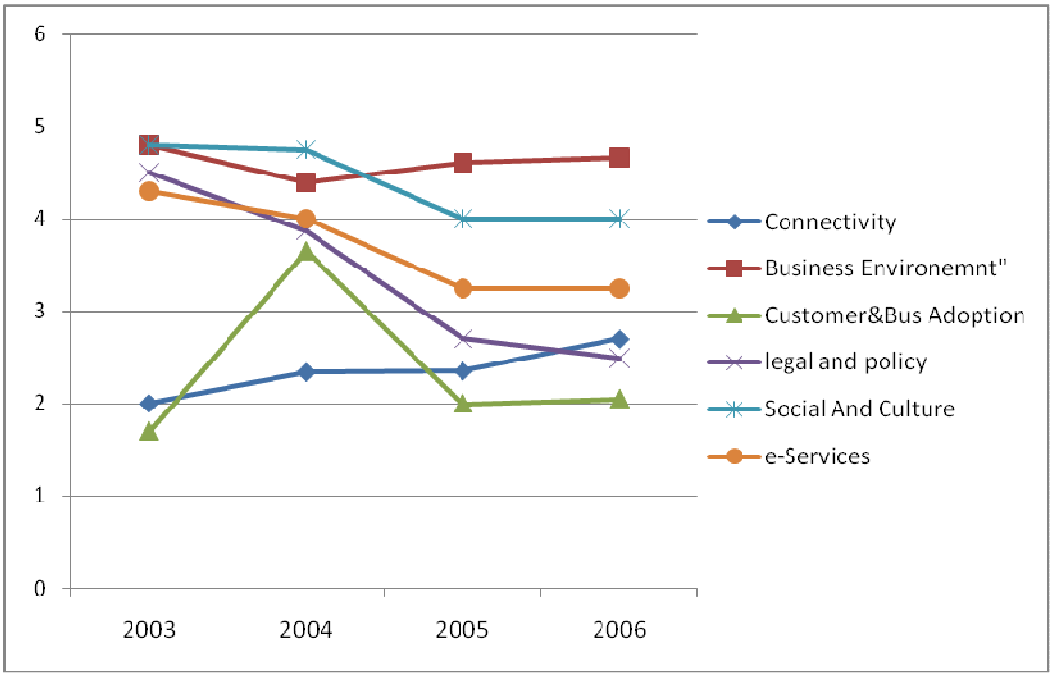


Figure 3: e-readiness factors trend in recent years

Unfortunately the detailed index before 2003 was not reachable. We can see the constant decrease in legal, e-services and social & cultural scores. There is also a constant increase in Connectivity index. It seems that decrease in legal and policy environment has the most notable impact on the overall score. This means, there were investment in connectivity domain, when there were not enough adoption to this connectivity capacity by the related business and customers, although, the business environment has not faced a severe change during the period.

4. Dynamic Hypothesis

In recent years although, this field attracts people attention and increasing resources, but expected advancement has not been observed. We can explain what happens by this hypothesis: Because of extra emphasis on communication infrastructure development and yet governmental communication infrastructure in Iran, they encountered budget shortage for other IT factors, especially legal, consumer & business environment and content support groups. The resource reduction, decreases business environment indicators and eventually e-readiness index. Then legislators think they should focus more on communication factor and decrease other factors budgets.

It is worth noting that in this world, connectivity indicator can't grow independently. During difference of connectivity and consumer & business adoption indicators increase, a new balancing loop activated to prevent connectivity factor to grow more. The logic behind this loop may be the effect of growth inconsistency on investment rate and effectiveness. So this factor falls too. From other point continuous reduction in legal factor in turn help e-readiness index to fall. This phenomenon changes the mind of legislators to do something for this technology, but they increases connectivity related budget (growth loop). Another important point relates to the way politicians looks on the new technologies. Nowadays Iran politicians consider four new technologies: information technology, biotechnology, nanotechnology and nuclear technology. It's deniable that these technologies compete for governmental funds, and now because of weaknesses in information technology growth, the focus of funds changed toward other technologies. So current e-readiness indicator value and expected one according to invested budget can change this field budget in the future.

5. Causal loop Diagram

We describe the causal loop diagrams step by step to make it more understandable. We categorize e-readiness factors in three categories: First factors category which has improper growth such as "Connectivity", Second category which has normal growth such as "Consumer & Business Adoption", and at last factors such as "Legal" which descended in the last years and have high importance as the organizer of information technology space. (For simplification of

the model we only focus on the three factors (EIU model has 6 factors.) and suppose that other factors has no effect.

At first we draw the model like figure 4. This model shows a goal-seeking behavior for the three factors which without any barrier reach their goal. E-readiness indicator value is made from them with proper coefficient.

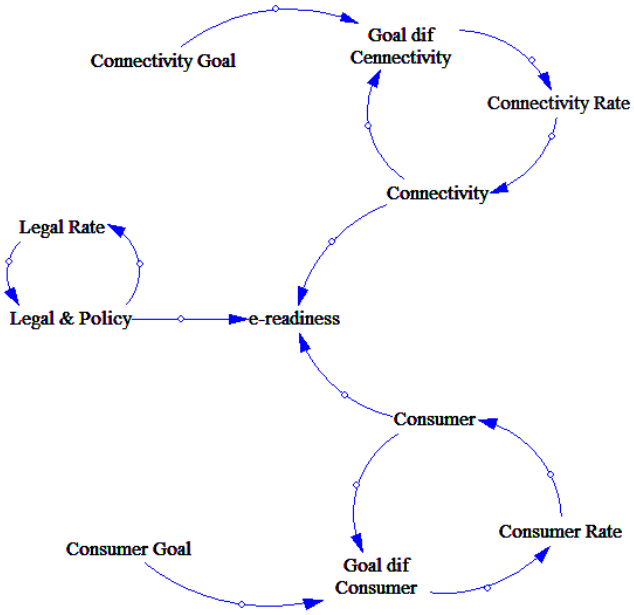


Figure 4 Goal seeking behavior of e-readiness factors

It seems that while connectivity value increases the required budget to continue the growth will increases too, also we may encounter technology limits. This argument is also true for Consumer factor. We assumed that Connectivity factor will increase only with budget.

In the next figure a balancing loop has been added between Connectivity and Consumer factor. To show this fact that when communication foundation exists but there is no services on it, it will make no revenue and also may disturbs investment efforts. But if connectivity infrastructure be prepared, other factors will grow faster too. So we change its causal loop diagram as this:

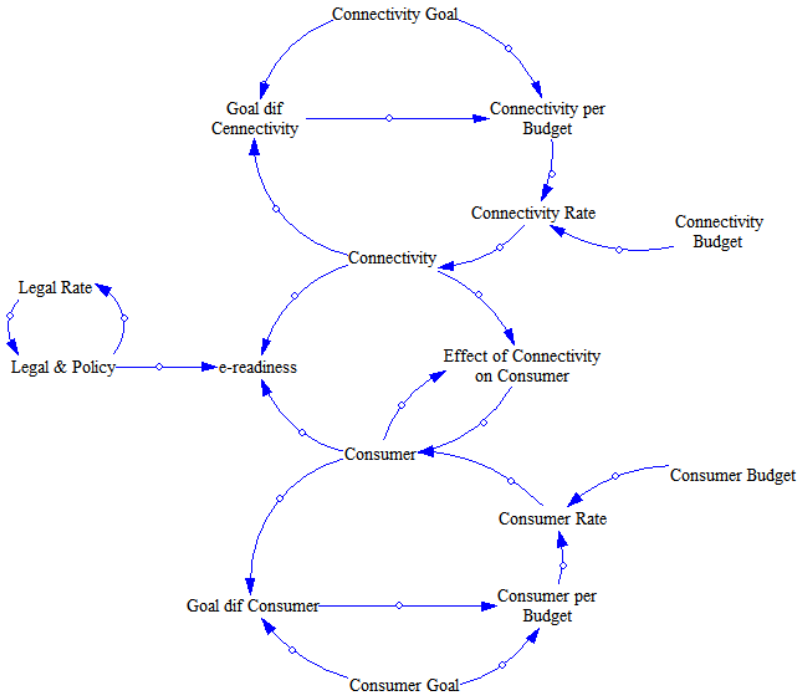


Figure 5: connectivity factor growth control loop added

Let's continue with budgeting dynamic structures. An important point regarding to dynamic theory is because of limited budget, sum of Communication budget coefficient and Consumer budget coefficient is constant. So if we increase communication budget, consumer budget will be decreased and vice-versa. Another fact is when budget committee sees descend in e-readiness trend ignores information technology or at least would not increase its budget, because cost/benefit ratio according to e-readiness indicator falls. Somebody may ask why budget committee would not increase the budget while this field needs it. One answer is technologies competition for more budgets, another may be something similar to "Eroding Goals" archetype [12].

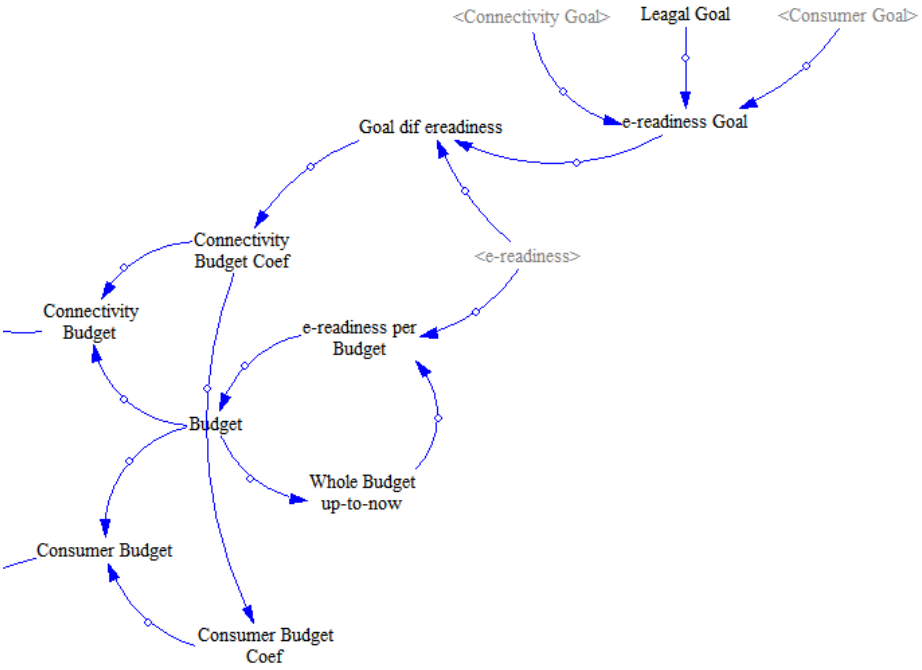


Figure 6 budgeting dynamic structure

At the end the causal loop diagram will looks like figure 7:

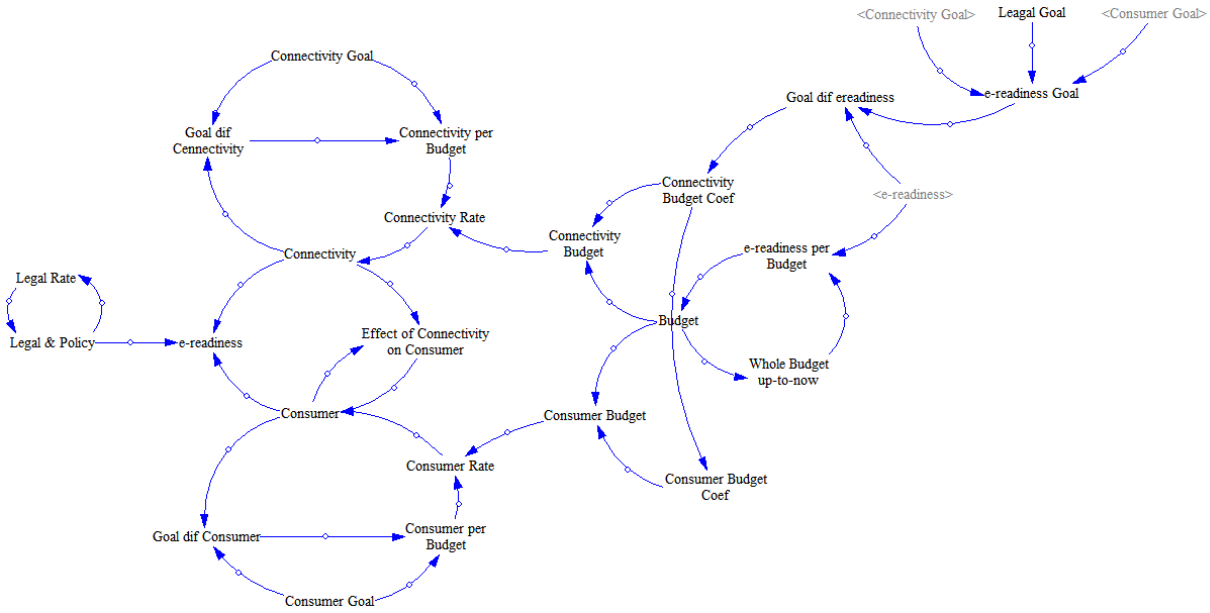


Figure 7: causal loop diagram

6. Stock - Flow Diagram

Figure 8 shows Stock and Flow Diagram for first causal loop diagram.

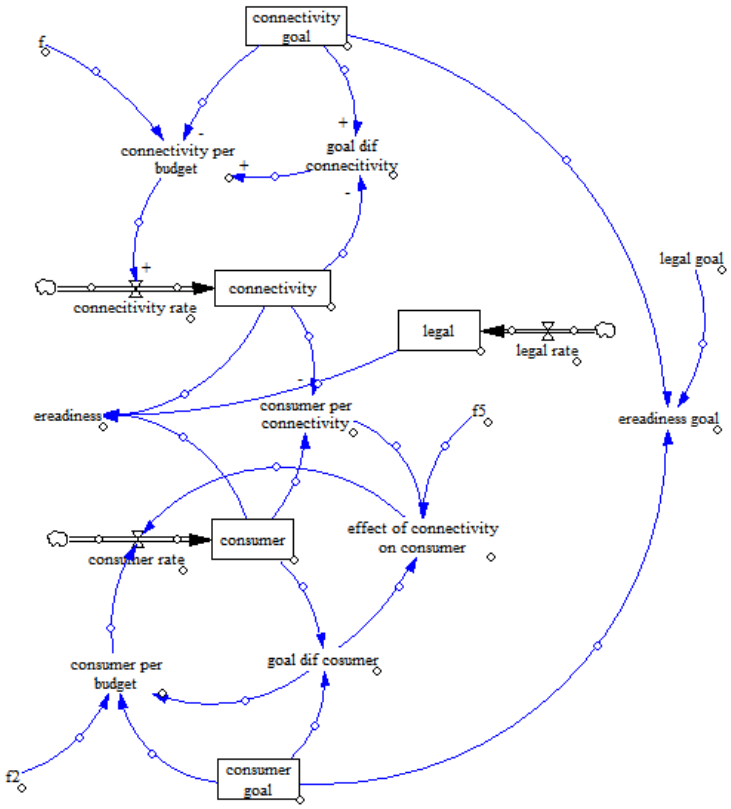


Figure 8: First casual loop stock and flow diagram

In this figure Consumer and Connectivity variables represent Communication and Consumer & Business Adoption factor in order. Legal factor structure designed according to continuous descend pattern as implied in before. “f” and “f2” functions used to decrease factor’s growth rate while it grows, using “Connectivity per budget” or “Consumer per budget”.

“f5” function used to create the effect of connectivity on consumer factor. Hence when we have connectivity infrastructure, we can make services on it, connectivity factor can drive some growths in Consumer factor.

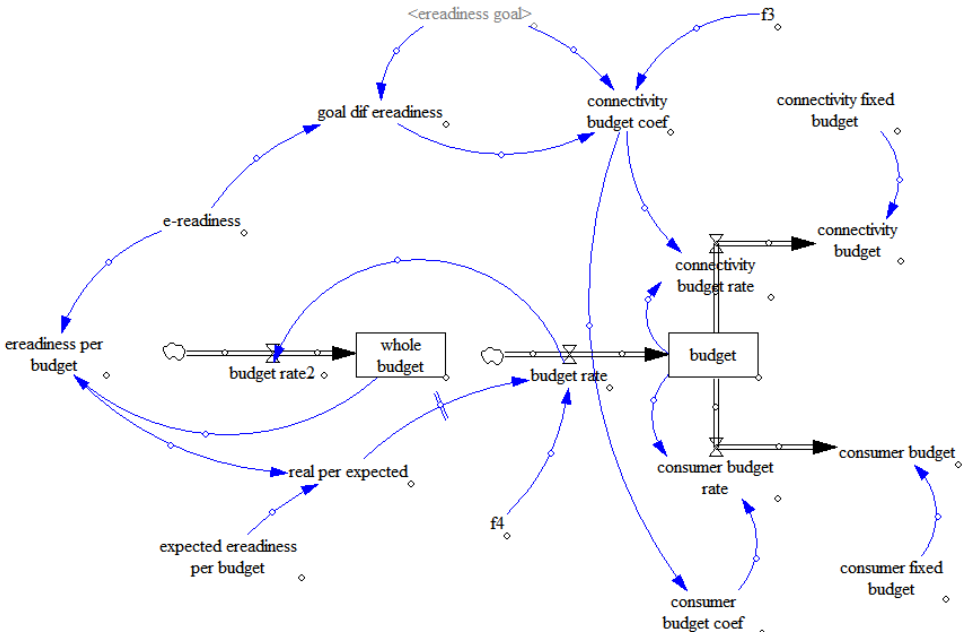


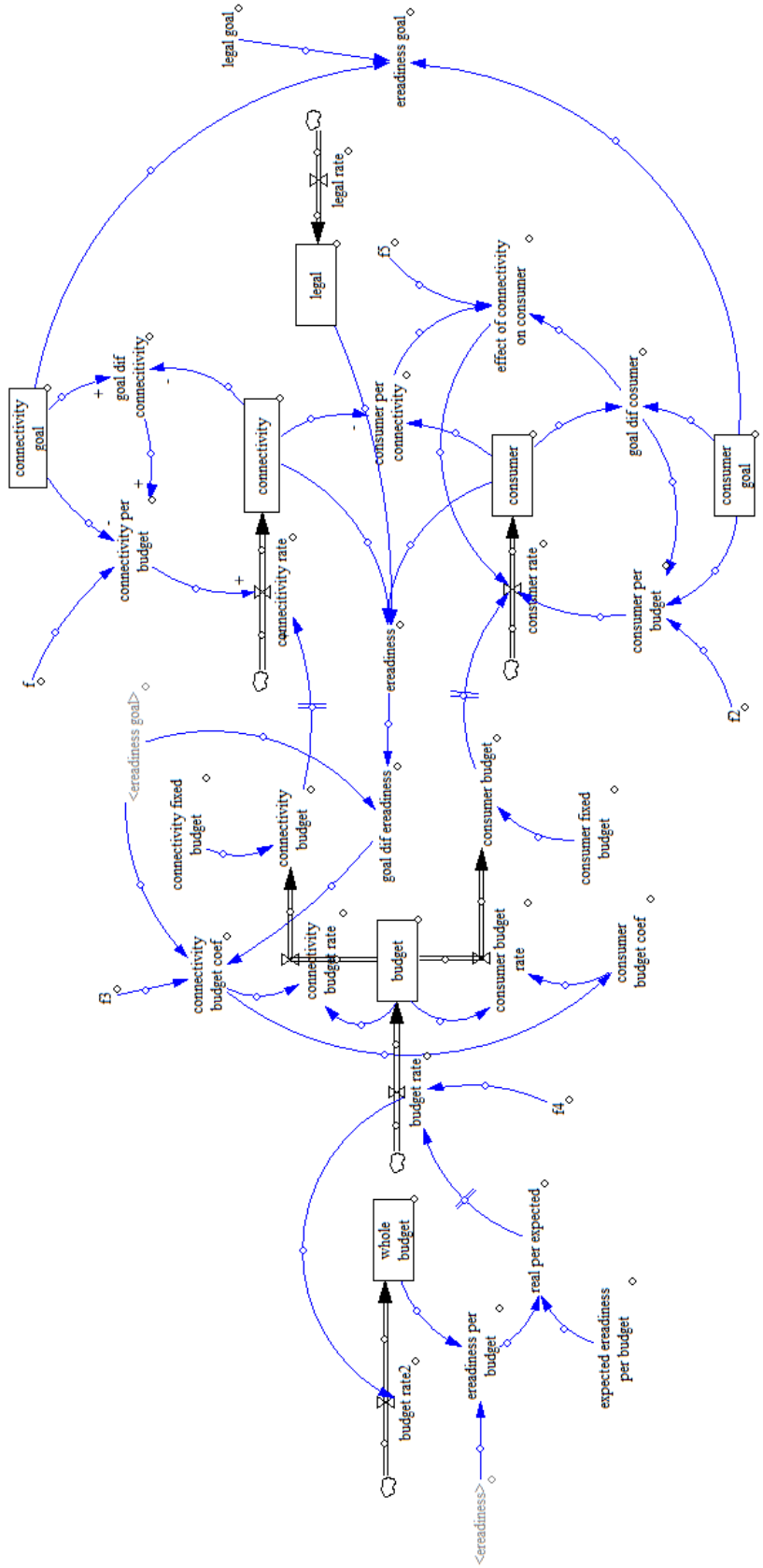
Figure 9: budgeting dynamic structure

Previous figure shows budgeting dynamic structures while regards two points:

1. Current budget is determined from ratio of whole budget result (current e-readiness per expected e-readiness which should be obtained with this budget) to whole budget.
2. Consumer and Connectivity factor budgets are not equal, but sum of them equals to current budget. We think this structure is particular for Iran, so it is not a public structure. It seems because of communication related background of "Communication and Information Technology" ministry and other government politician men; they are not so mature in information technology to pay attention to other factors.

Figure 10 shows all mentioned structures:

Figure 10: stock and flow diagram



7. Simulation & Analysis

Figure 11 shows simulation result for main variable:

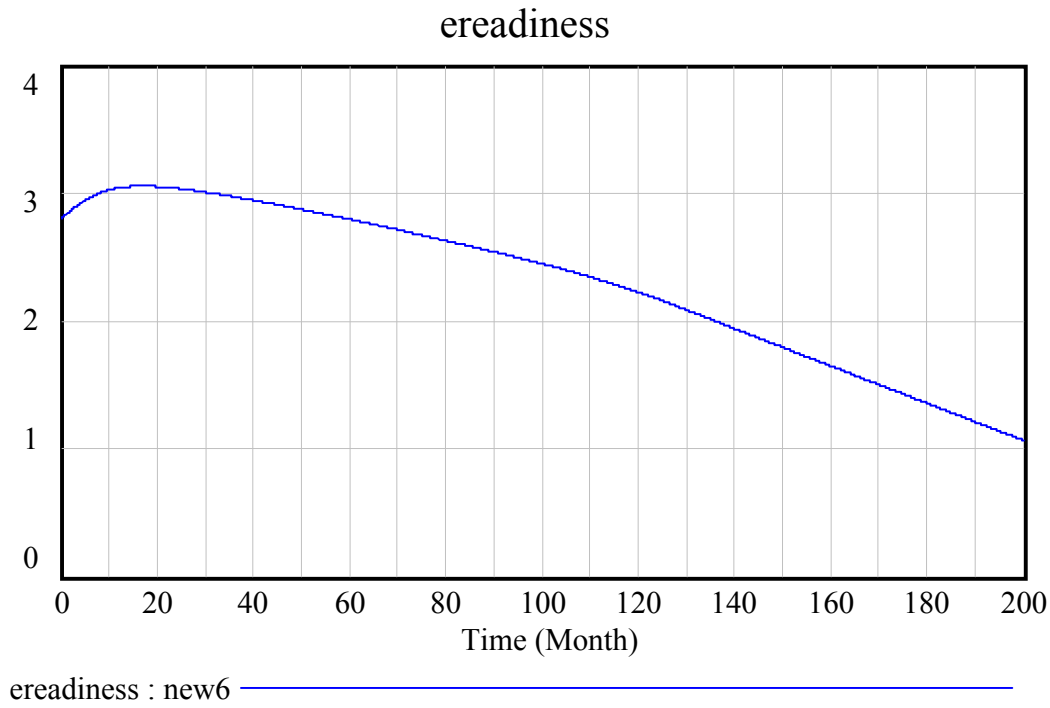


Figure 11: simulation result for e-readiness

As we can see in reference mode diagram, e-readiness behaves like this. Although at the beginning it increases because of connectivity and consumer factor growth, it would descend soon because of budget reduction and Legal factor's decay. It's important point to mention that this overshoot behavior is not the result of its generic structure [11], but for growth of two factors and intense decay of another. Before extremum point, because of Connectivity and Consumer factor growth, e-readiness will also increase but while budgeting policy changes ex parte Connectivity factor, Consumer factor descends, and at last by fall of Legal factor, e-readiness indicator value falls too.

As we can see in the next figure, annual budget decreases until reachs an equlibirum. At first because of furthur progression expectation, it increased but, while e-readiness falls (as an indicator that shows benefits resulted from used budget) budgetting committee and investors would decrease this field budget.

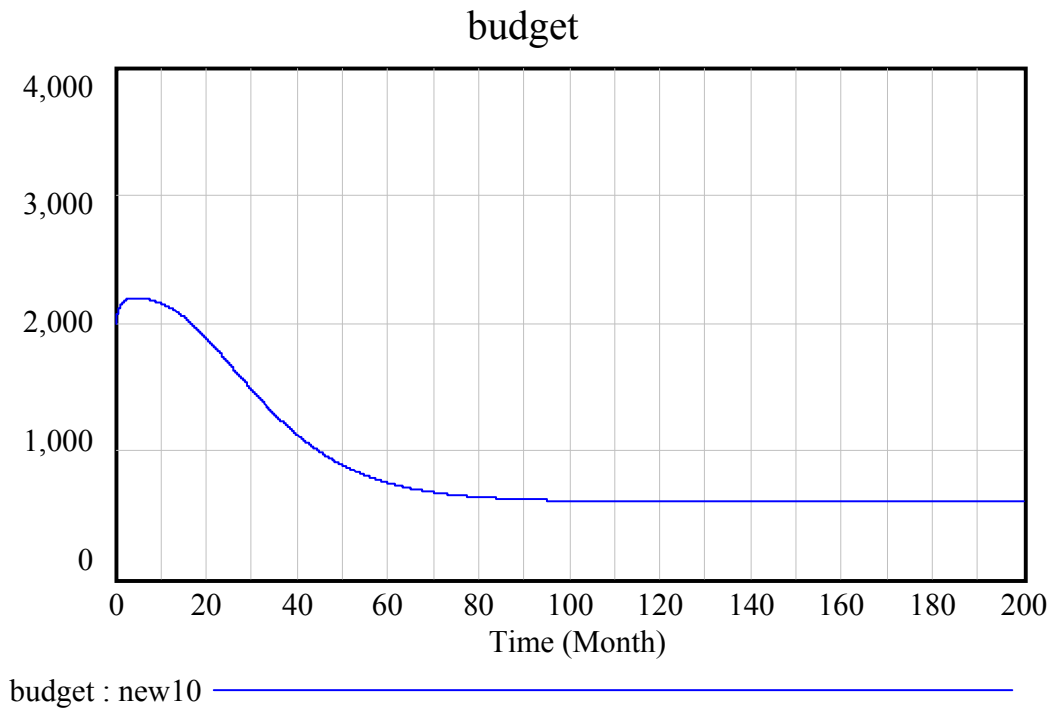


Figure 12: budget variable trend

8. Solution Policy

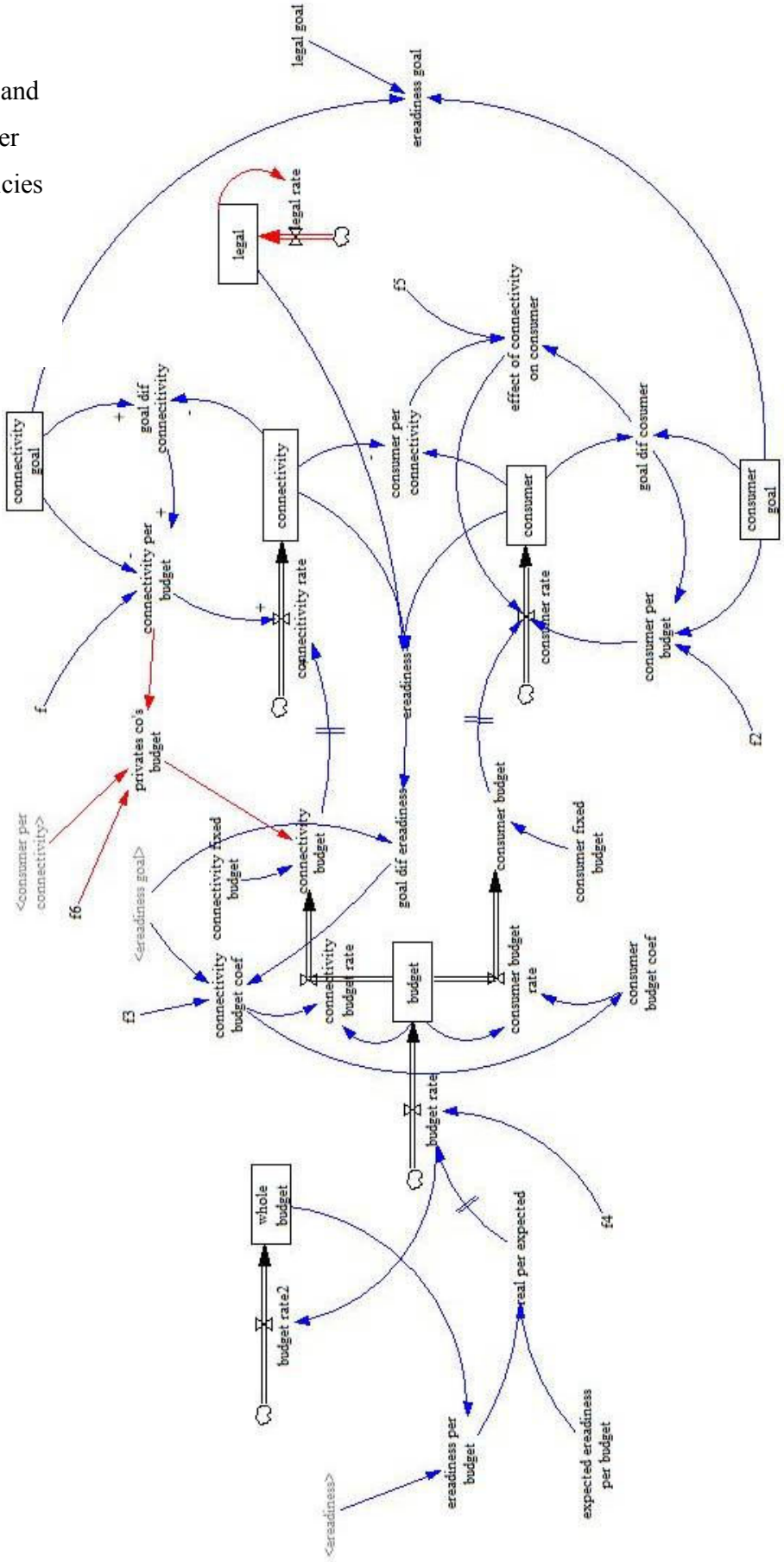
The common avoidable solution is that government reduces Connectivity factor investment and makes this area ready for non-governmental companies.

Available solutions to improve e-readiness state are:

- Developing a new procedure for legislation in information technology field to restrict Legal factor descent that can be done through improving legislation process steps including preparation, approval, execution, and assessment.
- Government focus on areas where private sector has no power on them like Consumer & Business Adoption fields and planning and management of private companies in connectivity related areas. By executing this policy, government can coordinate IT services growth with communication infrastructure. And extending information technology market as an enabler and an individual industry. It can be shown that by this policy, budget performance increased and market will be more competitive.

Next figure shows stock & flow diagram when these policies applied. (Red color used for new structures)

Figure 13: stock and flow diagram after applying the policies



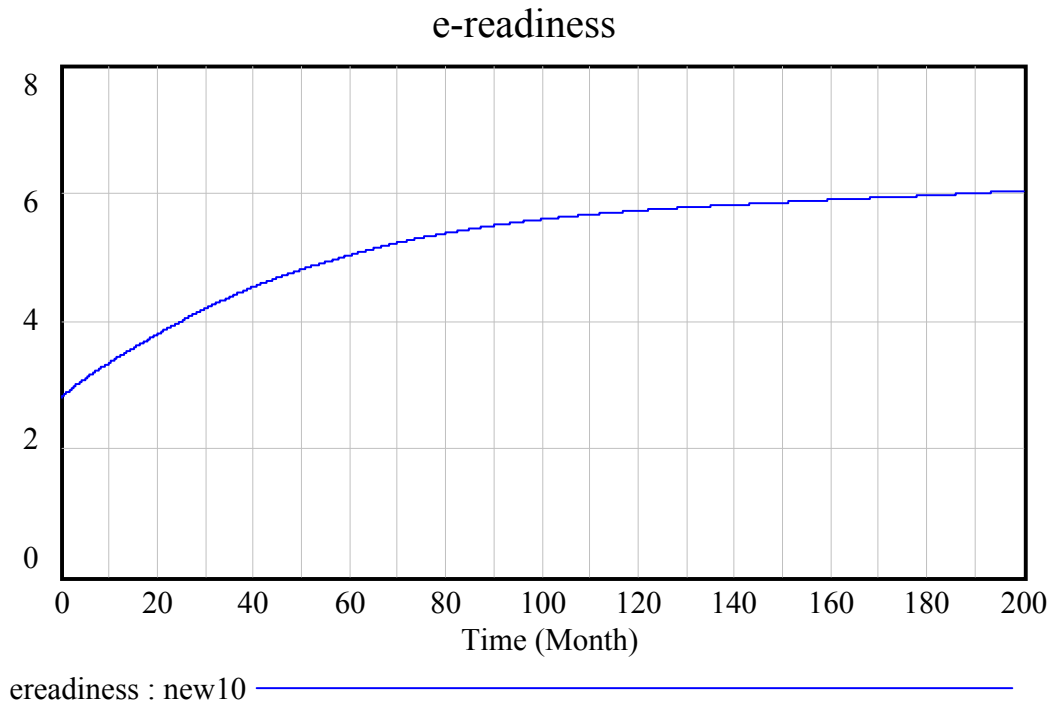


Figure 14: e-readiness trend after applying the policies

9. Conclusion and Further Research

When we have limited budget to manage a technology in national level, it is better to develop management structures and prepare infrastructure for private institutes to play their role better, or concentrate on areas where private companies has little impact. This can't be happened unless we employ information technology experts and have a long term plan for it.

Inevitable, there exist few weaknesses of the proposed model. Considering all 6 e-readiness factor, using more indicators (national and international), implementing real structures instead of lookup functions, and validation/generalization of the model for more developing countries are future works which can be done to complete this model.

10. References

[1] "*Information Economy Report 2006, The Development Perspective"*, 2006, UNCTAD, http://www.unctad.org/Templates/WebFlyer.asp?intItemID=3991&lang=1

[2] *"Information Economy Report 2005, The Development Perspective"*, 2005, UNCTAD,

http://www.unctad.org/Templates/WebFlyer.asp?intItemID=3591&lang=1

[3] *"The e-readiness Rankings, A white paper from The Economist Intelligence Unit",* EIU, 2003-2006.

(2006) http://www.eiu.com/site_info.asp?info_name=eiu_2006_e_readiness_rankings

(2005) http://www.eiu.com/site_info.asp?info_name=eiu_2005_e_readiness_rankings

(2004) http://www.eiu.com/site_info.asp?info_name=eiu_2004_e_readiness_rankings

(2003) http://www.eiu.com/site_info.asp?info_name=eiu_2003_e_readiness_rankings

[4] *"The 2002 e-readiness Rankings, A white paper from The Economist Intelligence Unit"*, EIU, 2002. http://unpan1.un.org/intradoc/groups/public/documents/APCITY/UNPAN010005.pdf

[5] *"a view on budget bill 1386, ICT and modern technology",* Research Center of National Parliament of Iran, 2007.

[6] Dada, Danish.(2006) *"e-readiness for developing Countries: moving the focus from the Environment to the users"*, EJISDC (2006) 27, 6, 1-14

[7] Albdavi, A. , (2003) *"Formulating national information technology strategies: A preference ranking model using PROMETHEE method*" European Journal of Operational Research 153 (2004) 290–296.

[8] Sharifi, H. , Zarei, B., (2004), *"An adaptive approach for implementing e-government in I.R. Iran",* Journal of Government Information 30 (2004) 600–619.

[9] Shin, J. , Park, Y. , (2007) *"Building the national ICT frontier: The case of Korea" ,* Information Economics and Policy, accepted on Jan 2007.

[10] Erumban, A.A. , Jong, S. (2006) *"Cross-country differences in ICT adoption:*

A consequence of Culture?" , Journal of World Business 41 (2006) 302–314.

[11] Sterman JD. 2000. "*Business dynamics : Systems thinking and modeling for a complex*

world". Irwin/McGraw-Hill: Boston.

[12] Braun, William. (2002) "*The System Archetypes"*, http://www.uni-klu.ac.at/.gossimit/pap/sd/wb_sysarch.pdf

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