

Assessment of Egyptian Software Export Capabilities Using a System Dynamics Approach

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ABSTRACT

Several countries such as India, Ireland, and China established successful export-oriented software industries; Egypt is attempting to engage in similar activities. This research assesses the Egyptian software industry using the Software Export Success Factors Model developed by Heeks and Nicholson in 2002; thus, identifying success factors and challenges for Egypt to substantially increase software and IT services exports.

Based on a Systems Dynamics approach, a Mental Model (Causal Loop Diagram) has been prepared as a step towards building a model to simulate the expected effect of key software-related infrastructure variables on the Egyptian software export revenue. The paper concludes with policy suggestions to improve the expected software export revenue. Simulations of software export industry over a period of 10 years point to the following:

1. Abundant financial supply is necessary but not sufficient to build a strong export-oriented software industry. Injecting an additional 30% financial resources resulted in an increase of 8.4% in software export revenue and 2.1% in job opportunities with respect to the reference mode.
2. Produced software value has the highest impact on software exports revenue. Improving IT staff productivity by 42%, and delivered software quality by 10%, and decreasing the resistance to change by 20%, led to an increase of 68.7% in software export revenue and of 12.9% in job opportunities with respect to the reference mode.
3. Innovation and R&D improve software exports revenue. Enhancing R&D by 50% and IT staff innovation contribution by 10% resulted in an increase of 14.4% in software export revenue and 3% in job opportunities with respect to the reference mode.
4. Export promotion of high quality software warrants a software export revenue increase. Improving the software export promotion efficiency by 14% and quality of delivered software by 10% led to an increase of 38.7% in software export revenue and 8% in job opportunities with respect to the reference mode.

KEYWORDS

- Egyptian export-oriented software industry
- Software Export Success Factors
- Systems Dynamics
- Systems Thinking

1 INTRODUCTION

Developed countries, like USA, Japan and Germany, are among primary providers of software and Information Technology (IT). Nevertheless, several developing countries, such as India and China, have significant contributions to the international software market. Despite the limited resources and poor infrastructure India once possessed, it developed and executed a clear vision to excel in IT. India started by concentrating on services involving body-shopping outsourcing services and now it delivers turnkey projects using the highest quality standards in the industry, one of the results is the exponential increase of export revenues from US\$ 4 million in 1980 to over US\$ 7 billion in 2002¹. This great success motivated researchers to study and analyze the factors behind software exports success. Egypt might have an opportunity to contribute in the software export. This study attempts to build a simulation model for Egyptian software export success factors.

2 PROBLEM DEFINITION

Egyptian software development efforts started before the 1980's. Several initiatives and efforts were made to encourage exports of software and (IT) services. The revenue of Software exports was estimated at US\$ 15 Million in 2001, which is a small value compared to India's software exports estimated around US\$ 7 bn for the same year. Trade balance is a deficit of (US\$ 6.6 bn) in 2002/2003 down from US\$ 9.4 bn in 2000/2001². Exports of Software and IT services could possibly become sources of foreign currency and could help reduce the balance of trade deficit.

Egypt is classified among the fourth tier "infant" software-exporting nations³, as the Egyptian contribution to global software markets is still limited, (Carmel, 2003a).

The World Economic forum publishes Global Information Technology Report (GITR) that ranks different countries according to network readiness index (NRI). NRI gives an indication about the relative classification of the country and its readiness to use Information and Communication Technologies (ICT). In 2004/2005 Egypt is ranked 57th among 104 countries which is an improvement over 2003/2004 ranking 65th among 102 countries compared with the same rank in 2002/2003 but among 82 countries.

3 RESEARCH OBJECTIVE

The purpose of this study is to assess the state of software industry in Egypt using the software export success model by Heeks and Nicholson in 2002; thus, highlighting strengths and weaknesses in the Egyptian software industry. A Systems Thinking Approach is used to build a business dynamics model in order to simulate the software export industry in Egypt. The model helps test different policies to enhance the software development industry, reaching recommendations to improve Egyptian software industry and its strategic orientation.

¹ Source: Indian Department of Electronics Annual Reports, Dataquest (India) surveys, several years.

² Source: Central Bank of Egypt, Monthly Statistical Bulletin, vol. 88 July 2004. p.42

³ Carmel characterizes the fourth tier exporting nations that have less than 5 years of software exporting experience, less than 10 organizations exporting software and annual export revenue less than \$25 Million.

4 THEORETICAL FRAMEWORK

The software export success model by Heeks and Nicholson (2002) is adapted to include factors relevant to Egypt, taking into consideration some factors emphasized in the oval model by Carmel in 2003c. Figure 1 shows the resulting framework.

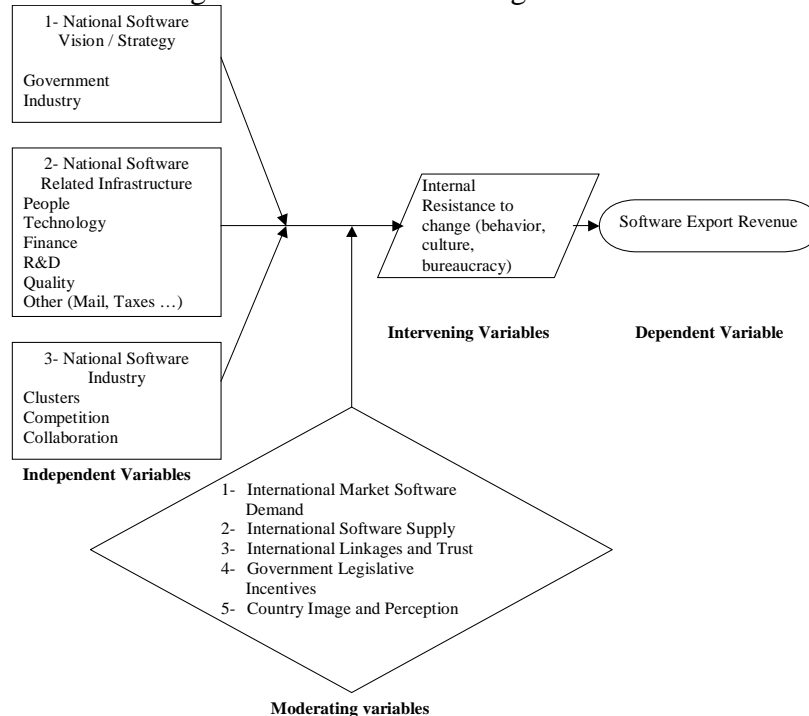


Figure 1: Theoretical Framework

Source: Heeks and Nicholson (2002) adapted by the Researcher

- **Dependent Variable**

- **Software Export Revenue**

- It is the value of software products and IT services exported from Egypt, estimated in 2001 as US\$ 15 million. This is of primary interest as the objective is to increase the export revenue. Currently, there is no reliable source of accurate information regarding the exact value of revenue. Therefore, an estimate is made within the research.

- **Independent Variables**

- Independent variables of direct influence on exported software and IT services revenue are:

- **National Software Vision and Strategy**

- This is a vision shared by policy-makers, a relatively small, but committed group of government officials and private entrepreneurs. This vision formulates what software could achieve for the country (Heeks and Nicholson, 2002). It contains future targets, strategies and means of achieving them.

- MCIT is promoting and trying to build the information society in Egypt. The Egyptian vision statement and plan detail several projects to build and promote an export-oriented software industry.

- **National Software-Related Infrastructure**

- National software-related infrastructure is the key driver to build a successful software industry. It comprises factors related to the country's infrastructure, including People, Software Technology, Finance, Research and Development (R&D), Software Quality and other factors. *People*, who are competent in technical skills, are the main catalysts for successful software industry; English language is a key requirement to deal with international

customers and acquire state-of-the-art knowledge. Increasing the IT, marketing and management skilled staff, enhances Egypt's opportunities to successfully export software. *Software Technology* is in a continuous state of development, thus Egypt should adopt state-of-the-art technology so as to produce software complying with the market demand. *Finance* is an essential component for building software industry, as it helps in acquiring technology, in funding research and development, and in creating job opportunities. Banks and venture capital would be necessary, since self-financing might not be sufficient to fund software industry requirements. *Research and Development (R&D)* gives Egypt a comparative advantage and might help reach a competitive position to improve the export revenue. Improving *Software Quality* helps in gaining customers' trust and hence, sustaining and growing the export revenue. Providing distinguished software quality helps increase the revenue and increase customers' satisfaction.

National Software Industry Characteristics

This represents the industry characteristics related to company locations (clusters), rivalry state: either competition or collaboration among different firms. Egypt is currently forming a cluster for software industry in the Smart Village, in an attempt to encourage collaboration between different software firms.

- **Moderating Variables**

Moderating variables have a strong contingent effect on the relationship between independent and dependent variables. They are:

International Software Market Demand

This is the international market demand for software and IT services. When potential demand in the international software market increases, Egypt's chances to attract IT projects and to export software improve. Higher demand increases opportunities for software exports and conversely, lower demand would diminish the possibilities to export software.

International Software Supply

It consists of the Software and IT services developed by different countries for export. Increased difference between demand and supply in the international software market improves Egypt's chances to export software or IT services. Higher international software supply diminishes the Egyptian opportunity to export software, assuming constant demand.

International Linkages and Trust

Linkages emerge between individuals, between work groups, between firms, and between nations due to geographic, cultural, linguistic, or ethnic connections; or as a result of one or more liaisons that have created the linkages (Carmel, 2003c). Egypt should work on strengthening linkages with software-importing nations, taking advantage of the Diasporas in addition to English and European language skills of IT staff. Ethnic and language linkages with Arab countries facilitate software and IT services delivery to the Arab Region. Stronger linkages with software importers, improve Egyptian software export chances. A strong track record and an increased number of CMMI-certified software firms build trust in the Egyptian software industry.

Government and Legislative Incentives

This consists of governmental procedures, rules and laws enacted to encourage the software industry; for example Intellectual Property Right (IPR) and Digital Signatures laws enacted in 2002 and 2004 respectively. The Egyptian government should provide all possible incentives to encourage the software industry. IPR and Digital Signatures laws were enacted but still an effort should be made to apply them and enforce their proper execution. Tax holiday, simplifying licensing issuance and reducing customs procedures would encourage the software export industry.

Country Image and Perception

“*Doing Business*” web site of the World Bank⁴ provides a summary of business climates in different economies identifying specific regulations and policies that encourage or discourage investment, productivity, and growth. Key indicators are used to help measure the ease or difficulty of operating a business: starting a business, hiring and firing workers, enforcing contracts, getting credit, and closing a business. Regional and OECD averages are provided for each topic for comparison. Egypt should work on improving the country image and perception to encourage multinational companies and foreign investors to establish a software industry in Egypt.

- **Intervening Variables**

Intervening variables are ones that surface between the time independent variables start operating to influence dependent variables, and the time their impact on the later variables is felt.

Resistance to Change

This is the resistance to change work habits due to behavioral, cultural or bureaucratic heritage. The resistance to change and non-productive work habits should be minimized to help build a world-class software industry.

- **Research Assumptions**

The following are the research assumptions:

1. The Software Export Success Model developed by Heeks and Nicholson (2002) is valid and applicable to Egypt. The Model is used as a sensitizing device to gain a preliminary understanding of what issues need to be explored and as a means for analysis.
2. The Oval Model developed by Carmel (2003) is valid and applicable to Egypt. The Model is used as a sensitizing device to gain a preliminary understanding of what issues need to be explored and as a means for analysis. It is not used in a deterministic, causal sense.
3. Increased international software supply reduces the available international market demand for software, hence reducing the possibilities for Egypt to export software. Bigger differences between international software outsourcing demand and supply improve software export opportunities for Egypt.
4. The International market demand value for software is large enough to absorb competent supply. The research assumes that the gap between demand and supply is constant for the next 10 years.
5. Egypt software production is small compared to the international software demand, hence, Egypt is considered as a price taker. Since software production is an export-oriented activity, it is reasonable to assume that 70% of domestic production will be exported.
6. The model developed in this study does not emphasize the effect of the national software industry including the clusters effect, the rivalry state (i.e. collaboration or competition) between different software development firms on the expected software export revenue.

- **Research Limitations**

The following limitations apply to the research:

1. Limited accurate comprehensive data about software industry in Egypt. The research is based on secondary sources of data and in-depth interviews.
2. The research is limited to IT services and software export.

⁴ <http://rru.worldbank.org/doingbusiness/>

3. Limited access to current and potential software importers from Egypt to collect their feedback and perception regarding importing software from Egypt.
4. The model developed in this study could help identify the effect of national software-related infrastructure on the expected software export revenue.
5. Some national software related infrastructure, namely: Government and Legislative Incentives, Country Image and Perception, Communication Infrastructure, and Quality, are assumed of limited impact during the assessment period of 10 years.

5 RESEARCH QUESTIONS

Major Research Questions

Egypt attempted to build a software industry since the early 1980s; around the same time India started building its software industry and in the year 2002 it exported more than US\$7bn worth of software and IT services. On the other hand, the Egyptian contribution to software export is not highly acknowledged in the international market and the main research question is:

To what extent can Egypt be successful in exporting software and IT services? What are the success factors and challenges for Egypt to substantially increase software and IT services exports?

Minor Research Questions

Egyptian export-oriented software industry should be based on successful software export factors. India set a model for developing countries to capture a great portion of the international software outsourcing market and is classified among the first tier software exporting nations⁵ (Carmel, 2003a).

Answering the following research questions helps assess the extent of success of the Egyptian software export-oriented software industry:

1. What is the national software vision and strategy to encourage the IT development industry?
2. What is the effect of increasing the financial resources provided to the software industry on software export revenue?
3. What is the effect of increasing productivity and innovation on software export revenue?
4. What is the effect of the increase in R&D on the software export revenue? Would increasing the acquired technology be more effective than the innovation content of the developed software?

6 SOFTWARE INDUSTRY IN EGYPT

Software industry development initiatives in Egypt date back to the early 1980s when several small companies developed business applications and IBM established the scientific center in Cairo. Since then, many initiatives to develop software and provide IT services have been attempted. Several software houses and IT firms develop software solutions and provide services to the local market and export to Arab and other markets. Few software products made it to the international market.

The Egyptian Ministry of Communication and Information Technology (MCIT)⁶, founded in 1999, is currently promoting and building the Egyptian Information society. The Smart

⁵ Carmel characterizes the first tier exporting nations that have more than 15 years of software exporting experience, hundreds of organizations exporting software and annual export revenue greater than \$1 billion.

⁶ <http://www.mcit.gov.eg/>

Village⁷ inaugurated in 2003 provides high technology infrastructure and a proper environment to develop a cluster that houses software and IT firms.

In 2004, Egypt actively participated to the World Summit on the Information Society (WSIS). Since January 14th, 2001, the Internet-access price has been included in the telephone call bill and has been available to any landline. Value-added Internet services and fast access, such as the Digital Subscriber Lines (DSL) are also available and facilitate digital communication and information interchange.

The Intellectual Property Rights (IPR), law number 82, has been enacted since 2002. The Law of Electronic Transactions and Cyber Crimes has been approved by the Peoples Assembly in 2004.

According to MCIT monthly report posted on the Internet the number of registered IT companies is close to 1000 companies. The total number of job opportunities in the IT sector is about 30,000 persons.

In 1999, MCIT prepared the National plan for telecommunication and information for Egypt. The plan goals were:

1. Promotion and development of the Communication and Information industries for the purpose of developing an advanced industry that depends on the thoughts and minds of the Egyptian youth and occupies an advanced position among our industrial exports.
2. Building an information society that can pursue and absorb the huge flow of information and up-to-date knowledge; and can optimize their usage.
3. Provision and development of the Communication and Information systems to serve the national issues associated with the reform and growth of the Egyptian economy, and raising the standard of living for the citizen and the family.
4. Provision of the manpower needed for the communication and information sectors.

The plan identified work dimensions and specific projects, of which some materialized and improved Egypt's information readiness. Among the achieved projects outlined in the plan are:

1. Professional development program that helped establish education and training centers in different governorates. IBM professional development program initiated in March 2000 trained 20,000 youth in different IT disciplines.
2. Enhancement of National Post Authority⁸ to provide modern services efficiently.
3. Establishment of the National Center to document cultural and national heritage (CULTNAT). CULTNAT documented and registered a significant portion of Egypt's cultural and national heritage. This project resulted in the launch of Eternal Egypt⁹ Internet site that highlights a significant part of Egypt's history on the Internet.

Many other projects in different areas are still in different implementation stages.

6.1 Egypt's Vision of the Information Society

MCIT (2003) published a brochure "Building Digital Bridges" outlining the Egyptian vision, regarding the information society. The document reflects the government's acknowledgment of the significance of information technology to prosperity. The document sums up key-challenges and actions identified to build an information society bridging the digital gaps.

Challenges

The key challenges to building an information society include:

⁷ Visit the Smart Village's web site <http://www.smart-villages.com/index.htm>

⁸ <http://www.bareed.org/>

⁹ <http://www.eternalegypt.org/>

- **Awareness and Advocacy:** the government is trying to increase citizens' awareness of the potential benefits that might result from the application of the new technology.
- **Universal and Inclusive Access:** high access costs and lack of equipment are two factors that limit citizens' access to ICT.
- **Education and Illiteracy:** relatively low literacy rate, estimated at 56.9%¹⁰ in 2002 limits the use of IT as an educational media.
- **Linguistic Diversity and Cultural Identity:** two thirds of the Internet content is displayed in English, which is a language barrier for creating and using Internet content. The lack of Arabic Internet content is one factor hindering ICT usage in Egypt. Modest English language capability is another factor.
- **Development of Local Content:** Citizen-Driven Information; Internet information content should be of interest to local population.
- **Skills Gap:** user skills are limited to e-mail and word processing.

The following section highlights some of Egypt's responses to overcome the above challenges.

Bridging the Digital Divide: The Egyptian Information Society Initiative

The MCIT policy promotes 7 initiatives to build the Information Society:

1. **e-Readiness:** equal access for all. Developing an appropriate communication infrastructure to provide an easy and affordable access to all citizens.
2. **e-Learning:** nurturing Human capital. The aim is to promote the use of ICT in education and to develop a new generation of citizens who understand, and are comfortable with the use of ICT in their daily lives.
3. **e-Government:** the goal is to reach a new level of convenience in government services, offering citizens the opportunity to share in the decision-making process, and to improve efficiency and quality.
4. **e-Business:** a new way of doing business. Creating new technology-based firms, improving workforce skills, using electronic documents, and developing e-payment infrastructure to enable ICT to become a catalyst that increases employment. Creating new jobs and improving the competitiveness of Egyptian industries.
5. **e-Health:** increasing the availability of health services. Applying ICT in the health sector to improve citizens' quality of life and to provide more efficient work environments for physicians and health-care workers.
6. **e-Culture:** promoting Egyptian culture. Using ICT to document the Egyptian cultural identity. Electronically storing manuscripts, archives, index material and natural heritage, then offering worldwide access to cultural and historical material in order to generate and promote interest in Egyptian cultural life and heritage.
7. **ICT Export:** Industry development. Fostering the creation of an export-oriented ICT industry.

For each initiative, the report presents the objectives, policy guidelines, proposed solutions to challenges, current state, and future plans pointing to the way forward.

6.2 Egyptian Software Industry Geared Towards Exports

The government represented by MCIT attempts to promote software export and has demonstrated positive initiatives towards preparing an environment conducive to software exports, for example- to name a few:

1. Enacting the laws for Intellectual Property Rights (IPR) and digital signatures.

¹⁰ Source: Development Data Group World Bank, ICT At a Glance for Egypt 10/3/2003.

2. Participating in international trade fairs and World Summit on Information Society (WSIS) and hosting International Telecommunications Union ITU May 2004.
3. The inauguration of the Software Engineering Competence Center (SECC) in June 2001. SECC supports the development of Egypt's software industry by raising the industry's standards and improving the software engineering practices used in developing software. SECC acts as a liaison between the software industry leading software corporations worldwide, and the government, represented by MCIT. SECC works on establishing an environment to attract foreign direct investment for subcontracting Egyptian software companies for offshore development. SECC promotes the software engineering profession and SEI CMM certification. The achieved 6 successful certification assessments are detailed as follows:
 - a. CMM Level 2: IT Soft May 2004.
 - b. CMM Level 3: IT soft June 2004, DMS and C-TDC IBM Egypt August 2004.
 - c. CMMI Level 3: EDS Egypt August 2004, Raya Software September 2004.

The software industry is actively participating to planning, vision formulation and committed to actively participating in the plan implementation as demonstrated by the number of software development firms that recently passed the CMM certification process. The government is also attempting to enhance the country's image and ranking according to different benchmarks reflecting the eagerness to actively create a healthy environment for the software industry.

The assessment of Egyptian software export capabilities result is summarized in Table 1.

Table 1: Assessment of Egyptian Software Export Factors

Software Export Factor	Egypt
Demand	Potential for increasing external demand. Potential for enhancing internal demand.
National Vision and Strategy	Vision and strategy present: Data services then climbing the value chain.
International Linkages and Trust	Low linkages, Egypt is not well known among software exporting countries. Low trust in the region.
Software Industry Characteristics	High competition between software firms. Room for encouraging cooperation among firms. An old cluster in Free zone of Nasr City and a new cluster in Smart Village.
Domestic Input Factors/ Infrastructure	Low-cost human capital; World-class communication infrastructure; Available access to capital; Limited R&D.

7 RESEARCH METHODOLOGY

7.1 Systems Thinking Model

Dynamic modeling phases include the analysis of the cause-effect relationship of the main variables under study, resulting in a causal loop diagram. The causal loop diagram is then mapped to a stock and flow diagram. The stock and flow diagram would give better insight about the extent of effect and relationship between variables.

7.2 Reference mode

Egypt's software exports have experienced sluggish growth rates during the previous period; however, starting in the year 2002, the focus given to the information and communication technology (ICT) field led to the increase in software exporting prospects as shown in Figure 2.

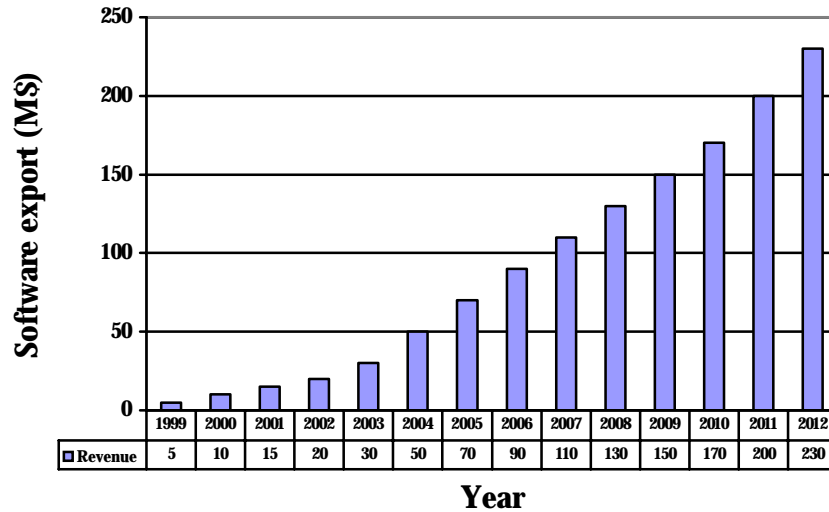


Figure 2: IT Exports Revenue Projection

Egyptian software potential exports could still improve at higher rates. The objective of the system dynamics model simulation is to attempt to illustrate Egypt’s software export success factors and suggest policies to improve software exports.

8 SYSTEM DYNAMICS MODEL

From a high level perspective, the software export success factors suggested by Heeks and Nicholson (2002) are depicted in Figure 3.

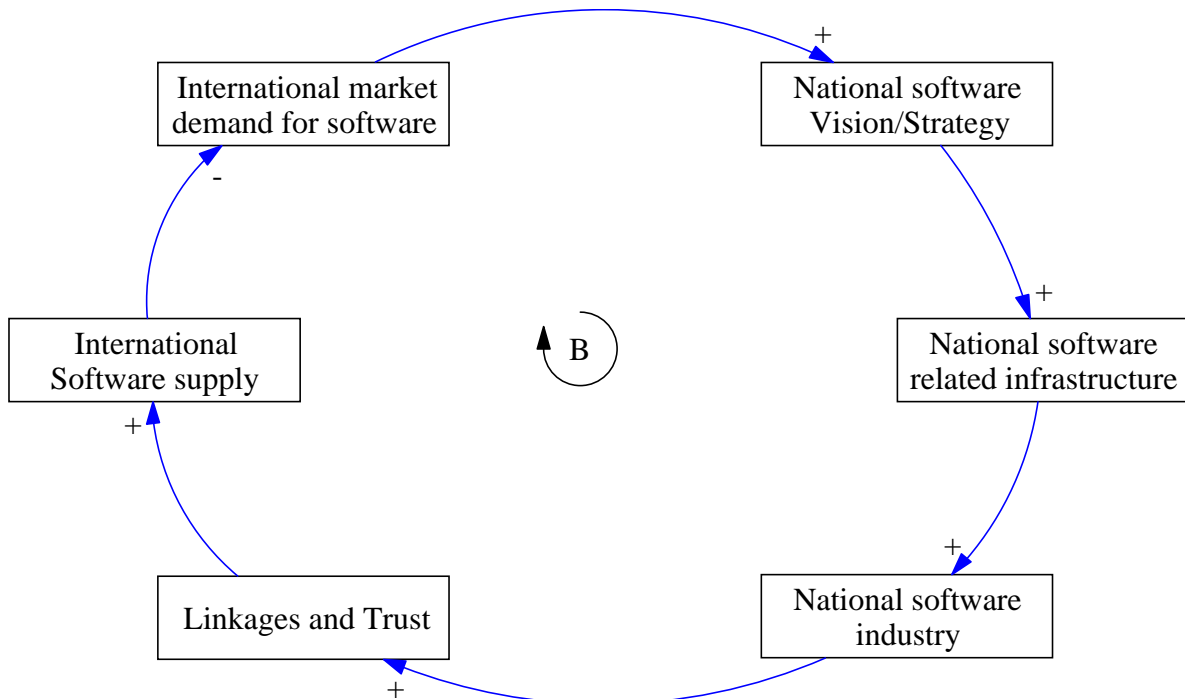


Figure 3: International Software Export Factors

The international market demand for software encourages countries to create a vision to build a software-exporting strategy. The national software strategy should encourage the erection of

a national software-related infrastructure. The national software industry builds on the national-related infrastructure, a solid infrastructure strengthens the industry and vice versa. The National software industry attempts to establish linkages with international software markets and attempts to gain their trust. Some software development subsidiaries established in the country enjoy a strong international linkage. The national software outcome of countries adopting a software-exporting strategy increases the international software supply. As the software industry evolves rapidly, the supply of a certain software industry could reduce the demand for the same technology. Technology continuous evolution creates a need for additional investment to provide state-of-the-art software that satisfies the demand. The overall effect of a software industry is of a balancing nature as the increased number of countries exporting software raises the entry barrier to software export and exerts pressure on developers to innovate in the software industry.

The Egyptian software export interaction with the international market is shown in Figure 4

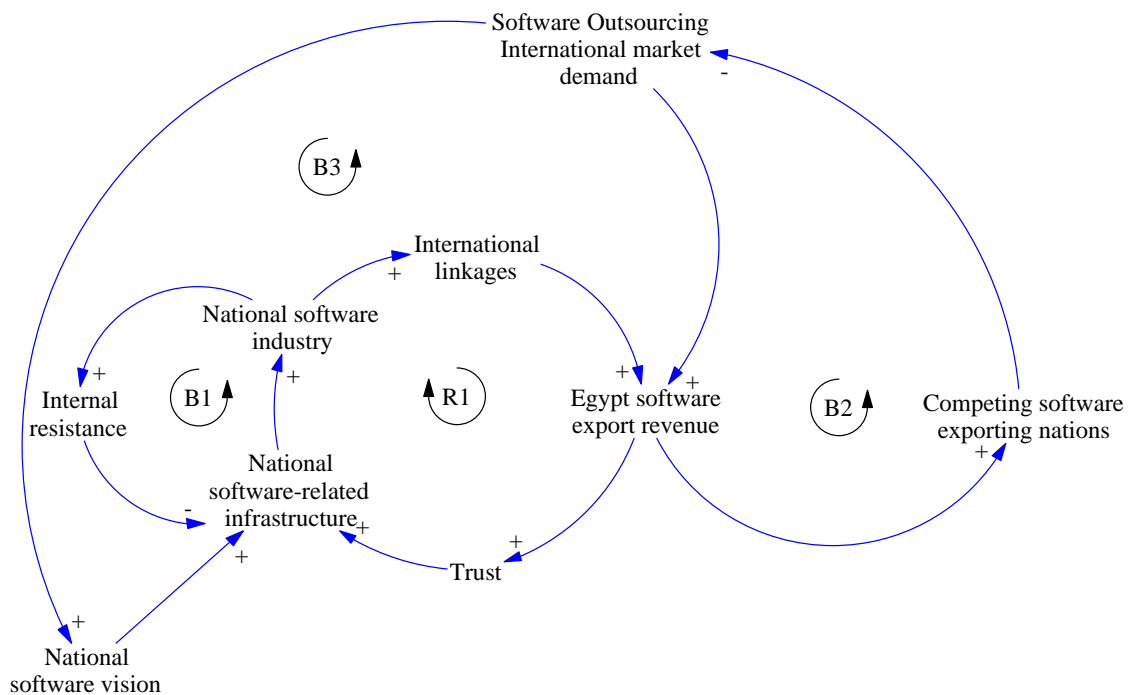


Figure 4: International Software Market Interaction

R1: Is a reinforcing loop in which successful national software-related strategy, infrastructure, and industry succeed in building strong linkages to export software. The country that builds a good track record in software export revenue and quality gains trust, then it becomes in a better position to export more software.

B1: Bureaucracy, high taxes, long customs procedures, tedious procedures to establish a company and poor quality of life are among the internal resistance factors that limit the growth of national software industry.

B2: Early entrant and competitive software exporting nations such as India, China, Philippines, and others fulfill a huge portion of international software demand, which limits the chances of a new entrant to easily capture a big portion of the international market.

B3: The increase of software international market demand encourages countries to formulate a vision that results in a software-exporting strategy. Countries attempt to strengthen their national software infrastructure and industry to allow the industry to strengthen the linkages with international software market. However, the international software supply and

competitive software exporting countries capture a significant portion of international software market demand, which limits the Egyptian software export growth.

Delving deeper in the dynamics of software export model reveals the causal loop diagram, shown in Figure 5. The causal loop diagram shows the main software export success factors relevant to the research study. Constant factors are marked in gray, and leverage loops are highlighted in red.

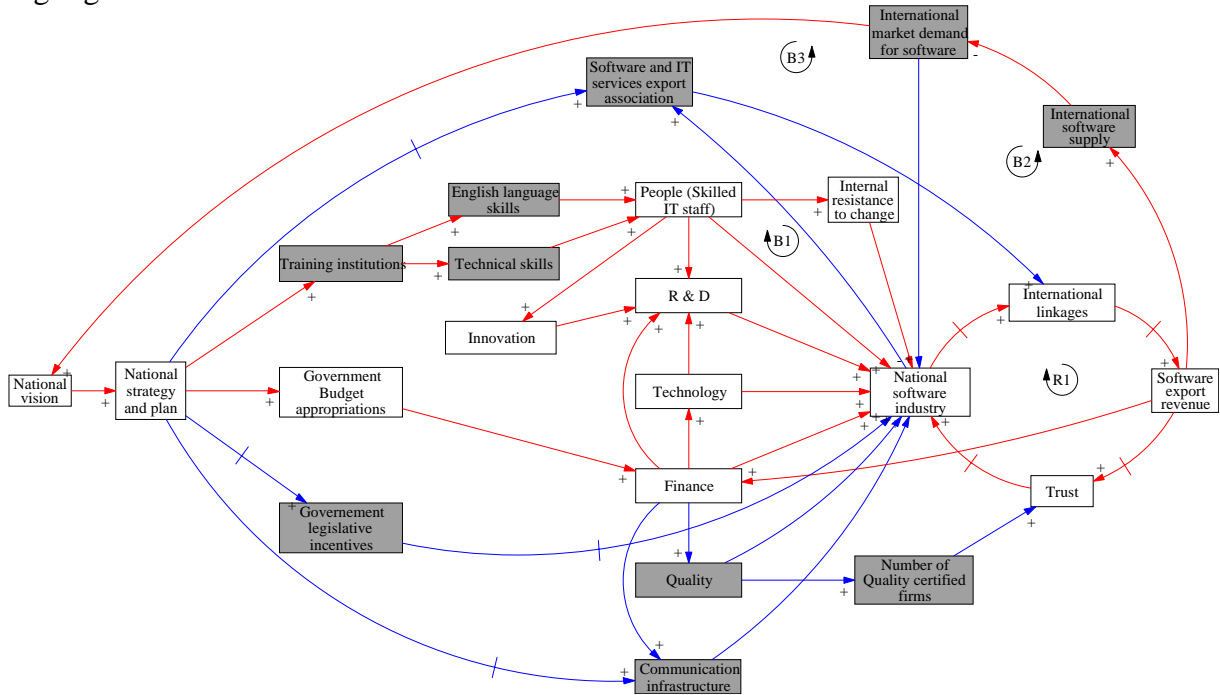


Figure 5: Causal Loop Diagram International Software Market Interaction

8.1 Causal Loop Variables

The causal loop diagram consists of 23 variables, which mainly represent the software-related infrastructure and industry characteristics, each variable is describe in Appendix 1: Causal Loop Diagram Variables.

9 CONCEPTUALIZATION

9.1 Key Leverage Causal Loops

The causal loop diagram in Figure 5 revealed more than 53 loops, constant factors are marked in gray, and leverage loops are highlighted in red. Based on practice and theory, in addition to the research assumption, the leverage loops become as depicted in Figure 6.

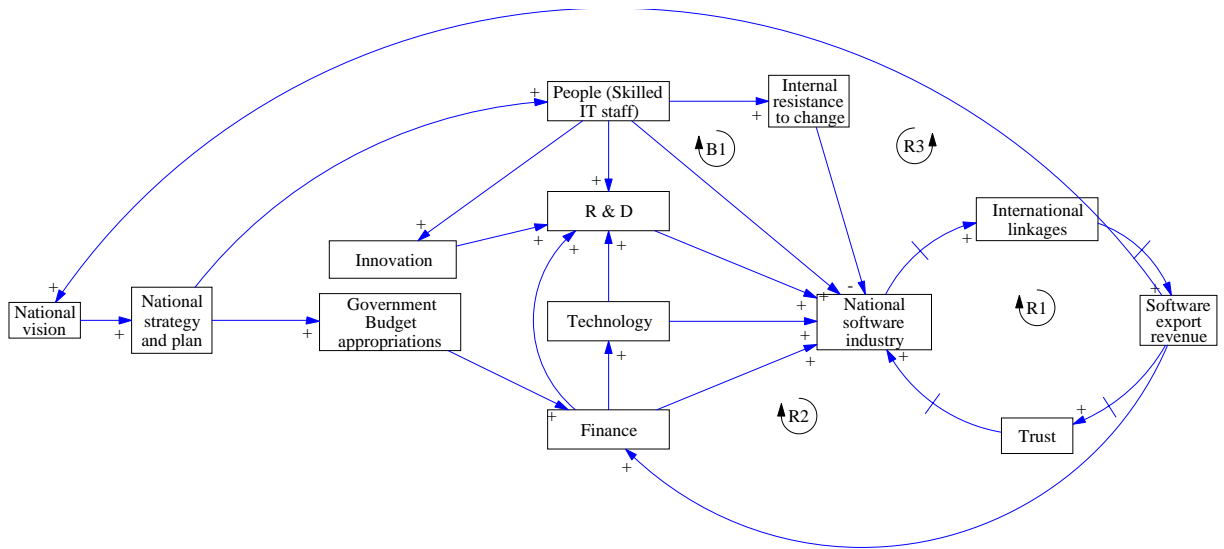


Figure 6: Key Leverage Causal Loop Diagram For Software Export Industry

Key leverage loops effects are described in Table 2.

Table 2: Key Leverage Causal Loops

No.	Loop Name	Loop Route	Loop Description	Loop Type ¹¹	Delay ¹²
1	Export Loop	National software industry International linkages Software export revenue Trust	The capacity of the Egyptian software industry and its potential to build linkages with the international software market and export software builds trust in the Egyptian software industry. This improves the capability of the software industry to build stronger linkages and further increase software exports revenue.	R	Y
2	Finance Loop	Software export revenue Finance Technology National software industry International linkages	Software export proceeds increase the available finances to enhance the software-related infrastructure by acquiring Technology or investing in R&D. Improved software-related infrastructure strengthens the National software industry, and hence augments the potential exportable software and builds stronger linkages with the international software market, eventually increasing the software export revenue.	R	Y
3	Vision Loop	National vision National strategy and plan People (Skilled IT staff) Innovation R & D National software industry International linkages Software export revenue	The Egyptian Vision to build an export-oriented software industry should be supported by a strategy and plan to build a software-related infrastructure. High caliber people properly equipped with state-of-the-art technical skills and English language innovate and develop differentiated software that is difficult to imitate. The innovations and R&D results should increase the software industry capacity to develop potential exportable software. Export-oriented software industry should build strong linkages with international markets in order to export the national software, and then improve the software exports proceeds.	R	Y
4	Resistance to change	People (Skilled IT staff) Internal resistance to change National software industry International linkages Software export revenue National vision National strategy and plan	People are the main constituent of the software industry as it is a knowledge-based industry. The human contribution is the most significant component of the software industry. Negative work behavior, bureaucracy complacency and resistance to change reduce the capacity of the software industry to produce exportable software. The resistance to change erodes the potential exportable software. Hence, limiting the growth of the software industry. It also poses a burden and cost on the software industry, leading to a reduction in international linkages, and software export revenue growth.	B	Y

¹¹ Loop Type coded as follows: B indicates a Balancing Loop, R indicates a Reinforcing Loop.

¹² Delay coded as follows: Y indicate the existence of delay, N indicates no delay in the loop.

10 DYNAMIC MODELING

10.1 Stock and Flow Mapping

The causal loop diagram presented in Figure 6 is used to build a simulation model for policy analysis and testing. A stock and flow diagram¹³ is built to simulate the dynamic behavior of the model. The dynamic model defines variables in terms of stock (or levels), flows (or rates of change), converters (or factors or coefficients), and connectors. The causal loop variables are converted to stock, flow, or converters, and then mathematical equations or graphs relate the variables to each other. The stock and flow diagram is mapped from the causal loop diagram using mapping cards developed for this purpose¹⁴. Mapping cards helped reveal the necessary data for collection and input to simulate the system behavior.

10.2 Data needed

The stock and flow mapping cards, presented in Appendix F, revealed variables and data necessary to simulate the model. Data variables and initial value are presented in Appendix 2: Simulation Variables and Data Needed.

The Stock and Flow diagram used to simulate the system dynamics is shown in Figure 7.

¹³ The dynamic model defines variables in terms of stock (accumulators or levels), flows (or rates of change), converters (or factors or coefficients), and connectors. Stocks collect whatever flows in or out of them, they represent accumulated quantities within the system and they exist in the system even if flows stop. Flows are the changes to stocks. Converters convert inputs into outputs, they hold values for constants, define external inputs to the model, calculate algebraic relationships, and serve as the repository for graphical functions. Connectors connect model elements. For more details on the modeling process, refer to *Systems Thinking and Modeling* by Kambiz E. Maani et al, (2000) or *Dynamic Modeling for Business Management an introduction* by Brenard McGarvey et al. (2004).

¹⁴ Dr. Khaled Wahba presented this methodology in the Business Dynamics course, 2004.

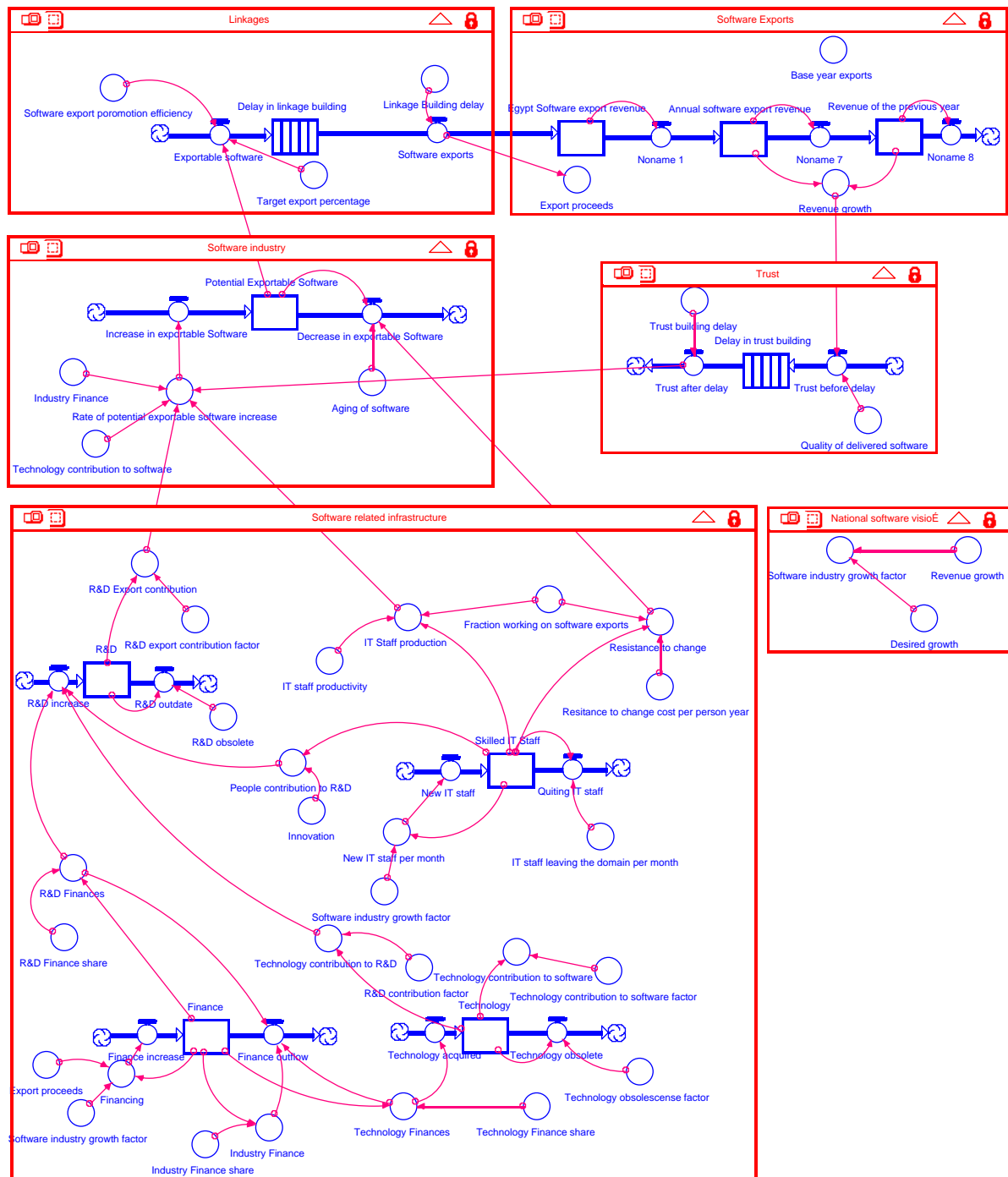


Figure 7: Stock and Flow Diagram for Export-Oriented Software Industry

11 MODEL VALIDATION

11.1 Sensitivity Analysis Test

In order to validate the model, behavior sensitivity analysis is performed. Software export revenue variation is evaluated in accordance with changes in the values of parameters over the ranges specified in Appendix 2: Simulation Variables and Data Needed. The model sensitivity test is done by running the model five times in order to compare the variation effect of the following key parameters over the reasonable range:

1. Effect of desired growth on annual software export revenue. Values less than one produce no change in behavior, although the desire to shrink the software industry, as the realized software export revenue sustains the software export behavior. Values equal to or greater than one show a steady increase in the annual software export revenue as the desired growth factor supports different software-related infrastructure growth, hence, leading to a steady increase in annual software export revenue.
2. Effect of software export promotion efficiency on annual software export revenue, increasing the Software Export Promotion Efficiency significantly increases the Annual Software Export Revenue. This indicates the importance of establishing efficient software export promotion associations to increase Egyptian software exports.
3. Effect of IT staff productivity on annual software export revenue, increasing the IT Staff Productivity significantly increases the Annual Software Export Revenue. This highlights the importance of improving IT staff productivity to increase Egyptian software exports.
4. Effect of Quality of delivered software on annual software export revenue, increasing the Quality of Delivered Software increases the Annual Software Export Revenue. Poor quality software damages the Trust in the software industry and significantly reduces the software export revenue. Although high quality software has lower effect than increasing IT staff productivity. This highlights the importance of delivering reasonable quality software.
5. Effect of Technology Finance share on annual software export revenue, increasing the Finance allocated to Technology does not increase the Annual Software Export Revenue.
6. Effect of Innovation on annual software export revenue, increasing the Innovation contribution of IT Staff increases the Annual Software Export Revenue. This highlights the importance of innovation to increase Egyptian software exports.
7. Effect of Resistance to Change on annual software export revenue, increasing the Resistance to Change Cost reduces the Annual Software Export Revenue. Hence, the resistance to change should be kept to a minimum value in order to increase Egyptian software exports.
8. Effect of Target Export Percentage on annual software export revenue, Increasing the percentage of exportable software uniformly increases the Annual Software Export Revenue; hence, increasing the percentage of potential exportable software ready for export would be of benefit to the Egyptian software exports.

11.2 Reference Mode Reproduction Test

The input parameters settings in Appendix 2: Simulation Variables and Data Needed reproduce the reference mode shown in Figure 8, which depicts the behavior over a period of 10 years for:

1. Annual software Export Revenue
2. Finances in Software Industry
3. Value of the software oriented R&D
4. Number of skilled IT staff or Job opportunities in the IT industry
5. Potential exportable software

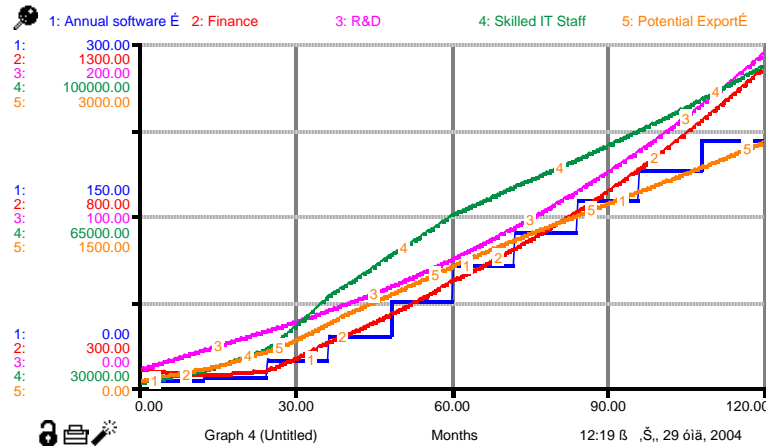


Figure 8: Reference Mode for Annual Software Export Revenue and Software Infrastructure

Numeric simulation results are presented in Table 3. The results show steady growth in the software industry infrastructure. To achieve annual Software Export Revenue of \$215M in 10 years mandates increasing the number of skilled IT staff and establishing a strong Research and Development infrastructure worth \$200M to nurture the export-oriented software industry.

Table 3: Simulation Results – Reference Mode (Run 0)

Year	Software Export Revenue [US\$ M]	Potential Exports [US\$ M]	Finance [US\$ M]	R&D [US\$ M]	Technology [US\$ M]	Skilled IT Staff [Person]
0	5.00	50.00	350.00	10.00	100.00	30,784
1	5.00	153.97	332.69	21.18	112.22	33,170
2	8.19	303.28	346.05	32.11	122.87	37,466
3	22.73	545.18	428.81	44.08	135.53	48,183
4	43.37	799.92	509.64	58.09	152.54	56,707
5	74.62	1,049.34	607.27	74.26	173.85	64,949
6	105.32	1,280.49	701.90	92.75	199.49	70,840
7	135.61	1,495.90	808.89	113.61	229.24	76,348
8	163.29	1,705.32	933.21	137.20	263.66	82,265
9	189.45	1,917.17	1,073.28	163.91	303.36	88,640
10	215.11	2,138.18	1,228.47	194.12	348.82	95,510

11.3 Other Validation Tests

Additional tests were performed to validate the model behavior. Model equation checks and reviews were performed. The model was also subject to extreme parameter settings to inspect behavior at the extreme ranges. Setting input parameters to the minimum values shown in Table 4 result in the system behavior depicted in Figure 9.

Table 4: Minimum Values for Input Parameters

IT Staff Productivity	Innovation	Export Promotion Efficiency	Linkage Building Delay	R&D export contribution factor	Resistance to Change	Desired growth	Quality of Delivered Software
\$5,000/Year	\$10/Year	20 %	2 months	0.1	\$10/Year	0.7	0

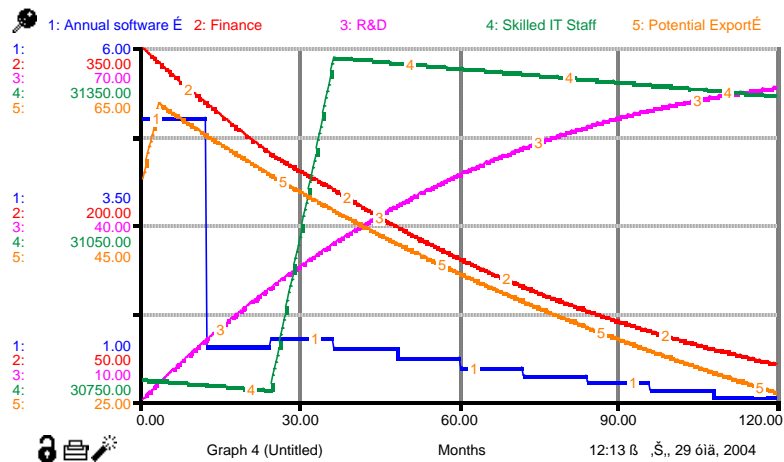


Figure 9: System Behavior Under Minimum Values for Input Parameters

Figure 9 shows a decay in annual software export revenue, and finances; the increase in R&D, and Skilled IT staff job opportunities created in IT industry do not help sustain the software export industry. The model shows a destruction of the IT industry under minimum values of input parameters.

12 POLICY ANALYSIS

12.1 Scenario Planning

This is created to analyze the effect of changing values of input parameters on the behavior of the system, with the main objective to improve software export revenues. Table 5 shows different scenarios for the policies to increase the software export revenue. The first row shows the values of parameters for the reference mode; the subsequent rows show five different scenarios to improve software export revenue.

Table 5: Simulation Runs Design

Run No.	Objective	Initial Potential Exportable Software	Initial Skilled IT Staff	Initial R&D	Initial Finances	Initial Technology	IT Staff Productivity	Innovation	Export Promotion Efficiency	Resistance to Change	Desired growth	Quality of Delivered Software
0	Reproduce Reference Mode	\$50 M	30,784 persons	\$10 M	\$350 M	\$100 M	\$35,000/Year	\$100/Year	70 %	\$100/Year	+30% 1.3	1
1	Provide Additional Financial resources	\$50 M	30,784 persons	\$10 M	\$500 M	\$100 M	\$35,000/Year	\$100/Year	70 %	\$100/Year	+30% 1.3	1
2	Improve productivity and quality. Work harder	\$50 M	30,784 persons	\$10 M	\$350 M	\$100 M	\$50,000/Year	\$100/Year	70 %	\$80/Year	+30% 1.3	1.1
3	Improve innovation. Work smarter	\$50 M	30,784 persons	\$15 M	\$350 M	\$100 M	\$35,000/Year	\$150/Year	70 %	\$100/Year	+30% 1.3	1.1
4	Improve Linkages. Work closer to customer	\$50 M	30,784 persons	\$10 M	\$350 M	\$100 M	\$35,000/Year	\$100/Year	80 %	\$100/Year	+30% 1.3	1.1
5	Recommendation	\$50 M	30,784 persons	\$10 M	\$400 M	\$100 M	\$50,000/Year	\$100/Year	80 %	\$80/Year	+30% 1.3	1.1

12.2 Scenario Analysis

The following scenarios for enhancing the Egyptian software exports are studied

1. The first scenario attempts to improve software export revenue by injecting an additional 30% to the financial resources available to the Software Industry. The simulation results reveal a slight improvement in the software export revenues starting from the 4th year. The overall result after a simulation period of 10 years is 8.4% increase in software export revenue and 2.1% increase in job opportunities over the reference mode. This shows the limited effect of increasing available financial resources on the software exports.
2. The second scenario “Work harder” suggests a 42% productivity improvement and a 20% decrease in resistance to change with a 10% improvement in delivered software quality. The simulation results reveal a significant increase in software export revenues. This scenario represents an overall positive improvement on the software industry, including a significant increase in job opportunities. The overall result after a simulation period of 10 years is 68.7% increase in software export revenue and 12.9% increase in job opportunities over the reference mode. These findings confirm the importance of human contribution, as the software industry highly depends on people and their intellectual contribution.
3. The third scenario “Work smarter” suggests a 50% increase in the initial R&D and IT staff Innovation contribution with a 10% improvement in delivered software quality. Simulation results reveal a moderate increase in software export revenues. The overall result after a simulation period of 10 years is 14.4% increase in software export revenue and 3% increase in job opportunities over the reference mode. This scenario confirms the importance of R&D and Innovation to the software industry, and the increase in software export revenue.
4. The fourth scenario suggests a 14% increase in export promotion efficiency with a 10% improvement in delivered software quality. Simulation results reveal an increase in software export revenues. The overall result after a simulation period of 10 years is 38.7% increase in software export revenue and 8% increase in job opportunities over the reference mode. This scenario confirms the importance of establishing strong linkages to international markets to promote Egyptian software and realize higher export revenue.
5. The fifth scenario suggests a 14% increase in initial finances, 14% increase in export promotion efficiency, and 42% productivity improvement with a 10% improvement in delivered software quality in addition to a reduction of 20% to the resistance to change. Simulation results reveal an increase in software export revenues. The overall result after a simulation period of 10 years is 109.5% increase in software export revenue and 19% increase in job opportunities over the reference mode. These findings confirm the importance of establishing strong linkages with international markets to promote the Egyptian software and realize higher export revenue.

This last scenario significantly improves the software export revenue over the reference mode with reasonable expenses mainly focusing on productivity improvement.

12.3 Scenario Comparisons

The scenario focusing on increasing the value of the IT staff production (Run 2) has the highest impact on software export revenue. The recommended scenario (Run 5) suggests a combination of policies to increase the value of IT staff production, enhancing software export promotion efficiency, improving delivered software quality and providing sufficient finances for the software industry. Numeric details in Table 6 include percentage change in Software export revenue, Skilled IT staff (or jobs opportunities provided in IT sector), and finances compared to the reference mode (Run 0) at the base year 0 after 5 and 10 years.

Table 6: Simulation Results Summary

Run No.	Objective	Software Export Revenue [\$ M]						Skilled IT Staff (job opportunities) [Person]						Finances [\$ M]					
		0		5		10		0		5		10		0		5		10	
		Est.	%	Est.	%	Est.	%	Est.	%	Est.	%	Est.	%	Est.	%	Est.	%	Est.	%
0	Reproduce Reference Mode	5	0%	74.62	0%	215.11	0%	30,784	0%	64,949	0%	95,510	0%	350	0%	607.27	0%	1,228.47	0%
1	Additional Financial Resources	5	0%	80.94	8%	233.23	8%	30,784	0%	66,276	2%	97,542	2%	500	43%	789.52	30%	1,424.33	16%
2	Improve Productivity and Quality	5	0%	117.82	58%	362.79	69%	30,784	0%	72,754	12%	107,814	13%	350	0%	802.86	32%	1,917.68	56%
3	Improve Innovation	5	0%	83.38	12%	246.01	14%	30,784	0%	66,765	3%	98,415	3%	350	0%	648.04	7%	1,372.39	12%
4	Improve Linkages	5	0%	100.06	34%	298.31	39%	30,784	0%	69,868	8%	103,113	8%	350	0%	723.89	19%	1,620.71	32%
5	Recommendation	5	0%	145.09	94%	450.76	110%	30,784	0%	76,625	18%	113,700	19%	400	14%	980.12	61%	2,370.57	93%

13 CONCLUSION

13.1 Basic Run Conclusion

The basic run reproduced the reference mode behavior. The main conclusions drawn from the simulation results are:

1. Increasing the software export revenue requires creating a strong software-related infrastructure including building Software-Oriented Research and Development Centers that produce innovative ideas to increase potential exportable software.
2. The software export industry would provide more job opportunities to competent and skilled IT staff.
3. The value of the software produced by an IT staff is a detrimental factor. IT staff productivity and value of the developed software has a high impact on increasing the software export revenue.
4. Improving linkages with the international software market increases the chances of exporting software.

13.2 Policy Analysis Conclusion

Scenarios to improve the software export revenue over a period of 10 years revealed the following conclusions:

1. Abundant Financial supply is not sufficient to build a strong export oriented software industry. Injecting an additional 30% financial resources resulted in an increase of 8.4% in software export revenue and 2.1% in job opportunities with respect to the reference mode.
2. The software value produced has the highest impact on the software exports revenue. Improving the IT staff productivity by 42%, and 10% in delivered software quality, with a 20% decrease in the resistance to change resulted in an increase of 68.7% in software export revenue and 12.9% in job opportunities with respect to the reference mode.
3. Innovation and R&D improves the software exports revenue. Improving the R&D by 50% and IT staff innovation contribution by 10% leads to an increase of 14.4% in software export revenue and 3% in job opportunities with respect to the reference mode.
4. Export promotion of high quality software warrants a software export revenue increase. Improving the software export promotion efficiency by 14% and quality of delivered software by 10% results in an increase of 38.7% in software export revenue and 8% in job opportunities with respect to the reference mode.

14 RECOMMENDATIONS

14.1 General Recommendations

Egypt can improve its export oriented software industry by attempting the following:

1. Establish a community for emigrants to promote Egypt as a software-exporting nation. Transform “brain-drain” into “brain-gain”.
2. Create a software producers association and a marketing body to link and market IT firms in Egypt to the international market, similar to NASSCOM in India.
3. Make use of the commercial representative offices that Egypt has to establish links and promote software trade in the 60 countries where the offices reside.
4. Egypt should focus and excel in IT domains with comparative advantages, in order to achieve sustainable revenues in IT. Key focus IT domains are:
Arabization and linguistics: enable software for use by Arabic language users and translation of user interface.
Educational software: preparation of software that presents cultural, geographic, historic, natural, and religious heritage unique for Egypt.

Entertainment: Entertainment software and high technology media to present the unique artistic content Egypt possesses and that is well perceived in Arab and international market.

14.2 Recommended Policy Scenario

The recommended policy suggests a 14% increase in initial finances, 14% increase in export promotion efficiency, and 42% productivity improvement with a 10% improvement in delivered software quality in addition to a reduction of 20% to the resistance to change. The simulation results in Figure 10 and Table 7 reveal an increase in software export revenues. The overall result after a simulation period of 10 years is 109.5% increase in software export revenue and 19% increase in job opportunities over the reference mode, which confirms the importance of establishing strong linkages with international markets to promote the Egyptian software and realize higher export revenue.

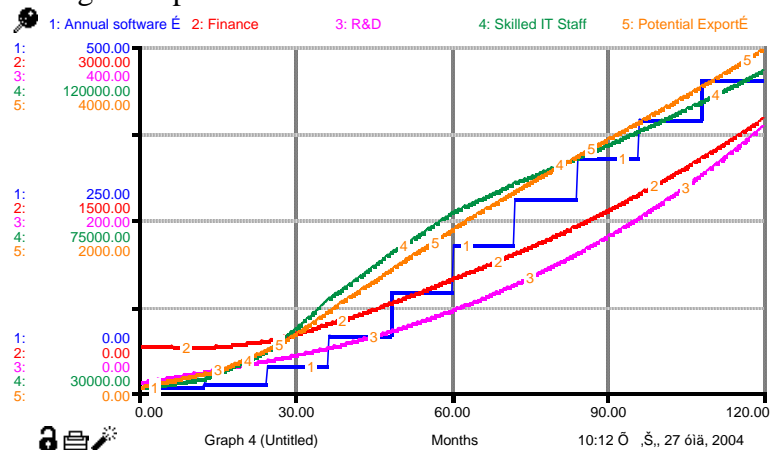


Figure 10: Recommended System Behavior

Table 7: Recommended Simulation Results

Year	Software Export Revenue [US\$ M]	Potential Exports [US\$ M]	Finance [US\$ M]	R&D [US\$ M]	Technology [US\$ M]	Skilled IT Staff [Person]
0	5.00	50.00	400.00	10.00	100.00	30,784
1	5.00	202.20	381.84	22.41	115.68	33,170
2	11.01	475.38	435.97	35.10	130.70	40,277
3	35.91	917.12	588.15	50.24	150.98	53,949
4	79.79	1,400.08	767.65	69.64	180.65	65,951
5	145.09	1,872.82	980.12	94.00	220.72	76,625
6	212.10	2,311.14	1,199.03	123.81	271.40	84,317
7	277.48	2,721.15	1,438.62	159.30	332.35	90,889
8	337.58	3,121.92	1,715.29	201.14	404.35	97,932
9	394.51	3,531.57	2,026.20	250.19	488.64	105,522
10	450.76	3,964.05	2,370.57	307.24	586.13	113,700

To implement the recommended model and significantly increase the software export revenue the policy-maker should attempt the following:

1. Maximize the productivity of the IT staff by providing them with better education.
2. Minimize the resistance to change by setting a model role and setting clear goals and objectives to produce software complying with international market requirements and delivering reliable software complying with the client's requirements.
3. Establish a software export promotion association to strengthen the linkages between the Egyptian software industry and the international software market. The objective is to

increase the software export promotion efficiency and develop software that could be more efficiently exported.

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APPENDIX 1: CAUSAL LOOP DIAGRAM VARIABLES

Table 8: Causal Loop Diagram Variables

No.	Loop Variable	Description	Cause-Effect Relationship	Level ¹⁵	Causal Loop ¹⁶	No. of Loops
1	Software export revenue	The value of software products and IT services exported from Egypt in one year.	Egypt's objective is to maximize software export revenues. The increase in software export revenues has a positive effect on the national welfare in terms of available financial resources. In addition, it improves the international trust in Egyptian software industry, and adds to the international software supply.	N	MV	53
2	Linkages	Egyptian ability to export software to the international market. It is represented in the model as a fraction of the potential exportable software	Increases the Egyptian ability to export software. Egypt should work on establishing strong linkages to the international software market in order to increase export revenues.	I	MV	53
3	National software industry	Refers to the state of clusters, cooperation and competition in the software industry. The outcome of the software industry in terms of potential exportable software (including products and services).	Improving the software industry in order to produce more potential exportable software, building on the software-related infrastructure to increase the possibility to export more software, hence, increasing the software export revenues.	D	MV	52
4	Trust	Buyers' confidence doing business in Egypt. Hence, trust Egypt to be an international software-outsourcing provider.	Higher trust levels improve the potential exportable software and increase the possibilities for Egypt to export software.	I	MV	6
5	People	IT-skilled staff in various software industry disciplines with world-class Technical and English language skills.	People with world-class IT skills both technical and English language increases Egyptian potential exportable software.	F	MV	16
6	Research and Development (R&D)	Research and development, oriented towards creating high value software and IT services unique to Egypt	Successful R&D to provide world-class software products and IT services, add significant value to potential exportable software	F	MV	16
7	Technology	Tools, software, hardware, and methodologies used to develop products and IT services	Use of the state-of-the-art technology improves the potential exportable software	F	MV	8

¹⁵ The variable level coded as follows: N = National; I = International; D = Software industry, F = Software related infrastructure

¹⁶ Causal Loop are coded as follows MV = Model Variable; EX = Exogenous Variable

No.	Loop Variable	Description	Cause-Effect Relationship	Level ¹⁵	Causal Loop ¹⁶	No. of Loops
8	Finance	Funds and Financial resources available for software industry including: Capital of IT Firms, Venture Capital Investments, Bank Loans and other fund sources.	Abundant Financial resources help in building a strong software industry and related infrastructure including Communication infrastructure, R&D, Technology, and Quality.	F	MV	28
9	Quality	Egyptian software products and IT services should comply with or exceed customers' expectations to maintain customer relationships and improve reputation.	Improved quality increases the potential exportable software and reduces cost of re-work and repair. Distinguished quality is a key requirement to obtain a reputable quality certification.	F	MV	8
10	Communication Infrastructure	Involves networking infrastructure and services to provide fast and reliable data interchange. NRI is used to measure this variable.	Fast and reliable communication infrastructure increases the capability of the software industry to produce potential exportable software.	F	EX	6
11	Government and legislative incentives	Involves all the incentives governments provide to the software industry, including tax exemption, Intellectual Property Right laws and efficient processes for licensing and doing business.	Efficient government processes and encouraging legislations that could be efficiently applied flourish the software industry, and hence, improve its capacity to produce potential exportable software.	F	EX	2
12	Government Budget appropriation	Government financial support to allocate adequate financial resources so as to fund different software requirements.	Government budget support to finance the software industry and related infrastructure is a key requirement to produce exportable software.	F	MV	14
13	Training institutions	Public and private training institutions providing English language, Technical, Marketing, Managerial and other skills necessary for the software industry.	Efficient training centers enhancing English language and priding state-of-the-art technical education, significantly enhances the IT staff skills and their ability to create exportable software products or IT services.	F	EX	16
14	Software and IT services export association	An association to promote the Egyptian software industry to the international market.	A web site, trade missions and trade shows are among the tools that help create and strengthen international linkages and software exports. Software industry helps the association succeed in its mission.	F	MV	27
15	National Vision	The government and industry vision to create a software industry and its necessary infrastructure.	The main motive behind building a software industry and its required infrastructure based on high international demand for software outsourcing.	F	MV	35

No.	Loop Variable	Description	Cause-Effect Relationship	Level ¹⁵	Causal Loop ¹⁶	No. of Loops
16	National strategy and plan	A strategy with a specific action plan to build an export-oriented software industry.	A Realistic and ambitious plan to build an export-oriented software industry helps increase the software export revenue.	F	MV	35
17	Internal Resistance to change	Preference to maintain status quo, non-productive work habits, and bureaucracy resist the changes necessary to build an export-oriented software industry.	Resistance to change waste resources hinders export-oriented software industry.	D	MV	4
18	English language skills	English is the language for doing international business.	English language skills are necessary for IT staff to understand the IT technology and communicate internationally.	F	EX	8
19	Technical skills	Knowledge software technology, marketing, managerial and other technical skills necessary for software industry.	Higher technical skills help IT staff innovate and create world-class software products and IT services for export.	F	EX	8
20	Innovation	Ability to think in a creative manner to produce differentiated approaches, creating a competitive situation difficult to imitate.	Innovative ideas help R&D in creating higher value in potential exportable software. People are the main source of innovation.	F	MV	4
21	Number of Quality certified firms	Number of firms that obtain a distinguished software quality-related certification mainly CMM certified firms.	Higher number of CMM-certified firms in Egypt increases the international trust in the software industry and promotes software exports.	D	MV	4
22	International market demand for software	International demand for outsourcing software products development and IT services.	Higher international demand for software encourages Egypt to create an export-oriented software industry.	I	EX	37
23	International software supply	Outsourcing software product development and IT services provided by different nations.	Higher international supply fulfills a significant part of the demand, thus reducing the opportunity for Egypt to export software.	I	EX	37

APPENDIX 2: SIMULATION VARIABLES AND DATA NEEDED

Table 9: Data Needed

No.	Central Variable	Cause-Effect	Initial values	Data range
1	Target Export Percentage	Percentage of Potential exportable software that could be actually exported.	0.7 70%	0.3 - 0.8 30% - 80%
2	Software export promotion efficiency	Efficiency of the software and IT services export association to promote potential exportable software to the international market. This is a measure of international linkages.	0.7 70%	0.2 – 0.8 20% - 80%
3	Linkage building delay	The elapsed time to promote and export software to the international market	3 months	2-6 months
4	Aging of software	The number of years after which the software becomes obsolete and loses its value.	3 Years	0.5 – 5 Years
5	Base Year Exports	Software exports in base year to start the simulation.	\$ 5 Million	\$ 5 – 50 Million
6	Quality of delivered software	Software quality in terms of compliance to requirements and reliability. Quality certification and trustful track record increases the trust in the software industry.	1	0-2
7	Trust Building delay	The elapsed time to build incremental trust in Egyptian software industry	3 Months	2 – 6 months
8	Percentage of IT persons working on software exports ¹⁷	Higher percentage of skilled IT staff working on software export would increase the potential exportable software.	0.3 30%	
9	IT Staff leaving the domain per month	IT staff turnover or skilled people leaving software industry to work in a different industry, reduce the potential exportable software.	0.0001 0.01%	0 - 0.0005 0 % - 0.05%
10	IT Staff productivity	The average value produced from one IT skilled person during one year. Higher productivity levels increase potential exportable software	\$ 35,000 /Person Year	\$ 5,000 - \$ 100,000

¹⁷ NASSCOM annual industry survey, the IT Software and Services Industry is projected to employ 650,000 IT professional by March 2003. This reflects a growth of 24.4% from last year's employment of 522,250. Of the total, almost 205,000 are working in the IT software exports industry; 160,000 are employed in IT Enabled Services; 25,000 in the domestic software market and over 260,000 in user organizations. http://www.nasscom.org/artdisplay.asp?Art_id=1608 Accessed on 22/9/2004

No.	Central Variable	Cause-Effect	Initial values	Data range
11	Resistance to change cost per person per year	The lost value due to negative work habits and resistance to change; it reduces the potential exportable software.	\$ 100 / Person Year	\$ 10 - \$ 20,000
12	Innovation	The average value of innovative ideas each skilled IT staff contributes to R&D per year.	\$ 100 /Person Year	\$ 10 - \$ 50,000
13	R& D export contribution factor	The percentage of R&D that results in valuable software products or IT services for export.	0.3 30%	0.1 – 0.5 10% - 50%
14	R&D Obsolete	The validity period or R&D. The R&D becomes obsolete after a certain duration	5 Years	1-10 Years
15	R&D Finance Share	The Share of finances allocated to fund R&D. Higher percentage of financial resources allocated to R&D	0.1 10%	0.01-0.15 1% - 15%
16	Technology contribution to R&D	Percentage of Technological resources allocated to R&D	0.1 10%	0.01-0.15 1% - 15%
17	Technology finance share	Finances share allocated to fund Technology acquisition It increases the Technology value.	0.3 30%	0.1 – 0.4 10% - 40%
18	Technology obsolescence factor	IT evolves rapidly, so Technology becomes obsolete every 2 years.	2	1 - 5
19	Industry Finance Share	The Share of finances allocated to fund the software industry	0.2 20%	0.1 – 0.3 10% - 30%
20	Desired Growth	The desired annual growth in software industry set by the vision statement.	1.3	0.7-1.7

LIST OF ABBREVIATIONS

CMM	Software Capability Maturity Model
CMMI	Software Capability Maturity Model Integrated
DTE	Developing and Tertiary Economies
GITR	Global Information Technology Report
GNI	Gross National Income
ICT	Information and Communication Technology
3Is	India, Ireland, and Israel
ILO	International Labor Organization
IPR	Intellectual Property Rights
IT	Information Technology
MCIT	Ministry of Communication and Information Technology
NASSCOM	India's National Association for Software Services Companies
NRI	Network Readiness Index
OECD	Organization for European Cooperation and Development
SECC	Software Engineering Competence Center
SEI	Software Engineering Institute in Carnegie Mellon University
WSIS	World Summit for Information Services

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