A NATIONAL IT STRATEGY
FOR
TURKISH CONSTRUCTION INDUSTRY

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MAY 2004

A NATIONAL IT STRATEGY
FOR
TURKISH CONSTRUCTION INDUSTRY

A THESIS SUBMITTED TO
THE GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES
OF
MIDDLE EAST TECHNICAL UNIVERSITY

BY

NİHAN KUMAŞ

IN PARTIAL FULFILLMENT OF THE REQUIREMENTS FOR
THE DEGREE OF MASTER OF SCIENCE

IN

CIVIL ENGINEERING

MAY 2004

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ABSTRACT

A NATIONAL IT STRATEGY FOR TURKISH CONSTRUCTION INDUSTRY

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May 2004, 333 pages

In this thesis, a national information technology (IT) strategy applicable to Turkish construction industry for future implementation of IT is developed, advising guidance to current and future stakeholders but also researchers and decision makers to set the right priorities and pre-harmonization for IT in construction. Within this study, the present situation of the industry is discussed, so as to structure today's required industry abilities fulfilling tomorrow's demands and innovative IT solutions. Then, a coherent vision is developed for agile, model-based/knowledge-driven Turkish construction industry. Following the analysis of IT trends and opportunities, a national IT strategy framework for the industry is specified. Finally; other country applications are examined to give direction for the developed strategy implementation approach.

Keywords: IT in Construction Process, National Strategic Planning, IT-enabled Construction Business Models

ÖZ

TÜRK İNŞAAT SEKTÖRÜ İÇİN MİLLİ BİR BİLGİ TEKNOLOJİSİ STRATEJİSİ

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Yüksek Lisans., İnşaat Mühendisliği Bölümü
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Mayıs 2004, 333 sayfa

Bu çalışmada, gelecekteki bilgi teknolojileri uygulamalarında; şu anki ve gelecekteki iştirakçilerin yanı sıra araştırmacılar ve karar yetkililerinin inşaat sektöründe doğru öncelikleri ve ön-uyumu kurabilmeleri için yol gösteren, Türk İnşaat Endüstrisi'nde uygulanabilir milli bir bilgi teknolojileri stratejisi geliştirilmiştir. Bu çalışma kapsamında, geleceğin yaratıcı bilgi teknolojileri çözümlerini gerçekleştirebilecek ve ihtiyaçlarını karşılayabilecek günümüz sektör gereksinimlerini tasarımlamak amacıyla, sektörün şu anki durumu tartışılmıştır. Daha sonra, atik, model tabanlı bilgiye dayalı bir Türk İnşaat Endüstrisi için tutarlı bir vizyon geliştirilmiştir. Bilgi teknolojileri eğilim ve fırsatlarının analizini takiben, sektör için milli bir bilgi teknolojileri stratejisi belirlenmiştir. Son olarak, geliştirilen stratejinin uygulamasına yön vermesi adına diğer ülke uygulamaları tartışılmıştır.

Anahtar Kelimeler: İnşaat Sürecinde Bilgi Teknolojileri, Milli Stratejik Planlama, Bilgi Teknolojileri Olanaklı İnşaat İş Modelleri

DEDICATION

This thesis is dedicated to the loving memory of my superior civil engineer, my father, Halis Kumaş, who is no longer with me.

When I was a very young girl, every evening my father would solve crossword puzzles with me dictating me the answers. By the time I was ten years old and able to solve puzzles successfully. At those years, it was my only success to find the right words and my only happiness to get my father's well done. I had always been very successful at school. I was getting degrees and gifts from the examinations and proud of myself to invite my father to the reward ceremonies. My brother was very good at playing basketball and when we went his matches I had always envied that my father was also proud of him. My father should have loved me more, because I loved him more than my brother. I had decided to enter the school team, but unfortunately I had broken my leg that year and never played basketball since then. So, the only way to get my father's well done had remained to study my lessons. I had always been the top in university preparation examinations. But the real examination result was a big disappointment for me. It was the time when I had realized that in fact he was proud of everything I had done not because of it was so difficult to achieve, because I had achieved that. I have never forgotten his happiness when he heard that we would be colleagues. But I should always deserve his trust. Then I have promised to do my best for all the responsibilities I have taken on. Unfortunately, he passed away before my graduation from the university. But his well-done's never left me alone; I always felt his happiness when I succeed. I know that if he was here with me today, he would be very proud of me as usual and I deserve his praise this time again. However, I know he is here with me.

ACKNOWLEDGMENTS

I express gratitude to Assistant Prof. Yasemin Özdoğan Nielsen for her sage guidance, suggestions, comments and patience throughout the study. My sincere appreciations go to all industry stakeholders participated in my survey for sharing their experiences in relation to the RTD priorities for construction IT in Turkey. Discussions with them were of great help to me; I convey my thanks to the large number of people who gave me their valuable time and helped me to formulate ideas. I would also like to thank to all my friends for their encouragement. I am particularly indebted to Nihal Alkış for her personal supports and great trust to me.

Furthermore, I would like to acknowledge the support of my mother, Aysun Kumaş, without whom I would never have known the depth of love and my brother, Cenk Kumaş, without whom I would never have known the warmth of brotherly love. My great gratitude goes to them for providing me everything to do my best.

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LIST OF ABBREVIATIONS

ADSL	Asymmetric Digital Subscriber Line
AES	Advanced Encryption Standard
API	Application Programming Interface
ASP	Application Service Provider
bcXML	Building Construction XML
BPR	Business Process Re-engineering
BTYK	The Supreme Council for Science and Technology
CAD	Computer Aided Design
CAE	Computer Aided Engineering
CAS	Country Assistance Strategy
CD	Committee Draft
CGT	Capital Gains Tax
CIS	Commonwealth of Independent States
CORBA	Common Object Request Broker
CRM	Customer Relationship Management
DECT	Digital Enhanced Cordless Telecommunications
DES	Data Encryption Standard
DIS	Draft International Standard
DSS	Decision Support System
DWF	Design Web Format
DWG	Drawing
DXF	Drawing Interchange File Format
EAN-UCC	European Article Number - Uniform Code Council
ebXML	Electronic Business XML
EIA	Environmental Impact Assessment
ERP	Enterprise Resource Planning

ESA	European Space Agency
ETSI	European Telecommunications Standards Institute
EU	European Union
FIST	Factors, Implications, Strategies, Tactics
Gbps	Gigabit
GDD	Global Data Dictionary
GDP	Gross Domestic Product
GIS	Geographic Information System
GNP	Gross National Product
GNSS	Global Navigation Satellite System
GPRS	General Packet Radio Service
GSMP	Global Standards Management Process
IAI	International Alliance for Interoperability
IFC	Industry Foundation Classes
IMF	International Monetary Fund
IPR	Intellectual Property Right
IRDA	Infrared Data Association
IS	Information System
ISO	International Organization for Standardization
IST	Information Society Technologies
IT	Information Technologies
LAN	Local Area Network
LDAP	Lightweight Directory Access Protocol
MIS	Management Information System
OASIS	Organization for the Advancement of Structured Information Standards
OHS	Office and Health Safety
OWL	Ontology Web Language
PAS	Publicly Available Specification
PC	Personal Computer
PDA	Personal Digital Assistant
QA	Quality Assurance

RDF	Resource Description Framework
RFID	Radio Frequency Identification
ROI	Return on Investment
RTD	Research and Technical Development
SBA	Stand-by Arrangement
SDAI	Standard Data Access Interface [STEP]
SME	Small and Medium Enterprise
SOAP	Simple Object Access Protocol
SOMA	The Secure and Open Mobile Agents
STEP	Standard for the Exchange of Product data
SVG/X3D	Scalable Vector Graphics/
SW	Semantic Web
SWOT	Strengths, Weaknesses, Opportunities, Trends
TCA	Turkish Contractors Association
TMO	Temporary Multiorganization
UDDI	Universal Description, Discovery and Integration
UMTS	Universal Mobile Telecommunications System
UN-ECE	United Nations/Economic Commission for Europe
CEFACT	United Nations Centre for Trade Facilitation and Electronic Business
USB	Universal Serial Bus
VERA	Information Networking in the Construction Process (Finland)
VR	Virtual Reality
VW	Virtual Workspace
WAN	Wide Area Network
WLAN	Wireless Local Area Network
WPAN	Wireless Personal Network
WS	Web Services
WSDL	Web Services Description Language
WWW	World Wide Web
XML	eXtensible Mark-up Language
XSD	eXtensible Schema Definition

TQM	Total Quality Management
KM	Knowledge Management
LCM	Lifecycle Management
ICQ	International Comet Quarterly
IRC	Internet Relay Chat
HTML	Hyper Text Markup Language
NAS	Newly Associated States
EDI	Electronic Data Interchange
VAN	Value-added Network
IPDB	Integrated Project Database
SO	Smart Organization
CEO	Chief Executive Officer
VO	Virtual Organization
HR	Human Resources
OOM	Object-Oriented Modeling
PMU	Physical Mock Up
DMU	Digital Mock Up
VRT	Virtual Reality Technology
CAX	Computer Assisted Anything
CAVE	Computer Aided Virtual Environment
LOD	Level of Detail
AR	Augmented Reality
MRCVE	Reality – based Collaborative Virtual Environment
BOT	Build-Operate-Transfer
HVAC	Heating, Ventilation, & Air Conditioning
GPS	Global Positioning System
NIST	National Institute of Standards and Technology
TCP/IP	Transmission Control Protocol/Internet Protocol
http	Hypertext Transfer Protocol.
URI	Uniform Resource Identification
EAI	Enterprise Application Integration
FU	Functional Unit

TS	Technical Solution
FUTS	Functional Unit/ Technical Solution Decomposition
EDM	Electronic Document Management
WfM	Work-flow Management
SBC	Server-Based Computing
OO	Object Orientation
NGI	Next Generation Internet
WiFi	Wireless Fidelity
SGML	Structured Generalized Markup Language
XSL	eXtensible Stylesheet Language
GDL	Geometric Description Language [Graphisoft]
UAP	Urgent Action Plan
STAP	Short-term Action Plan
SPO	State Planning Organization
IDA	Interchange of Data between Administrations
FP6	European 6th Framework Program for Research and development
ITU	International Telecommunication Union
WTO	World Trade Organization
TUBITAK	The Scientific and Technical Research Council of Turkey
TIDEB	Technology Monitoring and Evaluation Board
TTGV	Technology Development Foundation of Turkey
TAFTIE	The Association for Technology Implementation in Europe
NIIF	National Information Infrastructure Development Program
R&E	Research and Education
MRC	Marmara Research Center
ITRI	Information Technologies Research Institute
NRIEC	National Research Institute of Electronics and Cryptology
BILTEN	Information Technologies and Electronics Research Institute
SSA	Social Security Agency
ISE	Istanbul Stock Exchange
CMB	Capital Markets Board of Turkey

DMO	Government Supply Office
VAT	Value Added Tax
UYAP	National Judicial Network Project
say2000i	Accounting Offices Automation Project
MERNIS	Central Census Management System Project
VEDOP	Internet Tax Office Project
POLNET	National Police Network Project
e-Sale	Government Supply Office's Electronic Sale Project
ccTLD	Country Code Top Level Domain
WSIS	The World Summit On The Information Society
SEN	The Romanian National Electronic System
GSM	Global System for Mobile Communications
PSTN	Public Switched Telephone Network
TA	Telecommunications Authority
OIZ	Organized Industrial Zones
MIT	The Ministry of Industry and Trade's
EICC	Euro Info Correspondence Center
PIAP	Public Internet Access Points
TOBBIOS	TOBB – Business Opportunities System
TOBB	The Union of Chambers of Commerce & Industry and Commodity Exchanges of Turkey
FDI	Foreign Direct Investments
UlakNet	Turkish National Academic Network
GEANT	Gigabit European Academic Network
KOSGEB	Small and Medium Industry Development Organization
MEDFROIST	Euro-Mediterranean Network for sharing IST learning resources
SEI	Romanian Educational IT-Based System
TRIPS	Trade-related Aspects of Intellectual Property Rights
WIPO	World Intellectual Property Organization
TSE	Turkish Standards Institution
SQL	Structured Query Language

UEKAE	National Research Institute of Electronics and Cryptology
PKI	Public Key Infrastructure
NCB	National Computer Board
CORENET	Construction and Real Estate Network
eSS	e-Submission system
G2B	Government to Business
SBUF	Development Fund of the Swedish Construction Industry
BPM	Building Process Messages
MOPO	Models for the Construction Process
PIIP	Process Information Integration Platform
SEED	A Software Environment to Support the Early Phases in Building Design
NSERC	Natural Sciences and Engineering Research Council
IRC	Institute for Research in Construction
OECD	Organization for Economic Co-operation and Development

CHAPTER 1

INTRODUCTION

With increasing globalization and the resultant increase in competition, product development and innovation have become vital parameters, just as the increasingly international involvement of companies in the global marketplace necessitates intensified research and development efforts. As the corporate sector becomes more international, new methods of working in cross-disciplinary and multicultural environments are finding favor. To use these methods, engineers need high professional qualifications that enable them to convert their expertise into something that can be used in modern corporate contexts realizing that information technology is crucial and it should be integrated into all engineering fields.

Construction sector should be supported by knowledge-intensive and model based IT enabling holistic view and decision making throughout the various business processes and the whole building lifecycle by all stakeholders. Markets will become increasingly international in the future, and the new business culture will also bring international investors to the Turkish scene. The sustainability of development will become one of the most important values in Turkey and construction sector will have a central role in the successful implementation of sustainable development.

Information technology (IT) is the umbrella term that encompasses the entire field of computer-based information processing: computer equipment, applications and services, telecommunication links and networks, digital databases, and the integrated technical specifications that enable these systems to function interactively. The rapid development and expansion of these technologies over the last twenty years has ushered in the current historical period widely referred to as the “Information Age” or “Information Revolution,” comparable in economic and social magnitude to the Industrial Revolution of the early 19th century (The Harvard Policy Group on Network-Enabled Services and Government, 2001).

The 1970s and 1980s have witnessed the development of many technological advances in the construction industry. At the same time, IT has been perceived as a driver for many of the construction business and operational processes. The 1990s have seen a technological shift in the construction sector from IT driven solutions to IT enabling ones. The industry, however, has become frustrated with the failing of IT as many companies have invested in the wrong technologies without addressing business needs. Developing IT systems that support business processes taking into account process, people and cultural needs is now rectifying this.

But still in Turkey, while many of IT projects achieves high quality results, they do not overall create the right impact that will progress the industry from its current state to full adoption of proven and emerging technologies. The reasons behind a lack of impact are especially, lack of national business process model vision and strategy, limited number of industry leaders with a primary goal of technology watch and process improvement, lack of industry commitment in R&D efforts, and the inappropriate R&D project results that are far from construction industry average practice.

R&D efforts and initiatives in the area of construction have traditionally been fragmented and very much subject orientated. Little emphasis is given on long-term strategies that would create the right impact in order to enhance and change practices in the industry. Developments in IT have the potential to affect business strategies, organizational structures, and management processes. However, integrating IT within an organization’s business needs so that it creates value for the company, project and their clients, remains a key management task. Construction organizations need to re-shape their approach to strategic planning to keep pace with today's world. They need to focus on setting vision, providing high-level contextual strategies that can be clearly expressed and related to each other, and translating those strategies into action in the form of clear rationalization and implementation procedures. This would lead the way towards a sustainable knowledge-driven construction industry that enhances needs and aspirations of individuals and society as a whole, in a fashion, which is economically, socially and environmentally appropriate and sustainable. This can be achieved by using IT as a support to change the construction and management processes through the introduction of new working methods and new technology (The ROADCON Consortium, (2003). "ICT Requirements of the European Construction Industry: The ROADCON Vision")

The implementation of IT into an organization and its measurement of effectiveness are problematic tasks but it is especially perplexing for the construction industry because of its heterogeneous nature and unusual characteristics (Choi and Ibbs,1990; Sanvido and Mederos,1990). Introducing Information Technology (IT) into any organization is a strategic, business driven decision. The drivers for IT could be any, or a combination of;

- competitive advantage
- process improvement
- creating an environment for growth and efficiency
- creating opportunities for new products and services

In this context, and given the ever increasing international competitiveness and complexity of buildings that have to meet continuous economic, societal, environmental and technology requirements and challenges, it is clear that in the future, IT will be the key enabler and instrument to support leading edge, innovative and powerful solutions targeting the main issues that the construction industry is facing today.

The underpinning idea in the future use of IT is computer-interpretable (model-based / semantic-driven) information that will enable:

- Enhanced automation, integration and communication in construction;
- Functional applications supporting the multipurpose needs of the construction industry and users;
- Increased impact of construction on sustainability, including economical growth, employment, and the quality of life.

The time is now to react, and Turkey has much to do to create an IT supported model-based / knowledge driven sustainable construction industry. This report is expected to be able to add positive impacts to the debate about what actions must be taken to achieve this in a practical way.

1.1 AIM OF THE REPORT

This report specially aims;

- to promote a clear, coherent and shared vision of IT support in Turkish construction sector for agile, model-based / knowledge driven construction to create self-sustaining continuous improvement leading to world class performance and better profitability
- to provide a coordinated national IT policy approach for the effective integration of IT into the construction processes towards achieving that vision, where the use and deployment of IT are considered as a main enabler that will support enhanced and improved practices with value creation, total life-cycle & supply-chain performance, through reduction of costs, time delivery & quality of delivered products. The policy should lead to solve sustainability issues as managing and empowering resources (construction workers / knowledge / IT), including transfer & training and satisfying the needs of end-users, stakeholders and society as a whole, in the built environment, for improved quality of life.
- to provide strategic advice to the government on the impediments, trends, opportunities, recommendations and potential benefits of IT in the sector for improving the quality of construction delivery and competitiveness of Turkish Construction Industry

- to provide a consistent approach in the use and adoption of IT by government agencies. This will assist enterprises in their resource investment planning and also achieve enhanced and simplified partnerships between government and industry.
- to influence, encourage and support the effective take up of IT in both the public and private sectors of the construction industry by suggesting methods for management and how best to mobilize best resources and best practices from industry and service organizations
- to suggest the way to enhance the capabilities of construction enterprises, including small and mediums-size enterprises (SMEs), to act and collaborate effectively on projects by setting up and promoting value-added Internet-based flexible services that support teamwork in Turkish construction industry
- to promote adoption of a common IT platform for Turkish construction companies which will make it possible for the companies to achieve consensus on common IT priorities realizing the most important tools, infrastructures and processes and also to increase the benefit to the customer through improved market communication, greater efficiency, higher quality and lower costs
- to prepare the ground and the knowledge required to implement the IT priority themes in construction by encouraging the collaboration of key actors to develop consensus on IT challenges, its strategies, constituencies and implementation models and consequently to achieve ambitious clearly defined scientific and technological objectives.
- to help the Turkish property and construction industry in collaboration and innovation to develop Turkey into a modern nation by enhancing its competitiveness in the global market place and to improve the quality of life of Turkish citizens

In order to achieve these aims, a systems analysis of Turkish Construction Industry to examine the present systems in operation was carried out. Having identified the problem areas, deficiencies and additional management information requirements, an IT-based strategic framework was designed.

1.2 RESEARCH OVERALL METHODOLOGY

Research overall methodology illustrated in Figure-1 can be summarized as follows;

- research on construction business cases and industrial requirements based on the literature review about wide experience of the worldwide construction leaders in related RTD
- determining IT state-of-the-art and IT requirements in Turkish Construction Industry in the fields of technical advances and commercial offerings based on the consultations with stakeholders, key players, policy makers and funding bodies both in public and private organizations
- synthesis of literature review and current results for the integration of human, organizational and technical elements to provide a wider understanding of how the application of information technology (IT) can assist the Turkish building and construction industry to become more efficient, innovative and internationally competitive.
- assessment of the latest developments and opportunities offered by IT applicable to construction Industry
- development of a national IT vision for Turkish Construction Industry and the corresponding strategies to achieve it containing future requirements and implementation plans

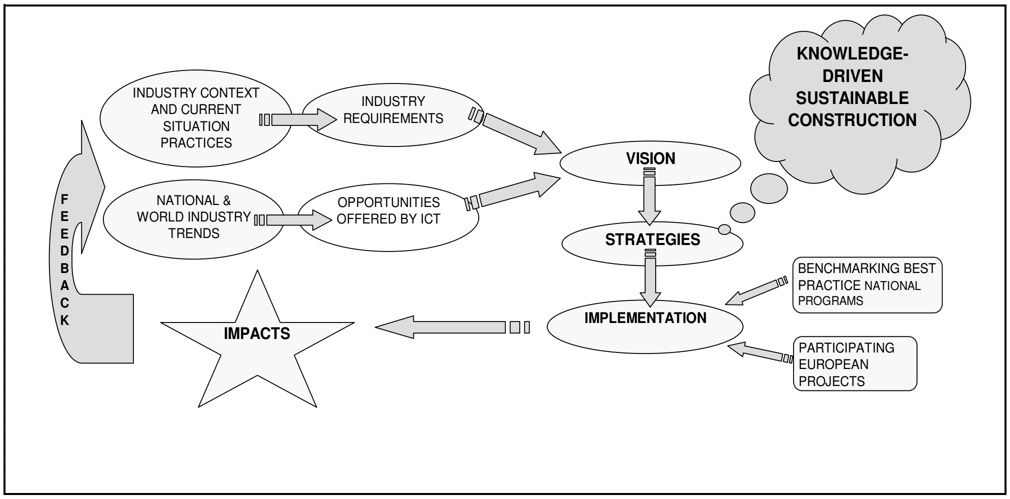

Figure 1 – Research Methodology

1.2.1 Information Sources

The strategy presented in this report is based on the literature review about wide experience of the worldwide construction leaders in related RTD, assessment of industry requirements, analysis of IT trends and opportunities, consultations with professionals throughout Turkish construction leaders and surveys of various public and private enterprises. Information collection was by face-to-face semi-structured interviews, involving key players at a national level drawn from a wide base of industrialists (from construction as well as IT sectors), researchers, policy makers and funding bodies who possessed an overview of the business, its problems and needs, and provided a background of information. Additionally, interviews were carried out with staff at lower levels of the organization, as more detailed information was required. Company brochures and documents were also collected to assist in understanding internal procedures and systems that were in operation.

1.2.2 Strategy Framework

In order to understand and integrate the different views and expectations of many stakeholders groups and reach a common ground for discussions about strategic directions, a common framework is used, which is adapted from ROADCON and VOMAP projects, illustrated in Figure-2. The figure shows the positioning of the prime focus of the industrial stakeholders and steps of the analysis.

Four main strategic goals should be identified in the form of a layered hierarchy: Industrial and societal impacts, business processes, IT applications, IT infrastructure, technologies and standards.

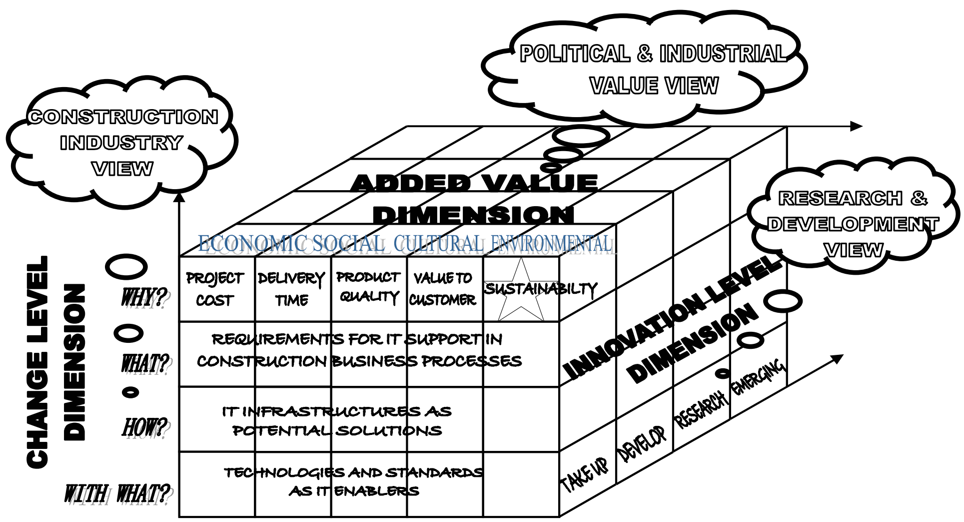

Figure 2 – Framework for IT in Construction (Sources: ROADCON Project, 2003, VOMAP Project, 2002)

From an industry point of view IT is an enabler that allows industry to reach attractive benefits integrating IT into its business processes. As the industry is maturing the business drivers are inclined to shift from basic cost, quality and time towards “higher” level values such as customer perceived value, whole life performance and sustainability. These trends have clear implications to the expected IT support. At the same time changes in business processes are also catalyzed by the evolving IT opportunities (Hannus et al., 2003).

This framework consists of a set of interrelated, rather orthogonal, “dimensions”. With this model, it is possible to address:

Change Level Dimension (Vertical dimension, strategic goals): This dimension shows the sense of how enablers like standards and technologies can guide to impacts. It shows the inter-relationships between anticipated impacts, business processes, IT applications, IT infrastructures, technologies and standards. In this dimension, the four layers are:

- Impacts / Industry priorities (why”), represent some vision in terms of expected economic, societal (social & cultural) and environmental impacts of new IT. Especially for “economic” a shift is seen from “quality” to “value”
- Business processes (what?), refer to requirements for IT support in various construction business processes in the product/service lifecycle and supply-chain.
- IT Solutions (how?), identify IT architecture, applications and infrastructure software tools as potential solutions to business requirements. Examples are CAD systems, cost estimation and time scheduling tools, etc. Here, IT infrastructures are such platforms that provide integration and interoperability between applications, access control, secure and reliable communication, etc. Examples for infrastructure components are: corporate databases, product model servers, application servers, LAN, intra/extra/internet.
- IT enablers (with what?), identify the layer of the underlying enablers for implementation and interoperability, typically generic and specific specifications and software technologies that are used to develop IT systems but also hardware technologies like work stations, PCs, mobile phones, Personal Digital Assistants (PDAs) and laptops; independent of any specific IT system. Examples are Java, XML, IFC and Bluetooth.

Another way of looking at the four change levels is according to the integration or interoperability issues as follows;

Impacts <> Cooperation
Business Processes <> Coordination
IT Solutions <> Communication
IT Enabler <> Connectivity

,where there is a dependency between the change levels (cooperation needs coordination needs communication needs connectivity).

A key aspect here is to understand the interdependency of the interests of different stakeholders. In fact, the industry is mainly interested in potential business process improvements and expects support for this from various IT applications and systems. In this manner, the industry's expectations are closely associated with impacts, their requirements are related to business processes and IT applications are seen as potential solutions.

Added Value Dimension (Horizontal dimension): This dimension reflects the global aspects that have to be taken into account for obtaining a balanced solution that can be long-lasting in a holistic sense over time (whole product/service lifecycle and supply-chain) and space (built and operating environment). This view identifies the political and industrial expectations on the impacts of IT. These are the shifting new values in the emerging knowledge society and the trend should be from quality to value listed below;

New Values (the three Ps)

PROFIT: Economic values: value (beyond quality), time and money (price/cost).
PEOPLE: Social & cultural values: safety, comfort, work satisfaction, protecting cultural heritage
PLANET: Environmental values: non-polluting, non-disturbing, etc.

These new values should be considered not only for company level but also for the individuals and the construction industry domain and even for the society as a whole. On the other hand, not only the local effects should be focused on but also the effects on neighborhoods, districts, cities, regions and even countries, continents (like Asia or Europe) and the whole world (global effects).

Innovation Phase Dimension (Depth): This dimension explains that, all impacts, business processes, associated IT applications regarding all added value dimensions can be viewed as being in a certain state of actualization in time. Some need research, others further development and some are ready for take-up. Commercially available technologies are ready for take-up e.g. in trials and pilot projects. Maturing technologies need to be further developed and adopted for specific application purposes and user needs. Research is needed to find new ways. Finally, emerging new technologies and business priorities need to be explored.

1.2.3 Key Concepts

A number of issues can be identified impacting on the success or failure of any adopted IT strategies in construction. These issues should be taken into special consideration from the beginning before developing an IT strategy. The key concepts identified below and shown in Figure-3, are supported by worldwide trends in the application of IT in the construction process.

- Emergence of the information age and convergence of digital technologies
- Model-driven / knowledge-driven approach
- Support for decision-making
- Total life-cycle & supply-chain performance (including indicators)
- "Functional economy" versus "knowledge economy"
- Managing and empowering resources (people / knowledge / IT), including transfer and training.
- Integration of products & processes, design & construction & operation
- Legal and contractual issues such as copyright, intellectual property and lack of precedents

- Availability of projects which demonstrate the use of IT and show measured enhanced and improved practices:
    - With value creation
    - Through reduction of costs, time delivery & quality of delivered products
- Satisfaction of the needs and aspirations of stakeholders and society as a whole, in the built environment, for improved quality of life
- Awareness and understanding of IT and its potential benefits across industry to date

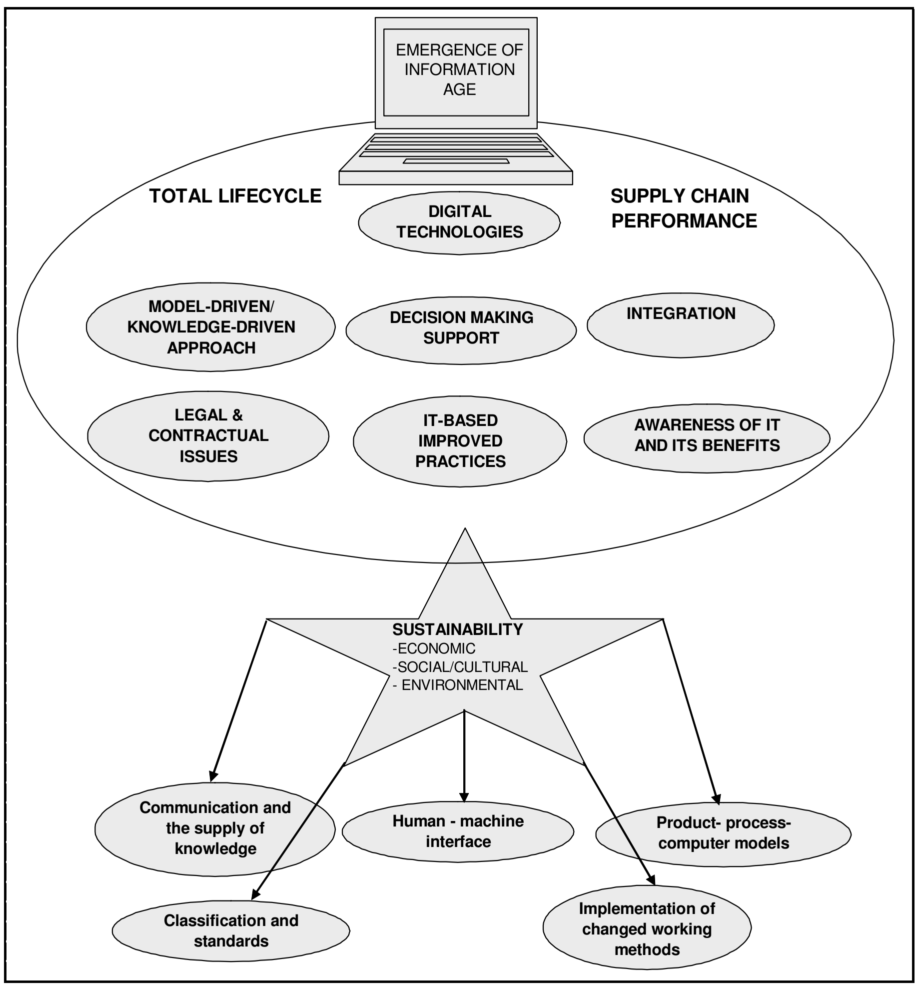

Figure 3 – Key Concepts and Areas of Interest

Considering these issues shows the way for sustainability. Furthermore, five areas of interest are pointed out, each should be acted upon within the fields of research, development and implementation. The areas are: Communication and the supply of knowledge, human-machine interface, product/process/computer models, classification and standards, implementation of changed working methods.

Effective adoption of IT will contribute to a more integrated and innovative industry leading to increased efficiency and improved delivery of projects for clients. When used effectively, IT enables improved decision-making that contributes to higher quality and lower cost outcomes through access to relevant and timely information. It is recognized that in the dynamically changing world of IT, the sharing of ideas between industry stakeholders will lead to improvements across the construction industry as a whole.

The interest is in how to make the best use of the limited resources in a mid-income country like Turkey, cooperating internationally and at the same time avoiding to be totally dominated by the great international actors in the market.

1.3 NEED FOR A NATIONAL IT STRATEGY

We are gradually moving towards a digital world where the economic development of a nation will depend more and more on its ability to access the appropriate information and transform this information into new products and services to compete in the global market place. Labor costs and natural resources will play a diminishing role in achieving competitive advantage. The effective utilization of information as a competitive tool, both by firms and by the nation as a whole, lies at the heart of this challenge.

In the history of civilization, no work of science has so expansively impacted human development as Information Technology (IT). Undoubtedly, IT has been the greatest change driving force of this century and promises to play this role even more dramatically in the coming decades. IT is changing every aspect of human life - communications, trade, manufacturing, services, culture, entertainment, education, research, national defense and global security. It is breaking old barriers and building new interconnections in the emerging global village. IT has also become the chief determinant of the progress of national communities and individuals. Surely, there can be few more vital themes needing to be addressed by national policy-makers around the world (The International Federation for Information and Documentation (FID), 1999).

National informatics policies and strategies should be established and updated, paying special attention to the impact of the convergence of information, informatics and telecommunication technologies, focusing on the main tasks of government regarding the development and use of the new information and communication technologies.

An informatics strategy is a plan for the development and most favorable deployment of information technology, data resources and services. No country can point to a single comprehensive national informatics policy; only to a set of fragmented laws, regulations, decrees, standards, each dealing with a different aspect of information management.

On the other hand, most countries have sectoral IT strategies governing the implementation and operation of IT programs. The perspective within which proposals and recommendations on national informatics or IT policies are formulated differs broadly from country to country in accordance with their social, economic and political objectives.

The term 'information society' describes a society where knowledge and information acquisition, storage, processing, transmission, dissemination and use, also including the development of interactive communication techniques, play the major role. Politically, the information society should be a democratic society. Economically, it should determine a substantial economic growth. And culturally, it should turn into a knowledge-based society benefiting proper information and knowledge. It is sure that we are witnessing a radical process of transformation that supposes a comprehensive change for society (The International Federation for Information and Documentation (FID), 1999).

Today we have the capability, at minimal cost, to process incredible quantities of information, to store it in a tiny space and to send it instantly to any point on the globe. The barriers of volume, time and distance to the availability of information have gone. This double phenomenon of cost reduction and attentiveness coincides with a political era of liberalization that supposes the disappearance of public monopolies and the liberty for the private sector to compete. We are entering a world in which information will be overabundant and cheap (our principal problem will not be the lack of information but an excess of information – a new way of being uninformed). Instead of moving people we will move information; instead of consuming materials or energy, businesses will more and more replace work with technology - which is no more than a type of knowledge - which we will learn without the necessity of someone being there to teach us. The citizen of the future should have the adequate technical and cultural skills (a problem of education); as well as all the necessary technological means that allow access (the problem of infrastructures). Besides, the business environment should encourage initiatives directed at engaging in the new disciplines (the problem of the business sector) and lastly that the public authorities should create an administrative (public services) and judicial (legislation) environment that assists not hinders the transition. (The International Federation for Information and Documentation (FID), 1999)

This means that the point of departure for developing Turkish construction society should be people's needs, so that the development can be based on high-standard know-how and the utilization of modern information and communications technology. Information networks must be exploited for international marketing. The public sector must develop its processes, electronic services and transparent decision-making, availing itself of the opportunities inherent in IT.

On a general level, the construction industry - also internationally - is a few years behind in the use of IT compared with other industries. If construction companies could use their computers to work together instead, they could achieve a lot more. That's why it's a good idea to make it a national effort, something the various industry players are also very much interested in.

Michael Porter's five forces model illustrated in Figure-4 demonstrates how an individual company's strategic position is influenced by other organizations with which it relates. All organizations within a construction company's own five forces model have been incorporated into the network. Suppliers, sub-contractors and industry clients represent supplier and buyer power. The threat of new entrants and substitute products are represented by other types of construction organizations, management consultants, associated industries and international participants. Rivalry and jockeying for position are represented by competing construction firms participating in a competitive way.

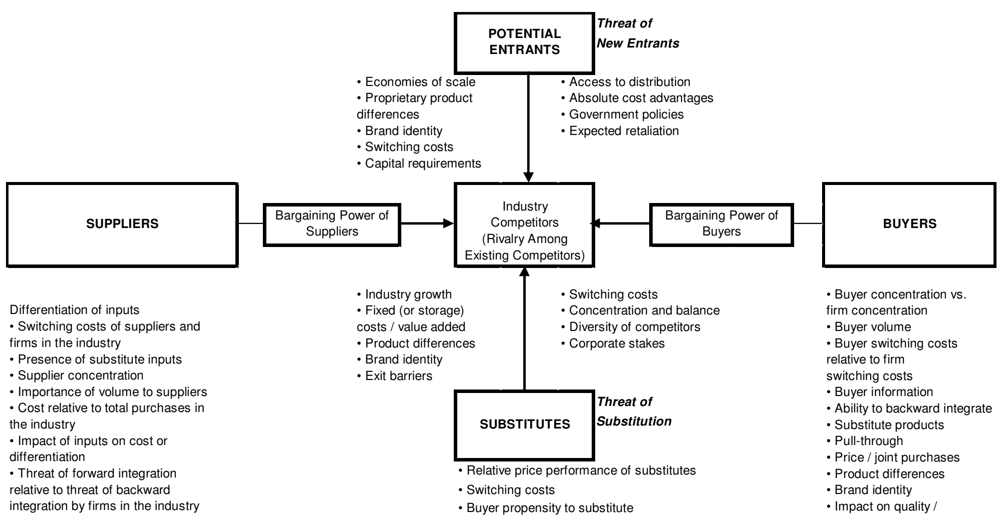

Figure 4 – Five Forces Analysis of Construction Market and Competitors (Source: Porter, (1980). "Competitive Strategy")

A national IT strategy can be justified on a theoretical basis. Michael Porter has made a series of studies showing how and why certain clusters of companies in sectors in different parts of the world were outperforming others in international competition. He derived his diamond model to explain superior performance by international clusters of companies. The elements extend beyond a simple model of comparative advantage based on internal factors of production to embrace external issues of customer demands and links with associated industries. An industry getting together to create a strategy is necessary beyond leaving performance of companies to chance. This can be depicted as in Figure-5.

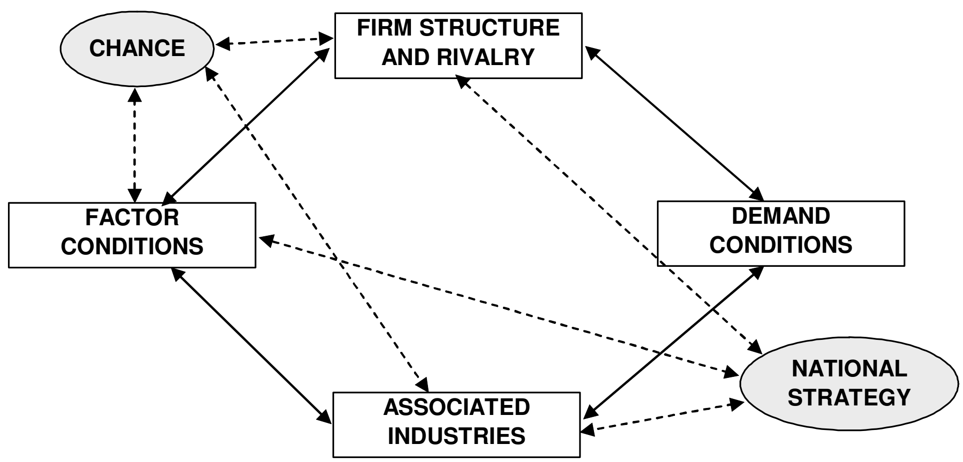

Figure 5 - The Need for a National Strategy (Source: Porter, (1980). "Competitive Strategy")

The main objective of a national IT policy for construction is to cost effectively obtain and optimally use informatics to process information as an integral factor in national development of construction industry. The free flow of scientific and technological information and its assimilation are essential preconditions for progress in developing countries. Turkey has to combine the particularities and advantages of a small and different country towards the international community. Many other small states will face the threat of being excluded from the global information society if they are unable to adjust to the demands of participating in it. For Turkey, the challenge of preparing itself for the new international society lies in education, strategic planning, globalization, innovation, sustainable development and it is time to make the greatest efforts.

At the same time, it is vital to create an environment, which will encourage personal initiative and so promote private investment. It is the responsibility of the public sector to develop a legal and cultural environment that permits this. Four areas of concentration for the government should be emphasized, namely: (The Danish Government's IT Policy Action Plan 97/98)

1. Citizen's rights in the information society
2. The existence of IT literacy on all levels
3. Stimulating interaction between citizens and the administration to realize the vision of an open public sector
4. Developing security solutions to encourage electronic commerce and other communications requiring top-level security.

1.4 IS PLANNING PROCESSES

Turkey needs a vision and corresponding strategy in order to be able to make full use of the opportunities inherent in the Turkish information society and toward off the threats involved. The overall goals of the Turkish information society initiative are:

- to increase welfare and offer jobs and income to provide equal opportunities for the acquisition and management of information and for the development of knowledge
- to improve conditions for entrepreneurship and the quality of working life and promote competitiveness to increase opportunities for human interaction and cooperation to strengthen democracy and opportunities for social influence
- to improve security and the individual's data protection and status as a consumer to develop services and cultural provision and increase international interaction
- to increase Turkey's attractiveness as a location for innovative enterprises

• to lessen inequality between regions, and
• to support the objectives of sustainable development.

In particular, the construction industry needs to communicate large volumes of complex information. However, the diversity of the projects, and the large number of different stakeholders, can make information sharing difficult. IT can help construction companies reduce the problems of communication and information sharing. By developing an IT vision, construction companies can gain a competitive advantage in their business. They can also grasp more value from their expenditure on IT. However, establishing an IT vision is only the first step. Visioning must be a continuous process, and should be interlinked with the company's ability to implement the vision, and to learn as an organization.

An IT strategy is a long-term plan for the development and deployment of information systems within the organization. It is concerned with the exploitation of IT either to support business strategies, or to create new strategic options. The existence of such strategy will encourage the integration of existing and future information system (IS) to eliminate information redundancies and inconsistencies and the inefficient use of information systems resources (Tanyer, Ali Murat, 2001).

However, no formal IT strategy exists for Turkish Construction Industry. Rather, an IT Master Plan has been prepared for all industries in 1996 but not formalized. Therefore, in Turkey, there is an urgent need to plan, select, recruit, train and develop future IT leaders so as to accelerate the whole process of IT diffusion.

Major investment is being made for the development of computerized system and within a short time period, the system cannot satisfy users' requirements and the departments' objectives. Hence, the system has to be modified to:

- ensure compliance with legislation
- cope with increasing workload
- satisfy users' new requirements

However, without the appropriate support, the conversion of plan into action would be hardly possible. IT should be regarded as an enabling tool, capable of bringing fundamental changes in information management and information sharing, rather than an automating mechanism within the industries.

In order to help translate national and international commitments and policy objectives into reality requires that Turkey should have a description of where she wants to be in 10 years - she needs a “target scenario”. She must then focus on ways and means for getting there and develop a national IT strategy for transition to a knowledge economy; with sustainable development at the heart of integrated policies for growth, employment, social cohesion and the environment.

In particular, Turkish construction industry’s goal should be to be able to simulate the entire construction process so that everyone - contractors, construction workers, builders and end users - can see exactly what they’re supposed to do long before the first shovel even touches the ground. This allows them to avoid many of the mistakes and delays that occur today. A total simulation will also better allow them to change individual parameters and then find out exactly how the changes will affect other parts of the construction, both before construction starts and also later if or when the finished structure has to be modified.

In order to share awareness and understanding among professionals & users, to communicate future to others and to provide consistent foundation for decisions, the information resources direction should be set with the steps as; (Mackay, Dr. Nancy, 2001)

1. **Information Resources Assessment** identifies how well information resources are meeting the needs of the organization. Inventory of hardware, software and people should be critically evaluated; quality of resources should be controlled in order to meet business needs of organization. Assessing current resources includes; measuring IS use and attitudes, reviewing the IS organizational

mission (especially the mission statement) and assessing performance versus goals (efficiency, effectiveness, competitiveness)

2. **Information Vision and Architecture** creates an ideal view of the future in terms of the use and management of information. As an expression of the desired future for information use and management in the organization, the information vision creates a mental image and must relate to the business vision. The information vision speculates how the competitive environment will change, analyses the current system whether it can do future job and identify changes to allow company to take advantage of future environment. It provides input to the information systems organization to design an architecture that depicts the way an organization's information technology resources should be deployed to deliver the information vision. The architecture involves human component (personnel, values/culture, management system) and technological component (hardware, software, network, data)
3. **Information Resources Plans** set long-run and short-run goals and initiatives to accomplish those goals. The objectives are set to establish goals for user satisfaction, network performance, etc. Internal and external analyses are conducted often by SWOT analysis or FIST Method (shown in Figure-6) and strategic initiatives are established using the tools such as Critical Success Factors, Analysis of Competitive Forces, or Value Chain Analysis (shown in Figure-7).

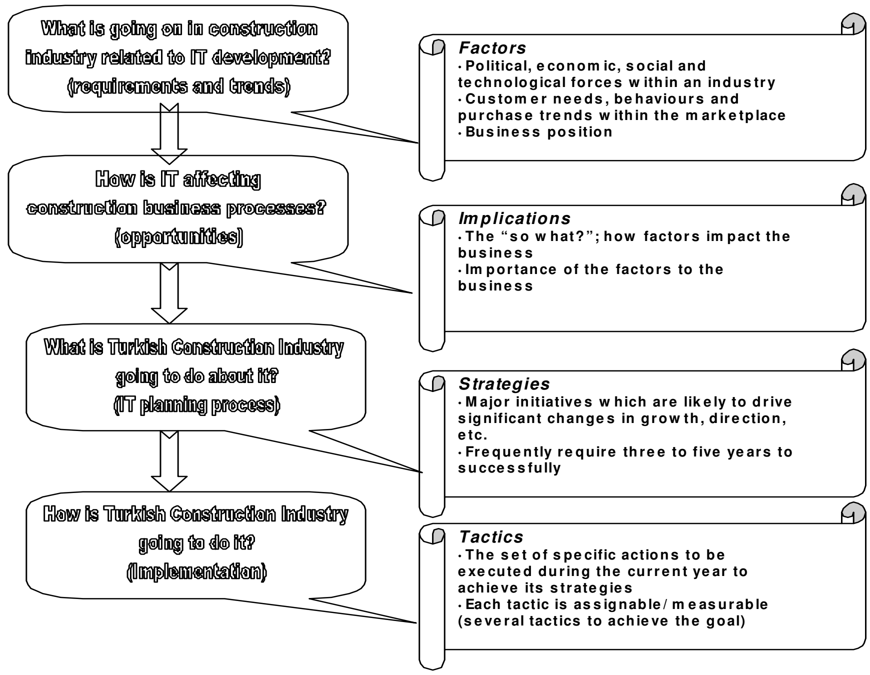

Figure 6 – FIST (Factors-Implications-Strategies-Tactics) Method

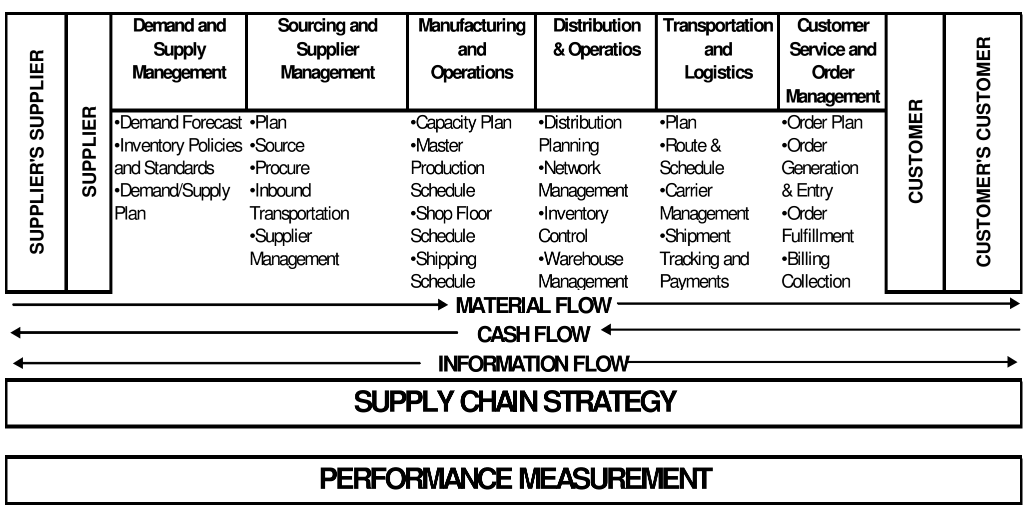

Figure 7 – Value Chain Analysis Example (Source: The Ernst & Young Supply Chain Model)

Guidelines for Effective Planning;

- Make sure everyone understands the purpose of the planning process
- Planning effort should be iterative
- Plan must reflect realistic expectations
- User-managers **MUST** be involved!
- Plans should incorporate all applications of IT, if possible
- Plans must consider barriers, constraints, risks, critical success factors

The process of formulating an information strategy plan should be divided into six stages (Construct IT, 2000)

1. Initiate the information strategy planning project
2. Identify your business position
3. Examine the systems and technologies available on the market
4. Develop an IT vision
5. Develop a system and technology roadmap
6. Prioritize solutions

Formulating a vision is only the first step. There is often a major gap between developing a vision and the ability to implement it. Implementation requires that the vision should be integrated with other strategies, as well as resources, project planning and teamwork.

Business strategic planning is the managerial process of developing and maintaining a viable fit between the organizations objectives and resources and its changing market opportunities. The aim is to reshape the company's businesses and products so that they combine to produce satisfactory profits and growth. It translates the organization's vision into a set of initiatives that describes how to accomplish the mission and vision (Construct IT, 2000)

The strategy implementation produced at the end of this study has to integrate a series of measures likely to overcome these barriers in order to achieve an effective change in the use of IT by Turkish construction industry. Figure-8 below indicates major stages of information strategy planning.

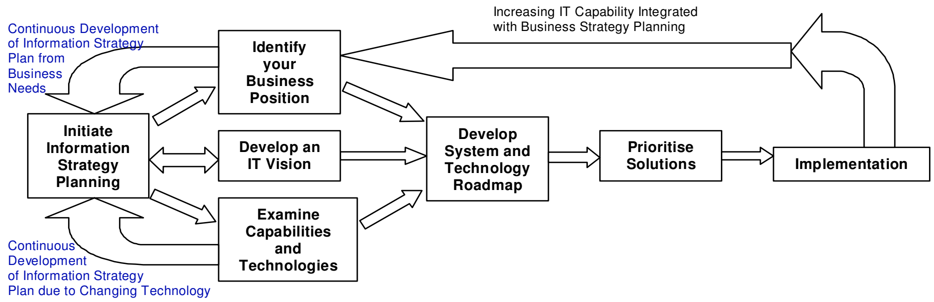

FIGURE 8 – Major Stages for Continuous Information Strategy Planning (Source: Construct IT, (2000). "How to Develop an Information Strategy Plan")

After initiating the planning project, the role of IT for the future direction of the business should be identified. Then, the current and emerging technologies available on the market are reviewed and these stages provide input for the visioning stage. The vision provides an overview of business needs. It also highlights the critical information to be shared with principle supply chain. Vision statements vary in length from one sentence to several pages, but should always have a clear, easily understood format. One major barrier to vision implementation is that the majority of the workforce often does not understand the vision. The vision statement must be formulated in a user-friendly format and communicated widely within the company

Another important decision at this stage is determining the level of risk to be taken on IT investment. IT may be used as a strategic tool to achieve a competitive advantage. Alternatively, it may be used as an operational tool, supporting core activities. In terms of technology uptake, a distinct pattern exists in the way organizations adopt technology, as shown in Figure-9.

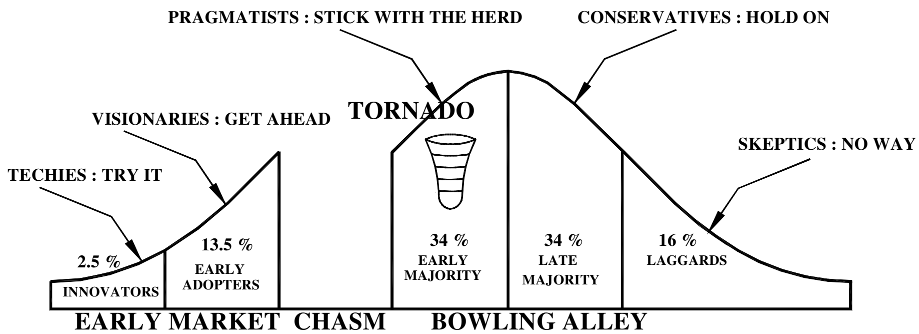

Figure 9 – Technology Adoption Curve and Market Analysis

Once the vision has been committed to document form, the strategic planning process continues into its next stage; developing a systems and technologies roadmap. The vision is updated each time the strategy is reviewed. The IS planning process is shown in Figure-10 below in detail.

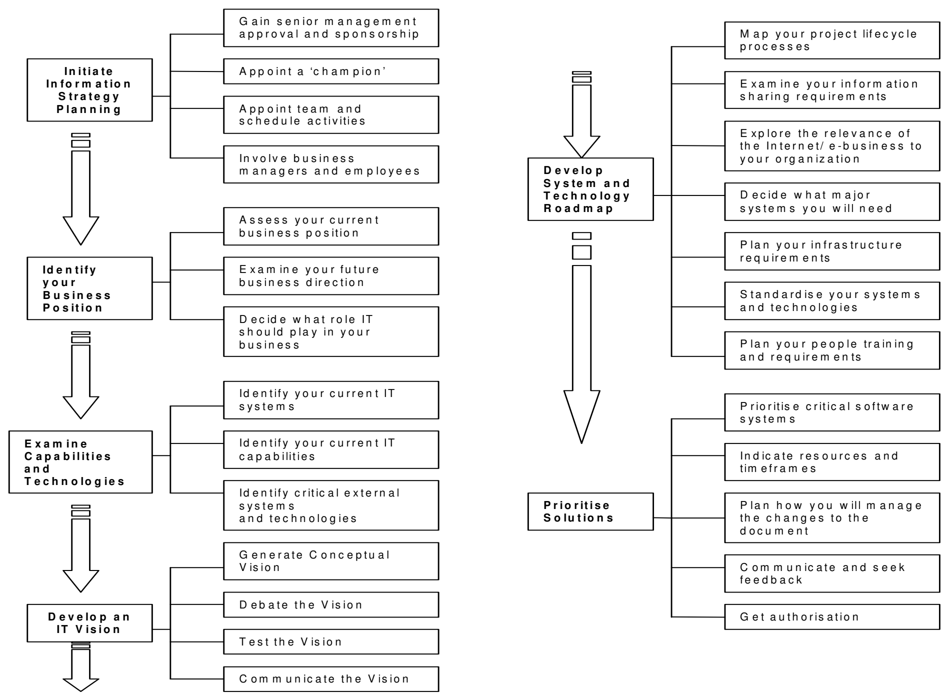

FIGURE 10 – Major Stages for Continuous Information Strategy Planning Details (Source: Construct IT, (2000). "How to Develop an Information Strategy Plan")

Developing a national IT Strategy addresses the whole information resource of the country. This includes strategically managing basic day-to-day data, information that is used and analyzed to make decisions, and reviewing the computer systems used to deliver information. In developing an IT strategy it is also necessary to examine how IT systems and electronic management of information relate to general business functions and plans for overall strategic development. The IT strategy developed for Turkish construction industry, should answer the following questions:

- Is IT adequately supporting major construction activities? What are the requirements of Turkish construction industry for IT support? (knowledge management, ambient access, model-based engineering etc.)
- Can IT be used to create sustainable values to the industry? (model driven interoperable industry, performance based systems, sustainable cities, intelligent buildings etc.)
- What new technologies and trends are available to address current and future construction business needs? (virtual prototyping, web based processes, adaptive systems, collaborative engineering etc.)
- What are the offered IT opportunities enabling the industry trends? (mobile communication, positioning technologies, flexible interoperability, semantic driven processes etc.)
- What are the key concerns to be taken into account and their levels of implementation? (sustainability, globalization, coverage, convergence of digital technologies etc.)

CHAPTER 2

TURKISH CONSTRUCTION INDUSTRY STRATEGIC ANALYSIS

2.1 TURKISH HOUSING SECTOR

In 1950's an annual average rate of 6 percent of urbanization and the rate of population growth of more than 2 percent significantly increased the need for housing in Turkey. After 1960, the housing shortage gradually increased despite the fact that share of investments in the housing sector had reached the level of 20 percent of the total investments. The state had taken measures to meet the need for housing and also supported mass housing projects within the framework of a plan taking into consideration the characteristics and environmental conditions of the cities. In keeping with this, the state, in 1984, founded the Collective Housing Administration Directorate in order to meet housing demands of the citizens belonging to the middle and low income levels, and with the aim of developing the housing sector in Turkey. The administration has provided credit to close to 1,125,889 domiciles between 1984 and May 1999. 1,043,450 of these domiciles completed are residences that have been constructed by cooperatives supported by credits obtained through the Collective Housing Administration, under the supervision and inspection of the Ministry of Industry and Trade. (Republic of Turkey, Ministry of Foreign Affairs, (2004). http//www.mfa.gov.tr)

On 17 August 1999, an earthquake occurred in a large area of Turkey's most densely populated region, leaving as a consequence over 15,000 dead and about 100,000 families homeless in the aftermath. Immediately afterwards, the administrative, social and technical needs of the region were determined by the government who then commenced with a three phase plan of gradual transition to provide the victims with housing. As for intermediate and long term cures, the government aims for planning of resettlement in the whole area to be undertaken within the scope of this zone being earthquake sensitive.

According to calculations made in recent years, it is necessary to construct more than 400,000 houses in Turkey every year. This is calculated by taking into consideration the need for replacement and improvement of the squatter's housing regions. Efforts are continually underway to create new sources for brand new housing projects, finding means to utilize small personal savings, and through improving and expanding the range of opportunities, which the capital market has to offer. (Çakır, Özgür, 2000)

The view that a system is set up whereby all residences and workplaces be required to insure themselves throughout the country is becoming widespread.

2.2 CONTRACTING SERVICES ABROAD

Due to the economic crisis in the domestic market, the export of Turkish contracting services began in the first half of the 1970s. With the first contracts signed in Libya, Turkish international contracting services started their rapid development phase due to the incremental reconstruction activities of the oil producing countries while importing the necessary technology from European countries. Since then, they have made remarkable progress and there have been a significant change in the pattern of Turkish overseas contractors' portfolios. (Republic of Turkey, Ministry of Foreign Affairs, (2004). http//www.mfa.gov.tr)

During 1972-1979 periods, most of the works outside of Turkey were undertaken in North Africa, primarily in Libya, and followed by Saudi Arabia, Iraq, Kuwait etc... The total value of the projects undertaken in this period was US$1.8 billion. Within 1980-1989 period Turkish contractors entered the Soviet Union and the total value of the projects undertaken in this period was US$12.3 billion with a great increase relative to the past ten year period. In 1990's, the Turkish contractors shifted their activities to the Commonwealth of Independent States (CIS), Eastern Europe and the Asian countries, due to the economic problems and political instabilities in the Middle Eastern and North African countries, and have undertaken important works in the Russian Federation, Ukraine, the Caucasus, Central Asian Republics, Germany, Pakistan and the Far East. The proximity of Turkey to main markets has facilitated the provision of workers, technicians and construction materials; and this, in turn, has been one of the factors that positively influenced the successes of the Turkish contractors. A significant development in this period was the diversification of the countries where work was carried out, with the emergence of markets such as Pakistan, Turkmenistan, Kazakhstan, Uzbekistan, Bulgaria, the United States, Azerbaijan, Croatia etc. The total value of the projects in this period amounted to US$19.8 billion. Of this, the Russian Federation accounted for US$7 billion and the other former Soviet Union countries US$5 billion.

Turkish contractors have established very good relations with clients, gained first-hand knowledge of the region and its business environment and successfully completed a wide variety of projects, employing Turkish labor and using Turkish goods and building materials. The shift from basic works to more high-tech works has been the sector's main characteristics in the 1990s. Much of this experience was won at home, but Turkish major contractors have also developed a formidable record abroad. A big boost to the Turkish economy came in December 1999, with Turkey's acceptance of candidacy to the EU membership. Following a positive growth in 2000, the sector was badly affected due to the economic crises of November 2000 and February 2001. Negative economic growth, higher taxes and higher interest rates along with continued delay in important public tenders in accordance with the IMF's stand-by agreement, are the major drawbacks for the Turkish construction industry today. (Republic of Turkey, Ministry of Foreign Affairs, (2004). http//www.mfa.gov.tr)

The Table-1 below summarizes the growth rates of the GNP and the sector:

Table 1 – The Growth Rates of the GNP and Construction Sector Growth Rates in Turkey (Source: SIS, SPO, 2004)

	GNP Growth (%)	**Building Construction Growth (%)**
1999	-6.1	-12.7
2000	6.3	4.4
2001	-9.5	-5.5
2002	7.8	-4.9
2001	5.0	-16.2 (within 9 months)

Besides, the construction sector has suffered a period of hardship due to the economic crisis in the Russian Federation and the Commonwealth of Independent States, as an extension of the global crisis, along with the stagnation in domestic market. The focus of attention is on a search for new foreign markets with the objective of eliminating the stagnation in national and foreign contracting services. The total value of the projects in 2000-2003 periods has amounted to only US$4.5 billion.

The value of the works reported by the TCA member companies in the 1972-2003 period is US$38.5 billion and the value of the unreported works is estimated at US$6.5 billion, combining to give a total of US$45 billion. The value of works carried out by non-members is estimated to be US$5 billion in the same period. Therefore, it can be said that an estimated US$50 billion of work has been carried out by Turkish contractors abroad in the last 30 years, earning Turkey a share of over 2% in the global construction market.

The breakdown of international construction projects' values by country between 1972-2003 is illustrated in Table-2 as follows.

Table 2 – The Breakdown of International Construction Projects' Values by Country between 1972-2003 (Source: SIS, 2004)

Country	**Total Amount (US$)**	**(%)**	**Number of Works**
Libya	10,476,077,017	27.30	312
The Russian Fed.	8,409,630,754	21.91	402
Saudi Arabia	4,404,906,194	11.48	139
Turkmenistan	2,029,200,991	5.29	122
Kazakhstan	1,812,655,593	4.72	103
Iraq	1,629,750,865	4.25	59
Pakistan	1,362,361,167	3.55	16
Uzbekistan	1,010,304,704	2.63	64
The USA	751,800,897	1.96	21
Bulgaria	626,673,698	1.63	6
Azerbaijan	621,816,067	1.62	50
Kuwait	525,431,630	1.37	9
Jordan	474,481,112	1.24	19
Others	4,243,450,987	11.05	242
TOTAL	**38,378,541,676**	**100.00**	**1564**

The contracting services sector plays an important part in the progress of the Turkish economy and will continue to contribute to the development of the relations Turkey has with neighboring countries and with other countries that she considers to have economic ties with. Foreign contracting services are one of the most important service sub-sectors in the Turkish economy from the viewpoint of its relationship with the other sectors, its influence for earning foreign currency and its employment potential.

Today, Turkish construction and engineering firms are able to design, erect, build and operate almost all kinds of civil and industrial projects, such as dams, hydroelectric and thermal power plants, industrial plants, petroleum and natural gas pipelines, tunnels, petrochemical complexes and refineries, high-rise buildings etc. The experience gained in the Middle East and Commonwealth Independent States carried the Turkish Contractors to an outstanding position in comparison with their competitors some additional advantages such as geographical proximity, low labor cost and high quality technical personnel make Turkish contractors noteworthy. The work of Turkish contractors abroad has come to be accepted worldwide and the quality of the construction, their relative cheapness and speed has impressed both the employer institutions and the end users extensively. Turkish contractors are now exploring the significant needs of the products and services of the countries in which they are operating or intending to operate. The necessary factors lacking is financing capacity and technological advance. Although Turk Eximbank extends credit lines to the target markets (currently only to the Russian Federation and Central Asian Republics), due to the economic situation, they are far below the requirements of the Turkish contracting sector. Especially in the Middle East and the Central Asian Republics, tenders issued are being won by contracting firms, which also extend financing facilities, and are sophisticated technology users providing them inevitable competitive power (Çakır, Özgür, 2000).

The Turkish contractors, who use the most advanced technologies in the world and have been gradually expanding their volume of business abroad, have also provided extensive contributions to the revival of the construction industry that can make high quality production and can use new construction technologies in Turkey. It is apparent that Turkish construction industry is in need of innovation and process improvements if it is to remain competitive in today's digital economy. This is where the government and national funding bodies can play a determinant role to create the impact that would improve the practice in this industry sector.

In general and as in Turkey, the construction industry is a "SME dominant" and geographically dispersed industry that it exhibits characteristics that differentiate it from other industrial sectors in terms of working practices and solutions. These include the following (ROADCON Project, 2003):

- Construction is one of the most geographically dispersed sectors
- The sector is heterogeneous in the nature of its organizations and highly fragmented, depending on a large number of very different professions and firms (architects, quantity surveyors, engineering consultants, contractors (principal and specialist) and building manufacturers and suppliers), which are mostly small in size, tend to respond to local market needs and control only one element of the overall building process. Thus, there is no dominant actor to enforce IT solutions on projects.
- Construction remains a largely nationally focused industry with some (still largely national) discipline dominant players (in architecture, structural engineering, building services, electrical engineering, cost engineering infrastructure etc) whereas automotive, aerospace and chemical industries or services providers have relatively few but very dominant global market leaders
- The entry-level for new companies is relatively low because the need for operational capital is small (except for large to very large operations).
- The industry is highly regulated and dependent on standards and common working practices. Regulations and standards are more rigorous in construction than in most other sectors of economy, with the involvement of several levels of governments (local, provincial, national, European). Disciplines in the industry therefore do work on common Standards (national, European and international) and industry companies sit on many standards committees (everything from materials to fire, health & safety, environment, etc.).

- Construction is highly project oriented rendering innovation capitalization extremely difficult. Any IT used within a project must be deployable and profitable to all /several partners.
- Moreover, each construction project is a prototype. The final product tends to be very durable, lasting 25-50 years and longer. When construction facilities become obsolete they are most often repaired, modernized and sometimes radically transformed to suit new requirements rather than disposed of and replaced with new.
- Each project is unique in the sense that there are 'properties' of construction problems that are inseparable from the project. In solving construction problems, a great deal of solvers' efforts is placed on the understanding of the problems in order to recognize the similarities of the problems at hand with previous solved problems. The similarities will enable solvers to recall their experiential knowledge, as there is no sufficient formal and procedural knowledge to solve construction problems, construction problem solvers have to reply on their experiential knowledge.
- Actors are involved in numerous projects at the same time, moreover on the basis of temporary and often short-term business relationships: project partners may never work together again. In order to procure a construction project, a variety of organizations are temporarily combined to create a 'temporary multiorganization' (TMO) (Cherns & Bryant, 1984) to discuss and exchange information
- Information exchange within any construction project is mainly between actors others than the client and is not, therefore, contractually controlled. There exists poor communication between stakeholders during all life cycle phases. When construction problems arise, relevant organizations have to work together to determine appropriate concessions and compromises before solutions can be obtained (Alty, 1993).
- The business process is such as it does not organize a face to face market. Facility owners, promoters, owners are not directly clients

but more intermediaries between end-clients and industry. It is therefore difficult to ensure a client-orientation into each and every segment of the value chain and to create a clear focus on end-user requirements amongst the actors.

- The industry is very labor intensive, with high mobility of the workforce and growing skills needs as construction technology becomes more sophisticated.
- Construction is shifting more and more to a service and this in turn challenges construction to shift from a physical facility constructor to a provider of an economical framework to all man-made activities and industry.
- There are literally so many businesses engaged in or supplying the construction industry, but most (95%) of them are at or close to the SME definition. The industry is nearly unique in its dependence on SME working teams who own most of the construction industry skills but cannot afford to invest individually in advanced developments. They often rely on (largely national) trade associations to look after their medium- and long-term interests, whilst focusing on more short-term improvement timescales
- The industry is not really controlled by any one player and is organized around consortia with a dominant sub-contracting culture. In some cases experienced clients can take control, but often drive will vary project to project. This makes it difficult to really marshal "industry" direction and drive progress.
- Industry companies do not have the types of staff to do the kind of technical assessment required

Due to these characteristics and the context depicted above, various industry solutions can be identified relating to IT support to handle fragmentation in terms of communication, information exchange and document management, to provide structured project documents and coordinated interactions between actors.

The Building and Construction industry in Turkey has always been trying to respond to the changing requirements. In order that a more rapid development can be achieved, the companies that are engaged in the construction sector are organized, according to their specialization field, as associations, foundations or unions. The Turkish Contractors Association (TCA), one of these organizations, has been operating since 1952. TCA has the objective of supporting Turkish contractors and consultation firms in their activities at home and abroad, engaging in international initiatives, contributing to the solutions of the main problems which they faced by raising the economic and technological level of the construction sector to meet the needs of the day and increasing the competitive strength of Turkish contracting firms at home and abroad. The present members of the TCA are 94 big companies that realize 60 percent of works at home and 90 percent abroad. The Union of International Contractors, established by the TCA members with the objective of concerning itself more closely with works carried out abroad, also serves under the same structure with the TCA. (Turkish Contractors Association, (2004), http://www.tmb.org.tr/)

Several ways have been developed to increase its competitiveness such as organizational approaches resulting in new contract types like Design-Build-Operate. In addition, the application of IT has stimulated several new approaches. Incremental and separate approaches have led to improvements, but major long-term progress toward sustainability can only be achieved in a systemic approach. However, too little is yet known about the systemic relationships between social, political, cultural and economic dimensions of sustainable development.

The rapid emergence of information technologies, and particularly of fast and cheap global communications, notably of the Internet in the 1990s, has considerably widened the scope for change. The advancements in information technology and developments in hardware and software platforms have often created the need for companies to undergo organizational changes in order to embrace the latest technologies. The society and industries of the future will strongly be fashioned by the emergence of the information and communication technologies and by the emergence of a networked knowledge world society. These technologies now offer an opportunity to empower and integrate billions of people, even in the poorest countries, and through this, to spread prosperity and education more widely than ever before. These technologies therefore offer different paths of economic and social development on Turkey as being a developing country help to move faster to a better quality-of-life without the enormous investments and environmental damage of centralized industrialization. Turkey is still at the beginning of this change to a networked knowledge society, and the challenge is therefore to channel the momentum of change. As the opportunities for sustainable development in this new environment become clearer, Turkey will no doubt see better how to optimize technology developments for its citizen's benefit.

Theory of IT relativity states that ability to compete in the global marketplace, which the IT industry is helping to create, is inexorably bound to the country in which they are based and that country's IT "maturity". Simply explained, it means that even a well managed company based in a country which ranks poorly in terms of IT maturity will find it far more difficult to survive and prosper in the future than an average managed company based in a country which is a highly sophisticated user of technology. (Hayward, R., 1998)

Today, however, no matter how much the local media and government talk up the few very limited success stories, Turkey has all the necessary elements required to continue to be a leading user of advanced IT solutions within the government and the business sector. Now more than ever, whether an organization wins or loses in the global marketplace will depend on how it leverages investment in IT. There is a direct correlation between the future of Turkey and the strategies businesses can and should adopt to take advantage of technology advances. That's why this report is necessary.

2.3 NATIONAL FACTORS AND COUNTRY ASPECTS FOR IT DEPLOYMENT

We are witnessing today a historical phenomenon that is considered by some, in respect of its social, political, and economic effects, as a new industrial revolution equivalent to the British Industrial Revolution. Some calls it a transition period to a new age, namely information age. This concept is distinguished mostly by the radical changes in technology base of the production systems and labor process. Information technology is playing a determinative role in such changes. In context of these technological changes, it is obvious that the countries having superiority in technology and science are progressing towards an absolute domination in industry and in all the other economic activities (Turkey's Science and Technology Policy, 1999).

Turkey cannot afford to quarantine itself from global trends. Whether it realizes it or not, Turkey is engaged in a competitive battle with other countries to secure scarce global capital to create a prosperous local IT industry and time is running out. Isolationist policies are an admittance of defeat. If Turkey can't play in the big league it might as well leave the game. Some politicians in Turkey seem more intent on recreating the past than laying the groundwork for the future.

Another phenomenon that we are witnessing today is "globalization". Globalization can be defined as a process through which a norm gains global validity and becomes the only acceptable norm in its area. For instance, no matter what region the information technology sprang and matured in, it has become a world technology. In a world where the conventional protectionism has vanished, the determinant factor in international competition will be the innovation ability of the nations.

While the "globalization" trend is continuing, it seems that a political process gaining power on national motives is dominating the world. The nations perceiving that they could not be competitive one by one are tending to form regional blocks, such as European Union. The regional blocks are trying to establish and reinforce their internal law systems. Today, the process of forming a world that would be dominated by inter-block competition is witnessed. It seems that when the blocks accomplish the political and legal infrastructure of organizing their in-block single markets, countries that are not involved in any block will hardly have a chance to survive.

In brief, technology has become the key factor in competitive advantage of nations as well as in competition among the firms. Therefore, the countries having superiority in science and technology are progressing towards dominating the information age and the future world. Turkey does not have an active role in those processes, that carry the seeds for 21st Century, but she is directly affected by the consequences of them and will unavoidably continue to be influenced deeply.

Turkey, in respect of those global processes, has to cope with many problems. Among them, the most vital one is to catch up with technological changes of the age. However, Turkey's challenge has two legs in this respect. Turkey, which inherited the Ottoman Empire that missed the evolutionary process towards an industrial society after the British Industrial Revolution, has not surpassed the industrialization threshold yet. Now it has to face the problem of overcoming this historical gap as well as keeping up with the changes in the new age while the industrial societies are evolving into a new era. The ability to be shown by Turkey to settle these two problems simultaneously will determine her future. To cope with these two formidable problems at the same time necessitates gaining ability in science and technology. Gaining ability in science and technology does not only mean gaining ability in scientific and technological research. A nation can gain competitive advantage in the world market if only she has the innovation ability. (Turkey's Science and Technology Policy, 1999)

Improving the scientific and technological ability of Turkey and creating a country that dominates information technology is Turkey's only strategic choice. Besides, each industry should have its own information technology policy creating an IT-supported country when combined. Thus, as being among the widest industries, construction industry should develop its national IT strategy as soon as possible.

The national dimensions and country aspects should be considered, indicating the directions and critical issues for developing an IT policy for Turkish Construction Industry. Key drivers for national IT diffusion are shown in Figure-11 below;

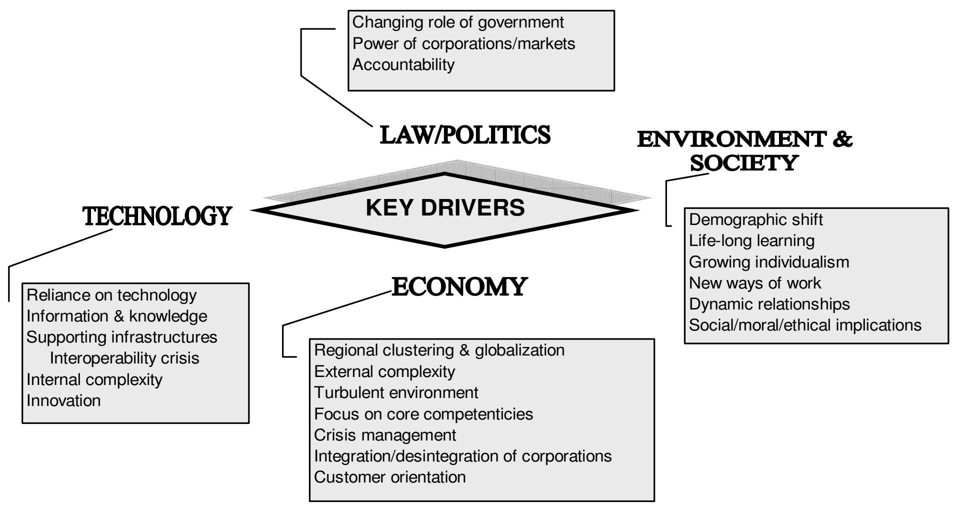

Figure 11 – Key Drivers for National IT Diffusion (Source: THINKcreative Project, 2002)

2.3.1 The Economic Dimension

The economic system lies at the heart of sustainable development. For the economic system itself, sustainable development requires stability, that governments are able to sustain the financing of social systems, particularly businesses are able to sustain feasibility and profitability through a period of rapid technological change and globalization.

Throughout the five-year planned periods applied in Turkey since 1963, "high growth rates" and "structural changes for industrialization" were taken as the basic targets. The industrialization strategies adopted, and economic policies followed, show a great difference before and after 1980. The Economic Stability Program of 24 January 1980 and the policies followed subsequently, reflect a more profound change in the economic and industrial policies, in contrast to the stability programs previously put into effect every 8-10 years. Especially as of 1985, the governments introduced the "build-operate-transfer" model in order to accelerate infrastructure investments in the industrial sector and to obtain the needed financing with better terms. Concerning the capital markets, the necessary preconditions were prepared with the objective of providing for the investment of small savings in industry, and the Capital Market Board was established with a law in 1981. In parallel with these measures, banking services were modernized and the necessary regulations were prepared for further acceleration of international transactions. Special importance was placed on the improvement of transportation and communications services which are indispensable preconditions of the industrialization policy. (Republic of Turkey, Ministry of Foreign Affairs, (2004). http//www.mfa.gov.tr)

The fundamental source of growth in the industrial sector is the investments and dynamism of the private sector. Furthermore, research and development activities conducted by the Turkish private sector began to be supported systematically by the state, which started to support research and development activities carried out by the private sector since the mid-1990s. Further- more, legislation related to the support of the state for research and development activities went into effect in 1995.

Activities carried out towards the integration with the world markets are continuing at full speed. Turkish industry, with its experience and knowledge, has reached a level to undertake and direct joint investments in all the countries of the world, especially in the Middle Eastern, Islamic countries and Central Asian Republics which gained their independence in the period after 1990.

The Customs Union Agreement between the European Union (EU) and Turkey, which came into effect as of 1996, favorably influenced the competitive power of Turkish industry, because intermediary and investment goods which could be imported less expensively and more easily, raised the quality of the production in the industrial sector. The objective of the changes made in regulations is to accelerate the inflow of foreign capital as well as to increase the international competitive power of industry. In 1999, a constitutional amendment envisaging the resolution of disputes arising in government concession specifications and contracts related to public services by "International Arbitration" was realized. Thus, the way was cleared for foreign capital interested in making investments in projects requiring large sources and advanced technology. As a matter of fact, the inflow of foreign capital, which is supported in accordance with the policies for integration with the world markets, is continuing. This development, which positively influences the technological and competitive power of domestic companies, facilitates the opening of these companies to the markets of the EU and the world. (Republic of Turkey, Ministry of Foreign Affairs, 2004, http//www.mfa.gov.tr)

Yet even if more funds are made available, it is questionable if the funds can find the right innovation and vice-versa. This is the key element missing today. Private industry needs to step in to this gap and act as a bridge between smart people and smart ideas and the funds and management expertise to appropriately leverage those skills and inventions into commercial ventures.

The concept of economic sustainability must include resilience: the system's ability to respond to shocks. For many years Turkey's economy seemingly defied rationality but fiscal imbalances and delayed structural reforms finally led to a series of crises. The crisis effects on GNP per capita can be seen from the Figure-12 below;

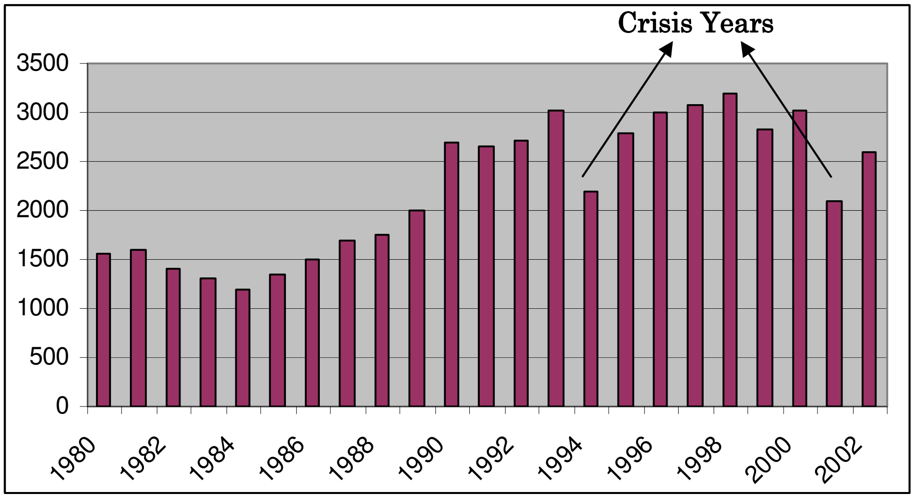

Figure 12: GNP per capita ($) (Source: State Institute of Statistics, 2003)

Turkey has learned from crises and been strengthened by reforms over the past ten years. Natural disasters as well as financial crises were painful but also shocked the system and focused the nation on the need for fundamental reforms to modernize the country and its governance. The economy started to rebound strongly, and the Government, which came to power with significant popular support following early elections at the end of 2002, has now the opportunity to put Turkey on a sustainable economic growth path. But this will be a challenge as the economy, while recovering is still vulnerable and the debt remains high. The international environment presents both economic uncertainties and political risks that absorb the Government's attention. The Middle East remains on edge. The international economic situation remains cloudy. Nevertheless, if Turkey is successful in steering through this difficult period and getting on the path towards EU accession, the country could achieve stable growth and improved living conditions (Document of The World Bank Report No. 26756 TU, 2003).

Taking into consideration the effects of high inflation and interest rates on Turkey's economic performance over the last 25 years, the government focused on an economic program which aims to free the country from inflation and enhance the prospects for growth and for a better standard of living for all parts of society. Thus, a disinflation and fiscal adjustment program was initiated on December 22, 1999 supported by a stand-by arrangement (SBA) with the International Monetary Fund.

Significant progress has been made towards achieving the program's goals, like growing GNP, decreasing inflation, falling of public debt-to GNP ratio, declined interest rates, output growth etc. These results have been achieved through the strict implementation of the policies, which have garnered credibility in both domestic and international financial markets, as also reflected in upgrades by major credit rating agencies. The Credit Rating Agency Moody's, has announced that the credit note of Turkey will be reviewed with a possible upgrade. (Republic of Turkey, Turkish Embassy.org at Washington DC, 2004, http://www.turkishembassy.org/)

A highly inequitable economic system like in Turkey can discourage effort and innovation, and envy can result in socially, politically, culturally and even environmentally costly disruption. The mix of skills needed for economic sustainability goes beyond IT skills. However, to realize the full potential of the technology, appropriate implementation needs to be carried out to suit particular requirements and establish systems that, not only function correctly, but also allow users to make full use of the technology.

Unfortunately, Turkey does not have the right economic, regulatory or cultural climate to encourage IT start-ups. Turkey's high taxes make it an unattractive location for investment. Besides, Turkey's current tax regime and employment regulations are far too complex for anyone trying to arrive at a major investment decision, or start a new company, to understand fully. Tax reform is overdue and critical. Turkey must have a globally competitive tax system and reform must have an outcome of simplicity and relative equality with our regional trading and investment competitive neighbors. Personal, capital gains and company taxes must be comparable to our major trading partners, especially the United States, since America today controls the world's capital. CGT is zero in Singapore and Hong Kong, and less than 10% in many other countries.

The Country Assistance Strategy (CAS) of the World Bank Group for Turkey is designed to help Turkey to implement fundamental reforms. The Bank is ready to assist Turkey to reduce economic vulnerability and achieve high and stable growth, and continue the process of addressing some long neglected social and environmental problems. The expected outcomes are structured around four development themes in line with the Government's priorities: (i) sound macroeconomics and governance; (ii) equitable human and social development; (iii) attractive business climate and knowledge; and (iv) strong environmental management and disaster prevention. These efforts will also prepare Turkey for EU membership, an objective pursued with full determination in Turkey. (Document of The World Bank Report No. 26756 TU, 2003)

In view of Turkey's particular poverty profile, with low levels of extreme poverty but relatively high incidence of vulnerability; whether Turkey succeeds in putting its economy on a sustainable, high growth path is important not only for the well-being of its citizens but also for the prosperity and stability of the region

On the other hand, the risks to the success of bank support are not insignificant. The situation in Turkey has been and will continue to be subject to continued uncertainty as events unfold on the ground. The active support of the International Finance Institutions has been instrumental in helping Turkey address the risks and pursue its reform program. The three main risk factors are: (i) the continuing macroeconomic vulnerabilities arising from the 2001 crisis and subsequent international and regional developments; (ii) a potential loss of consensus for political or social reasons stemming from the social impact of reforms; and (iii) institutional challenges in implementing the program. The new Government's stated commitment to the program demonstrates that political support for economic reform in Turkey transcends specific political parties and personalities. The irreversibility of the structural reforms put in place since 1999 cannot be taken for granted and the near-term risks remain significant given the depth of Turkey's economic vulnerabilities and extent of the reforms that lay ahead.

2.3.2 The Social Dimension

Social sustainability can only be achieved by increasing social equity, solidarity and reducing poverty, worldwide. In the 1990s, this solidarity was primarily seen in relation to preservation of our natural environment and resources. However, our more direct responsibility for social equity both to present and future generations should be to study for a possible and credible overall target to reduce income inequalities within Turkey and with other countries by 2030 through global contracts, more co-financing, including through widening opportunities for entrepreneurship and participation in work, together with a balanced liberalization of world trade in services and new local investment facilities. This could be part of a broader strategy for the next 30-50 years.

This is only achievable and sustainable through an accelerated and determined transition to a networked knowledge society, with IT empowering entrepreneurship and trade in all communities.

Turkey needs more innovative IT -related degrees. Society needs to hold people who have engineering and science degrees in more esteem. The Turkish education system does not compare to systems in Asia/United States/The United Kingdom, and there are not enough 'good' people in IT in Turkey. Governments should actively promote entrance to universities for science and engineering courses, rather than doubling university tuition fees for these students. At least the government has made some progress in ensuring all students nationwide have access to computers. IT must become a core part of all courses even more than it is today, not just the technologically oriented ones. Once they have seen what it can do, it will be the application of technology by non-technologists that will drive demand, and demand will drive investment. A challenge for all training programs is the pace of technology change. Unfortunately, Turkish companies do not seem to take training of employees, even in the IT field, as seriously as other nations.

Another social aspect for IT development that, trade unions are very powerful in Turkey and the country still has antiquated labor practices. The current government has made some headway in labor reform, but many overseas investors are still very wary of labor laws in Turkey, which make it very difficult to be flexible in rapidly changing business circumstances. Job security is now a major issue in Turkey politics. Internationally, Turkey's work practices remain infamous. Today's business is all about IT-enabled logistic systems, with just-in-time delivery. Any export-oriented IT manufacturer has to be assured of efficient and competitive entry and exit from Turkey.

The international perception is that Turkey is a great place to go on vacation, but the work ethic is poor. Several events need to occur to help alter this perception: successful world-leading Turkish IT companies; making Turkish achievements better known; several well publicized and major IT investments by multinationals; and leverage of opportunities to showcase local talent.

2.3.3 The Cultural Dimension

If we have learned one thing from nature, it is that loss of diversity increases environmental instability. If the goal is sustainable development, then multiple cultures must be preserved and nurtured. Unfortunately, the developing world increasingly finds their values, beliefs and cultures at best ignored and at worst besieged by the homogenizing effect of globalization. To avoid a catastrophic "clash of civilizations" in a multi-cultural world, cultural sustainability has to become a priority, taking into account two distinctive elements: Cultural identity and diversity as a legitimate goal in itself; and respect for fundamental human rights. Culture is crucially important to overall sustainability because of the need to find a shared base of beliefs and goals for a global governance system with the power to conceive, implement and enforce sustainability policies on a global scale.

The European Union is one model. It involves a multitude of different but co-operating cultures, turning the threat of cultural divisiveness into the asset of cultural diversity. However, global cultural sustainability will be possible only on the basis of global dialogue and cultural interaction. In this, communications technologies play an increasingly important role: The emerging global networked knowledge society will be central to shaping a global culture of co-operation (European Commission Information Society Directorate, 2002).

We clearly need culturally diverse and vibrant societies in which individuals have the opportunity actively to participate and to pursue and fulfill their need for a sense of identity and a sense of belonging. We need to develop a clear and verifiable policy which sees cultural diversity as an asset and cultural literacy as a main vehicle for sustainable development. Such a policy would help our citizens respond positively to globalization and immigration.

Turkey needs a vision of a modern democracy with close ties to its history and traditions, fully integrated in Europe and playing a strategic role in the regional context. The cultural sustainability issues should be added to any strategy developed such as, everyone should preserve our language and learn at least two foreign languages to engage in cultural exchange, cultural products and services should be produced at a local, regional and national level to increase indigenous cultural production, export of cultural products and services should be increased in particular to countries with a negative balance of trade in this sector etc.

Furthermore, organizational culture is another aspect to be taken into account while examining a nation's cultural aspects towards technological development. Projects, organizations, people and contracts do not exist in a vacuum; they are embedded in a variety of industrial, social, legal and other contexts that determine what is possible and, often, what is desirable. The collaborative process, then, is a matter of inter- and intra- organizational cultural assessment and development. The processes, habits and techniques of organizations, as well as all those indefinable features of group life that give an organization its identity comprise its culture. In establishing a working relationship, participants endeavor to shape a new and more profitable culture that will define their interaction. They are explicitly accepting the need to do things better and smarter and more cooperatively. No ventures can succeed without a favorable cultural backdrop.

Besides, the way to achieve our envisioned IT-based future scenarios also passes from issues related to entrepreneurial and risk-taking culture of organizations. It is not such a simple task that governments can legislate to create it. Academic institutions can act as a catalyst for research, but it comes down to individuals with good ideas, talent and lots of energy to be combined with capital at the right time and with the right advice to succeed.

The Economist magazine once wrote about what makes Silicon Valley succeed, concluding that location helped (proximity to major metropolitan area, research centers and universities, plenty of available land and attractive weather), but that the real reason is a unique culture and way of doing business. There is a culture of tolerating failure, of risk-seeking and of reinvestment in the community, of an enthusiasm for change, of promotion on merit, of obsession with product, of collaboration, of variety and of the notion that anyone can play. It is this culture that Turkey should be teaching in schools and attempting to emulate in its business environment. (Hayward, R., 1998)

On the basis of these concerns, Turkish government should encourage the formation of regional centers to provide the cultural backdrop for change. These regional centers should have well developed communication strategies that keep the momentum going.

As an agent of organizational change, then, collaboration between a regional centre and industry participants can be a powerful technique. First, it focuses on the regional need of the respective organizations to succeed together in a potentially hostile external environment. Second, by addressing specific research projects the collaboration is grounded in reality rather than mere wish fulfillment. Third, internal organizational change is driven by interaction with other parties operating under similar conditions and the need to adapt; the frame of reference for change is established by necessity rather than convenience.

2.3.4 Political Dimension

The construction industry is a vital part of a nation's economy. The industry is large and fragmented and has not been a high priority for national governments. While this in itself is not a problem, it leaves the industry vulnerable in a rapidly changing marketplace. The government should recognize the importance of construction industry and inject a large amount of capital in fostering change in the industry. By adopting a more innovative approach and improving links in the whole industry supply chain to undertake research and development the construction industry would be better placed to innovate and as a consequence capitalize on the challenges and opportunities presented by the national and global market.

In construction industry the government plays essentially two roles: regulator and client in construction processes. Clear government leadership will raise the awareness of both industry and clients and encourage a more rapid take up of IT than would otherwise occur. As a major owner and user of constructed facilities the government has a role to play and perhaps took the lead. A fundamental requirement is that the government as a major industry client provided the leadership for industry improvement. Innovative research and development should be recognized as a critical success factor. A proportion of any research and development budget should be set aside for the purpose of identifying and assuring the continuous transfer of scientific discoveries into business. The government is the only construction client entity to have the motivation and resources to follow these objectives and provide leadership. (Lenard, D., Abbott, C., 2001)

Turkey has a big government mentality that fosters conservatism and risk-avoidance. Local IT companies need to realize that very few of the established successful worldwide IT companies asked for or received any kind of government assistance in their countries; they sought success in the real global commercial marketplace. As with any major change, there will be winners and losers as the economy moves into the digital age. These fears are not confined to Turkey. However, there is no holding back the technology revolution. What alternative is there for a modern, open economy dependent on trade with the rest of the world for its very survival? The government and private industry must ensure that technology adoption is fair and evenly distributed, widely accessible and as inexpensive as possible. Much work needs to be done to make technology less threatening and to train people faster to take advantage of it.

A bridge needs to be formed to close the gap between good ideas and commercialization, which is not just about money. Better this bridge is put together in the private sector than by government, with people willing to take risks and experience in the global IT marketplace. Many individual Turkish innovators are passionate believers in their technology, and ill-prepared to face the reality of intense competition or to deal with the necessary work involved in capitalizing on their intellectual property

Throughout revolutionary period our public leaders including elected and appointed officials and their overseers in all branches of government, have too often ignored technology issues or have delegated them to others. The conventional wisdom has been that technology is either not very important, or requires technical expertise rather than leadership, or is simply too risky for leaders to get personally involved.

These views are changing, however. Due primarily to the astonishing growth of the Internet and e-commerce, technology is now widely acknowledged as a critical force in shaping the future. The need for skillful and committed leadership has become obvious. But the risks are still there. As a result, public leaders—often under enormous and competing pressures–remain uncertain about how to successfully engage technology-related issues.

There are many well-meaning politicians, but they can not inspire and lead the Turkish public and create as much passion, enthusiasm and national support for IT. And they don't have the necessary resources and competitive environment to dispel negative perceptions. Can any Turkish politician today command the same respect and attention for IT initiatives as U.K.'s Tony Blair has managed to do in a very short time with his grasp and leadership of the Year 2000 problem?

Given the haul of constant change and conflicting interests, leaders find it difficult to focus or to take decisive action. Distractions abound and hesitation is natural in an environment defined by uncertainty and complicated tradeoffs. Distractions are especially severe in the public sector, where organizations cannot simplify decisions by focusing on a single market niche. Public organizations are mandated to spread their attention across incredibly complex, contested, and interrelated problems such as crime, poverty, and the environment.

Given the large size of many public agencies— along with the checks and balances designed to foster debate and deliberation—governments tend to grow cautious and inwardly focused. They find it extremely hard to innovate at the pace required today. In the tumultuous shift to a knowledge-based economy, with digitized information and globally interconnected networks, governments are finding it increasingly difficult to cope. (Maa Microsystems, (2004). http://www.maamicro.com/)

To succeed, governments need leaders able to focus on the right IT-related problems long enough and effectively enough to make a difference. The Government should aim to obtain increased value for money in its capital works procurement through the wider use of technology which enables improved communication and therefore increased client satisfaction, reduced coordination errors in construction, greater understanding of their work by construction workers, less ambiguities and discrepancies in documentation and increased recognition of the part of all players in the briefing, design, construction and operation of facilities.

But this level of activity is stretching industry resources. Part of the solution is to use new information technologies to raise productivity and reduce costs. Although many industries have embraced information technology, its use by the construction industry in Turkey is limited.

The fragmented approach to potential investors by Turkish government (and even local city councils) is counter-productive and confusing. If all the various individual announcements, projects and initiatives from the government were packaged together and announced with great fanfare, the global impact would be far greater. But this does not reflect political reality, or the timings of various elections.

Promoting Turkey as a "product" for investment requires clarity, simplicity, a clear image and a sense of national identity. There is no room for ambiguity or confusion over what Turkey is, what it stands for, what it believes in and what it is trying to achieve. There is a dire need for a national IT strategy, with specific goals.

In the public sector, significant change is difficult, and failed change is often punished strongly. Little wonder that many leaders have tended to sidestep the work involved in using information technologies, or has delegated it to others. Not so long ago, delegation was a safe answer and probably good enough. But it is clearly not good enough now. You cannot take your hands off the steering wheel just as your vehicle enters a dangerous stretch of the road. But an equally wrong answer is to view technology as a magic bullet. Leadership to help the organization adapt to information age challenges requires commitment and work from all quarters, not just directives from on high. Leaders must be engaged, and must keep their staff engaged.

While the process leading to the information society is a revolution in the true meaning of the word, if we want to seize the best of that revolution, we cannot leave its development entirely to market forces, or assume that those objectives will simply be attained by legislation or political and administrative control. The democratization of future society will need the great majority of the population to have access to information technology and a real ability to use it. The need to provide digital access to public information for the citizens and industry should be considered in the context of open government using information technology to allow citizens to participate in government - what the source calls Electronic Democracy. Those in positions of political power must work towards a position where access to the new technologies and the new information and communications services is made available on the basis of equal opportunity for all, so that the advent of the information society can be a progressive factor for the whole of our society. Freedom of information shall be acknowledged, guaranteed and defended in conformity with the country's laws, and the international treaties which Turkey is part of.

Apart from necessary regulations about freedom of access to provide digital democracy Turkey lacks further mandatory requirements about political control by law and legislation about data protection and intellectual property rights.

Information Economy' refers to the role of government in providing a legal and regulatory framework that ensures the information economy is safe, secure, respectful of personal privacy, certain and open. Provisions with regard to the kinds of organizations which may carry out data processing, and under what conditions, and with regard to the processing of legal data and data concerning national defense and public order should be organized by special laws. The transfer of personal data to other countries is permitted provided that such countries guarantee a level of protection at least as high as that provided under the Turkish law (The International Federation for Information and Documentation (FID), 1999).

Besides; the rights of copyright owners need to be balanced with the interests of users in the digital environment. New rights and appropriate exceptions will be introduced together with enforcement measures, and limitations on the liability of infrastructure owners. Protection of intellectual property rights and copyrights in the IT field, particularly for software products, is a requirement to be respected in order to create an healthy environment for the development of IT in Turkey. The law should provide for the establishment of an official registration system creating a new media content and information highway as an important vehicle for distributing valuable works protected by copyright.

In fact, things are not as bad as above-mentioned issues make them seem. It is true that in terms of actual adoption of technology, in areas like embracing E-commerce, home access to the Internet or dealing with the Year 2000 problem, Turkey ranks very high on any world scale. But the more seems difficult to reach because of the fragmented, unstructured way towards technological developments as the results of lack of national IT strategy, collaboration and shared mind across the country.

Here is the leader of Malaysia that is officially underdeveloped, is plagued each year by high levels of pollution, has somewhat dubious ties between politics and business, is in the middle of a severe economic downturn, has authoritarian leaders, institutionalized racism, a poor record on intellectual property protection, an embryonic service industry, lax accounting standards, skilled labor shortages, low literacy rates and where 15 percent of schools do not have electricity. (Hayward, R., 1998) If Malaysia can capture so much mind share within the global IT community despite its shortcomings, imagine what Turkey could achieve with the right leadership and programs.

Unfortunately when science & technology is considered, the main deficiency of Turkey is not having a science & technology policy as usually supposed. The deficiency is not applying the needs of the available policies with a systematic approach, continuity and political stability as a whole. The efforts to put into practice national science and technology development in Turkey have always lacked the right leadership. Thus; the progress occurred so slowly, with great unimportance and perhaps ignorance resulting documented, approved but not implemented policies.

*"Scientific and Technical Research Council will be established for the purpose of organizing, coordinating and promoting basic and applied research. Scientific and Technical Research Council will help in directing the research activities to the targets of the plan and settling the research priorities accordingly." **(The First Five Year Development Plan)***

In the later plan documents (in annual programs of the last years of The Second Five Year Development Plan [1968-1972] and The Third Five Year Development Plan [1973-1977]) technological development and technology transfer have been taken into consideration and in The Fourth Five Year Development Plan [1979-1983], for the first time, the concept of "technology policy" has been mentioned and "integration of the technology policy with the industry, employment and investment policies and enhancing the technological abilities of certain industrial sectors" have been envisaged; but in 1960's and in 1970's, the basic policy in science and technology was the promotion of basic and applied research in natural sciences.

At the beginning of 1980's, Turkish Science Policy: 1983-2003 was prepared. This was the first time that a detailed science and technology policy document had been tried to be prepared. This new approach has created a new institution: The Supreme Council for Science and Technology (BTYK), which enabled designing of science and technology policies with the participation of ministers, high level bureaucrats and representatives of non-governmental organizations who take role in the management of the economy and arrangement of the main fields of activity of the social life.

However, The Turkish Science Policy: 1983-2003 could not have been implemented. The Supreme Council for Science and Technology that had been established in 1983 could make its first meeting on 9 October 1989. Its activation had been possible, although partly, in the new period started after its second meeting on 3 February 1993. In this meeting, the document entitled "Turkish Science and Technology Policy: 1993-2003" was approved by the Council. The policy stated in this document has been elaborated and based upon a solid ground with "The Project for Impetus in Science and

Technology" in the scope of Fundamental Structural Transformation Projects involved in The Seventh Five Year Development Plan (1996-2000). This project constitutes one of the main headlines of The Seventh Five Year Development Plan (Turkey's Science and Technology Policy, 1999).

In summary, the purpose of the policy followed from the establishment of the Republic to the 1990's was gaining capability in the fields of mathematics, physical sciences, engineering, health sciences and agricultural sciences and attaining a respectable place among the countries that contribute to the World's science and technology, to that common inheritance of humanity

Technology, and science as the source of technology, has directly become a productive power and this is the distinguishing characteristic of this century. At present, capability in production means capability in science and technology. As a result, science and technology has gained strategic importance in economic development and social welfare. Parallel to this change, "science policies" of countries have become "science and technology policies" and these policies have been started to be knitted with economic and social concepts.

The document entitled Science and Technology Policy of Turkey (TÜBİTAK, BTP 97/04, August 1997) has been approved by The Supreme Council for Science and Technology at its meeting of 25 August 1997 and with this document, National Science and Technology Policy and Agenda for implementation of this policy took its final form in respect of;

- surviving the vitality of national economy,
- sustaining economic growth,
- upgrading the living standards, and
- international competitive advantage,

Within the framework of this policy, in order to attain the economic and social goals of the nation, it has been suggested some regulatory measures to be taken in the fields of science and technology. These measures have been generally associated with the rational using of the resources and with the pursuing an integrated strategy for;

- enhancing the intellectual capacity (intellectual or intangible capital) of the country,
- upgrading the R and D ability of the country in the new pervasive generic technologies,
- focusing this ability in the fields of economic priority,
- encouraging the activities aiming at the transformation of scientific and technological findings into economic and/or social benefit immediately,
- accelerating the diffusion of new generic technologies in all fields of economic activity,
- financing the technology-intensive mega-projects that will raise the technological ability of the country and create vividness in the economy.

Taking into account Turkey's capabilities and world scientific and technological trends and forecasts, the following generic technologies, in general, have been accepted as priority areas of activity:

- informatics,
- advanced materials,
- biotechnology, and
- (aero) space technology.

Turkey has to establish her National Innovation System with all the necessary building blocks of it in order to enhance her ability in science and technology, and to get the capability of transforming science and technology to economic and social benefit. (Turkey's Science and Technology Policy, 1999)

It should be underlined that the key point of success is to handle the issue of establishing the National Innovation System with all its economic, political and social dimensions in systemic integrity and continuity. The National Innovation System has been assumed as a fulcrum for Turkey to be able to evolve, going beyond the threshold of industrialization, into the information era. This assumption clarifies why the establishment of the National

Innovation System constitutes the focal point of the National Science and Technology Policy aiming at creating a Turkey that

- has public awareness in science and technology,
- has enhanced her ability in science and technology, and
- has gained capability of transforming science and technology to economic and social benefit (in other words, has gained capability in innovation),
- has got the respectability among the countries that contribute to the World's science and technology, to that common inheritance of humanity.

The decisions taken from now on are wished to both form a turning point for applying the National Science and Technology Policy with systematic integrity, continuity and political stability as a whole and create a new leap and a new enthusiasm about National Innovation System.

2.3.5 The Environment and Resource Use Dimension

A growth-based strategy for environmental sustainability can only be achieved by further stimulating technology developments and innovation. The emergence of a global networked knowledge society opens new opportunities for improvements in resource-use efficiency. The application of information and communication technology is vital to the development of environmentally sustainable production, logistics consumption, and for the emergence of a mosaic of environmentally sustainable lifestyles. Without a rapid availability of these technologies to the vast majority of all people in the networked knowledge society, environmental sustainability will not be possible. However, neither will an accelerated transition to the knowledge society automatically lead to sustainability (European Commission Information Society Directorate, 2002).

Technological advances enable higher value to be associated with all goods and services; they can allow some material goods to be replaced by on-line services; they can enable better logistics in business supply-chains and transport; and they can enable structural change in the way work and business is organized. We need a redefinition of the term 'workplace' and a rethinking of many aspects of city design.

Protection of the environment continues to preserve its place on Turkey's agenda. The Environmental Technical Committee, established with the coordination of the Ministry of the Environment, has assumed the task of determining environmental problems of high priority which need to be solved. The Ministry of the Environment, besides developing basic policies, also provides coordination among the other related organizations. Nongovernmental organizations, besides the public organizations, support the activities for the protection of the environment in Turkey. The written and visual media also contribute significantly to the formation of environmental consciousness and to increase the sensitivity of the society on the subject. Furthermore, a harmonious relationship has been established among public administrators and professional organizations of industrialists and merchants (Republic of Turkey, Ministry of Foreign Affairs, 2004 http://www.mfa.gov.tr/)

The Organized Industrial Regions, which are gradually becoming more widespread in Turkey, have assumed important duties from the aspect of the protection of the environment. The National Environmental Strategy Action Plan is being prepared with the financial support of the World Bank to provide the integration of environmental policies to the sectoral policies. The project activities supported by the World Bank to determine the solid waste management policies throughout the country are continuing with the coordination of the Ministry of the Environment. The Regulation for the Control of Dangerous Wastes went into effect in August 1995 to provide for the control of dangerous wastes from their formation to their elimination. In accordance with the Regulation for the Control of Dangerous Chemical Substances and Products, which is currently in effect, the statements on the General Classification and Labeling Rules for Dangerous Chemical Substances and Products is being prepared. Revision activities related to the Regulation for the Control of Noise Pollution, the Regulation for the Control of Water Pollution, the Regulation for the Protection of Air Quality and the Regulation for Environmental Impact Assessment (EIA) are continuing. The Turkish governments are making efforts to put into effect as soon as possible, laws that will be revised according to the present requirements related to measurement, control, fuel, improvement, technological changes and traffic regulations for preventing air pollution stemming from exhaust gases.

Turkey places great importance on the development of cooperation with countries in the region on the subject of the protection of the environment. Turkey participates in the Environment Program along with the countries with coastline on the Black Sea and also takes an active role in Projects for the Protection of the Mediterranean Sea Against Pollution. Within the framework of the bilateral environmental cooperation agreements, the annual application programs with Hungary and Israel have been accepted and agreements envisaging bilateral cooperation in the field of the environment have been signed with Kyrgyzstan and Tajikistan.

Existing environmental policies (on national, or world level) should include stronger support for de-materialization: e.g. by using new ways of organizing work and lifestyles to reduce travel, and to improve the quality of life through access to immaterial services, notably for government services and social interaction. Turkey should encourage the substitution of material goods consumption through the consumption of immaterial services like “innovation” or added value. Frameworks must be created supporting “green entrepreneurship” and corporate social responsibility; which support a global dialogue on environmental sustainability and encourage cultural exchange on environmentally sustainable lifestyles.

2.4 CURRENT SITUATION IN RELATION TO IT USE IN TURKISH CONSTRUCTION INDUSTRY

A survey about the current and planned use of information technology (IT) and its impacts on the construction industry in Turkey is conducted by face-to-face appointments and e-mailing to 50 organizations. In order to identify actual and potential business benefits, senior/middle managers of acknowledged technology leaders across the industry sectors were interviewed. Through interviews with senior/middle managers of organizations that could be described as less advanced technology users various inhibitors of IT adoption were identified. Besides, meetings with IT suppliers to the industry have conducted in order to identify future technology directions. The main items discussed have been:

- the state-of-the-art in terms of existing tools, processes, infrastructures, key indicators, standards;
- their requirements and ideas – related to IT in Construction (including for example how they can support / improve construction processes);
- their priorities in the vision and expected timeframe for future implementation
- co-operation policies among all the relevant actors, and establish how to mobilize key stakeholders towards realizing the strategic goals, and secure full users' involvement
- their contribution to the strategy and their interests in participating in specific R & D themes

From these interviews, a descriptive overview of IT use and an analysis of the requirements of the industry about the application of IT were developed.

2.4.1 IT Infrastructure of the Turkish Construction Industry

First part of the questionnaire investigated the general IT resources of the organizations. To get a general idea about organizations' IT infrastructure the questions asked about their hardware, network architecture and operating system they use.

2.4.1.1 Hardware

Table 3 – Survey Results related with IT Hardware

Organizational Level (N=50)

	N	%
PC	50	100%
LAN	50	100%
WAN	10	20%
Intranet	5	10%
Internet	50	100%

Project Site Level (N=43)

	N	%
Mobile Phone	43	100%
PC	33	76,7%
LAN	21	48,8%
WAN	10	23,3%
Satellite phone	10	23,3%
Internet	20	46,5%

As can be seen from the Table-3 above, among the most popular forms of IT hardware were PCs, laptop computers and mobile telephones. At the organizational level, all of the contractors sampled stated that they used PCs as their major IT hardware platform and they all stated that their PCs were linked via a local area network system. Only 20% of them have WAN that help them to communicate with their construction sites and offices around Turkey. A small percentage as 10% of them use their network as an intranet because the lack of IT education, and also because procurers are not aware of the benefits of an intranet. The companies, which have construction sites or offices abroad, use internet as a communication media because they consider internet as a cost-effective communication solution.

At the project site level, there were substantial differences in IT hardware usage from the organizational level. Mobile phones were found to be contractors' primary IT hardware on-site, with most contractors stating that mobile phones had improved their communication and decision-making processes. It was found that all of them used mobile telephones, and 23,3 % of respondents having sites abroad used satellite phones at site. 76,7 % used PCs, and 48,8% had networks in place on site and they were all connected to internet to exchange site information. Only 23,3% of them have WAN that help them to communicate with their offices. Several contractors indicated that networks were only used on site when the project was large enough to support a network infrastructure. Most contractors had a desire to upgrade their existing hardware and increase their hardware portfolio in the future, but the financial outlay was perceived to be a setback.

2.4.1.2 Operating Systems

Microsoft Windows Operating Systems, Microsoft Windows2000/XP, are dominant in the industry but there are still Microsoft Windows98 usage within the sample with a percentage of 5% giving no reason for not to upgrade the system. Typically, software was upgraded when a modified version of the package became available. Many organizations were reluctant to introduce more advanced software applications, primarily because of the anticipated additional training required and therefore the loss of productivity.

2.4.2 The use of Information Systems in Turkish Construction Industry

This section aims to determine the current use and applicability ratio of certain information systems, information system components, knowledge acquisition, sharing technologies and applications.

2.4.2.1 Electronic Communication

Table 4 – Survey Results related with Electronic Communication

Electronic Communication (N=50)

	N	%
Telephone, Fax	50	100%
E-mail	50	100%
Instant Messaging	34	68%
e-documents and e-drawings	25	50%
Whiteboard, discussion forums, shared best practices	0	0%

Table-4 above shows the survey results throughout Turkish construction industry related with electronic communication. The extent of electronic communication and information transfer was considerably limited to the organizational level. The telephone and fax were undoubtedly the most popular forms of information interchange used by all contractors at both levels. While phone conferencing, fax modems as well as e-mail were used by all, none of the respondents use video conferencing. Instant messaging is commonly used with a percentage of 68% and 50% of the firms use e-documents and e-drawings. The respondents have never mentioned whiteboard, discussion forums and shared best practices. The results show that Turkish Construction Industry cannot fully benefit from groupware tools and applications.

2.4.2.2 Business Processes

Table 5 – Survey Results related with Most Used Software Programs

Most Used Software Programs (N=50)

	N	%
Microsoft Products (word processing, spreadsheet, presentation)	50	100%
Autocad	50	100%
Primavera, MS project	25	50%
SAP2000, StaadPRo, Etabs, Probina, Babalioglu	32	80%
X-Steel (3D integrated)	10	20%
COMOSYS (Integrated)	1	2%

Table-5 above illustrates the percentage of most used software among Turkish contractors. The survey revealed that all of the respondents use all components (word processing, spreadsheet, presentation) of the office automation system. Microsoft products are commonly used in this area. Typically, AutoCAD is used by all of the respondents for usually 2D drawing applications. As being a more recent program X-Steel is used commonly within majority of companies specialized on steel construction constituting 20% of the sample.

Primavera and Microsoft Project are dominant packages in the market for time and resource planning & management. 50% of the organizations interviewed use them but unfortunately the rest do not have a structured project management system.

The most widespread structural analysis program is SAP2000 across the industry. StaadPro and Etabs are also used across the industry for specific purposes. Similarly Probina is commonly used for reinforced concrete design. Besides a Turkish owned software package program Babalioglu is also used for some for reinforced concrete design applications. An integrated analysis, design, drafting and document management software, COMOSYS developed by a Turkish software vendor Proya, has recently been ready for sale and used by its founder organization Prokon. However, Proya is appreciated with the general response of the industry about the program that they claimed many organizations were willing to buy but they were waiting to see some successful applications. This also indicates the conservative and risk-averse attitude of Turkish Construction Industry towards innovation.

A variety of specialist application industry software was used for document control, cost control and reporting, cost planning, estimating, and cash flow forecasting. Advanced software applications such as those based on knowledge-based expert systems and simulation were rarely used. At the project site level, the use of software packages was limited to office administration, cost control and reporting, and document control.

The results show decision support systems are used rarely in Turkish construction industry. The DSS used here generally comes as a part of an ERP package and extracts strategic operational information. The majority of firms believe that construction professionals will become more familiar to DSS and ERP in the next 5 years.

2.4.2.3 Knowledge Management

Table 6 – Survey Results related with Knowledge Management Applications

Knowledge Management (N=50)

	N	%
Datebases	25	50%
Data Warehousing	0	0%
Data mining	0	0%
GIS	8	16%
Multimedia Applications	18	36%

As can be seen from Table-6 above, Turkish construction organizations are in a great need for knowledge management applications. 50% of all respondents use databases to hold customer contact details, stock details, material specific information and machinery details, to store time and resource planning information or to hold information about their e-papers and e-drawings.

When asked if they use data-warehousing or data mining tools all of them replied no, but it is foreseeable that most of them will start to use data-warehousing tools in the near future. The minority of the respondents with a percentage of 16% uses GIS for site planning or in surveying practice. The majority of them do not seem to benefit from GIS. The majority of the firms think that in the near future GIS tools will help them in site selection, and management

36% of the respondents use multimedia applications for improving communication with customers and some of them use it for also training purposes. Half of the respondents are willing to use internet based multimedia applications in the near future, and also think that multimedia applications will be used as a main tool in company presentations and in firm training activities.

2.4.2.4 Modeling Applications

Table 7 – Survey Results related with Modeling Applications

Modelling Applications (N=50)

	N	%
2D CAD	50	100%
3D CAD	25	50%
Virtual Reality	0	0%
Neural Network Applications	0	0%
Simulation	0	0%

The survey results about modeling applications of Turkish construction organizations as seen from Table-7 shows that all of the firms uses CAD for 2D and 50 % for 3D design. Also the majority of firms are aware of the advantages of virtual reality tools but they cannot use them due to the lack of educated staff. Majority of firms use Computer Aided Cost Estimation tools as standalone software packages that are not integrated with any project management package. The minority of cost estimation software can calculate cost by using CAD drawings.

None of the respondents use Neural Network Applications. The industry is not aware of the importance of advanced AI. Also none of them are using tools for construction process simulation.

2.4.3 Turkish Construction Industry IT Culture

This section aims to understand the industry's view on emerging technologies and strategic dimension of their current usage. The research method was usually open-ended questions to get a clear idea about industry IT culture.

60% of the organizations believe that their usage of IT is at the strategic level and IT applications are critical to sustaining their future business strategy. 40% of them believe their usage of IT is at turnaround level and IT applications are important to the future success of their organizations.

However, Table-8 below depicts the number of respondents of different types that indicated different levels of agreement with a series of statements.

Table 8 – Survey Results related with Organizational IT Culture

	All 50 respondents				
Very Low, Low, Medium, High, Very High	**VL**	**L**	**M**	**H**	**VH**
Encouraging team working and knowledge sharing	0	14	7	29	0
Official and established ICT strategy including training policy	16	6	18	10	0
Preparing for organisational changes to implement ICT supported working practices	19	9	16	6	0
Cultural attitude favouring use of ICT	14	10	11	15	0
Data Flow Management	9	10	13	9	9
Collaborative works organisation between distributed teams using innovative interfaces	19	16	11	4	0
Ensuring employees are aware of business/community issues	0	0	14	26	10
Actively encouraging your employees to seek out improvements, improve and always find some way of getting "well done"	10	20	9	11	0
Improving business management methodology as the result of the feedback from the employees (employee feedback)	9	19	12	10	0
Rewarding employees for suggesting improvements and maintaining linkages with other industry participants with complementary skills	28	10	3	9	0
Ensuring that resources are available to support business imporevement priorities	0	9	27	5	9
Providing training and guidance to technical staff in the communication skills needed to present and disseminate data, ideas, interpretations and findings(e.g. creating and using intranet research websites, writing non-technical white-paper summaries of technical innovations, creating value-added intelligence reports on competitors)	9	25	5	11	0
Participating in apprenticeship programs	0	10	19	11	10
Increasing your understanding of customers' expectations	0	0	10	14	26
Improving business management methodology as the result of the feedback from the customers (customer feedback)	0	0	14	21	15
Providing a broader range of services to your clients	0	0	6	10	34
Enhancing your organization's technical capabilities	4	4	21	11	10
Introducing new technologies, new skills and competencies	6	21	14	9	0
Investing in local research and development	30	10	4	6	0
Participating in the development of industry standards and practices	34	11	5	0	0
Protecting your organization's intellectual property	25	6	8	11	0
Delivering products/services which reduces your client's cost	0	9	21	9	11
Seeking business outside Turkiye	0	0	5	14	31
Increasing your market share	0	14	8	19	9
When you make changes, measuring how well the changes have worked that is continual scanning/development	0	3	5	11	31
Deciding how to target and measure success with stakeholders	0	0	4	16	30
Following a written strategy to keep the loyalty of key experts within the business	20	10	6	14	0
When problems occur, looking for innovative long-term solutions rather than quick fixes	0	3	10	16	21
Maximizing the use of available best practice through well supported strategies	19	8	8	6	9
Archieving reports from projects in a form that makes them easily accessible to relevant personnel(e.g.in a library,within a structured database)	0	5	10	14	21
Assessing at the end of each project to identify factors effecting success or failure (e.g. failures in information flows, contextual information about suppliers, customers, collaboratives, equipment etc.)	0	5	0	11	34
Utilizing strategic cross-project reviews and contributing towards the evolving stocks of corporate knowledge (e.g. as a source of intelligence on internal capabilities, external technologies, markets, competitors)	8	18	0	9	15

The chart indicates that many of the respondents answered as medium and also low for many items, conflicting their belief that they had an IT culture at strategic level.

The following themes relating to the various business areas within construction that can benefit from the use of IT are discussed during the meetings. In order to get reliable results, the industry should be segmented into sectors and the results should be examined within each sector. Each sector has a number of different specialized topics that address relevant issues and technology.

– **Architects**

  Potential Usage Areas and Opportunities Discussed

  - Automated design and documentation
  - Electronic support for project administration
  - Support for presentation and marketing of designs through rich multimedia software tools including 3-D images, fly-throughs and presentation of building performance characteristics such as lighting and shadow effects
  - Electronic document management
  - Integration of an extended range of services including urban planning and design, building design and quantity measurement and costing.
  - Very significant productivity gains, by those firms who have moved to 3D CAD and re-engineered their processes, enabling a commensurate increase their portfolio of work
  - Ability to integrate work flows from land use planning through to building documentation, working at increasingly detailed levels of design
  - Ability to demonstrate designs using virtual reality simulation.

But currently in Turkey, few architects are designing in 3D. Most architectural firms use CAD to some extent and use email to send CAD files to consultants. Some firms have used CAD technology merely to automate existing work processes whereas a smaller proportion have integrated design and documentation so that there is no longer a discrete documentation stage – documentation is derived directly from the CAD data. Some firms have developed sophisticated design presentation processes using an extensive range of multimedia tools to create highly realistic images (static and dynamic) of the designed building. Some are using automated costing tools to give customers better cost information at an early stage while some are using accurate information generated from 3D CAD to negotiate lower cost building contracts for their clients.

– **Quantity Surveyors**

Potential Usage Areas and Opportunities Discussed

- Increased productivity through streamlined data entry and data management
- Increased productivity through automated quantity and cost calculation
- Faster measurement through the use of digitizers
- Elimination of measurement through direct calculation of quantities from CAD files
- Faster transmission of quantity and cost data via email
- Expanded services in relation to feasibility, duration and cost planning using expert systems.

Accordingly in Turkey; while there is an emphasis on automating data entry and calculations, many practitioners continue to emphasize on manual measurement. Use of email to send data to architects and contractors is widespread as well as there is a great attention to non-traditional services in areas such as feasibility evaluation, duration and cost planning including life cycle costing

– **Consulting Engineers**

Potential Usage Areas and Opportunities Discussed

- Support for calculation in analysis and design through specialist calculation tools
- Use of email for communication with business partners
- Use of advanced modeling tools, e.g. 3D modeling, computational fluid dynamics, radiosity analysis, to support more accurate analysis and design, particularly to meet performance-based design criteria
- Documentation of building structure and services through CAD, moving from 2D to 3D CAD representation
- Use of computer-based workflow management and document management to improve quality assurance

- The development of knowledge-based systems in design and the integration of design and CAD documentation processes.
- Ability to model and analyze designs more accurately leading to the potential of evaluating various solutions and refining the final design in terms of the relevant parameters.
- The development of IT-based design packages, linked to analysis programs and drawing on previous standard details, has meant that documentation is gradually becoming semi-automated.
- Ability to joint venture with groups who have complementary design capabilities, providing single source solutions.

A great majority was aware of these, but only a few of these potentials were in use. There was a widespread use of IT to automate existing engineering practices and use of email to send and receive CAD drawing files internally and externally whereas a few firms trying to build markets for services based on advanced modeling tools. Some use document management to improve quality assurance

– **Principal & Specialist Contractors**
  Potential Usage Areas and Opportunities Discussed

- Electronic tendering resulting efficient and more accurate estimation and tendering
- Better project planning using 3-D (and 4-D) modeling for simulation, as well as better resource management using project planning and scheduling software
- Better inventory management and reduced costs
- Computer based work-flow management
- Better project/contract management through data sharing, and document management
- Elimination of duplicate effort through improved access to information
- Better project control and co-ordination because of ready access to latest information

- Better accounting/budgetary control and cash flow management
- Use of Global Positioning Systems for setting out
- Improved safety management by using database systems
- Cross-sectoral integration to provide single source solutions
- Sourcing of components and materials using IFC's and from the Web.
- A significant increase in turnover, in which IT has played a critical role
- Faster and cost effective communication to the extent that significant investment in IT is expected to pay for itself within two years
- The ability to manage projects despite large distances between the head and site offices, including real time audio-visual linkage to review and discuss design/construction issues
- The ability to overcome shortages of skilled workers by integrating processes through intensive use of IT in off-site pre-manufacturing processes
- Early detection and resolution of problems related to project management
- Significant reduction in re-work and duplication.

But the current use by contractors and specialist contractors was generally an automation of existing processes of Project planning and scheduling, Estimation and tendering, Project management and cost control, General administration and accounting, Asset management. Electronic funds transfer, Email for exchange of documents/information, QA management, Drafting.

– Building Suppliers & Manufacturers

Potential Usage Areas and Opportunities Discussed

- Integrated systems for optimizing ordering and dispatch
- Integration of product design and manufacture
- Use of NC and robotics to fabricate complex components and sub-assemblies off-site
- Logistics and inventory management systems

- Internet/web-based customer and supplier interfaces
- Electronic tendering
- Executive information systems for retail management
- Sales-force automation for mobile access to corporate/customer databases
- Improved service to customers
- Just-in-time management of logistics & inventory
- Higher productivity and efficiency
- Shorter product development times
- Access to timely and customized business information for management & marketing.

But the current use of computer-based technologies by building suppliers include; Logistics and inventory management, Financial and asset management, Wide-area and local area networks and email for corporate communications, Automation of sales and ordering processes, Integrated systems for optimizing ordering and dispatch.

Generalized situation is;

- Automation of existing work practices has brought a range of generic benefits:
    - Productivity gain
    - Increased business turnover
    - Shorter cycle time
    - Systems to manage larger and more complex projects
    - Improved accuracy and consistency of documentation.
- There was a general perception that the use of IT brings with it an expectation of faster cycle and response times.
- Companies want to interact with some very simple mechanisms – that might hide and handle complex issues – that can help them to make business in a better way (simplicity)
- Among all the organizations interviewed, relatively few have re-engineered their business processes along with the adoption of IT,

however those that have done so have experienced significant gains in productivity and commensurate competitive advantage.

- For some firms, IT has enabled expansion into new markets, and positioned them to compete internationally.
- Among larger organizations in all sectors, IT use is widespread, and electronic intra- and inter-organizational communication via email is common.
- The Application Service Providers (ASPs) has emerged as a good option providing integrated e-business environments. The problem to be tackled is: how comfortable the companies feel knowing that an external entity is somehow involved in their business?
- There are still some technical and cultural problems. A number of marketplaces have stopped operating. The main reason reported is that clients were not prepared to take part of eBusiness world. This is reminding words "We tried to sell a Ferrari to people without driving license" (Xavier de Cuverville, director of marketing at B2Build in France, one of the marketplaces that has stopped its operation).
- Administrations essentially play a regulator role, i.e. the government publishes through the Web the norms/standards that have to be followed by companies operating in the AEC sector. There are small initiatives targeting the e-government for the AEC sector in which the government acts as a client that publishes its call for tenders and make them available through the Internet. However, these initiatives can be summarized as "publication of call for tenders using the Internet as the dissemination channel". It obviously reduces the cost of preparing the calls (the government does not have to print hundreds of copies of huge documents, rather the supplier has to do it), even if only this part of the process is electronic. The rest follows the traditional paper-based way.

It is important to emphasize that private companies are also trying to exploit this market, which means, they provide "pay-to-use" e-services.

2.4.4 Industry Future Plans

This section aims to get an idea about the future plans of the industry related to IT development. Questions are asked about how IT will be used in their company and which areas they think as vital or important to adapt.

When each respondent was asked to indicate the anticipated future requirements and expenditure of the organization on IT over the next five years, many stated that they expected it to be average. Few respondents answering questions pertaining to the organization's current investment in IT had accurate figures, yet each respondent could not give a reasonable estimate of the percentage of annual IT investment. Many respondents found it difficult to predict their future investment in the selected IT categories.

The general consensus that IT is important and firms could not remain competitive without it is obvious. Furthermore, most contractors planned on upgrading their existing software, with no intentions of implementing advanced technological or software applications in the short term. Nevertheless, most did recognize that they needed to embrace advancements in IT if they were to remain competitive. Consequently, contractors need to be better educated about the potential applications of IT. Table-9 below indicates the survey results about the Turkish construction Industry future plans.

Table 9 – Survey Results related with Industry Future Plans

Future Plans (N=50)

	Vital	Important	Not important
IT training and education	86%	14%	0%
Multimedia Applications	44%	56%	0%
Data Warehousing	40%	40%	20%
ERP	28%	62%	10%
Digital catalogues	32%	48%	20%
Collaboration	56%	44%	0%
Integration and Interoperability	40%	60%	0%
3D Modelling and Visualisation	34%	66%	0%
VR	34%	46%	20%
Simulation	10%	60%	30%

IT training has been found as the most important requirement of Construction IT in Turkey. The 86% of the firms think it is a vital issue and 14% of them think it is important. All firms agree that their employees need more IT training. Multimedia Applications are found as a vital requirement by 44% of the respondents but 56% considers it as an important topic. Multimedia can be used as an efficient medium for marketing purposes and in firm education. The industry is aware of the benefits of multimedia applications but there is a lack of trained employees.

Companies believe that they do not have a reasonable level of control on their data and Data Warehousing and Data Mining techniques will be very helpful to manage data resources. Data Warehousing Applications has been found as a vital area of research by 40% of the participants and has been found important by 40%. The rest as 20% do not find is as an important issue.

28% of the firms think the Effective use of ERP is a vital area for Construction IT research. For 62% of them this subject is important but the rest as 10% do not consider ERP as important. The respondents believe internet and related technologies will change project management concepts, and industry will share project management information in electronic project management portals.

Digital catalogs will be an effective medium for the construction procurement in the future. 32% of the respondents think Digital Catalogs will be vital tools for the future of procurement and 48% of them find it as an important requirement. 20% of the respondents do not think digital catalogues as industrial requirement.

The Collaboration in Construction has been found as one of the most important topics. 56% of the industry think that their communication problems will be solved by advanced IT applications and find this subject as a vital area of research for the future. 44% of the respondents find this subject as an important area of Construction IT.

About half of the respondents believe that they will use internet based office automation systems in the near future with the liberalization of telecoms sector having started from January 1, 2004.

Firms explain that they have data, time and financial loses because, the softwares used for different aspects of the project are not integrated. 40% of the respondents find this subject as a vital issue and 60% of the firms grade it as an important requirement.

34% of the firms find Project Model approach vital and 66% of the respondents find this approach important. However, 34% of respondents find Virtual Reality as vital area of research, while 46% of the firms find it as an important area and are willing to use VR applications in the near future. The respondents also think CAD related technologies would change the way they exchange design information in the next 5 years. But, only %10 of them thinks they are finding construction process simulation tools as vital issue. For 20% of the respondents VR is not important and also 30% of contractors think simulation trivial.

Thus, there was a general consensus on future expectations such as;

- Use and efficient deployment of IT to contribute to a highly competitive Turkish Construction networked economy
- Collaboration with standardization bodies to ensure coherence and fast innovation in technology deployment
- Contribution to European policy development in various areas of construction and related industries
- *Technical aspects*:
    - promote data/object models & APIs for open information exchange & sharing
    - foster the whole life-cycle view, with interfaces between related disciplines and development of product model templates
    - improve information management, and links between information management and workflow requirements in virtual organizations

- improve networks communication, e.g. e-mail & Web facilities, in house Intranet sites, workflow systems, etc.
- improve company knowledge & learning in a broad scope
- promote best practice guides & business recommendations

The agreed potential benefits discussed leading to win-win-win solutions described in the Figure-13 below;

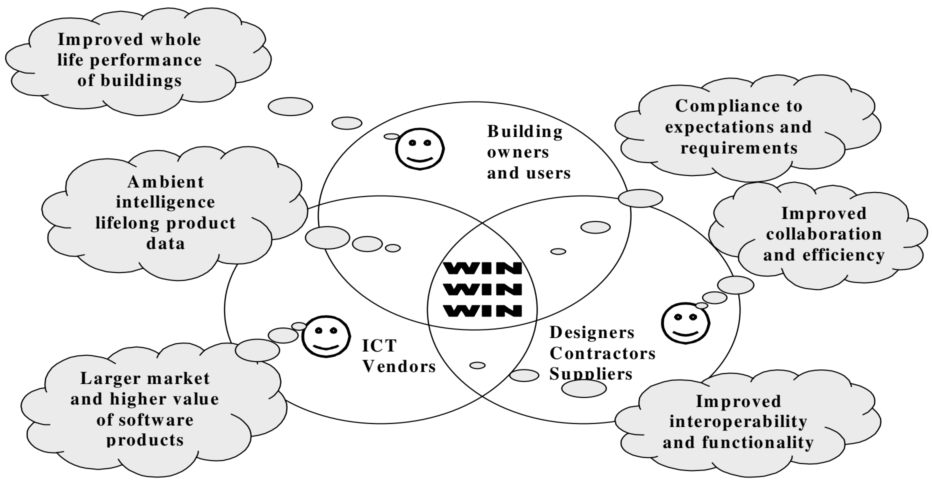

Figure 13 – Benefits to Key Stakeholders (Source: ROADCON project)

2.4.5 IT Adaptation Level

According to the survey results described in Table-10 below, in order to examine the level of IT adaptation of Turkish construction industry, the sampled companies can be classified into 3 different phases;

Table 10 – Survey Results related with IT Adaptation Level

Adaptation Level (N=50)

	N	%
1st Phase - Automation	32	64%
2nd Phase - Information Management Process	10	20%
3rd Phase - Business Process Re-engineering	8	16%

1st Phase-Automation (64 %): This industry view is based on the gains firms have made through automation. Typically, firms have adopted IT systems and tools which directly assist in the performance of their specialist tasks. This has allowed them to automate a number of time-consuming and error-prone activities and gain benefits in cycle-time, productivity, and accuracy. IT is used to carry out tasks that previously were performed manually. Its benefits are achieved with little organizational restructuring. For example, the use of CAD for drafting has resulted in firms in all sectors gaining these benefits when changes to drawings are required.

2nd Phase – Information Management Process (20 %): Some firms I have interviewed have begun to leverage the information they collect as a by-product of automation to improve their management processes. This is typically the second phase of IT adoption for an industry, when firms start to "informate" – IT is used to add value beyond its role in reducing costs. Leading edge innovators in the Turkish building and construction industry are transforming their organizations with IT-based strategies which add value for their clients.

Five or more years ago, they automated many of their technical activities, which initially led to cost advantages. Now these cost reductions are being absorbed into the industry cost structures, and the benefits passed along to clients rather than being realized by the organizations

3rd Phase - Business Process Reengineering (16 %): Further, in a few of the firms studied the use of IT has begun to transform the way they do business – they have started to reengineer their core business processes. This is the third phase of IT adoption. Such potentials are enabled by IT but requires more than mere adoption of the technology. Adoption of a particular IT system cannot on its own provide sustainable competitive benefits. The achievement of competitive benefits typically requires organizational change. And successful change requires learning and accommodation, all of which takes time. For example, the productivity gains for architects from CAD are only maximized when drafting is integrated with the design task. Successful transformation of businesses is achieved incrementally over several years through a cycle of learning and organizational change.

While some industry leaders have moved beyond automation, by comparison with other industries such as retail and financial services, building and construction has been a late adopter of IT. A number of factors, which emerged during the study, may help to explain this relative slowness.

1- The benefits of automation for individual firms have been substantial, and for many may have seemed sufficient.
2-Automation is attractive to a cost-focused industry because it principally addresses cost reduction.
3- Most firms were found to be very cautious in relation to technology risk and the risk associated with organizational change.
4- Industry profit margins are generally so tight that firms do not feel able to invest in change.
5- Many firms believe that investment in IT is a one-off rather than a continuing development of a crucial business competence - having reaped the benefits of automation; they do not expect a new generation of IT-enabled change. IT-based automation has therefore become a competitive necessity for firms to remain in business but does not in itself yield them a sustainable advantage.

However, IT can be, but typically is not as yet, used to facilitate the creation of a transformed supply chain. By taking a different approach to cross-sectoral relationships, for example by encouraging greater concurrency between tasks conducted by firms in different sectors through greater sharing of information, it may be possible to achieve substantial savings in time and money for the client.

In a supply chain characterized by the sharing of information and knowledge, the potential exists to increase the total value to the ultimate client (the developer/operator of the building or plant) by improving performance on multiple dimensions including operational manageability and return on the asset. For example, if architects, engineers, contractors and clients start to share information when a design is first being conceived, with appropriately rich communication channels it may become possible to design and build more efficiently, with less difficulty for the designers and builders, and with far greater benefit to the customer because new kinds of solution are developed collaboratively which are safe, aesthetic, easy to build, and perform better for the client.

Unfortunately there was a lack of cross-sectoral collaboration in Turkish Construction Industry. There was a focus on firm-specific cost-reduction eliminating the idea of concurrent engineering. If the industry continues to pursue the current competitive dynamic without exploring cross-sectoral potential, the risk is that (1) it will have limited opportunity to internationalize because current firm-specific cost-reduction does not confer any sustainable advantage and hence is not sufficient to expand into overseas markets, and (2) overseas firms might successfully enter the Turkish market.

2.4.6 Impediments to Adoption for Turkish Construction Companies

Each contractor identified the major problems, which they had experienced with the implementation of IT (hardware and software), as shown in Table 11.

Table 11 – Survey Results related with Impediments to IT Adoption

Barriers that prevent from more advanced use of IT (N=50)

	N	%
Training	40	80%
Cost of technology	37	74%
Conservative nature of industry	25	50%
Security of hardware at site	12	24%
Legal Support for use of IT	8	16%
Incompatability/interoperability problems	8	16%
Lack of technical support	5	10%

The most common problems experienced with IT were: the lack of training associated with its implementation and systems knowledge, with 80% of contractors perceiving this to be a problem and the cost of technology, perceived to be problem with 74% of contractors. Implicitly contractors were unaware of the impact that potential advanced applications of IT could have on the organization's competitive position. This was found to be the case with majority of contractors using highly specialized planning and scheduling software for simply doing bar charts. Besides, several contractors commented that it was difficult to keep up to date with the advancement and innovations in both technological and software developments, expressing their concern that the economic climate of the industry did not enable them to devote the necessary time and money to follow advancements in IT.

In Turkey and also all over the world the construction industry is highly conservative preventing taking up of new techniques naturally. 50% of the contractors stated their risk averse nature of business as an important barrier for IT development.

On the other hand, the security of hardware was perceived to be a problem with 24% of contractors. Typically, hardware applications were kept to a minimum on site in case of theft. This appears to be the main reason for the differential between the use of IT at the organizational and project levels.

Besides, 16% of the respondents complained about the lack of legal validity of e-documents and e-contracts as an impediment allowing them to follow the information revolution. Also, 16% of the contractors stated that incompatibility and interoperability problems directed them to continue the traditional methods for their transferred documents to be readable.

Furthermore, lack of technical support for users was considered to be a problem for 10% of contractors, all of whom experienced problems relating to a lack of systems knowledge and training.

The regional character of the construction industry, cultural aspects and the limited vertical and horizontal integration impede the deployment of IT in the construction industry as compared to other industries. The current barriers to IT deployment in the Construction industry can be summarized as follows. Some are related to the very nature of the construction industry while others are linked to the lack of IT maturity of Turkey and appropriateness of IT solutions today.

The social sciences researchers and industrials consider, from industrial experiences, that introducing IT innovation is not always successful due to many barriers which have to be removed such as:

a) Barriers related to the organization of the construction industry

- Lack of long-term partnering between actors that could result in proper IT strategy adoption and IT infrastructure deployment.
- Lack of trust among firms
- Owners or Contractors are scarcely involved in RTD or progress activities and projects.
- No global actor to enforce the use of standards and IT on projects.
- The high cost of innovating/learning a new technology and tight margins which make it difficult to fund innovating and learning
- Lack of a shared language by which to understand the supply chain processes
- Fragmented structure and adversarial nature of the industry resulting lack of a shared technology
- Industry disinclination to invest sufficiently in capital

b) Cultural and educational barriers

- Lack of awareness for IT potential (availability, opportunities and business benefits)
- Lack of preparedness for change
- Belief that the industry is doing sufficiently well that IT innovation is unnecessary
- Lack of IT strategy in most construction organizations (majority of SMEs). Especially, IT training is not really a concern for most organizations.
- Lack of confidence for e-transaction solutions (e.g. e-procurement)

- Lack of dialogue and good understanding on construction needs between IT researchers and vendors on the one hand, and practitioners on the other hand.
- Fear of over-investing in IT – there are several stories of companies actually or nearly going bankrupt as a result of spending too much on IT
- Relationships are still governed by conventional practices that privilege direct human contacts and reduce the potential of IT solutions for some kinds of activities.
- Belief that IT alone, without re-engineering/organizational change, can deliver promised benefits
- Resistance to re-engineering/organizational change necessary to gain a pay-off from the technology
- The difficulties an enterprise has to assess the innovation impacts on its organization, people, IT infrastructure, process, etc.
- The lack of an efficient innovation added value assessment
- There is a general need for cultural change in the Construction industry. While the potential gains anticipated through proper adoption of IT are desired, the necessary changes are resisted

c) Barriers related to existing IT offer

- Lack of robustness, flexibility and scalability of existing IT solutions.
- Lack of interoperability between IT solutions. Interoperability problems due to the complexity and diversity of the Design and Construction process that requires multi-dimensional solutions highly likely to involve IT solution from several vendors
- Loss of efficiency in using IT solutions due to multiple data inputting and time spent to learn new tools.
- Lack of solutions adapted to the very nature of the sector (including mobile and wireless solutions for site-based work).
- Persistent confidentiality and security problems (virus attacks, unauthorized access, hacking, etc.), even if this concern is shared by all industrial activities.

- IT solutions tend to be expensive with low immediate return on investment.
- High investment from one stakeholder to implement a solution when returns are high only when aggregating small returns of the level of each stakeholder.
- Piecemeal developments carried out without business (inter and intra-companies) global views.

d) Legal issues

- Legislation to support the use of IT may exist but it has yet to be fully realised by the research community and the construction industry.
- In some areas (e.g. liability and contract enforceability issues), the legal framework needs to be adapted to stimulate and regulate the use of IT

2.4.7 Current IT Diagram

Table 12 – Survey Results related with Industry IT View

	All 50 respondents				
Very Low, Low, Medium, High, Very High	**VL**	**L**	**M**	**H**	**VH**
From stand-alone specific engineering applications towards integrated **Total Life Cycle Support**.	0	6	9	11	24
From physical products and (semi-)automated building services towards **Intelligent Products and Smart Buildings**.	15	21	5	9	0
From reinventing and use of personal/departmental experience towards **Re-use and Sharing of Knowledge** at enterprise and industry levels.	0	4	3	18	25
From information access via company and project intranets and web towards **Ambient Access** to all relevant information anytime, anywhere regardless of physical location.	11	5	0	20	14
From document (and drawing) based ICT towards **Model Based ICT** (i.e. computer interpretable information).	11	18	10	11	0
From intrusive ICT ("humans serving computers") towards **Human Centered Environments** ("computers serving humans").	10	24	6	10	0
From document & paper based contracts and procedures towards **Legal and Contractual Governance** of ICT usage within and between enterprises.	5	21	4	6	14
From file based data exchange towards **Flexible Interoperability** btw. heterogenous ICT systems.	19	21	10	0	0
From business processes driven by lowest capital cost towards **Performance Driven Process** driven by customer perceived values.	19	8	9	14	0
From teamwork using email and project web sites towards **Virtual Teams**, able to collaborate seamlessly across organisational, geo-graph-ical and time boundaries as if they were co-located.	33	9	8	0	0
From taylored and configured ICT systems towards **Adaptive Systems** that learn from their own use and user behaviour, and are able to adapt to new situations without manual maintenance, configuration and support.	24	18	8	0	0
From limited ICT awareness of construction professionals towards the combination of enhanced **ICT skills** (via education, training) and built-in **learning** support within ICT systems.	0	14	11	6	19

Table-12 above records how many respondents of different types ticked different levels of their current application about the following principles.

According to the industry research it is understood that currently the use of IT is very limited. The lack of advanced IT applications appears to be alarming. Every professional uses computers, but no electronic semantical communication is possible and IT is not used on the project site level. Currently communicating in and over large scale construction projects is still done by traditional means: drawings, fax, mobiles and meetings. One of the negative results of the current IT use is human's function in the information streams as translation or transformation machines. They receive information on paper, extract the input required for their applications, perform their calculations, extract the required output and put that information again on paper to pass it down to others. This is, in terms of Lean Construction, a transformation process without added value (on the contrary it is error prone) that is seen as waste and should be eliminated. Eliminating humans from the information stream requires an Internet-based Communication Technology that is applicable for meaningful electronic communication (1) between humans, (2) between humans and computer applications, and (3) between computer applications. Only if humans (parties involved in a project) and computers share a common ontology of construction terms and definitions, then electronic communication becomes feasible.

It was found that many business processes are now almost completely computerized and but there is a lack of tendency toward a greater computerization of the remaining processes. Although most firms surveyed have adopted the Internet, design information is still exchanged in its traditional form. Among all the organizations interviewed, IT use is widespread, and electronic intra- and inter-organizational communication via email is common. Relatively few have re-engineered their business processes along with the adoption of IT, however those that have done so have not experienced significant gains in productivity and commensurate competitive advantage yet since there were generally at a very early stage. For some firms, IT has enabled expansion into new markets, and positioned them to compete internationally. Among the advanced users, the leaders are creating networks based on IT across organizational, national and international boundaries.

However, some companies have committed to a continuing investment in technological advancement and organizational change. By changing how they are organized and do business, they are planning to achieve far greater benefits than available through automation alone. Differing views were expressed regarding the ease of data exchange between different CAD documentation software, though it was generally agreed that software developers are now addressing issues of inter-operability. For example, Prokon chose to integrate the structural design and documentation processes, thereby eliminating the need for draftsmen. They have also discovered that they can add greater value for their clients by providing them with a wider range of services (like visualization, software interoperability) based on the new core competencies they have developed. Prokon is visioning to succeed in staying ahead of their competitors not merely by automating but by changing their organization as well. Their strategic advantage is their preparedness and ability to continually innovate, and to manage the change necessary to gain substantial business benefits.

The needs and requirements of the organization should be evaluated at both organizational and project level along with the usefulness of the technology to be implemented. It is suggested that if IT is not managed in line with an organization's needs, information processes may become ineffective and consequently impair decision-making.

Information technology in Turkish Construction Industry lacks a solid methodological foundation. The only paradigm that most researchers in the domain currently share seems to be "object-orientation" Other than that there is a multitude of different research directions ranging from computer programming to management strategies. Practitioners and researchers alike are offered a wide range of IT techniques and management philosophies, many of which claim to be the ideal solution to the industry's problems.

Current and recent buzzwords include knowledge-based systems, product data technology, the Internet, EDI as well as concurrent engineering, lean construction, business process reengineering, total quality management, supply-chain management, just in time production.

Often the discussion of IT technologies of interest to construction is centered on the most recent tools, general developments in commercial IT or computer science research have to offer (a "technology push" viewpoint). Good examples are object-orientation, World Wide Web, expert systems. A contrasting viewpoint would be to study the information management process in construction in a comprehensive way and to identify potential application areas for IT tools (a "problem driven" approach).

It is well understood that the majority of construction practitioners are interested in construction management applications rather than what the IT tool can offer (Tucker & Mohamed, 1996). This was made quite clear during the interviews, by practitioners who do not consider IT tools as being an integral part of their decision-making processes.

IT presents great opportunities for improving and changing business-to-business processes through the integration of both computing and communications technology. By becoming involved in 'E-business' your conventional methods of conducting transactions with other companies can be replaced with more efficient IT and communications systems. However, IT can also be used to transform the way in which you actually conduct your business with other organizations and to change the whole business process. The use of IT in such a way is known as 'E-commerce'. More and more businesses are realizing the benefits of both E-business and E-commerce.

IT can be used in projects to improve your performance and raise overall quality by the adoption of new procedures, which in turn can make your operations more profitable and raise your image as a company. In using IT to its full potential it will allow you to concentrate more on the process of building rather than the chore of managing your own administration and communications

Progress within the industry is being hindered by the fact that many procedures are not carried out using computer aided systems, when really they ought to be. This is because the software applications are either not available, people are resistant to change from their traditional methods or circumstances dictate that they have to use a manual approach.

With computer hardware costs falling daily and telecommunications technology becoming more efficient and faster, it is time for the building industry to take advantage of these opportunities and improve its performance.

At the end of the research, the resultant diagram in relation to the current situation about IT related areas in the Turkish Construction Industry is illustrated in Figure-14 below.

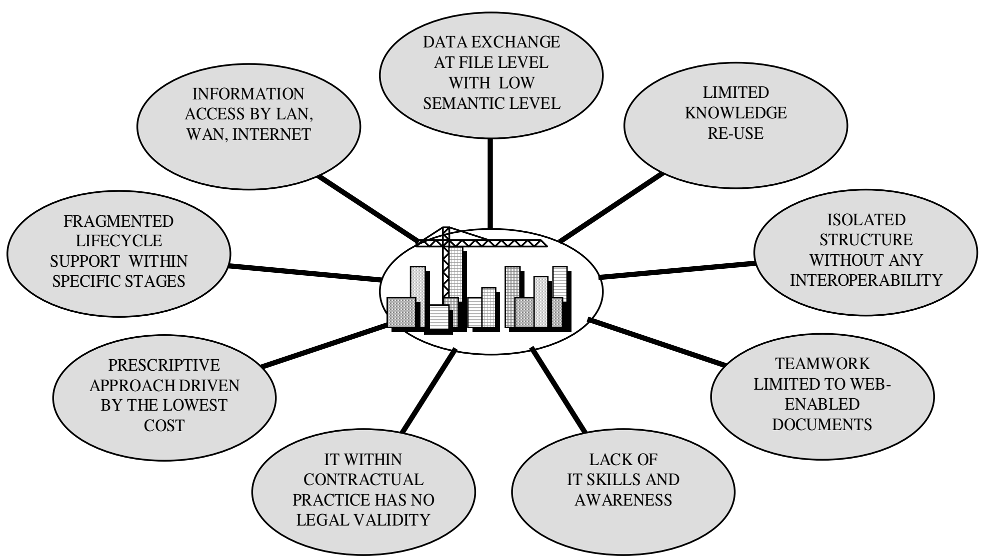

Figure 14 – Current IT Diagram

Information Access: Access to project and company information is enabled via Local and Wide area networks as well as the Internet.

Data Exchange: Data exchange between different applications and companies is available at file level based mainly on proprietary formats at low semantic level. Only 3D models are in use today, although the use is limited to situations where there exists a global actor responsible for most of the construction process.

Knowledge Re-use: A great part of construction knowledge is implicit: project best practices and know-how exist in the mind of individuals, and are available, at best, in the form of documents stored / archived on company intranets. There is a tendency to re-invent the wheel by not re-using past knowledge, and capitalizing on past experiences.

Document Based IT: Information is usually conveyed using documents, which promote the creation and sharing of human-interpretable information. Overall, instructions, information and knowledge are mostly distributed orally, on paper for technical documents (e.g. drawings), with limited uses of automation in highly mechanized operations.

Teamwork: The support for teamwork between distributed experts in participating companies is, at best, limited to the use of web-enabled document management systems ("project web sites"). Web-based collaborative service has for the time being a limited use within large and complex projects.

Lifecycle Consideration: IT in Construction tend to be application centric, dedicated to specialized engineering functions, within specific lifecycle stages, with a fragmented lifecycle support.

Isolated applications: In terms of interoperability, the current situation is essentially characterized by isolated links, solutions that are most proprietary, and incomplete standards (for instance IFC cover only part of the building components and are not yet open to urban domain or to civil engineering or to infrastructure). Moreover, software are in use but without any interoperability or aggregation possibilities, e.g. regarding the sites organization, and software applications most of the time do not use the same data sources.

E-Business: Generalized e-business (i.e. leading to a network of clients, suppliers, and partners in which the enterprise integrates requirements, design, production and logistics in one process geared to all partners involved) can be viewed as the "ultimate" IT-based implementation in the construction industry; however, very few (if not nearly none) companies have reached this stadium of e-business in the construction industry today.

Contractual Practice: The use of IT speeds up the transmission process, but often has no legal validity. The legislation to support technology may exist, but has not been adopted by the construction industry within contractual practices, and hence, the use of IT is currently not necessarily contractually valid.

Construction Site: The construction site has mostly negative impacts within the city and on the neighbors. The data to take in account the specific characteristics of the site and its environment are not available at the right time and they are not always accessible. The time schedule does not take advantage of potential automation for the site equipments.

Facilities and property management: The main software applications used in facilities management are space management and maintenance applications. Space management optimizes the use of space, determine how efficiently space is being used, identify profit-earning and leasable areas, calculate space costs and chargebacks, draw up tenant and employee occupancy plans, and more. Maintenance applications are used for automation of the full range of tasks involved in maintaining a facility: document and monitor preventive maintenance or repair work, work orders, work requests, and more. Contractors and building owners are poorly equipped with software tools dedicated to facility management

Buildings: Buildings contain various and increasingly versatile control and service systems. They are currently based on vendor-specific technologies using "dumb" devices, proprietary software platforms and wired connections and protocols. Monitoring, maintenance and services are done by specialized companies, each responsible of different systems.

Cost-driven Processes: Business process is overall driven by lowest cost. For instance, as regards the smoothening of the supply chain, "traceability" is ensured for major projects and just in time analysis is performed where logistics of components make them a very high consequential value items (e.g. for projects in developing countries). There is a growing awareness of customer perceived value, but not yet supported by prevailing business models. The end-user client needs are not perceived nor known by the stakeholders to the value-chain. The process is not yet client-driven.

IT Skills and Awareness: There is limited use of available tools due to lack of IT skills and awareness. IT training/education to construction professionals and students focuses on skills to use basic IT tools without providing a deeper understanding.

It is also worth noticing that, whilst the construction industry is dependent on standards and common working practices and therefore disciplines in the industry do work on common Standards (national, European and international) and industry companies sit on many standards committees (everything from materials to fire, health and safety, etc.), IT pervade all disciplines and interests and for which there is no separate construction discipline to take responsibility.

Besides some ignorance as regards the possibilities of current IT, a major reason for low-level use of IT in Construction is the lack of a consistent global framework for IT implementation & deployment, including the absence of a common language and definitions agreed by all parties in the construction industry, as well as standardization of information structures and flows: all those elements are essential preconditions for Construction companies to reach a upper level of automation.

On the basis of the current strategic overview of the industry relating to IT use, it is clear to understand that something more should be made across the industry to innovate, to develop better IT budgeting, to get a realistic IT benefits measurement process, to utilize best practices and to have an appropriate IT implementation strategy eliminating the current failure effects.

2.4.8 Motivations to Innovate

Increasing in importance since the beginning of the information revolution, innovation is now a driver for organizational success. In earlier eras, success depended mostly on control and continuity. While innovation was often supposed as beneficial, the pace of change was slow. As a result, organizations focused on perfecting previously learned behaviors. Now, however, failing to innovate quickly is often critical. Many technology companies, for example, find that half of today's revenues come from products and services not even invented five years ago. Survival depends on continual innovation. For governments, of course, the consequences of remaining behind the leading edge of change are not as dramatic, at least in the short term. However, while a slower pace of change is unlikely to take government agencies out of business, public leaders are coming under strong pressure to improve performance, and to catch up with newly established standards of e-commerce and e-government.

Enormous benefits are sacrificed if information technologies are used merely to automate existing processes, rather than redesign them. IT should be used for strategic innovation, not simply tactical automation. Digital networks empower leaders to expertise new, more effective relationships throughout their organization and across organizational boundaries. In the public sector, however, the systemic pressures working against such strategically significant innovations are strong. In most cases, governments have lagged behind the private sector in exploring the possibilities offered by an increasingly networked world, and in effectively applying innovations that work. Risk aversion, conflict avoidance, limited funds, and scarce knowledge have pushed government toward projects that are internally-oriented, and that focus on automating existing processes. The challenge is to push back and to provide for innovations with an enterprise-wide, cross-boundary perspective (The Harvard Policy Group on Network-Enabled Services and

Government, 2001). In response to career-threatening penalties for failure, it is persuasive for Turkish public leaders to avoid all but incremental moves toward digital government. Turkish society needs leaders with the ability to clearly communicate a vision for change that motivates and inspires others to push beyond their boundaries. Besides, the leaders should also avoid impulsive moves that threaten not only the project at hand, but other projects as well. Proceeding without understanding and managing the risk factors of a project, however, often leads to failure. Figure-15 below shows innovation principles in different environments.

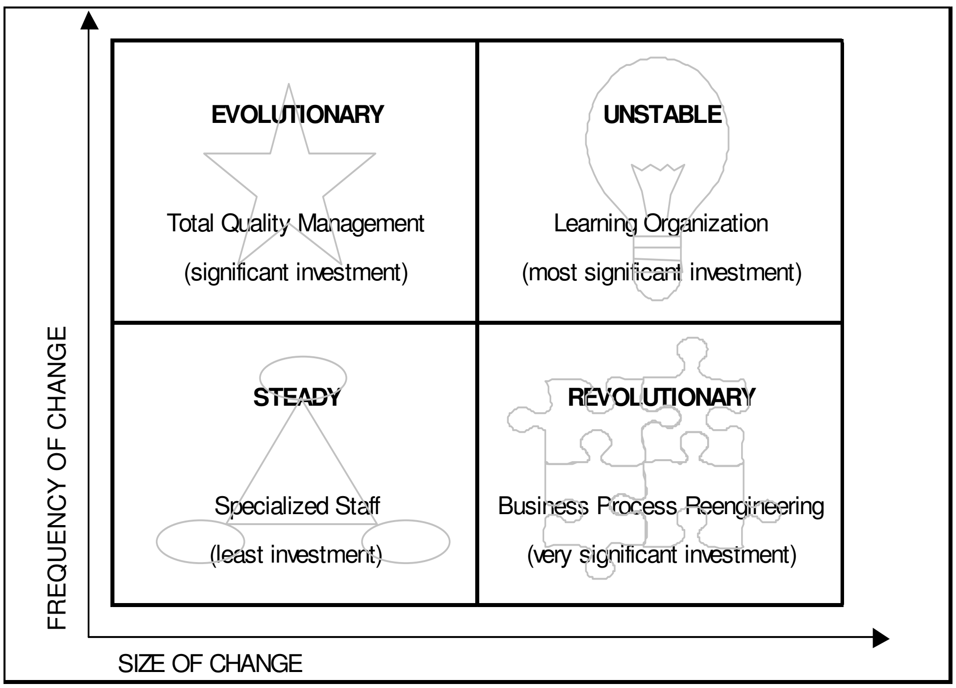

Figure 15 – Organization Innovation in Different Environments

If the organization is operating in a relatively stable environment, it can afford to pursue innovations that are small and relatively infrequent. As the environment demands more frequent change, leaders may need to augment staff efforts by pulling front-line personnel from their daily production work to participate in the search for improvements. Successful evolutionary changes typically rely on a bottom up, consensus-building style of leadership, like that developed within the Total Quality Management (TQM) movement If the organization's environment demands more revolutionary steps, however, a more aggressive leadership style is required. Revolutionary change—commonly initiated through reengineering or reinvention efforts—is almost always controversial.

Finally as in Turkey, if the environment is turbulent enough to demand large changes on a frequent basis, leaders not only need to be engaged in the change process, but must also be actively working to build an organization conducive to change. Success will require adaptive capabilities throughout the organization—within individuals and teams as well as within organizational systems and infrastructures. Creating the kind of learning organization needed to thrive in turbulent environments is an incredibly challenging task. However, as environments grow more turbulent, innovation is more important, requiring more resources as well as more directly engaged leadership making adaptation and change unavoidable.

Turkey should aim to establish a competitive environment that is conducive to fostering innovation (adding value) and promotes cooperation between government, industry, service providers and customers to develop a National Information Infrastructure and exploit the convergence of services, communications, information and technologies. We must ensure that all innovators have access to affordable information infrastructure to enable them to design, develop, trial and commercialize new information products and services for improving community well-being, and are rewarded for their efforts.

Establishing effective cooperation between industry (particularly small and medium enterprises) and public research institutions and universities is likely to facilitate greater levels of technology transfer. An environment providing the seamless integration of collaborated activities between industry and the research base is conducive to fostering innovation and entrepreneurship.

Innovation is purposive, but inherently stochastic. Computer technology serves citizens by providing

-**service efficiency**: the extent to which an application improves an operating

department's ability to meet the needs of its clients where an innovation is adopted because it augments or enhances services(speed up service delivery, better target services to clients' needs, ease interaction with clients etc.) without reducing costs and potentially increasing them

-**decision making and control**: the extent to which an application helps for decision-making and control over operational performance.

-**production efficiency**: the extent to which an application reduces the resources (staff, cost equipment) required to perform a service or increases the services that can be provided with the same resources.

-**professional status**: the extent to which an application enhances professional recognition (prestige and professional status) for you or your organization

-**symbolism of innovation** : the extent to which an application promises a new and better way of doing things and appeals to preferences for "things modern" or "change for the sake of change." but involves some risk Individuals may favor a new product or process because it is new, and simply represents a new way of doing things. (Perry,J., Kraemer, K., Dunkle, D. and King, J., 1992).

Public bureaucracies may be more risk averse so that the innovations they adopt may improve service rather than efficiency. That is, bureaucrats prefer service augmenting innovations because they increase agency budgets to which bureaucratic emoluments are positively correlated expand the clientele served by an agency, and obscure agency production costs by simultaneously altering input mixes and services provided.

Besides, because of their different roles in the hierarchy and their different professional orientations, we expect that different managers will select applications that reflect different mixes of values. Although all managers might hold certain values in common, we would expect that top managers would be more interested in applications that enhance decision making and control, department managers would be especially concerned with applications that promote productivity and service enhancement and systems managers would be most concerned with the extent to which applications were innovative and enhanced professionalism. But, the survey results revealed that only the department managers turned out as my expectations. There is a broad agreement in Turkey on production efficiency and service enhancement across organizational roles. Innovation and professionalism are not important factors in the managers' decisions about computing at any level and decision-making and control is not the overriding factor even for top managers.

For social judgment analysis (Hammond, McClelland, and Mumpower, 1980), a decision (referred to as 'judgment') is a function of the relative weight an individual assigns to the dimensions of the issue under consideration, the form of the relationship of the dimensions (referred to as 'cues') to the final decision, and the method used to organize these relationships.

In the survey conducted among Turkish construction organizations, the task set for the companies was to provide an overall assessment of the likelihood that a specific software application would be selected for use given a summary of the effects that five criteria would have if the application was implemented.

Respondents were asked to provide an assessment for the relative importance they assigned to each of the criteria (productivity, innovation, professionalism, decision making and control and service enhancement). Then, response rates to the value section of the questionnaire varied by role type as shown in Table-13 below.

Table 13 – Survey Results related with Innovation Motivation Criteria

	All Respondents	Top Managers	IS Managers	Engineers
Productivity	46	45	50	43
Service Enhancement	38	35	37	42
Decision Making/Control	8	10	8	6
Innovation	4	5	3	4
Professionalism	4	5	2	5

- Across the entire sample, productivity and service enhancement were weighted fairly equally as criteria utilized for selection of applications. On the other hand, such criteria as the innovativeness and professionalism were not used as criteria for the selection of IT opportunities. Decision-making and control over item was weighted substantially less in the final decision.
- Top management does not evidence a different pattern from that of all managers. Productivity and service enhancement were heavily weighted in the decisions regarding application selection, with productivity of moderately greater importance than service enhancement.
- IS management also placed heavy emphasis on productivity considerations in their decision-making. Interestingly, a greater proportion was influenced by productivity than top management and less emphasis was placed on innovative.
- The other department/division engineers showed a somewhat different pattern from top management and IS management. They assigned almost equal weight to productivity and service enhancement considerations.

The analysis above indicated that judgment patterns were very consistent across role types. To identify variations, cluster analysis was performed. The cluster analysis, indicated that there were four sub-groups among managers.

- Group 1:Productivity and Service Enhancement Dominants
- Group 2, The Organization Controllers,
- Group 3, Efficiency Dominants
- Group 4, the Risk Avoiders,

In general, Group 1 individuals tend to be the most experienced with computing and have the strongest beliefs in the promise of the technology to alter both productivity and service delivery in positive ways. The Group 2 and Group 3 managers tend to be in the middle on these measures, while Group 4 managers--the risk avoiders-- have generally less understanding of what computers can do and considerably less confidence in positive payoffs from their use.

The results suggest that the most powerful determinant of motivation may be an individual's experiences related to the technology. For instance, the results clearly indicate that most managers were not risk averse but a small subset of the population was prone to reject risky innovations. The risk aversion of this subset of managers may have been a product of social learning in which responsiveness to particular cues is a function of past experiences in similar situations.

2.4.8.1 Recommendations for Using IT for Strategic Innovation

In a world of ever-expanding computer networks, governments are being challenged to design and deliver services electronically (The Harvard Policy Group on Network-Enabled Services and Government, 2001). Progress is clearly being made, as Turkish government is taking advantage of the web to launch an e-government service. To succeed in the long term, however, government will need aggressive yet disciplined and continuing support for innovation. The job is not just to catch up, but to keep up, and where appropriate to push the boundaries. Recommendations for making IT use in

Turkish construction industry for strategic innovation can be summarized as follows;

- Adopting an externally-oriented, customer-focused strategy that thoroughly addresses social needs and cross-boundary relationships.
- Nurturing and supporting an innovations-friendly culture and workplace. Something as simple as a suggestion box or a series of luncheon meetings can be the source of a great new idea. Sending staff to seminars, conferences, and classes can also spark ideas, especially for cross-boundary innovations.
- Forming partnerships that support entrepreneurial new service delivery units.
- Organizations do not need to be on the "bleeding edge" all the time, but they do need to aggressively seek out and adopt innovative ideas once the "first mover" has proven the concept. Clear communication about successful innovation is worth some degree of expected failure—supporting disciplined risk taking- is necessary.
- Developing a flexible, standards-based IT architecture as a foundation for expansion and growth. Maintaining a balance between standardization and flexibility, first supporting experimentation, then standardization, and ultimately the elimination of outmoded practices will lead to an innovative environment.
- Engaging overseers in understanding and defining the value of innovation, keeping them engaged as projects progress, they are more receptive to IT-based innovations and will leverage this interest.
- Analyzing how the budget addresses the need for innovation and at first it will be effective to allocate 5-20 percent of IT budget for innovation, but for successful innovations to be sustainable they must eventually move to the main budget—revolving funds cannot sustain programs over the long term.

2.4.9 Budgeting and Financing for Promising IT Initiatives

When governments build their budgets, they focus heavily on program-by-program estimates of what it will cost next year to do what they are doing this year. This annual (or biennial) process of decomposing the enterprise budget into smaller pieces simplifies choices and helps manage the enormous complexity of government. This myopic nature of traditional budgeting makes it hard to fund high-value IT initiatives (The Harvard Policy Group on Network-Enabled Services and Government, 2001). Transition from traditional government budgeting to high value IT investments is described in Figure-16 below;

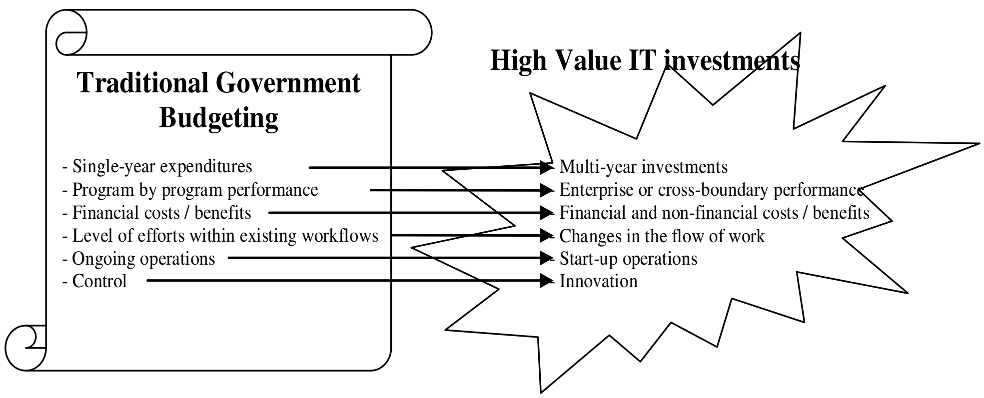

Figure 16 – From Traditional Government Budgeting To High Value IT Investments

As the tie between IT and government strategy becomes increasingly strong and clear, it is important to make funding available for IT. To meet this challenge, we can correct the program-by-program, year-at-a-time myopia that causes budgeting to overlook some of the most valuable IT investments, especially multi-year and enterprise-wide innovations. While the time may be ripe for a budget reform, it will not be easy. It will take a significant educational effort to highlight the need for reform. As e-government continues to evolve and grow in importance, we need to counteract the program-by-program, year-at-a-time biases that cause traditional budgeting to miss so many good opportunities. This can be done partly through better budgeting and partly through better financing.

2.4.9.1 Recommendations for Better IT Budgeting and Financing

- Improving traditional budgeting and use creative financing where appropriate
- Educating stakeholders to get the right people focused on the right issues. Educating those who should be involved in IT budgeting—including budget analysts, executive leaders, and legislative overseers—highlighting how to assess the risks and returns of IT investments.
- Developing a budgeting process that allocates significant time and resources to exploring how IT initiatives could advance country mission, strategy, and organizations.
- Considering IT investments as part of an overall portfolio of commitments and budget for a portfolio of IT investments that balances risk against return.
- Budgeting for the "net total value" of IT, not just cost reduction.
- Using multi-year financing vehicles such as leasing and share-in-savings agreements to finance projects where up-front costs lead to downstream benefits.
- Using non-tax financing tools including fees and public-private partnerships. To the extent that private users (rather than the general public) benefit from an IT-related initiative, financing IT should be considered through private funds (rather than public taxes). Private support can include fees and/or a variety of public-private partnerships (e.g. shared ownership, share-in-savings, sponsorship, and advertising).

2.4.10 Measuring IT Benefits

The added value created by IT deployment cannot entirely be evaluated objectively because all the returns cannot be quantified in money—and maybe they shouldn't be. Intangibles cannot be translated into a line-item on a profit-and-loss statement, but represent the most significant component of value and it's the most difficult to measure. They include items such as pursuing new markets; improving customer service; adding features that couldn't be easily added any other way, speeding time to market, how well the investment fits into business strategy; the cost of not making the investment; and the level of innovation required to adopt and implement it etc. One particular large Intel information technology investment showed an internal rate of return of 34 percent when the tangible benefits were assessed; when intangible benefits were quantified after a detailed study, the internal rate of return was found to be 255 percent. The myopic approach of IT benefits measurement is described in Figure-17 below.

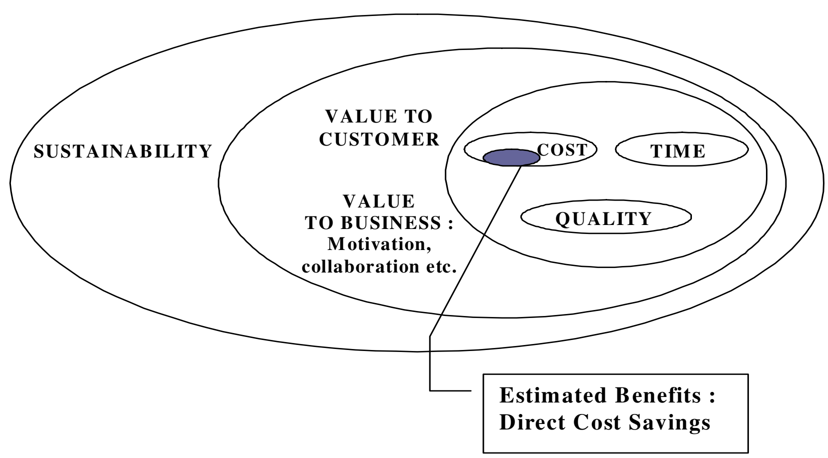

Figure 17 – Myopic Approach of IT Benefits Measurement

The reported benefits cover only the direct cost savings. Indirect cost savings as improved quality, reduced throughput time, improved customer satisfaction, improved employees motivation and improved collaboration are ignored.

The combination of tangibles and intangibles can create a pair of gaps that managers must face as they evaluate their investments. The first is a "subjectivity gap" between what is known or quantifiable and what is unknown. The costs are easy to get a handle on. The question is the benefits.

Are we really going to see that market share increase, or that increase in sales? The second is a "revenue distance," that describes how much distance there is between the investment itself and the revenue mechanism that it supports.

Once you've measured the tangible benefits of an IT investment, how do you measure the intangible ones? How do you know if you've gone too far? How much do the intangible benefits need to be worth in order for this investment to make sense?

Love and Gunasekaran (1997) suggest that the benefits of IT are not being attained for two reasons: Firstly, organizations in construction have been reactive to change, simply superimposing IT into hierarchical structures that are composed of ineffective and inefficient processes, which have not been designed for its support. Essentially, IT has been merely used to automate existing processes, thus exacerbating the already existing communication problems that exist. Secondly, IT has been implemented in an adhoc manner as organizations eschew devising strategic and tactical implementation strategies for its implementation (Betts, 1995)

Due to the lack of evaluation protocols that exist for evaluating the performance of IT, the initial reasons for investing and introducing IT become unclear and poorly focused. Consequently, IT applications appear may fail to deliver tangible benefits to organizations. While there is ample research on IT in the construction management and engineering literature and its potential benefits (e.g., Björk, 1993; Abudayyeh and Rasdorf, 1992; Brandon, 1983), there has been no serious attempt at evaluating its performance. Without a measure, it is difficult to maintain the support of management for introducing IT and their support for introducing new hardware and software applications (Tucker et al., 1996).

Semich, (1994), agrees, arguing that traditional ROI virtually ignores all that most companies are trying to achieve with IT and that a new method for measuring the value of apparently unquantifiable benefits of strategic systems is necessary. Standard techniques do not appear to be widely used in construction because they are designed for continuous process activities, rather than the one off projects of the construction industry. The lack of fit with sector culture and language is also a major inhibitor.

If construction organizations are to benefit from IT investments then new frameworks for identifying the costs and benefits of IT are required in their language such that construction business managers can understand and feel fully confident in applying them. Consideration of performance benefits and effectiveness must be considered as well as efficiency. Efficiency is, in this context, defined as the rate in which inputs are converted to outputs (doing things right), effectiveness is the rate of actual outputs compared to the planned (doing the right things) and performance is the level of new outputs enabled (doing better things). Table-14 shows a summary of the typical, process-based benefits that arise from IT investments that were synthesized. They are divided into three categories: typical efficiency benefits; typical effectiveness benefits; and typical performance benefit*s.*

Table 14 – Typical IT benefits (Andresen et al., 2000)

Construction Business Process	Typical Efficiency Benefits	Typical Effectiveness Benefits	Typical Performance Benefits
Business Planning	Reduced planning times	Increased Sales Minimising business risk Strategic competitive advantage Increased business flexibility Maintaining competitive capacity Reduced risk in new business ventures	Providing space and capacity for business growth Safeguarding future flexibility Overcoming obsolescence Increasing responsiveness of senior management to business problems
Marketing	Reduced marketing costs Ability to handle more enquiries	Improved company image Generating new business Increased market share	Improved strategic intelligence for new markets Improved public relations targeting and delivery
Information Management	Reduced communications costs Reduced paperwork Reduced IT costs	Easier international links Fewer information bottlenecks Improved quality of output Sustaining market share	Improved information version control Ease of capture of meaningful information More relevant and reliable data Improved filtering of info
Procurement	Reduced storage requirements Reduced transaction times Reduced transaction costs Improved delivery scheduling	Maintaining competitive capacity Faster response to supplier quotations Ability to provide instant price quotations to clients	Improving external access to stock levels and price information More effective identification and assessment of new suppliers
Finance	Faster invoicing Reduced transaction costs	Minimising business risk Better control of cash flow Reduced lead times for financial reporting	Improved/new transaction methods Improved forecasting and control Greater integration with other functions
Client Management	Quicker response to client enquiries Quicker response on current project progress	Improved quality of output Faster delivery of services Improved focus on client requirements	Improved information exchange with clients Increased client satisfaction Strategic competitive advantage
Design	Reduced lead times for design Reduced rework Increased information exchange	Improved quality of output Reduced technology risks More responsive ability to arrange meetings Increased speed of new design development	Improved idea sharing among project teams Improved integration
Construction	Reduced construction times Improved productivity Reduced waste	Improved quality of output Reduced technology risks Ability to exchange data	Improved idea sharing among project teams Improved integration Improved project relationships with strategic partners
Operation and Maintenance	Reduced operating costs Quicker access to operation and maintenance data	Improved quality of output Ability to refer back to data	Improved capture of design and construction decisions Improved full life-cycle information management
Human Resources	Reduced staff requirement Reduced training requirements	Improved record of staff skills Improved ability to select appropriate team members	More effective assembly of project teams Enabling of cross-functional teams Improved human relations Regularised working arrangements

2.4.10.1 IT Benefits Evaluation Framework

The proposed evaluation framework, represented in Figure-18, has some key features like identifying the business case and the strategic issues concerning an IT-based business innovation, allocating responsibility for benefits management, applying a process before and after an IT innovation, and evaluation and feedback.

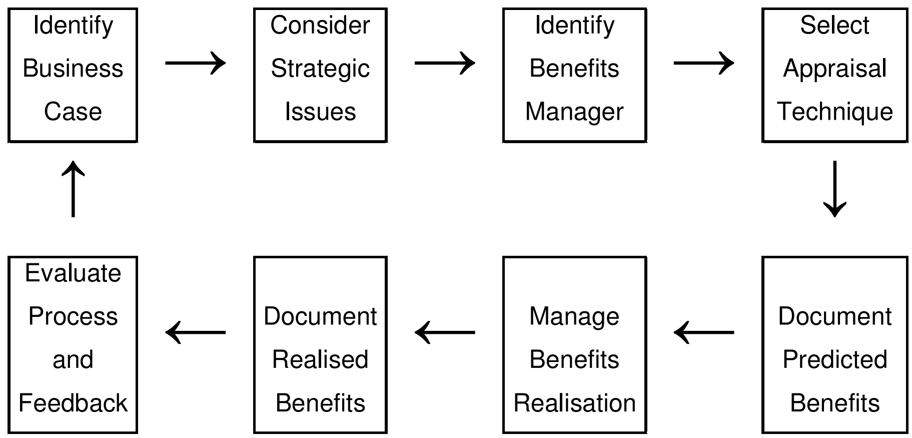

Figure 18 – IT Benefits Measurement Process (Andresen et al., 2000)

The first stage identifies the business case for a new IT innovation. Why is the business requiring an IT innovation to be made? The second stage involves checking the fit between the proposed innovation and business and information strategies. Business benefits are only likely to arise if they are strategy-driven. The framework then envisages applying an appropriately selected appraisal technique to allow predicted benefits to be calculated and documented in advance. The process of benefits realization is one that has to be proactively managed with reference made to earlier parts of the overall process. Benefits resulting from an IT innovation must be monitored during the course of an IT project and documented at a final stage in a way that allows comparison with predictions. This is necessary to allow post-innovation benefits evaluation to be undertaken and for the whole process to be evaluated to allow learning to take place within the organization and feedback to future exercises (Andresen et al., 2000).

Within the context of the framework, business processes were defined as processes that cut through an entire organization and that enable the organization to exist as a business entity and add value to fragmented, multi-participant, project-based supply chains.

This framework and the process it represents can be described in some detail. Table-15 shows the framework for evaluating business efficiency benefits. Tables-16 and Table-17 show the similar tables developed for evaluating effectiveness and performance benefits. In each framework the user first identifies the business processes that will be affected by the new IT innovation and selects the specific IT benefits that might be realized partially using the checklist in Table 14.

Table 15 – Measuring Efficiency Benefits (Source: Andresen et al., 2000)

					Expected Benefits			Measured Benefits	
1.Business Process	2.Specific Benefits	3. Implication to this benefit of not making the innovation	4. Means by which benefit will be measured	5. Person responsible for achieving and measuring this benefit	6. Monetary Value (£)	7. Likelihood of benefit occurring (%)	8. Expected benefit (£) Col 6 * Col 7	9. Specific Benefit Resulting	10. Monetary value (£)
Business Planning									

Table 16 – Measuring Effectiveness Benefits (Source: Andresen et al., 2000)

					Expected Benefits			Measured Benefits	
1. Construction Business Process	2. Specific Benefits	3. Implication to this benefit of not making the innovation	4. Means by which benefit will be measured	5. Person responsible for achieving and measuring this benefit	6. Likelihood of benefit occurring (%)	7. Weighting (column total = 100)	8.Predicted Benefit - (Col 6/100) *Col 7 (max =100)	9. Specific benefit resulting	10. Measured benefit (max = 100)
Business Planning									

Table 17 – Measuring performance benefits (Source: Andresen et al., 2000)

					Expected Benefits		Measured Benefits	
1. Business Process	2. Specific Benefits	3. Implication to this benefit of not making the innovation	4. Means by which benefit will be measured	5. Person responsible for achieving and measuring this benefit	6. Likelihood of benefit occurring (%)	7. Qualitative rating of the impact of the expected benefit. A = Very significant B = Significant C = Moderate D = Low	8. Specific benefit resulting	9. Qualitative rating of the impact of the measured benefit. A = Very significant B = Significant C = Moderate D = Low
Business Planning								

Table 18 – Overall Business Benefits (Source: Andresen et al., 2000)

Types of Benefits	Expected benefits	Measured Benefits
Efficiency Benefits - Quantifiable and Valuable	Total forecast monetary value £	Total realised monetary value £
Effectiveness Benefits - Quantifiable but non-valuable	Total forecast score /100	Total realised score /100
Business Performance Benefits - Non-quantifiable and non-valuable		

2.4.11 IT Best Practices Utilization

Existing in such a dynamic environment means that forecasting and managing change become key skills for business managers. Managers in successful businesses are becoming increasingly armed with a variety of tools that allow their businesses to be better than the rest. By examining how other, well-respected industries have employed IT in detail, opportunities will be presented to construction. Process of industrial research that enables managers to perform company-to-company comparisons of processes and practices to identify best of the best helps to understand and discover the practices needed to reach new goals. The continuous process of measuring products, services and practices against the company's toughest competitors or those companies renowned as industry leaders, supports to achieve the leadership performance levels that satisfy ever-increasing customer expectations.

Successful IT implementation requires that leaders and other stakeholders combine their knowledge of what to do with the motivation needed to get it done. To use benchmarking as a change method tool for the implementation of IT demands the necessary focus. The objective must be business improvement rather than technological deployment for any chance of success to be guaranteed. If participants are too confused, they will not know what to do or how to do it. If they are too conflicted, they will not believe that the project is in their interest. To manage these problems, leaders need strong interpersonal and political skills as well as the organizational authority needed to make these skills effective. (Harvard Policy Group on Network-Enabled Services and Government, 2001)

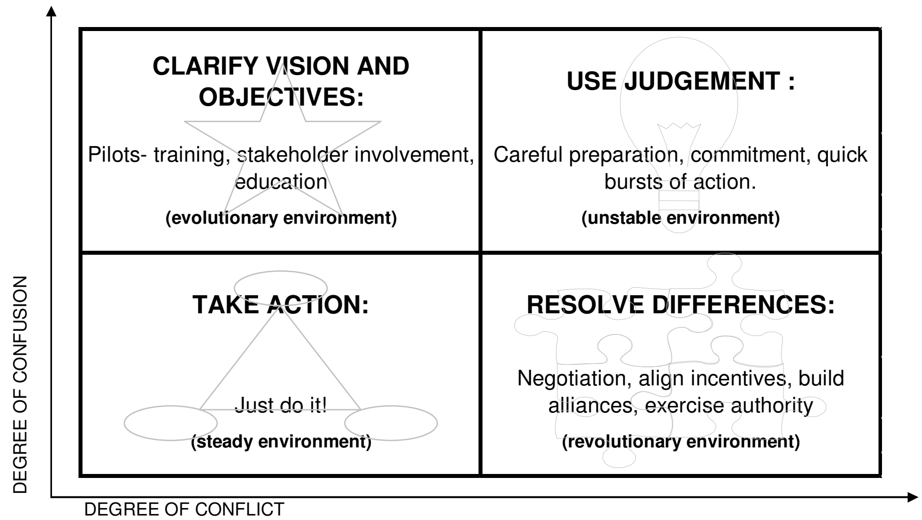

Figure 19 – The Implementation Leadership Matrix (Source: Harvard Policy Group on Network-Enabled Services and Government, 2001)

Projects in the bottom left quadrant of the matrix described in Figure-19 are relatively straightforward—and also relatively rare. Most stakeholders understand and support the work to be done. The guideline here is to "just do it." When confusion is high (top left quadrant), serious work is required to clarify the vision. Leadership for these projects is largely an educational and communicative challenge; working with those directly affected by the project to define and communicate the vision, the business objectives, and the implementation requirements will be necessary. This is the widespread case for Turkish construction organizations and in doing so; planning exercises, training programs, pilot projects, best practices and other tools are useful for helping stakeholders move from confusion to clarity.

When the problem is conflict rather than confusion (bottom right quadrant), leaders must work to understand the sources and strength of opposition and then move to resolve differences. Leaders must understand how quickly stakeholders can absorb change and then provide the right amount of pressure to achieve that rate of change.

Unfortunately, some of the most valuable IT initiatives involve high levels of both confusion and conflict (top right quadrant). While the benefits of such initiatives may be large, overcoming the barriers that hamper cooperation across organizational boundaries is difficult. Good judgment is especially essential in settings that are both confusing and conflicted, and discretion can be at least as important as valor. These are all show the necessary need for benchmarking and utilizing national as well as international best practices across the industry.

2.4.12 IT Implementation Failures in Turkish Construction Industry

The reasons for IT Implementation failures generally tend to be the same, whether one is implementing a small accounting package or an organization-wide Enterprise Resource Planning (ERP) system. ERP implementations tend to be associated with significant business process re-engineering. Prior to implementation, an extensive review has to be carried out to identify key organizational requirements that would then be matched to prospective systems. This first step is often overlooked.

An organization should:

- Agree the key business needs that will improve or make a difference to the organization.
- Agree and document the expectation of management including specific business performance objectives and benchmarks. For example, in a manufacturing concern, these could cover procurement cycles, MRP processes and quality management.
- Match the business requirements to the selected IT application product and carry out a cost-benefit analysis.
- Sign a performance-based contract with the preferred suppliers.

The quality of internal management is as important as the clearness of their vision. The basic rule is if management cannot quantify the expected benefits, they should not proceed with the IT implementation. Given our current economic problems, the tendency has been to focus on cost and not expected performance or product and supplier derivation. The key selection criterion is the degree of fit of the proposed IT system to the required functionality.

IT implementations tend to have a significant impact on organizational operations. Research shows that they often fail because management fails to recognize that there are limits to the amount of change an organization can absorb. This is particularly relevant where business process re-engineering is an integral part of the implementation.

An impact assessment needs to consider:

- **Technology**: is the technology available and appropriate? Good systems have failed to deliver because of a number of factors including availability of local expertise, telecommunications, etc.
- **Processes:** will the new systems simply duplicate current transaction processing or will it significantly improve the existing business processes?
- **People**: changes in processes invariably challenge the organizational culture, as new "ways of working" are introduced. Unless a pro-active change management approach is adopted, a negative and disruptive behavior develops.

Any successful IT implementation addresses three issues: Costs, time scales and quality. Emphasis on one criterion will negatively affect the other two. A balance of these three basic views must be achieved. A well thought out implementation will have a greater chance of succeeding. After selecting a system, both the IT supplier and management have to agree on a practical, achievable implementation plan that takes into account a number of factors including:

- project management expertise and availability
- roles and responsibilities
- implementation approach
- communication channels and problem resolution
- legacy data take-on
- new procedure development and training
- management of deliverables at each stage of the project.

2.4.12.1 Recommendations for Implementing Significant IT Initiatives

Leaders must respond to the organizational and behavioral challenges of major IT implementations (Harvard Policy Group on Network-Enabled Services and Government, 2001);

- Copying without embarrassment: Look, learn, and do. Keeping things as simple as possible by aggressively learning from others and building on standards set elsewhere will essentially solve the confusion and conflict problem across the industry. When software has evolved to become a commodity, be sure to buy rather than build. Consider adapting your work processes to fit the software rather than customizing the software to fit the way you presently work. A strategy that follows the pioneers quickly—while avoiding their mistakes—can work wonders to gain value at relatively low risk.
- Mobilizing and maintaining broad support in shaping the vision. Engaging supporters in shaping the project will keep the project focused and energized throughout implementation. Never stop communicating.
- Establishing channels in the development process for incorporating the knowledge and concerns of stakeholders in a disciplined way, provides to solicit input from those who will be directly involved in using the system.
- All development teams must have the technical and business expertise required to implement a new IT project. Successful teams also include “boundary spanners” that represent the interests of and

have the power to influence key stakeholder groups that must come together. Form a balanced project team, including people with knowledge and influence over the business operations to be affected. When teams include members from different organizations, project leaders must actively encourage discussion of interests and cultural differences.

- Kaizen: Implement in short, quick bursts or building blocks. Whenever possible, breaking up larger projects into smaller ones with short timeframes and deliverables that are visible and motivating will solve the problem. These small building block projects should have a demonstrated benefit in the short term while also advancing progress toward accomplishing longer term objectives.
- Before beginning implementation, thoroughly gauging reality to assess the motives of stakeholders and the degree of potential support and opposition will be essential. "Slow trigger, fast bullet" approach is useful for the toughest projects. Preparing as fully as possible for predictable problems and developing a team fully committed to success is the "slow trigger." Then, when committing to implementation, going as fast as possible to a place where the project has produced visible value that can sustain supporters is the "fast bullet." As did Eisenhower (and also Colin Powell during the Persian Gulf conflict), attack massively, and do not get stuck on the beach.

As governments move further into electronic service delivery, implementation challenges will continue to grow. Leaders should accurately assess and effectively address organizational and political barriers. They should have the vision to ;

- develop a smarter industry
- promote cultural change
- improve industry integration and capability
- promote innovation
- increase innovation take up through whole supply chain
- provide better access to project and industry information

- avoid repetition of mistakes from project to project
- improve regional development
- improve profitability
- improve long term viability
- better application of innovation
- greater certainty of outcomes
- reduce cost of projects
- reduce social costs (fewer mistakes and accidents)
- increase market share
- improve world competitiveness
- increase opportunities for SMEs and regional enterprises

These are all what Turkish Construction Industry requires and what IT supports and offers when managed effectively and strategically in order to fulfill business needs.

CHAPTER 3

IT REQUIREMENTS OF TURKISH CONSTRUCTION INDUSTRY

On the basis of wide consultation with Turkish construction industry in order to draw on the expertise of key players (e.g. Clients, Designers, Contractors, Facility managers, standardization bodies, representatives of SMEs, and Construction Industry associations) and reach a national consensus on these requirements; it is realized that the industry is in need for solutions that enhance the practice in general while giving equal consideration to people, processes and technology. The priority areas of Turkish Construction Industry that have been identified in relation to IT are Knowledge Management, Collaborative-Knowledge Supported Business, Model-based IT, Total Lifecycle Management, Human Resource Management, Quality and Performance Management, Smart Buildings, Adaptive Self-configuring Systems, Flexible Interoperability, Visualization, Legal and Contractual Management.

3.1. KNOWLEDGE MANAGEMENT

Knowledge Management is a strategy to transform company know-how into dynamic and distributed competencies, to extract, standardize, share, knowledge in order to support decisional processes in more and more dynamic context and to create a real competitive advantage based on intellectual capital. It is about the storage, manipulation and retrieval of data in order to produce valuable information, waste of experience and loss of an important resource .The vital issue is, however, that you collect relevant data and that it is disseminated in some easily accessible method.

The exponential growth of the Internet and corporate intranets can help companies reach new customers and collaborate more effectively with their supply chain partners. But these same networks also create an information overload that threatens to strangle decision-making and paralyze organizations. Better classification of data with regards its structure and context will allow the search and retrieval of information faster and more productive and reduce information overload. By helping to get the right information to the right people at the right time and in a personalized, usable format, KM technologies can accelerate decision-making, speed business processes and deliver a decisive e-Business advantage (Intel Corporation, 2001).

Knowledge Management increases competitive advantage by allowing continuous improvement. A variety of KM applications are emerging to provide competitive capabilities as automatic information retrieval, personal content categorization, learning and adaptation, enterprise information portals, e-learning and collaboration. Figure-20 below describes a knowledge management architecture.

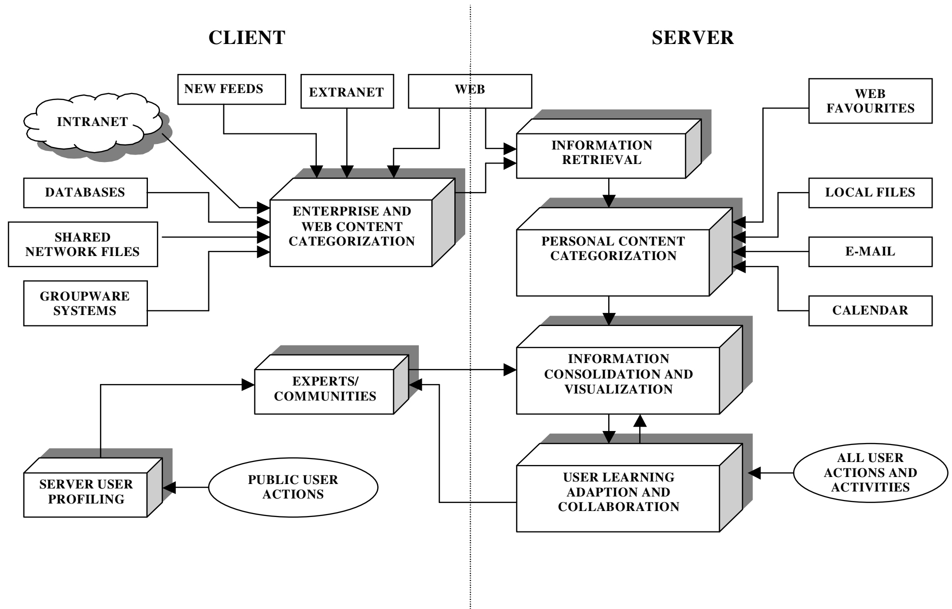

Figure 20 – Knowledge Management Architecture (Source: Intel Corporation, 2001)

As KM solutions evolve, they will transform the PC from a personal productivity tool to a knowledge assimilation and Internet productivity platform. A balanced computing environment enables companies to make effective use of current and future KM tools. Transforming tsunami of data and information into a manageable stream of knowledge increases both individual productivity and organizational effectiveness. Effects of market forces and IT capabilities on design and construction organizations are explained in Figure-21 below.

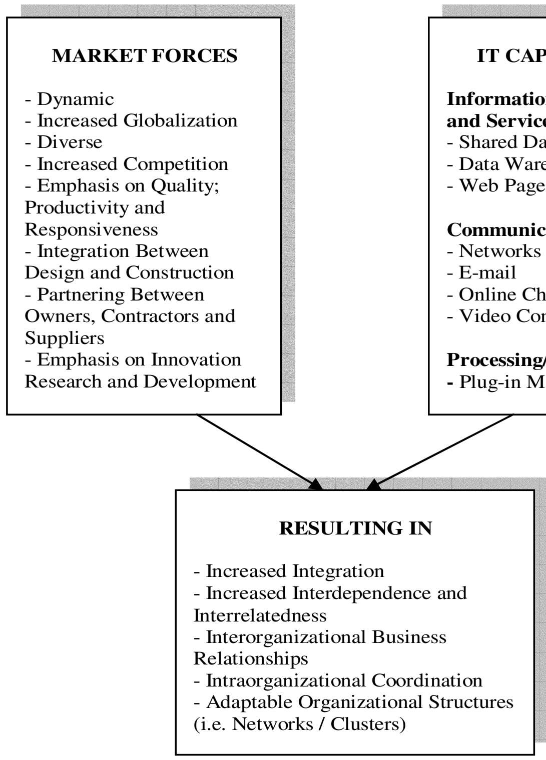

Figure 21 – Effect of Market Forces and IT Capabilities on Design and Construction Organizations (Source: Ahmad et al., 1995)

3.1.1 Knowledge sharing and re-use

Construction is a multi-organizational process that is heavily dependant on exchange of large and complex data. Successful completion of a project depends on accuracy, effectiveness and timely communication and exchange of critical information and data between the project teams (Akinsola et al., 2000). The exchange of knowledge, which can be used to build on and learn from the experience and knowledge of others, is the main principle of knowledge management strategy. It allows to capture the accumulated knowledge, so it is not lost whenever an employee leaves, thus promotes organizational learning. The ability to search for previous experiences of particular problems will help with new decision making, thus avoiding potential mistakes and increases profitability

Dedicated and intelligent search engines allow finding (through the web) all relevant information (legal, administrative, technical, professional, corporate, from similar past projects etc.) under a structured way adapted to practices. Access to structured databases of products/materials providing detailed and certified characteristics (technical, regulatory, economical, sustainability-oriented, etc.) and access to added-value information services, e.g. knowledge resource centers or networks will streamline business process through knowledge-driven industry.

3.1.2 Ambient access

Ambient access means that people and/or IT applications can always have reliable (in the right quality) and fast communication from any place (universal) to any other place (unlimited range or wide area). Turkish construction industry needs solutions to facilitate communication and collaboration between geographically dispersed actors (including in different time zones). Generalizing of the concept of "virtual desktop", the idea is to have remote access through Internet to the relevant information needed for the work, at any time, and independently of the physical location of the user, and the type of device used. There is a great necessity for specific tools for one-man remote operations (for instance maintenance activities during exploitation) (ROADCON Project, 2003).

3.1.2.1 Local Area Networks

A LAN is a group of two or more computers and peripherals within an office, which are connected. It allows computers to communicate with each other, which aids integration and collaboration between employees sharing expensive peripherals like plotters, printers, scanners and data backup devices. Everybody within the office can access all data held on other people's computers (subject to access permissions). A single point of entry to the internet can be set up, which will allow to minimize web costs and control access to and from the internet (ITCBP, 2004, http//www.itcbp.org.uk). Up to this extent, Turkish construction industry has these capabilities with a great portion, but most of them are unaware of the most important benefits because of lacking knowledge-supported collaboration. While there is an urgent need for group focused software such as workflow and cost accounting with suitable knowledge management, most of the companies still strives for simple errors like printer and lost network directories due to the lack of sufficient IT personnel.

3.1.2.2 Wide Area Networks

A WAN connects computers over distances as large as the next street, next town or potentially another country and is essentially a number of LANs that are connected. They can also be as simple as having a modem on a remote access server, which allows dial-up employees to connect to the company network. WANs are a highly strategic resource, enabling global connectivity that supports e-commerce and corporate communications, including videoconferencing. The users can see and have access to entire organizations information resources, without needing to know where it is physically located (data transparency) (ITCBP, 2004, http//www.itcbp.org.uk). Unfortunately, except from a few very large organizations, Turkish construction industry is far from this kind of global connectivity although most of the companies are aware of its necessity; especially between site abroad and head office. Their common belief is that, the site workers are so ignorant that they are not able to use any communication tool other than traditional radios. Besides, no matter it is the real case, there is a hierarchy in communication within the site and to the managers hindering all potential benefits of knowledge management strategy.

3.1.3 Supply Chain Management

It is found that there is very great opportunity in cross-sectoral IT to support a transformed supply chain. At present little is known about successful cross-sectoral application of IT. It would both raise awareness of the opportunities and increase the probability that the industry would successfully take advantage of them if the government were to undertake an international study to identify successful organizational models, critical drivers and successful management practices in the application of cross-sectoral IT. The knowledge gained from such a study would need to be disseminated and applied in order that the industry fully appreciates the opportunity and challenges facing them.

Turkish Construction Industry needs solutions to capture the requirements from the client, end-users, and other relevant stakeholders and manage the relationships between all project participants. A complementary change is necessary in cultural attitude of construction actors towards new technologies, in order to reach the desired transparent, cooperative and open supply chain. New multi-modal interfaces should be developed covering any kind of interfaces to enable the user to get free from the complexity of computers, in particular voice interfaces, sensorial or immersion interfaces, laser-projected plans, etc. The first requirement is up to date information about product and service suppliers, detailing their capability and products should be made available and searchable electronically. Next comes, search methods and query language for heterogeneous information repositories to enable efficient human and knowledge resource discovery across construction, e.g. containing varying information about building component to enable global searches and comparative analyses based on component properties.

3.1.4 Web-Based Processes

Internet is an increasingly invasive communication system changing the rules of business by removing some traditional barriers. The Internet has five key value-creating characteristics (Beddows,H., 2000), as indicated in Figure 22.

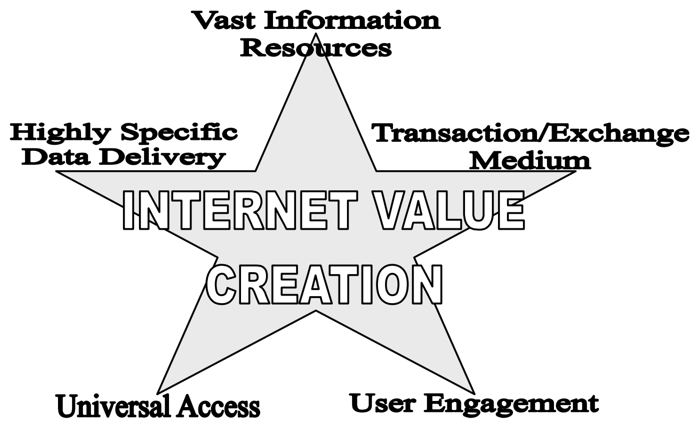

Figure 22 – Key Value Creating Characteristics of Internet

The Internet is being increasingly used as a communication backbone of the construction industry. Through web browsers and other standard tools, design and planning communication and information exchange take place.

Majority of construction companies in Turkey are now utilizing Internet as one of the effective and efficient advertising tool. The information advertised in a company webpage typically includes the company profile, services or products, recent projects, job vacancies and public feedback forum. The basic Internet services such as e-mail, remote login, file transfer, network news, and the World Wide Web have become familiar tools for majority of construction managers. The different chatting softwares such as ICQ, IRC, Net Meeting etc. are also frequently used to allow seamless discussion between two or more parties involved in a particular session, e.g. when the contractor and the engineer need to discuss a solution to an urgent problem encountered on the jobsite. Hyper Text Markup Language (HTML) can also be used for simple communication such as the use of forms, e.g. to send work progress information from the field, which can then be used for the preparation of progress reports.

However, the Internet is still typically used to support mainly secondary non value-adding activities in the construction value chain. It is increasingly used as a communication platform (email) and a source of information (web pages), but it has not yet been used as a place where the actual engineering work and primary non value-adding collaboration tasks are carried out. For instance, training tools, such as multimedia, can help train workers. However, there is a profound need for uniform and standard data in the construction industry. Without standard data it is difficult to establish a common performance measurement system or a uniform quality assurance program. Uniformity of procedures and standardization of data would greatly enhance the effectiveness of communication among the multiple construction organizations teaming up to build one constructed facility (Ahmad and Ahmed, 2001).

The deficiency in Turkey is a personalized human-centered environment, enhancing current, less flexible project-centered approaches and an open collaboration platform where new services and tools may be easily integrated and where providers of engineering information, services and tools meet project managers, engineers and architects. These will make flexible and customizable object-level data exchange possible and provide an infrastructure for on-line e-business by integrating seamlessly legal and financial transactions, at all system levels.

Today, with the rise of associated standards such XML (Extensible Mark-up Language), a whole new variety of options are being proposed such as providing dynamic and universal client programs independent of machine and running platforms. The convergence of information services, communication and computing functionality in the web technologies allows practitioners in construction to perform a web-based project management over the Internet. Using dedicated video cameras to remotely monitor construction sites through the Internet may seem like a small jump from ordinary security surveillance and the web-cam's unblinking eye may be key to a project management revolution by providing continuous pictures regardless of weather and safety conditions and save hours or even days of travel time. Moreover, all images are recorded for archiving and have date and time stamps. Additionally, virtual design studios allow designers and experts from different places to interact using audio and video conferencing.

They can also share the same screen and same program thereby entering the same virtual reality space. This allows discussing virtually any matter without the need to travel. On the other hand, one-way electronic bidding systems already are in wide use all over the world, but rarely in Turkey. These allow bid packages to be downloaded from a web site with bids returned on paper, sometimes with a requirement that files on disks accompany them. However, recently on-line systems to facilitate Two-way bidding have been developed. This two-way on-line bidding system allows the contractors to edit their bids till the last moment to make any necessary adjustments, which could be worthwhile like the following case.

"Late on night last year, a Kentucky specialty contractor bidding a $2-million guardrail job in Georgia learned that one of its suppliers had dropped a key price. The bids were scheduled to be opened in just a few hours in Atlanta, and the contractor had to act fast. The company president didn't sweat it. He went on the Internet, recalled his bid, changed it and won the work (Sawyer, 2001)"

3.1.5 E-Business

The Internet has changed everything. Individuals are now able to instantly communicate with an organization on a global basis, reaching into an organization to find what they want, when they want it. The Internet has effectively washed away the boundaries between the inside and outside of an enterprise. Customer's expectations and standards of what to expect from their suppliers have been raised to unprecedented levels, be it business-to-business or business-to-consumer. The challenge e-business presents to the IT organization is unprecedented (Agarwal, Bipin, 2000).

E-business is a collection of ways for businesses to use innovations in information technology and the Internet to create new value. Using innovations in information technology to create value is not a new phenomenon. But in Turkish construction industry, e-business is restricted to e-procurement processes for procurement of goods, materials and service including internal and external communication, transactions and supply chain and contract management. E-procurement process vision and advantages are described in Figure-23 below.

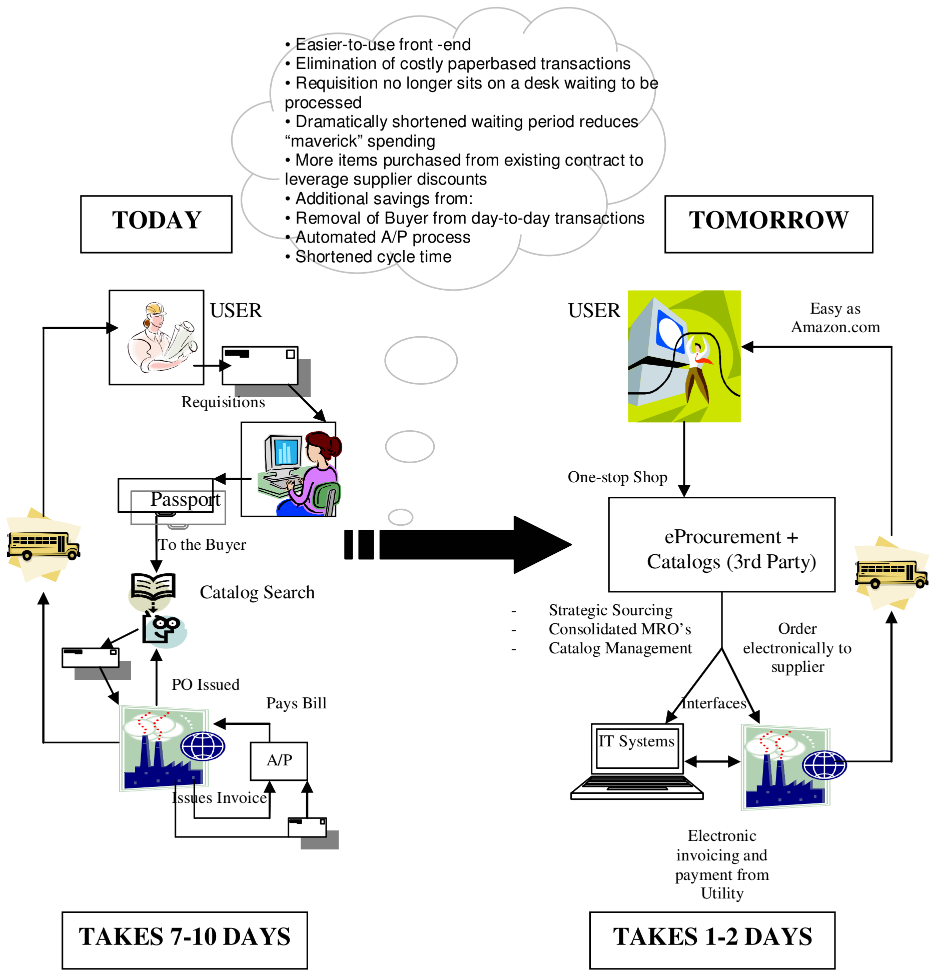

Figure 23 – e-Procurement Process Vision

E-business improves transaction and marketing efficiency enabling efficient product development and shorter cycle times. By increasing responsiveness and replacing channel push with channel pull, it provides new customers, new markets and new channels. These improves customer satisfaction, enhances loyalty. The benefits stretch from immediate opportunities to improve efficiencies to long-term strategic issues that include value-chain integration providing re-thinking the business model as shown in the Figure-24 below.

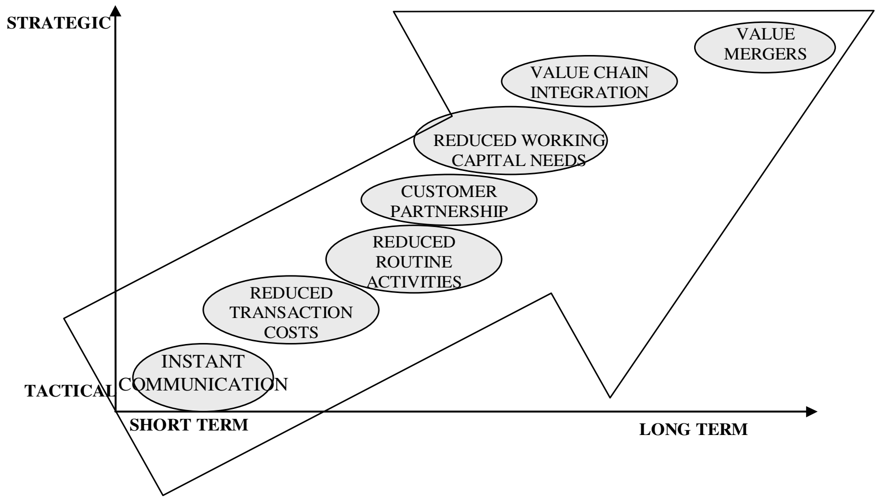

Figure 24 – Examples of Potential Opportunities of e-Business

One of the key aspects of e-business is Electronic Data Interchange (EDI) that is the application-to-application transmission of business documents in standard formats. In EDI, information is organized according to a specified format set by both parties, allowing a "hands off" computer transaction that requires no human intervention or rekeying on either end. Businesses immersed in electronic commerce have found EDI to be a vital component of their enterprise. It differs, however, from more elementary forms of electronic communication in how it provides for truly integrated information flow. EDI can thus minimize staff involvement and reduce the delays and errors that accompany the manual processing of business documents. By simplifying and streamlining business procedures, EDI can help organizations control costs, increase efficiency, and improve customer service levels. At the same time, EDI may save your company money through decreased safety-stock inventory levels and diminished administrative requirements.

In Turkish construction industry, there is a limited use of the traditional applications of EDI, which are purchase orders, bills of lading, invoices, shipping orders and payments. However, Internet-based EDI is not constrained to the proprietary network established between the supplier and customer necessary for the traditional EDI model. The Internet offers suppliers and customers the opportunity to establish EDI links with anyone on the web, without major incremental costs for each additional trading partner. Besides, the development of standards and the widespread use of computers have encouraged the use of EDI in many new arenas including health care insurance and management, record-keeping, financial services, government procurement, and transactions over the Internet. In order for EDI to work effectively, standards must be employed to ensure that the information being transmitted is universally acceptable. Standards are structured so that computer programs can translate data from in-house to standard formats and vice versa, either through the use of software at the user location or by the services of value-added network (VAN) communications vendors. Integration is an important aspect of the EDI function. The integration function allows systems to communicate with other departmental functions and internal applications. Data mapping, or translating data to and from your legacy system to the EDI system, is a key component of the overall EDI implementation.

In Turkish research, against the benefits of integrated Internet-based EDI, the companies surveyed raised a number of barriers being unaware of that, all can be solved by simple methods and it would have been ridiculous to talk about these excuse if they have recognized the resultant value offered by EDI for their organizations . These concerns can be summarized as follows:

- **Speed**: if there is a lot of traffic on the Internet, each transmission can be slowed down enormously.

- **Unreliability**: transmissions can be incorrectly addressed and be lost. Since information is transmitted in small packages of data, there is a risk that one or more of these packages may be lost. There is no third party, which can be contacted to rectify the problem
- **Security**: since the Internet is much more open, there is a risk that a transmission could be intercepted by a third party. Also, there is a greater risk of errors since standards have not (yet) been established to which customers and suppliers can adhere all over the world

While a few still believe they will be using the traditional EDI carriers, those who have a clear idea of future EDI usage believe they will be using Internet-based systems. However, an overwhelming majority of respondents do not know what type of link they will be using. Figure-25 below indicates traditional EDI carriers.

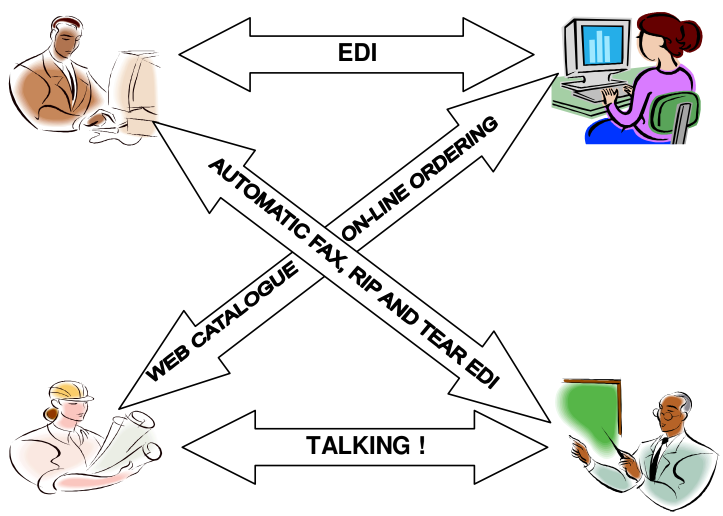

Figure 25 – Traditional EDI Carriers

The special necessity of electronic commerce in construction industry mainly comes from the nature of construction supply chain. Because product differentiation is limited, customer service is a key differentiating factor and hence within the top strategic priorities in market focus. That's why the IT tools providing better market conditions should be urgently introduced to the Turkish construction industry

Strategic Priorities for Respondents with Construction Market Focus are analyzed in the survey conducted and the results were as follows in Table-19;

Table 19 – Survey Results related with Construction Market Focus

Strategy	Critical	Important	Not Important
Reducing inventory/working capital	66%	0%	34%
Closer integration with customers	46%	44%	10%
Improving customer service	34%	59%	7%
Finding new customers	32%	59%	9%
Improving sales effectiveness	22%	66%	12%
Understanding future strategies/ requirements of customers & suppliers	27%	66%	7%
Improving business flexibility to change	24%	54%	22%
Improving business process planning	20%	61%	19%
Improving market effectiveness	12%	63%	25%
Closer integration with suppliers	12%	73%	15%

As can be realized from the priority analyses results, although Turkish construction companies can analyze their strategic directions truly, they mostly can not find the way for the right implementation and rarely get the way but can not gain full benefits because of some unawareness or traditional barriers. The topmost reason for this ineffectiveness is that, they generally do not try to re-engineer and wholly adapt themselves to the technology; instead they want technology to adapt their traditional methods.

3.1.6 Integrated Project Database (IPDB)

There are only a few enterprises in Turkish Construction Industry, having a single database, which holds all the information on a project and is accessible to all members of the project team. This provides consistent integration of all project data with single access point and greater data integrity. Seamless inter-working between heterogeneous CAD and IT tools used by the various disciplines involved in construction projects reduces errors due to minimizing rework and increases efficiency.

IPDB is still an active research area involving a vast study and there is not a "one solution fits all" at the present. Today in Turkey, some organizations achieve some level of integration but these are simple in their functionality and limited to particular disciplines. Integration across disciplines is unlikely to be realized until standards for the exchange of project information such as STEP and IAI's Industry Foundation Classes as well as a common vocabulary for the construction industry have been fully developed and integrated into a new generation of software systems.

The basic idea of a building product model is to facilitate and automate the data transfer between different applications used in different design disciplines and project lifecycle stages.

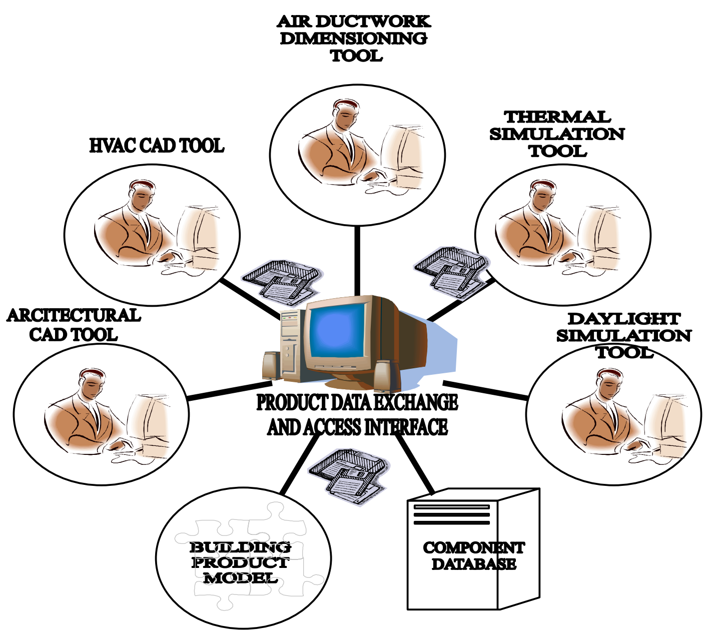

Figure 26 – Integrated Project Database Building Product Model

3.2 COLLABORATIVE, KNOWLEDGE-SUPPORTED BUSINESS

Construction projects are unique not only in terms of the features of the product, but the partners and the processes in which this product is built. This uniqueness is a major challenge for the application of information technology, as it typically leads to loosely structured, strongly decentralized and at the same time weakly integrated IT environments in which information requirements are not likely to be known beforehand (Hannus et al., 1995; IAI, 1999). Therefore, to achieve high efficiency and quality of the collaboration in each construction project, it is essential not only to support the communication processes within the project, but to consider the multi-project work and the individual needs of the players as well.

It can be said that collaborative processes have been the natural way of working in construction for decades. However, new developments in IT are opening new opportunities to improve efficiency and co-ordination of concurrent processes. At the same time, there are increased expectations among customers for higher quality, lower cost, more flexibility and more reliability in delivery. In addition, construction teams are asked to take on more risk not only for schedule and budget but also for user satisfaction. Construction teams are pressed to formulate ways to deliver faster and cheaper, without sacrificing quality and serviceability. The fast track approach, doing design and construction in parallel by using 'just-in-time design' is increasingly implemented. The fragmented approach of construction projects has affected project effectiveness inasmuch as current practices do not effectively encourage the integration, co-ordination and communication between the project team. To overcome such difficulties researchers have embraced the concept of collaborative engineering as a potential method for construction projects. This relatively new philosophy of design and manufacture has sought to re-introduce the flexibility and adaptability of the craftsman using multi-disciplinary teams, organized by process rather than function, to continuously consider all factors involved in process.

In Turkey, separation of design, engineering and production functions, and the consequent inability of these functions to communicate effectively lead to significant problems. It is clear that the importance of having seamless internal and external project interfaces is increasing. One of decisive factors in supporting it is undisrupted information flow. In the last decade significant efforts of research community have been directed to support concurrency of processes in design stage, considerably less for other project stages. Organizations should adopt collaborative business models based on electronically enabled interaction among their internal personnel, business partners, and customers. Without appropriate structures and processes in place, the potential of IT to improve decision-making and communication in projects will be lost.

Collaboration is not a new technology; it is just filling the communication gaps with project participants. But it requires a change of perspective since the traditional inward-focused company vision leaves collaboration opportunities unexploited. Collaborative networks should be developed first in logistics and supply chain, next in engineering and large-scale projects and then in services industry and public sector

KM-based business collaboration supports anybody anytime, anywhere with groupware integration for 'frictionless' collaborative value creation and provide context-aware person-oriented knowledge support for individuals and distributed groups. A context-aware collaborative environment for next-generation business network is a new type of co-operative environment that is person-centered, highly adaptive and knowledge supported. This will support the individuality need of engineers by supporting their individual creative work in flexible and adaptable fashion due to their different roles, expertise and personal experience.

Further on-line collaboration in construction to a new level provides an open concurrent engineering platform with access to intelligent services and tools that will support multi-project work for the engineers working concurrently on several projects at the same time

Collaboration in formal partnerships as well as in informal networks will dominate the way we work in the future. To enable the companies to shift from traditional organizations to flexible and agile networks, the whole lifecycle of collaboration has to be covered (VIP-ROAM Project, 2002,).

Integration and Interoperability of IT systems are an emerging user demand.

According to their level of collaboration, the future of construction companies shown in Figure-27 can be classified as follows;

-From the extended enterprise

-To virtual organizations

-To inter-networked, knowledge-driven, agility

-To smart organization ecosystem

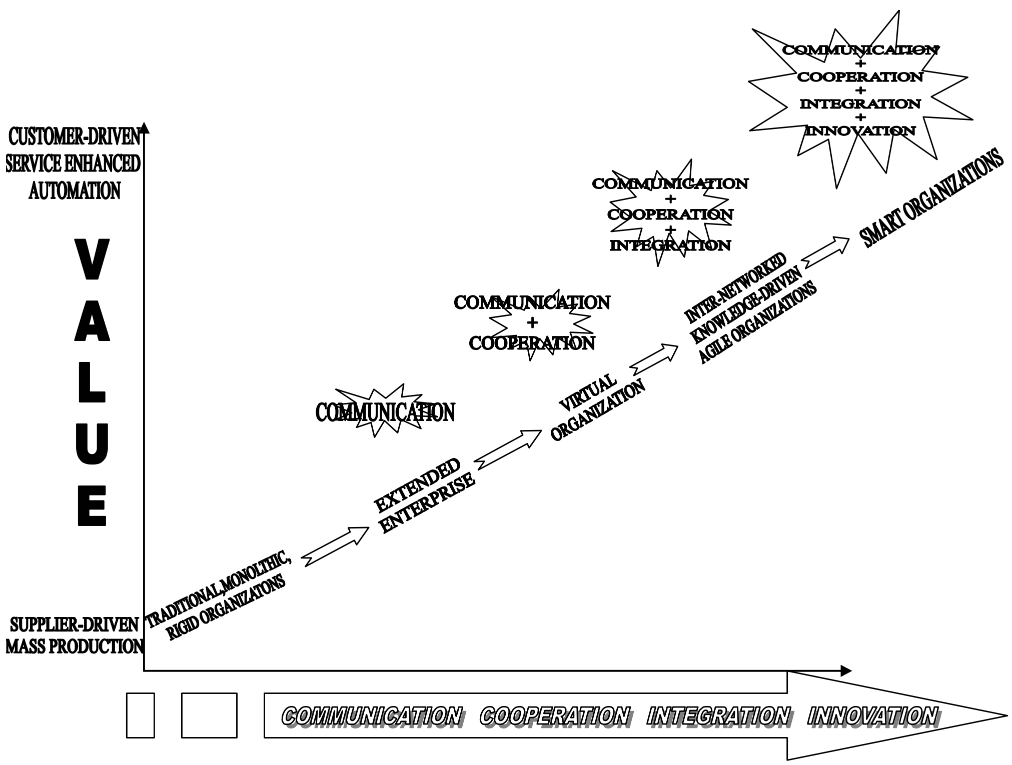

Figure 27 – Future of Construction Companies

Coming from the world of monolithic companies based on Taylor organization, the industrial community is facing a rapid and constant evolution. The growing introduction of Information Technology at all the levels of the various processes is making possible the development of new types of organizations inside and outside the companies. Most enterprises will be part of some sustainable collaborative networks that will act as breeding environments for the formation of dynamic virtual organizations in response to fast changing market opportunities and conditions.

These organizations are fitting better and better with the need of increasing competitiveness and reactiveness to the market evolution. After the extended enterprise built around the supply chain, the virtual enterprise based on the temporary association of players involved in a couple product/process development, the paradigm of networked enterprise appearing. The smart organization (SO) is a collaborative, networked organization, which network industrial competencies, connect individuals and innovate and create values.

3.2.1 Extended Enterprise (Communication)

The term "extended enterprise" represents the concept that a company is made up not just of its employees, its board members, and executives, but also its business partners, its suppliers, and even its customers. It collaborates with suppliers, partners and customers to streamline business processes - going beyond traditional boundaries and enhancing benefits for all. It can only be successful if all of the component groups and individuals have the information they need in order to do business effectively (VIP-ROAM Project, 2002,).

Extended enterprise applications include relationships between a company and its employees, managers, partners, customers, suppliers, and markets. You need to know your suppliers' stock conditions in real-time. Your customers and partners need to know about your latest products or services as soon as they're available. Your board and CEO need to have the latest financial information at their fingertips in order to make appropriate decisions about the company's future. The extended enterprise is an intricate, interconnected network of information, and you need true enterprise-strength solutions to tie all these together

3.2.2 Virtual Organization (Communication + Cooperation)

The term Virtual Organization (VO) is used for describing an operational structure created from different organizational entities for a specific business purpose. Most often also technology offering virtual reality, IT, is seen as an important enabler for VOs. A characterizing feature is a substantial application IT for the support of intra- or inter-company coordination and cooperation for the compensation of central management functions of the enterprise.

A virtual enterprise is a particular case of virtual organization. "A virtual enterprise is a temporary alliance of enterprises that come together to share skills or core competencies and resources in order to better respond to business opportunism, and whose co-operation is supported by computer networks."

"Organizational structures are called virtual, if legally independent enterprises, institutions and/or individuals, which appear and cooperate with the others as one enterprise, in order to pursue common business interests. Co-operation can be based on either a stable (static) or a dynamic network. A characterizing feature is a substantial application of IT for the support of intra- or inter-company coordination and cooperation for the compensation of central management functions of the enterprise. Virtual organizations aim at the optimization of the value creation chain by bringing in core competencies, as well as the spread of risk, costs, etc. of the individual partners." (Peter Weiß, Forschungszentrum Informatik, "Virtual Business Networking – State of the Art", Karlsruhe 2000)

As a conclusion, the following features are seen typical for Virtual organizations:

- Combination of core competencies built up from several organizations,
- High level of communication, enabled by IT
- Temporary coalition for a specific task
- Based on a long-term co-operation environment (breeding environment or enterprise network)

3.2.3 Networked Organization (Communication +Cooperation + Integration)

The trend is going towards integrated, networked companies with a common data basis and with a high level of the sharing of knowledge, data and tools an overall need for research and development in the following areas is needed:

- the integration of human needs into technical developments
- communication abilities
- seamless and integrated processes
- independent infrastructure and
- object oriented data models

A networked enterprise allows to share resources and to increase available resources for a project by the collaboration and integration of all partners. For the realization of a networked enterprise, the data sharing and interoperable applications are absolutely a must. This means as well an information exchange and shared services with a good working document and integrated data management. Workflow services, processes and workflow templates have to be connected under regard of possible problems with the security. To enable people – on the other side - to work in a networked enterprise, user-friendly collaboration tools have to be developed. Figure-28 below depicts a layered IT architecture for distributed engineering for construction

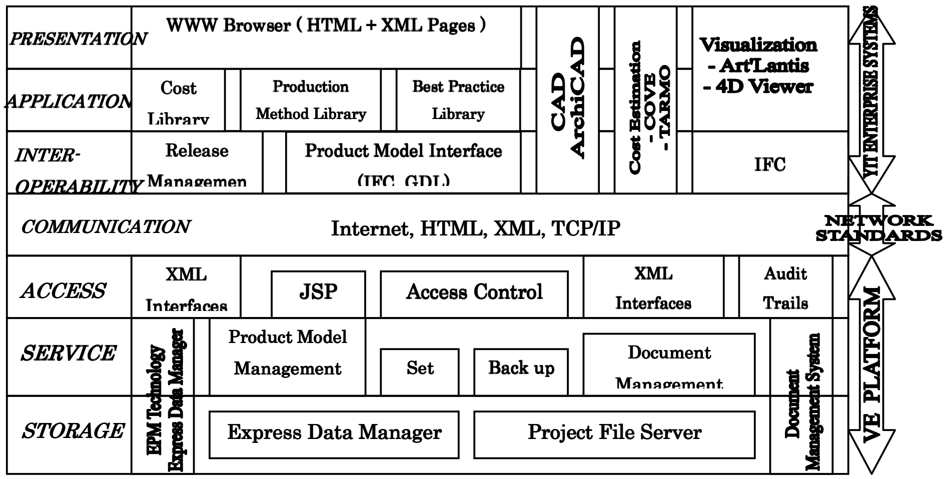

Figure 28 – Layered IT Architecture for Distributed Engineering for Construction (Source: YIT Perspective, 2001)

A very important requirement with highest priority for the participants as an enabler for a networked enterprise as a whole is a common data sharing. Integrated user-friendly collaboration-tools have to be developed in order to support collaboration of the employees. If a good working collaboration with the sharing of a common database and a common tool usage should be realized, this also means, that security problems must be solved. A shared and distributed product database has to be implemented and framework including standards and a knowledge base should be integrated into a networked enterprise. Integration of knowledge management into the network is a must. For more organizational aspects, an efficient set-up of methods and processes and a better cost estimation is needed. To enable an inter- and intra-company collaboration, access rights for every partner have to be established. In order to support these organizational requirements for networked enterprises, set-up of contractual and organizational aspects is needed. All in all, a well resource planning (including HR competencies) is needed as well.

3.2.4 Smart Organization (Communication+ Cooperation+ Integration+ Innovation)

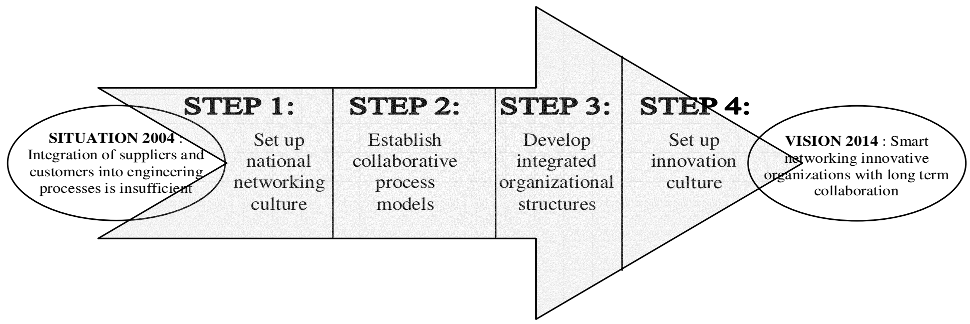

Figure 29 – Implementation Path for Future Construction Organizations

The ideal vision for the future shows Smart Organizations, which are inter-networked, knowledge-driven and agile, as well as intangible and well driven by customer and market requirements. Therefore Smart Organizations connect individuals by building up industrial competencies, creating values and remaining adaptive and innovative. In these organizations, the IT network is interconnected and limitless. The organizational network is an agile, flexible, organizational team and the networked knowledge is like a hyperlinked organization. In order to realize a Smart Organization in the form of a collaborative network with an advanced business, innovative human centered organizations with intelligent infrastructures are necessities. Service engineering and holistic product development will result from this adaptation (VIP-ROAM Project, 2002)

3.3 MODEL-BASED IT

If we consider the growing of semantic richness and locate Turkish practice;

Paper noD

Fax 0D

Document 1D

Time 1D

Cost 1D

Shape Representation (Drawings) 2D&3D (Turkish construction industry current position)

Time 4D

Cost 5D

Model-based nD

In the beginning all information was in analogue that is paper form. Paper was stored and communicated via postal mail. Next came the fax machine which introduced the first digital level of the same information by transforming the paper in a large set of 0 dimensional pixels. One step better was the actual (1 dimensional) textual documents and soon followed by the 2D and 3D graphical objects (the "electronic drawings") representing the objects shape (geometry and topology) (ROADCON Project, 2003).

Turkish construction industry is still at this stage of technology development. Although adding time was seen as 4D and adding cost was similarly seen as 5D. These model-enabled CAD systems do not contain intelligent ways without manual interpretation and re-entry, that is the understanding the meanings of property, rules and behavior. However in reality an object-of-interest has typically much more dimensions (say N) and the N-Dimensional or model-based concept was born. Essentially, "model-based" means parametric modeling of all objects and their properties in an explicit way, reducing the need for human interpretation.

However even up to 3D modeling stage, Turkish construction industry has gained significant advantages through the use of this simplest geometrical visualization technique and by using specification software applications to create project documentation. There is no need to discuss about the benefits provided by CAD systems starting with the application of 2D. CAD increased productivity allowing drawing quicker make amendments without having to redo the entire drawing; solved storage and paper transportation problem and increased quality by promoting consistency of information in a disciplined manner. Further 3D radically improved the process of tendering providing the ability to create building structures in 3 dimensions and apply photo-realistic rendering to that image. The creation of a complete building image and the ability to rotate and 'walk through' the design are powerful features providing better source of feedback and comment by means of the representation of the finished product, highlighting location problems and thus reducing the risk of all parties. This technology offers tremendous opportunities for design improvement right now, but has an even better future in terms of producing intelligent building models and systems. Although not being in use in Turkey, 4D and 5D modeling techniques provide more and more benefits solving the time and cost related managerial problems, which is the most important deficiency of Turkish construction organizations today, when their incapability and incompetence about schedule and cost estimation is considered.

It is also clear that the present design tools are discrete and provide isolated information, which support only a single discipline or task in the design process. Most computer tools only mean nowadays a faster way of doing the same actions which were done in the past by persons. Computer aided design has been used widely in the design process, but the way we are using it only represent a substitute of old drafting operations. Additionally; some of the organizations currently use that is assembly modeling and parametric modeling within 3D, serving as a decision tool allowing reusing models where only geometric aspects have changed.

Next will come the generalization of the concept of N-dimensional design and integration of simulation tools (acoustic, comfort, energy, environmental impacts, lighting, seismic resistance, indoor mobility for emergencies, fire resistance) in accordance with the specific characteristics of each project context (climatology…), & integration of optimization tools. Models must be efficient and evolutionary to introduce progressively solutions as possible alternatives and not be based since early stages on one technical solution only. Any weak assessment, determination, misunderstanding or unavailability of relevant information or knowledge during the early stages of the design process leads inevitably to basic design errors that can be very expensive and difficult to correct in the later stages (Phol et al, 1990, Hazhimoto, 1993). Nowadays design must try to get reliable and relevance information as soon as possible.

Having represented the geometric features, researchers have put their efforts in finding ways computers can store and use specialist knowledge. In this sense Neural Networks are formed by communication channels, which usually carry, encode data. These networks have been used mainly to forecast and as a decision tool with no geometric representation.

3.3.1 Object-Oriented Modeling

An object represents a real world object such a machine, a building, an operator, a process part, or a customer. An object is defined in terms of attributes and behaviors. Attributes are essentially variables that are associated with an object such as its size, condition, time in the system and are used to carry information about the object. Behaviors define the operational logic associated with the object. Every object can be considered in itself a model (door-model, wall-model, roof-model, air-flow-model...) subjective to be simulated isolated. But is when all the objects are linked to form the project model that the real meaning of the technique is achieved.

A decisive factor in OOM is the possibility to include knowledge in the objects. This knowledge in part will come from the data gathered in real experiences. These data will provide behaviors patterns in the form of probability distributions (stochastic), associated data (deterministic) or a mix of them. Obviously there will be other different types of knowledge within the objects such object dependency or environmental relations. This way of working gives us the possibility to test a great number of scenarios. The fact of working with objects may rise other advantages. In this sense the benefits that OOM can offer are summarized next:

Creativity- Since the existence of tested object libraries, more time is available for experimenting new approaches.

Communication- Management of technical and performance data between key members of the design team and project stakeholders is much easier. Risk can be stated instead of remaining hidden.

Certainty- By modeling the concept in this way the user arrives at the point of operating with a higher certainty that the concept works in practice and achieves the stated performance criteria to the satisfaction of the client.

Co-ordination- This way of developing a whole life appraisal oblige to a more strict consideration of the all variables and therefore the necessity of great co-ordination cannot be avoided.

The construction sector must demonstrate the advantages of this way of working and a real desire to improve through the use of new computer technologies in order to force software developers to build friendly packages. In this way designers will only have to link intelligent objects to create the model for simulating whole life appraisal. Scalability, flexibility and exchange standards will be essential requirements in objects libraries.

The latest advances in design focus have integrated environments and automated information processing techniques for complex engineering systems. The systems are capable of capturing both geometric and non-geometric product information such as design knowledge, part dependencies, life-cycle behavior or just physical features as color, weight or price. The result is a complete representation of the product designed. The technique is called Object Oriented Modeling if it refers to the elementary units that form a design or Knowledge-Based System if it refers to the rules that define the relations between the objects. This approach allows us to have intelligent electronic prototypes. These prototypes can give us 3D representation, a decision-making tool and co-ordination and integration of the total information flows between design members. The only way to get the total benefit of working with objects is to have a standard for exchanging information between element's models. The integration between objects and analysis tools as structural or fluids must be done through a common standard. With this new approach objects have the knowledge required to do review, fixing and evaluating without intervention of designers, of course the person who creates the object must add it all the constraints and rules needed to relate the object to the rest of the system. These features can save a considerable time, once we have the object it can be used in other projects, and a great number of errors are eliminated.

Use of a unique and sharable product model, provides to achieve better collaboration and improve process efficiency (also related to Total Life-Cycle). It's now possible for everyone to work on building product models together via computer. Instead of each working in parallel with their part of the project, each of the players can now work on a single shared model.

The purpose of product model research is to develop computer-interpretable models of buildings enabling more efficient information sharing between engineering disciplines and between life-cycle stages. Many of the leading researchers in this field have been involved in a large ISO standardization activity called STEP (Standard for the exchange of product model data), which defines product model structures for all branches of industry (Owen, 1993). Recently there has been an upsurge in the commercial interest for building product modeling, through an initiative by several large end users of commercial CAD systems to start to define the object classes needed in building product modeling (Industry Foundation Classes).

3.3.2 Virtual Modeling

Adding the attribute "virtual" to something requires the representation of the product, which allows simulating how it works and is built as if it were real. In Turkish Construction Industry, rarely -that is if it is so necessary to attract the client- conventional plastic models which is called Physical Mock Up (PMU) are mainly used for the representation of product (buildings, roads, environment etc.) as a concrete presentation method. Virtual Model is a model, which can be moved freely in the virtual space by using and creating the Virtual Reality (VR) technology. Main requirements are,

- credible appearance of the stimuli coming from the model: shape, texture, volumes/shading, spatial sound motion and control cueing;

- Credible behavior: functional models fidelity & stability, refresh rate, delays

So, it provides the following opportunities (VIP- ROAM Project, 2002) :

- **Integration with Digital Data**: It provides integration with digital information about the construction project such as CAD drawings, digital maps of periphery, scanned aerial photograph, on-site digital photos and documents.
- **Interactive Movement**: It can be interactively moved by using the interactive function of the VR technology, setting up different viewpoints like a video in the virtual space, that are hard to be observed from the inside of the PMU. Also, it provides flexibility to visualize the model on a large or small scale in conditions that a naked eye could not observed in the usual PMU.
- **Control By Script:** The three-dimensional structural models in the virtual space can be easily turned on and off, replaced, moved or erased.
- **Used On WWW:** The VRT data can be downloaded and viewed within the Internet browsers on the computer. So, it can be shared and viewed by the public domain providing collaboration for several users to participate in the same project.

In the future, digital models will be used more and more to help industry to build competitive enterprises and competitive products. These models will concern:

1. The product: structure, behavior and functions, for different complementary purposes (e.g. mechanical, electrical, systems, etc.)
2. The process linked to the development of the product (life cycle of the product)
3. The organization: the adapted organization, with adapted organizational processes (as project management, decision making - resources, etc.) that will run the industrial project, in the economical context.

3.3.3 Digital Mock-Up

Interaction DMU is proposed to support the development of the interaction modes of future products. The key feature to be provided is to put the user - be she or he an engineer or a potential customer - in "the system loop", in a realistic environment (VIP- ROAM Project, 2002)

It can be considered as a hybrid virtual-physical model. The few physical components are those coming into physical contact with the user - manual controls, seat - while every other contact-less entity has a virtual reality representation.

Interaction DMU integrates features belonging to Geometric and Functional DMU, to build a product representation, which is realistic in terms of perceived properties. The engineer and the user interact with the virtual product model not only in using but also in modifying it; this is an essential feature for the experimental development approach. Any modification is immediately implemented in the real time model and other representations (e.g. for styling, structural analysis, FTA) are influenced as well. The real time representation of the DMU is transparent to the users and modified at runtime. In this way, it is expected that the human-in-the-loop simulation be fully integrated in the product development cycle.

To fully capture the potential of the DMU approach they have to be dealt in an integrated way, together with the seamless and bi-directional link with geometrical and functional DMUs.

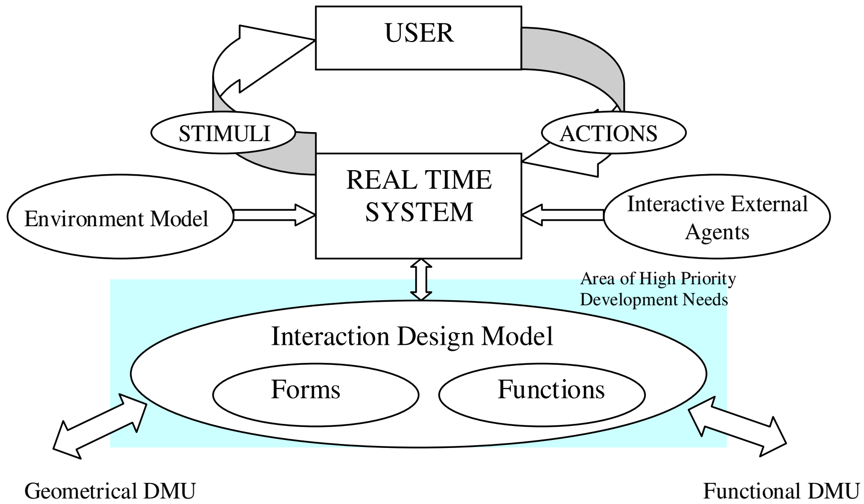

Figure 30 – Interaction DMU Approach (Source: VIP- ROAM Project, 2002)

All in all, for the enabling of an integrated DMU-model, a distributed product model environment with the utilization of interchangeable data is a must. These will enable the interdisciplinary collaboration. But today; the data quality is absolutely insufficient and taxonomy has to be designed and implemented providing interdisciplinary communication.

3.3.4 Digital Master Scenario

A system should be established in order to manage and control all the relevant information and product data like geometrical, physical and functional data, in one or more databases, integrating product documentation, defining the development process and providing data for further procedures. We can say in all phases of the product life cycle, an integrator should work for involved companies and systems like databases, product data management, workflow, CAx etc. The Digital Master is the collection of integrated models and processes for the digital representation of the product lifecycle. It works as front-end of the integrated PDM-systems. Furthermore the Digital Master shall fulfill the following requirements: distributed, open architecture, global, collaboration, flexible, managing risks, reproducibility, scalable, human and environment oriented, traceability (VIP- ROAM Project, 2002)

Digital Master is a collection of tools and a knowledge repository to automate transfer from one tool to another. It does not only contain and link product data but also process information, functions, behavior and requirements. It links the data coming from different life-cycle stages and disciplines in a consistent and valid multi-disciplinary data model.

These mean that in the future, the number of virtual prototypes will strongly increase. With all product development based on universal master data, networking and feedback loops are enabled. The aim is a seamless design and engineering from the user demands to the construction.

Today the realization of a digital master-process still lacks the integration between the different IT systems. An important issue to be solved is the linking of information entities between distributed systems, which was identified as the "Data linking". Another very important strategic development can be found in the knowledge and information maintenance problem, especially the issue of integration of tools in this area. To overcome current problems a flexible integration of the IT Systems is necessary. Interface specifications have to be modeled independent of the technology that later will be used for the implementation. The mobile aspect, security and authentication management should also be addressed in the IT infrastructure theme.

In order to realize such a scenario, joining the data from different data management systems and possibly saving it to a destination data management system is the current working definition of data mapping. Data mapping is necessary to transform the data model of the source systems to the destination system's data model. Even more important is the semantic mapping of engineering ontologies of different disciplines, companies or countries. The virtual data management system is able to automatically create from the underlying data a discipline-specific view on the product data and by that support the management.

3.4 SIMULATION

Simulation methodology is the modeling of a process or systems in such a way that the model mimics the response of the actual system to events that take place over time. Studying the behavior of the model, we can get insights about the performance of the real system. The characteristics of simulation that make it such powerful planning and decision-making tool can be summarized as follows:

- Captures system interdependencies.
- Accounts for variability in the system.
- Is versatile enough to model almost any system.
- Shows behavior over time.
- Is less costly, time consuming and disruptive than experimenting on the actual systems.
- Provides information on multiple performance measures.
- Is visually appealing and engages people’s interest.
- Provides results that are easy to understand and communicate.
- Runs in compressed, real or even delayed time.
- Forces attention to detail in a design (the process identification and activity mapping can help to get a deeper understanding of the whole design).

Whole life appraisal is through simulation. To carry out the simulation is needed to build models. A model is a simplified representation of system with the aim of simulating processes or behaviors and is where IT can play a decisive role to achieve more accurate predictions for whole life appraising.

In Turkish Construction Industry, there is no an adapted simulation tool, nor approach for front loading. This results in numerous and costly back loop. Based on 2D paper drawings, sketches are made for material organization, machine placement, and infrastructure within, to and from the construction site, etc. In addition, a timetable is prepared for activities and the division of labor (e.g. Gantt scheme), also based on 2D paper drawings. But, detailed planning is the basis for practical construction, which cannot be achieved using only two-dimensional representation of the building and its surroundings. The ability to visualize details, building components, review the entirety, as well as simulate the process or situations in three dimensions, would make construction more efficient, enhance quality and reduce costs. Our vision should be integrated front loading within the networked enterprise, few back loops, efficient and cheap change, and management for product customization.

The creation of a realistic impression of a product not only needs to be visualized geometrically, but also contain physical and functional attributes of the product's environment. This requires access to product data from different CAx systems made possible by comfortable and smooth interfaces between all other interdisciplinary systems. Functional examples are: parametric multi body simulation, metaphysics component simulation and system simulation.

3.4.1 Virtual Reality

Using Virtual Reality (VR), it is possible to navigate freely in real time in a three-dimensional environment and to study the building from various angles, measure distances, load/unload objects, create events, set collision detection, create interaction between objects, add lighting, textures, orthophoto or material and much more. It is possible to work individually or collaborate via the Internet. Visualizing the VR model can be conducted in various degrees of immersion, from desktop immersive (PC monitor) to semi-immersive (stereo projector on a screen) or fully immersive (CAVE, HMD, etc.). It is tempting to conclude that Virtual Reality is an almost total embodiment of the main aims of Ubiquitous Computing, as the computer 'virtually' disappears in such an environment.

Considering all the difficulties arising when constructing a large building, one can easily conclude that people working in a construction project would constitute the most likely candidates for the application of VR technology. Unfortunately, this is not the situation today. When speculating on why VR is not being utilized in Turkish construction industry today, respondents widely stated that neither software (functionality, implementation CAD-VR, level of detail, interaction, etc.) nor hardware (computer capacity, graphics card, visualizing systems, etc.) was sufficient to meet the expectations depicted by the visionaries. Indeed, it is not necessary to use supercomputers for VR modeling and visualizations anymore. Ordinary PCs with good graphics card is enough. Besides, the widely used 2D CAD technique is easy to learn, relatively cheap and almost the unique technique for information flow that is not easy to change. Even, the construction industry is highly conservative and has never been one of the forerunners of new techniques. "Why change it if it works," seems to be the general attitude in Turkish construction industry. But with extra costs of about 10 percent of the construction sum because of construction errors, extended time schedules, etc., we can conclude that the use of 2D CAD only is not sufficient. There has been application of 3D and VR visualization, with excellent results, in a number of operational areas, such as the automotive, oil and aeronautical industries.

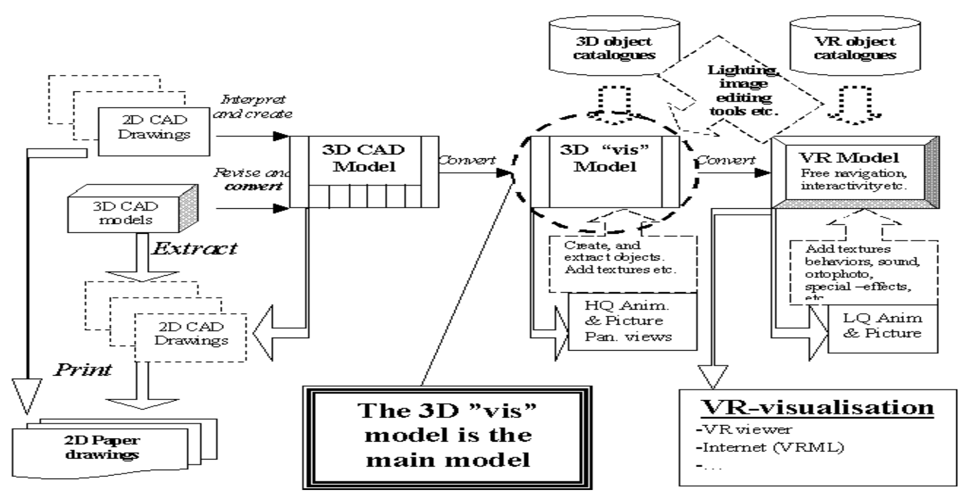

FIGURE 31 – The VR modeling procedure (Source: VIP-ROAM Project, 2002)

The figure is an example of VR modeling procedure. Based on data from the 2D/3D CAD and paper drawings, a 3D CAD model is created. All objects describing the building were oriented according to the building layout. The 3D CAD model was then exported to 3D Studio and additional features and objects, such as textures, ortophotos, the construction crane, site office, rail area, and existing rail station, are subsequently added. The complete 3D "vis" model is then oriented to the correct location in the city center district using an ortophoto. Finally, the 3D "vis" model is converted into VR format and visualized in Division MockUp, where also additional features, such as the sky and motion, were added to the VR model. The architects, constructors and other sub-contractors supplied the information. Additional sources detailing the surroundings, such as ortophotos and photos of building exteriors, were purchased from the Land Survey or produced using a digital camera. To keep the VR model files small and easy to handle, rendering was cautious and LOD (Level of Detail), as well as optimization of the VR model, is meticulous. Various lighting and image-editing tools are used in order to reduce file sizes and also for simulation of light and material behavior in the 3D/VR model. (VIP- ROAM Project, 2002)

However, such kinds of new technologies are not applicable to Turkish Construction Industry at the moment before providing the required infrastructure. Firstly, architects and constructors should plan directly in 3D CAD instead of 2D CAD. Besides, in order to complete these tasks comprehensive standardization work is required, thus a common standards-based system should be developed. For example, IAI (International Alliance for Interoperability) is working on an international classification system, Industry Foundation Classes (IFC), which facilitates the exchange of information about a project between different computer systems.

3.4.2 Augmented Reality (Human Computer Integration for Virtual Engineering)

While Virtual Reality (VR) replaces the entire real world with virtual images, Augmented Reality (AR) superimposes virtual images on the real world. Augmented Reality is a popular concept for using computers to overlay virtual information onto a view of the real world. On the spectrum between virtual reality, which creates immersible, computer-generated environments, and the real world, augmented reality is closer to the real world. Augmented reality adds graphics, sounds, haptics and smell to the natural world as it exists.

The main difference between AR and VR, however, is the immersiveness of the system. Virtual reality strives for a totally immersive environment. In contrast, an augmented reality system is augmenting the real world scene necessitating that the user maintains a sense of presence in that world. The virtual images are merged with the real view to create the augmented display." (MCMU, 1996)

Based on the AR CAD prototype, Mixed Reality – based collaborative virtual environment (MRCVE) is also under development to realize intuitive design review collaboration through face-to-face conferencing or virtual space conferencing

3.5 TOTAL LIFE CYCLE MANAGEMENT

The construction industry has been described as a fragmented process where different groups of professionals take part in an isolated way with a partial or limited approach to the whole life of the final product. The fragmentation in the whole life of the product is the main cause of the production of unsatisfactory products in terms of performance. Therefore a holistic approach is needed in every step of the construction process. New forms of developing projects and contractual arrangements as BOT (Build-Operate-Transfer) are showing that when a unique organization is involved in all stages, whole life appraisal is the required and most appropriate way of approaching to the project. This approach delivers better products, economically more efficient.

A great majority of Turkish construction companies still plan their business on the basis of fragmented lifecycle information due to separation between capital funding, recurrent expenditure, and maintenance costs. There is an urgent need for the adoption of a total lifecycle approach, including all management aspects at various stages of the project lifecycle, including preconstruction, construction and post construction (e.g. development management, project management, resource management, design management, etc.). IT offers methods and tools to evaluate lifecycle scenarios including risk management and incorporate flexibility to prevent unexpected events during lifecycle, through an integrated approach from programming to exploitation.

Total lifecycle management provides solutions to assist in the efficient and effective use of various resources needed to deliver and operate a building / facility including human resources, supply chain, financial aspects and costing by also managing risk and controlling the occurrences of contingencies. Assets management across lifecycle gives solutions required to better manage the asset of the facility during the exploitation while improving its global impact on the environment.

Government, business and non-governmental organizations can apply the life-cycle concept to their decision-making processes related to environment and product policy, design, and improvement. The life-cycle approach can also be used as a scientific tool for gathering quantitative data to inventory, weigh and rank the environmental burdens of products, processes and services. In the future, Turkish construction industry should be based on life cycle thinking and lifecycle cost including environmental and social impacts as described in the Figure-32 below.

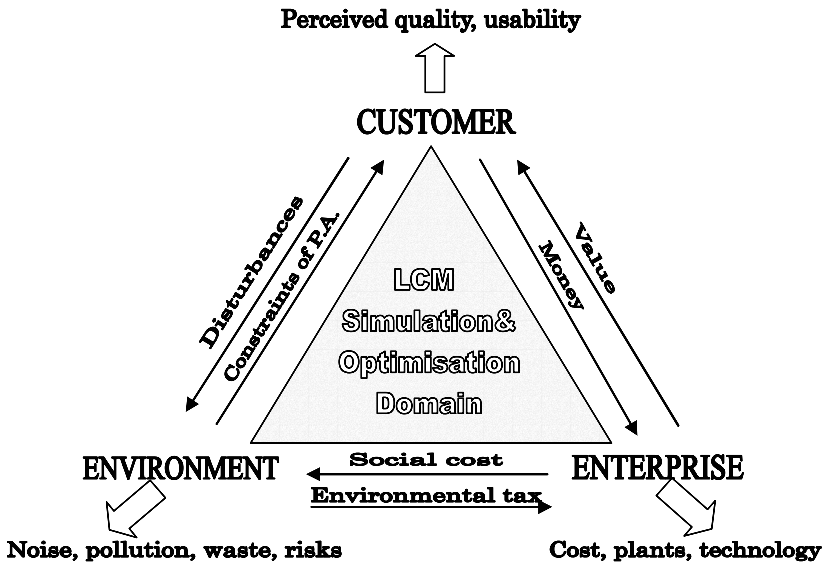

Figure 32 – Important Factors for Lifecycle Management (Source: VIP-ROAM Project, 2002)

IT will provide total lifecycle approach by promoting inter and intra company business process and application integration with communication and collaboration tools, realistic simulation and visualization of the physical construction process. The offered product modeling should be not only at level of design, but also including the production model and the approach towards object/model based process.

When the rapid introduction of IT including of eTendering and eProcurement, and eWork /eCollaboration is considered, changes on traditional construction management philosophies (including procurement methods and approaches) through total lifecycle thinking is a must and naturally be achieved. For example, consider how a financier would be wonderful if it simulates and determines the most cost effective solution for options including construction and energy costs, leasing returns and demolition effects.

3.5.1 Facility Management

There is a limited availability of "as-built" information to facility manager since it is not readily accessible or able to be interpreted and not kept up to date during occupancy in Turkish construction industry. The management of built assets throughout their life, including operation and maintenance, refurbishment and disposal will prove comprehensive facility management knowledge. IT provides various ways to achieve this. For example, by adapting IT tools maintenance contractor on site will be able to access to linked information from alternative manufacturer's catalogue for a product, including video and voice instructions and recent feedback from other maintenance contractors on operational problems throughout its life, thus decision-making will be both easy and successful.

3.5.2 Estimating With IT

Computerized estimating is the pricing of contracts using a software package instead of by the traditional 'by hand' method. Once the user has got used to the interface, computerized estimating is quicker and more accurate than manual methods.

However, in Turkey now, with increasing computerization of client's activities it is becoming almost a requirement to handle tenders electronically to improve corporate image. Electronic tenders form the basis of project valuations and costing information if tender secured, adding value by reducing project costs and improving information flow. The prices can be built up using historical tender details such as labor and material rates or from libraries of work rates, which are held by the system. Speed of calculation allows any number of 'what if' scenarios to be carried out, allowing estimators and directors to exploit any potential advantage or specification error Last minute adjustments resulting from late returning quotes or pre-submission tender pricing discussions are not a problem, as these systems can recalculate totals almost instantaneously.

Computerized estimating system would be able to import data, as well as specialist database products like pricing databases from a range of different formats. To have this, databases, like Oracle and MSSQL, should be developed which may also require resources to manage. The system can cope with more than one user working on the same estimate, avoiding information duplication. In fact, Turkish construction industry is technically ready for such a system, since it is not so complex to adapt.

3.6 HUMAN ASPECTS MANAGEMENT (EDUCATION AND SKILLS MANAGEMENT)

A decisive factor in the success of IT development is making full use of human potential. It is therefore necessary to disseminate general information on IT throughout society. Turkey needs to promote the 'mass dissemination of the benefits of information technologies for society', to promote mechanisms to stimulate the use of technology and access to information services in social sector organizations and the general population, and to promote educational programs for the population at large.

The future of IT is in the people developing it, running it, and supporting it. With the surplus of jobs on the market today, and the dire need for intelligent individuals to run this complex industry, the good ones can afford to be picky. Personal goals are different. The new generation of employees wants to participate in and actually cause change--their careers and satisfaction are their goals as well as the added value a company can give them in terms of professional development--not specifically the company.

These will lead to changes in the cultural attitude of the industry to IT, and in the personal attitude towards cross-cultural IT based collaboration. It is obvious that there is a great discrepancy between cities of Turkey that some are more advanced than others. Thus, a technology transfer between cities is necessary to create a fully IT literate nation, which requires improving trust and social cohesion in the workplace by supporting national accessibility, flexibility, and equality of opportunity for all actors in the construction sector.

3.6.1 IT Skills and Awareness

It is found that, in general, the IT skill base in Turkish construction industry is relatively low and understanding of the potential of IT as well as how to manage the introduction of IT are underdeveloped. Tight profit margins and a tradition of undercapitalization prevent investment in skills and awareness particularly among SMEs. There is not enough awareness of the need for organizational change to achieve business benefits

One of the key factors in encouraging people in any country to make full use of the opportunities provided by developments in informatics is the existence of an adequate variety of content in local languages and reflecting local culture. The specific and sensitive problem is how to ensure that users have access to information in their own languages (The International Federation for Information and Documentation (FID), 1999). Still there exist many professionals in Turkey who could not speak any foreign language or could not understand the content even if he speaks. So there is no reason why he could not use a program and why Turkish construction industry is highly unaware of the emerging technologies. The lack of qualified professionals is one of the reasons for the slow growth of IT implementations in Turkish construction industry. Being a citizen of Turkey should be synonymous with being well trained, open to the world and having a solid intellectual preparation for the needs of modern technology. Higher education provides deep understanding of the underlying theories, models and methodologies of IT applications for the construction sector.

Public and private sectors should cooperate and share their knowledge to achieve national awareness and rapid improvement in staff skills in the use of computers and communicating on the Internet. It is also important to convert and refine various information contents into an accessible and commercially feasible for to raise the skills level within the sector.

3.6.2 Training and Education

IT training/education to construction professionals and students focuses on skills to use basic IT tools without providing a deeper understanding. E-learning initiatives are heterogeneous and not yet widely spread, although gaining increasing acceptance in the field. Encouraging the training of human resources and the development of an informatics culture will also be promoted through the mass media, as well as continuing education and training programs.

Many of today's concepts in education will become obsolete with the creative incorporation of the new information technologies. It is considered that the effective development of computer literacy requires 'an overall, cohesive strategy for the entire educational field'; it is not enough simply to provide more computers in schools. (The International Federation for Information and Documentation (FID), 1999). E-learning should be used for transferring technology and lessons from good practice. It makes specialized education and professional and vocational training more accessible to SMEs in terms of affordability and availability. Besides, adapting user-friendly clever tools will reduce the need for learning, and provide built-in learning support when needed.

3.7 QUALITY & PERFORMANCE MANAGEMENT

The future of the construction organizations depends on increasing the level of performance and focusing on their core competencies. But today in Turkish construction industry, this is being tried to be achieved through control of construction by knowing the owner through personal relationships, forcing contractors to bid low and controlling the situation through their specifications and drawings, by negotiating their design contracts through a perceived qualifications basis. This control minimized competition and made political influences (factors which do not have construction performance as its objective) very important. This has been resulted in construction non-performance, the move to transfer the control to contractors, and treat the construction industry as a price based with very little risk and need for expertise.

That's why Turkish construction industry needs to improve quality by working in a more performance-oriented manner, leading to better value for money and avoiding uneconomic over-design in buildings due to lack of access to accurate total life cycle costing techniques. Development of procedures to effectively manage productivity and quality (including conformance to performance standards) and overall integration of processes throughout the total life cycle will improve sustainability. Developing, and re-using object based models for sustainable buildings, which will be open source and available on model servers provide improvement of decision-making monitoring and measurement of project progress & performance.

IT offers many decision support solutions to assist in process and product compliance with regulations across the building / facility lifecycle, selection of best design, construction and facility operation options, selection of sustainable product components achieving best performance and buildability, by taking into account all relevant values for performance assessment. IT tools provides integration of product, document and process models, flexibility to study alternatives and optimize design and selection of products/materials, thus supporting sustainability approach (along with a comprehensive policy), as well as for lifecycle thinking.

3.8 INTELLIGENT PRODUCTS & BUILDINGS

Turkish construction industry has constructed some examples of intelligent buildings but due to its high cost, insufficient technology support, industrial conservatism and some maintenance supplier barriers, today many projects of intelligent buildings are postponed or canceled. It has been understood the necessity is an improvement of maintenance process and decrease of maintenance costs, through standardized and flexible (online and remote) building management systems. Turkey is now trying to recognize the advantages of merely intelligent products, e.g. refrigerators, ovens etc. as providing a productive and cost-effective environment.

An intelligent building is one relating to a building's structure, systems, management, services and the interrelationship between them. Intelligent buildings help building owners, property managers, and occupants realize their goals in the areas of cost, comfort, convenience, safety, long-term flexibility, and marketability. As illustrated in Figure-33 below, the required technologies are HVAC, lighting, electrical power, wiring distribution, communications, controls, access control, security, life safety, elevators and escalators, domestic hot water, and information management (ROADCON Project, 2003)

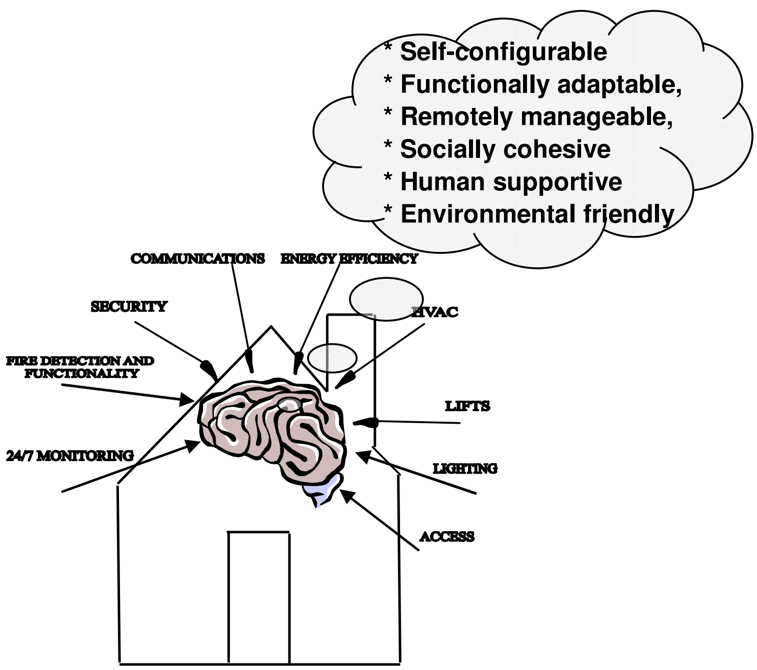

Figure 33 – Intelligent Building Model

Intelligent buildings and products support interactive workspaces, location and context aware services, ambient control and self-reporting through embedded IT in house / extended products and deployment of smart home services. Imagine how it would be wonderful if the feasibility is achieved for Turkish society as being addicted to their comfort and luxury while creating cost-effective, national energy saving, environmental-friendly, socially cohesive and secure nation. This is a construction industry-specific duty for the future of Turkey and also provides the industry sustainable competitive advantage and new domestic as well as international markets.

On the other hand, future's sustainable cities offer intelligent (self-configurable, functionally adaptable, remotely manageable, socially cohesive, human supportive, and environmental friendly) buildings, thus promoting urban ambient intelligence and sustainable ways of urban planning, living and working, while urban planning has been an irresolvable continuous problem of Turkey for many years.

3.9 ADAPTIVE AND SELF-CONFIGURING SYSTEMS

Adaptive and self-configuring systems learn from their own use and user behavior and are able to adapt to new situations, locating and incorporating new functionality as required (ROADCON Project, 2003). Information should be made available, on a "push" basis, to individual users, prioritized according to the user's interests, which are determined from their roles, previous history of information use, and the urgency and importance of the situation, through whatever medium is most appropriate at a given time. Further, users are given early warning of areas that may require attention, based on pattern recognition and uncertain reasoning (e.g. fuzzy or probabilistic logic, or neural nets).

Today, IT applications are based on "one size fits all" approach that requires manual configuration for specific uses, maintenance and support, resulting in time and energy spent. This reflects the industry need for semantic level rather than symbolic and syntactic level specifications, thus eliminating translation tasks. Semantics provide logic to systems automatically keep track of the social and knowledge networks of their users, suggesting appropriate references, applications and contacts that may be useful in a given situation.

3.10 FLEXIBLE INTEROPERABILITY

Interoperability is the seamless electronic exchange and sharing of project information between participants and across the life of the project in a way that is software independent and operating in an open systems environment. Currently, data are being re-entered for different software applications, but interoperable systems will let any software application communicate with any other application and extract relevant data from the unique model. There will be no need to re-enter any data throughout the project lifecycle for all of the participants. This will provide both collaboration and the integration of the industry as a whole, thus decrease oral communication, eliminate misunderstanding, ease and speed up all applications.

Like many other IT requirements; in order to achieve flexible interoperability Turkey needs a comprehensive standardization, thus a common standards-based system. For example, IAI (International Alliance for Interoperability) is working on an international classification system, Industry Foundation Classes (IFC), which facilitates the exchange of information about a project between different computer systems. Beyond IFCs, it becomes possible to connect enterprises' Information Systems in a short time and regardless of what standard or non-standard systems they may have/support.

3.11 LEGAL & CONTRACTUAL ASPECTS MANAGEMENT

Turkish construction industry firstly needs the acceptance of legal accountability of all IT transactions. Legal and contractual implications, such as addressing IPR, security, privacy, ownership issues, resulting from the introduction of IT solutions to traditional practices, and adaptation and development of consequent legal framework(s) should be generalized.

The issue of security frightens everyone. But you have to take risks if you are going to be the leader. There are always people who will try to get into your network and hurt you--but the biggest risk is internal. Besides using encryption, changing passwords regularly, applying the latest security software, and establishing firewalls--make sure that your people inside are classifying information correctly and using the security system properly

3.11.1 Intellectual Property Rights

Intellectual property is the legal ownership of a unique product or service created by an identifiable source. Protection of intellectual property rights and copyrights in the IT field, particularly for software products, is a requirement to be respected in order to create a healthy environment for the development of IT in our country. The rights of copyright owners need to be balanced with the interests of users in the digital environment. New rights and appropriate exceptions will be introduced together with enforcement measures, and limitations on the liability of infrastructure owners (The International Federation for Information and Documentation (FID), 1999).

Today, disciplines guard their own intellectual property and shared documents are provided as scanned images to limit alteration and reuse. But in the future intellectual property will be seen as property of the team or the virtual organization as a whole.

The main problems in this field are directly related to the ease and precision of copying that are possible in a digital environment. Detailed provisions are needed with regard to intellectual property rights in computer software and the commercialization of software. Illegal usage of various software products is very widespread in Turkish construction industry. There is need for legal intervention to this matter. Besides, special laws should concern the use of databases: its structure, authorization and prohibit, translation, adaptation, modification, distribution, the results of operations performed on the database, or their communication to the public.

3.11.2 Data Protection and Security

The use of computers and the reliability of the data they contain must be protected. To prevent the criminal sabotage of technological progress, it is essential to ensure the security of computer transactions. The public sector must take responsibility for data security in society and, together with enterprises, ensure that all critical systems function under all circumstances (The International Federation for Information and Documentation (FID), 1999).

Turkish construction industry, as well as the society as a whole, needs protection against breaches of security in computer networks and systems, and rules on the use of encryption technology to prevent crime in the digital environment. How to facilitate trans-border data flow and protect against intrusion into individuals' private information are critical issues to be taken into account.

Turkish government should provide a legal and regulatory framework that ensures the information economy is safe, secure, respectful of personal privacy, certain and open guaranteeing the integrity, authenticity, quality, protection and conservation of documents stored in electronic formats.

3.11.3 Virtual Identity Management

Virtual identity management provides to allow documents validation, in such a way that it is possible to guarantee the author identity and no change has been done to the original one; also including clarifying legal aspects around digital signature (in every country, EU, etc.).The information society must be a safe and secure place preventing the unauthorized tapping of communication, forging of documents and use of false identity.

The purpose of the digital signature is to have an electronic document (e.g. a file) transmitted rapidly, with protection against alteration or manipulation, and to know for sure who was the sender of the electronic document. To get a paper-free software system to work (concerning legal aspects), one of the essentials is to give declarations containing legal intent from one person to another one. There are one-way declarations like orders from the client to the contractor. And there are also two-way declarations, for example, when the contractor and his sub - contractor set up their contract. Such a contract consists of the one declaration of the sub - contractor that he is willing to work, and the other declaration of the contractor that he accepts. All these are declarations of legal intent. In Turkish construction industry there is a strong demand for the acceptance of declarations in electronic form.

The European Commission is preparing a directive on digital signatures which will be valid in every EU-country. Even, Turkey is preparing laws - combined with suitable contract clauses – providing the electronically transmitted declarations the same legal authority as paper - based declarations. The basic requirement in transferring reliable electronic declarations is the "digital signature".

3.12 MANAGING IT IN CONSTRUCTION INDUSTRY

Whilst the increased use of IT can provide many advantages it is a resource that must be managed effectively and strategically in order to fulfill business needs. There are also statutory and legal issues involving health, safety, data protection and electronic transactions to be taken into account. Having a strategic approach to the development of IT within business will enable to get the most out of the investments and to be aware of the statutory obligations.

To provide effective direction and adequate control, executive management of successful organizations must not only appreciate the possible benefits, but also properly manage the risks and constraints of information technology. The management of IT in organizations is considered to be a difficult task because it affects strategy, culture, structure, and processes. Managing IT project requires skills and practices that are commonly found and readily available within many construction companies and consultancies in order to ensure that your systems are fit for purpose, deliver the benefits that you require and conform to your expectations with respect to cost, quality and time.

In a highly abstract way the construction information process can be divided into integrated sub-processes which interact with each other at many different levels.

- Creation of new information
- Person-to-person communication
- Information search and retrieval
- Information distribution

The interrelationships between these are shown in the Figure-34 below. It should be noted that communication and information search activities are usually triggered within information creation activities to provide required inputs, whereas an information distribution is applied to the outputs of the "create information" activities.

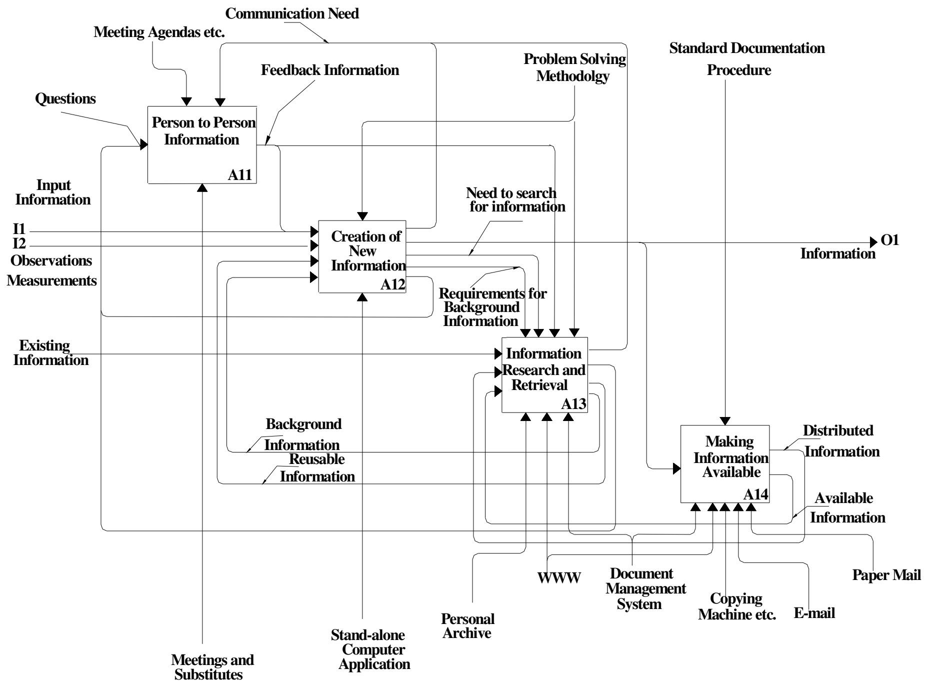

Figure 34 – Four Generic Information Process Activities (Source: Björk, B.C., 1996)

It is interesting to note that some of the most important effects of IT on the business processes in the industry have happened more or less in an unplanned fashion and not through conscious reengineering or proceeded by extensive research.

The needs and requirements for IT should be evaluated at both organizational and project level. If IT is not managed in line with an organization's needs, information processes will become ineffective and consequently may impair decision-making. Information technology may be considered a relatively new technological innovation, as a result, managers lack of experience and understanding of it makes their task difficult, and decision making more problematic (Li, 1996b). Many practitioners have commented on the difficulty of keeping up to date with the advancement and innovations in both technological and software developments, expressing that the economic climate has not enabled them to devote the necessary time and money to follow advancements in IT.

It is now become a tactical necessity, especially with the increasing popularity of partnering and strategic alliances that organizations electronically integrate their IS with each other. By doing so the flow of information between organizations may improve, thereby enhancing the effectiveness of decision-making. Indeed, competitive and economic advantages may also be acquired when IT is effectively integrated into an organization.

As IT applications become ubiquitous to construction, managing IT becomes inexorably complex. Consequently, there is a need for integrating intra-and-inter-organizational business units and operations, so that the benefits of IT can be harnessed both internally and externally. As the construction process overflows with copious amounts of information, the effective control and management of information is a demanding task. Construction organizations typically apply IT to cope with these increasing demands. However, it is also important that organizations do not loose sight of the cost implications associated with the adoption of new technology (Hochstrasser, 1992; Irani et al., 1997; Irani et al., 1998).

The adoption of IT remains nebulous for a number of reasons, mainly due to the large number of interacting socio-technical variables involved in its implementation and use. As a result, the implications of adopting IT can be numerous, with some organizations achieving more gain than others from their exploitation of IT. The involvement of key business areas within overall management of IT project is likely to ensure that the maximum benefits are gained from the final implementation of the system. Teams and individuals work best with new IT systems when they understand what they are using and why they are using it.

CHAPTER 4

NATIONAL IT VISION FOR

TURKISH CONSTRUCTION INDUSTRY

If Turkish construction sector is to achieve its full potential, then substantial and systemic changes in its culture and structure are needed. This in turn will require a range of innovations in business processes as well as technologies and products. Thus, **the dramatic shift of Turkish construction sector into an agile knowledge-driven model-based industry, integrating IT enabling holistic support and decision making throughout the process by all stakeholders and becoming capable of rapid response to the more demanding performance expectations of the global market** should be the overall vision for the industry.

In order to reach this vision, the industry is in an urgent need for accelerated acceptance of new technology and innovation, not only within tools but also in the approach to improve industry productivity, performance, and environmental and economic sustainability across the life cycle. The industry must move to a more integrated construction process with new solutions developed and implemented through cooperation and collaboration. Tools for integrating the design, construction and operation processes, interoperability of software and business systems, validated decision making tools, and repositories of credible information will highlight applying IT to improve industry productivity and sustainability.

Key elements of this vision include the following areas of concern;

1 Knowledge Management
2 Ubiquitous Communication and Computing
3 Collaboration
4 Model-based Engineering
5 Virtual Prototyping
6 Interoperability
7 Context-awareness
8 Lifecycle management
9 Performance-based Engineering
10 IT Skills and Awareness
11 Legal Aspects of IT

In view of these areas, meeting the needs of the future operating environment will require a sustained improvement in productivity and quality across the industry, resulting in IT-enabled agile knowledge-driven model-based integrated Turkish construction industry. Figure-35 below shows the IT vision developed for Turkish Construction Industry in this study.

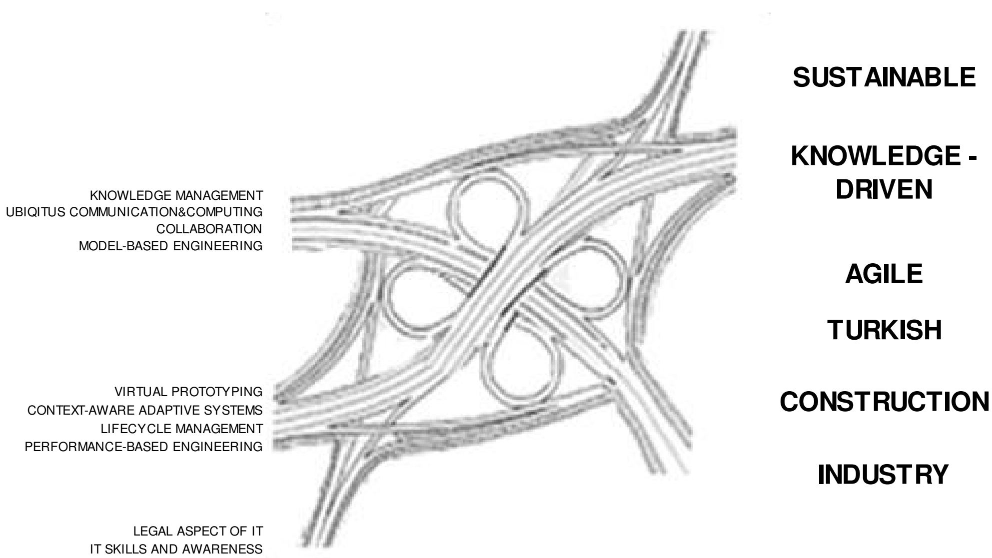

Figure 35 – IT Vision for Turkish Construction Industry

Turkish construction industry should envision two fundamental areas in terms of “advanced processes” and “advanced end-product”. However, the governing mission surrounding this vision should be about how future technological evolution, supported by IT in the construction industry of tomorrow, will sustain Turkey. Accelerated transition to information society is launched as part of Turkey’s commitment to join the European Union and to leverage Turkey’s potential to become an important player in the global arena. The improvements in the lives of Turkish society through a vibrant IT-enabled construction sector will provide a quality and cost-effective built environment, leading to intelligent usage of natural resources, effective development of national land and consequently the development of sustainable cities. Further, such a national development will be a great pace for global sustainable development of Turkey.

To identify the vision in detail, the envisioned processes have to be explained within the classified areas with clearly defined goals as follows;

Knowledge Management: In order for Turkish construction industry to achieve integration it must at first perceive knowledge as a corporate asset to be shared by all, for the benefit of the industry. In Turkish construction industry, knowledge is restricted to single projects and phases. This results in re-inventing the solution by not re-using past knowledge, and capitalizing on past experiences. Capturing and applying knowledge across multiple projects, industry-wide sharing of experiences and fundamental understanding of complex system interactions at all levels is compulsory for improvement of the industry. The aim is to have transparently immediate access to the right information, at the right time, in the right format, and from the right sources, both internal and external. Besides, Turkish construction industry is in an urgent need for the integration and automation of project information and the integration of data from the construction site into project information management systems. Digitalization of relevant up-to-date information and knowledge throughout the lifecycle (standards, regulations, specifications, products, etc.) will facilitate the development of a knowledge-driven decision support system

Ubiquitous Communication & Computing: Ubiquitous communication is the availability of IT support, applications and data, anywhere, anytime, regardless of physical location provided by industry-wide communications infra-structure, distributed and embedded systems, ambient intelligence and mobile computing. Technologies providing wireless network, multimedia interface, remote control, GPS and security are ready for use of the industry. The increased use of the Internet opens new business opportunities for construction organizations such as 'Project Information Exchange', 'e-Trading' and 'e-Tendering'. In the new era, "just in time" procurement strategies will become more popular. Developing 3rd Generation Broadband Mobile Network will provide the best interactive and intuitive seamless collaboration / communication services than any alternative networks, including high level security with IPR and identity management, better mobile and audio / video conferencing enabled, improved wireless data protocols, etc. Services to support self-configuration, semantics and context-awareness as well as systems to adapt integrated interface and network integrated devices should also be developed.

Besides, the emerging technologies exploiting 4th Generation Broadband Mobile Network will provide ubiquitous communication, computing and intelligent user-friendly interfaces augmenting human to computer and human to human interaction, adapting to the devices, user preferences and contextual conditions, and available / accessible to all.

Collaboration: Today, in Turkish construction industry there is a fragmented limited communication between different disciplines within a phase or between phases. Further, even in large organizations, teamwork between distributed participants is supported by web-enabled document management systems ("project web sites"). This gives rise to the need for transparent cooperative open supply chain. Virtual teams combine distributed knowledge by global collaboration environments that support cultural, linguistic, social and legal transparency.

Solutions for efficient data exchange, web-based negotiation and collaboration tools to support inter-enterprise teams will develop solutions and systems on workflow change management that will provide cohesion of distributed teams, shared repositories and transparent contracting.

Collaborative global virtual workplace for all project and business applications including the construction site will lead to joint management, control, and improvement of a supply chain. Developing the IT-enabled collaboration opportunity and restructuring the industry supply chain to leverage IT benefits facilitate the convergence of the multidisciplinary team toward a common vision and common weighting of the risks and stakes for it to be able to develop an optimal deployment strategy and plan.

Model Based Engineering: Today, the current document-based workflow process of Turkish construction industry is like a stream. When an engineer needs to perform a task, he/she retrieves applicable documents from the stream, performs the design/analysis task, generates additional documents describing the results, and adds the resulting documents to the document stream. A drawback of this approach is that it results in "islands of automation," in which engineers are forced to manually extract information (Hannus et. al., 2003). The industry is moving away from the document-based approach to a model-based approach.

Document based processes cannot be automatically processed and interpreted and this provides the creation and sharing of human-interpretable information. An example is 2D CAD. The information is scattered into several documents containing different views of the subject. Updating this kind of information is difficult laborious. Keeping it consistent is close to impossible.

Model driven approach implies a conceptual model, which is implemented across different software applications enabling all the needed aspects of the information and different computer simulations and analysis. It involves sharing project information via a shared concept or process model. Information is entered once and can then be used by all the different stakeholders during the whole life cycle of the project (ROADCON Project, 2003).

Besides, communication between the different parties involved in a construction project relies mainly on drawings and specifications. But computer visualization technologies, such as 3-D walk-throughs, can make communications more effective and user friendly. When visualization is combined with a model driven integrated construction environment, it offers exciting new potentials. It provides increased opportunities for simulation and "what if" analysis.

The vision is to adopt model-based engineering enabling context-awareness, automation, simulation and visualization based on computer interpretable data providing systems integration and user/context specific presentations/view.

Model-based, semantic information is at the core of the vision and has fundamental impacts on various uses of IT. Some of them are illustrated in Figure-36 below.

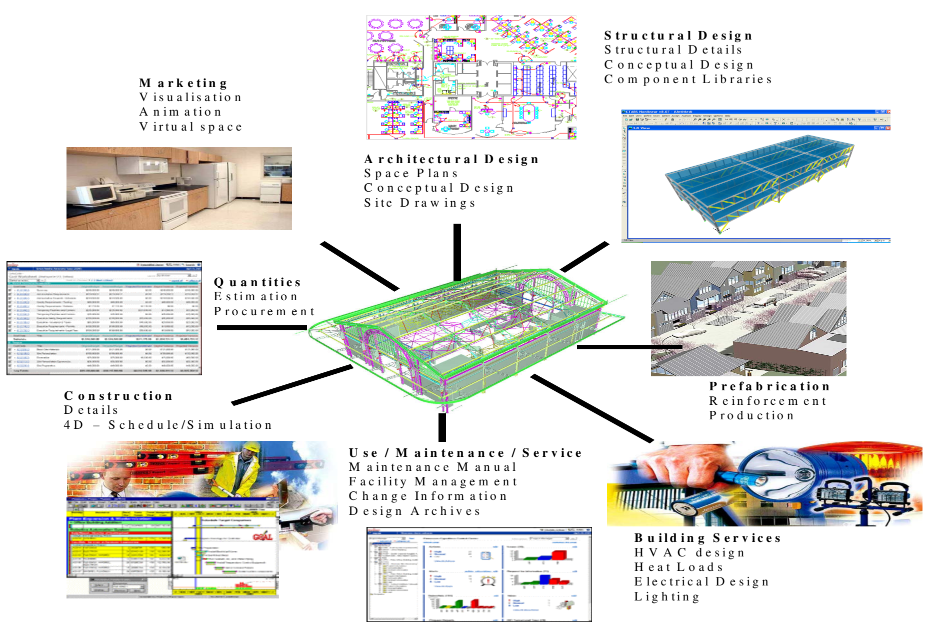

Figure 36 – Building Model Supporting various Engineering Applications

Virtual Prototyping: If the CAD modeling tools will be used the same way as drawings, the industry will not have been very much better-off. There have to be a change of mentality. The problem with a set of architectural drawings, for example, as a symbolic picture or model of a building is that they present an inadequate means for the rigorous testing of the form against the requirements of the program or context; they are a model of what the proposed building will look like, how it will be disposed three dimensionally in space, but not how it will behave.

Virtual reality and simulation are important tools that help the construction manager to analyze and measure productivity, analyze risk, allocate resources, plan sites etc. improving feasibility, planning and scheduling.

Since virtual reality tools allow the design team to quickly gain insight, virtual prototyping results in high quality feedback on the project. Increased opportunities for simulation and "what if" analysis provides early solutions from different technical points of view (acoustic, thermal, lighting, etc.). Improvements of coordination and communication around visual and intuitive models evaluate the whole lifecycle process earlier regarding different constraints.

Flexible Interoperability: Typically in Turkish construction industry data exchange between different applications and companies is available at file level-based that is done manually, needing a lot of non-essential human (interpretation) effort and introducing many errors in the process. IT applications communicate if at all, point-to-point based on incomplete, proprietary (vendor- or user-dependent) inflexible interfaces at a low semantic level where often only the syntax aspects are agreed (ROADCON Project, 2003)

The vision is to reach flexible interoperability between heterogeneous IT systems will enable seamless interaction between all stakeholders. In order to do so, Turkish construction industry should agree one form of syntax, semantics or both for information and functionality. Successful cross-sectoral application of IT requires a degree of standardization in technology. For such an industry where projects always involve external communication, open standards are crucial. Besides, people will easier reach consensus and actually use the standard if the standards themselves are more flexible, easily accessible, adaptable and extendable. Ontology approaches especially the web based ones are seen as a key opportunity here.

The overall goal is making computing simpler, cheaper, more secure, reliable, more effective and user-friendly, integrating all legacy systems and thinking and augmenting human creativity and learning by building computing solutions from dynamic architecture models and intelligent infrastructures.

Context Awareness: Context is a powerful, and longstanding, concept in human-computer interaction. Interaction with computation is by explicit acts of communication (e.g., pointing to a menu item), and the context is implicit (e.g., default settings). Context can be used to interpret explicit acts, making communication much more efficient. Thus, by carefully embedding computing into the context of our lived activities, it can serve us with minimal effort on our part. Communication can be not only effortless, but also naturally fit in with our ongoing activities. Pushing this further, the actions we take are not even felt to be communication acts at all; rather, we just engaged in normal activities; and the computation becomes invisible (Norman, 1998).

With increased user mobility, and with increased sensing and signal processing capabilities, there is a wider variety of context available to tailor program behavior. Moreover, context-awareness is a critical feature for a ubiquitous computing system because important context changes are more frequent. In a ubiquitous computing environment it is likely that the physical interfaces will not be ``owned'' by any one user. When a user owns the interface --as is usually the case with personal digital assistant or a laptop computer-- over time this interface can be personalized to the user. Context can be useful in these situations, as has been demonstrated by location-aware computing applications. Context-awareness will allow for this rapid personalization of computing services.

Context-aware systems extract, interpret and use context information and adapt its functionality to the current context of use. It involves application development that allows for collection of context and dynamic program behavior dictated by knowledge of the environment and understanding of a real-life situation. Any a context-aware application is able to assign meaning to the events in the outside world and use that information effectively easing many of the construction site internal and external processes (ROADCON Project, 2003).

Moreover, the vision for Turkish construction industry to take this one step further by providing adaptive systems of learning from their own use and user behavior, and able to adapt to new situations without manual maintenance, configuration and support.

Lifecycle Management: Turkish construction industry is in need of a seamlessly automated and integrated environment across the whole project lifecycle, from planning, design, procurement, construction, and into operations and maintenance. Executives need real-time information across multiple projects to make fast, accurate decisions. IT allows life cycle thinking and seamless transition of information and processes between life cycle phases.

In order to ensure holistic decision making, total lifecycle approach should be supported by user-friendly, functional applications and persistent data. At the beginning of the processes, total lifecycle performances should be used as inputs, to optimize different technical domains for planning and cost estimations to be conducted concurrently to test "what-if" scenarios and to assess feasibility and buildability.

Performance Based Engineering: Today in Turkish construction industry, the current situation is closer to the prescriptive-based than to the performance-based. Business processes are driven by lowest cost, although there is a growing awareness of customer perceived value, which is not yet supported by current business models.

A prescriptive approach describes an acceptable solution while a performance approach describes the required performance. The most serious problem with the prescriptive approach is that it serves as a barrier to innovation. Improved and/or cheaper products may be developed, yet their use might not be allowed if construction is governed by prescriptive codes and standards. Another problem with the prescriptive approach is that it makes it very difficult to cost-optimize building construction.

The 1925 publication, Recommended Practice for Arrangement of Building Codes, prepared by a committee of the National Bureau of Standards, the predecessor organization to NIST, explicitly states:

"Whenever possible, requirements should be stated in terms of performance, based upon test results for service conditions, rather than in dimensions, detailed methods, or specific materials. Otherwise new materials, or new assemblies of common materials, which would meet construction demands satisfactorily and economically, might be restricted from use, thus obstructing progress in the industry."

Certainly this statement is as true today as it was 79 years ago. But only recently have many countries actively moved to develop and apply performance-based building codes. There is genuine need for considerable improvement in the industry's performance, productivity and ability to meet increasingly demanding customer needs by the prudent integration of IT into the industry.

To facilitate world trade, internationalization of performance-based standards is needed. It is essential to understand customer needs and integrate that to production processes. Now is the time for rapid increases in application because numerous nations of the world are committing to applying the performance concept to building regulation, which will permit and encourage application to innovative building design and construction.

IT Skills and Awareness: A decisive factor in the success of IT development is the creation of a fully IT literate culture with full use of human potential. The lack of qualified professionals is one of the most important reasons for the slow growth of IT usage in Turkish construction industry. The growth in technology use in construction industry and rapid change in the industrial structure through the use of IT entails constant upgrading of knowledge and is resulted in the expanded demand for relevant IT skills. It is therefore necessary to encourage the training of human resources, allowing staff participation throughout the implementation process to be more effective and alleviate initial fears of the unknown, assisting in acceptance of the proposed changes. Users will know the benefits derived from computers, how to use information to make decisions and how to use the capabilities of information resources effectively.

Without an explicit understanding about how IT can be effectively used to improve organizational performance, its justification will remain to be weak. To ensure the continuous increase in IT based applications in the construction industry, sufficient awareness and skills have to be provided for various professions of the construction industry to evaluate, allocate and utilize appropriate IT systems.

Legal Aspects of IT: In order to achieve exclusive use of IT in electronic transactions, the three elements of legal, security and trust should be satisfied together. Legal barriers such as legal admissibility of emails, CAD drawings, use of ASPs, company vs. project information and legal issues of objects (such as IFCs), Protection of intellectual property rights and copyrights, data protection against loss, damage or modification, and against unauthorized use or disclosure, whether accidental or deliberate should be overcome by a legal and regulatory framework that ensures the information economy is safe, secure, respectful of personal privacy, certain and open. Different security levels should be imposed on all transactions using digital signatures, third party certification authorities, biometric systems, smart cards and/or digital notaries.

CHAPTER 5

IT-RELATED TRENDS AND OPPORTUNITIES FOR TURKISH CONSTRUCTION INDUSTRY

Once the priority areas and the vision established, IT-related trends should be defined which, especially if combined, satisfy the identified requirements. These trends are appropriate for both traditional building processes where the priority is on IT support, but also for more industrial building processes involving concepts like collaborative engineering and intelligent buildings where IT functions are enablers for innovation in the construction processes.

Referring to the IT framework explained in Chapter1, the industry trends can be classified according to change level dimension as follows (ROADCON Project, 2003);

- Impacts
  - Sustainability
  - Coverage
  - Globalization
- Business Processes
  - Industrialization (Prefab, IFD, Building Factories)
  - Service Orientation
  - Knowledge Reuse (over/beyond project or even company boundaries)
  - Performance Driven Processes
- IT Solutions

- IT Architecture
  - Collaboration
- IT Applications
  - Enhanced Functionality
- IT Infrastructure
  - Middleware (Data/Application Services, APIs)
  - Intra-, Extra-, Internet (Base Infrastructure: Ethernet, TCP/IPv4/6, HTTP(s), URI, (X)HTML)
  - Model-based
  - Information Sharing
  - Flexibility

- IT Enablers
  - Open Standards
  - Web-based Processes
  - Ambient Access
  - Generic Tools

5.1 IT TRENDS

5.1.1 Strategic Level: Impacts

Sustainability: The sustainability values can be provided with the right balance of the old economic values (cost, time and quality) and new economic, social, cultural and environmental values over time, which is over the total product life-cycle and supply chain, and the environment. These are the shifting values in the emerging knowledge society and the trend should be from quality to value representing 3P's as profit, people and planet (ROADCON Project, 2003)

Coverage: Not only the values themselves are shifting but also the entities experiencing these values and the scale of their effects. The impact will be not only for construction companies but also for individuals and the industry and society as a whole

Individual <> eWork
Company (SME & Large) <> Enterprise Application Integration (EAI)
Construction Industry Domain <> eBusiness & eCommerce ("extended" EAI)
Society <> eLearning&eGovernment (for citizens), eAdministration (for businesses)

Globalization: The emphasis should be on global competitiveness, impacts, operations, standards etc. Impact will be on larger scales; that are from local to global (world-wide) effects that mean, "Think globally, and act locally".
Location <> Work (Office/Site) <>Home <> Neighborhood <> District <> City <> Region <> Country <> Continent <> Global (world-wide) (ROADCON Project, 2003)

5.1.2 Strategic Level: Business Processes

Industrialization: The trend is the more use of standard processes and products. The Turkish construction industry lacks standardization of intermediate and end products. However, there seems to be a slow trend from "everything is always different" towards "sometimes things or at least parts of these things are not so different". The trend is increasing the use of standard processes, products and components. This, increasing level of assembly lowers the level of uncertainty leading normally to many errors and unplanned surprises in both engineering and realization tasks.

Service Orientation: The trend is offering combining knowledge-intensive services with products. In software programming there should be the principle of object orientation: keeping data and functionality together leading to stop just selling but become solution providers. Many suppliers become sub-contractors not just selling their products but first their expertise and experience by teaming up and precombining their products (the walls with window frames example) (ROADCON Project, 2003).

Knowledge Reuse: The trend is enhanced and systematic re-use of past experience and best practice from projects and product lifecycle performance within and increasingly also between companies. The idea is to split all information explicitly in project-dependent and project-independent domains where the latter functions as a kind of knowledge database. One step further is the reuse of knowledge beyond the company to overcome the re-invention of the wheel. The trend should be putting information and/or application software not on local desktops but on servers enabling easier reuse of both data and (software) functionality. This is an aspect of another trend referred to as "Information Sharing" but this is clearly a prerequisite for processes that want to reuse knowledge.

Performance Driven Processes: The trend is systematic compliance of technical solutions to functional & performance requirements throughout the whole construction product/service lifecycle and the supply-chain.

Going through the lifecycle phases of Design, Build and Operate one can associate the outputs of these stages with a description of the construction results in a certain actualization state. In other industries black box principles are quite common and one of them referred to as "FUTS-decomposition" (Functional Unit (FU) / Technical Solution (TS)) can be applied in the construction industry too.

It separates each building object into a functional appearance: all properties relevant for its use and inter-working with other objects and a technical implementation including details for the realization of the object. Figure-37 below the flexible procedure of FUTS decomposition principle;

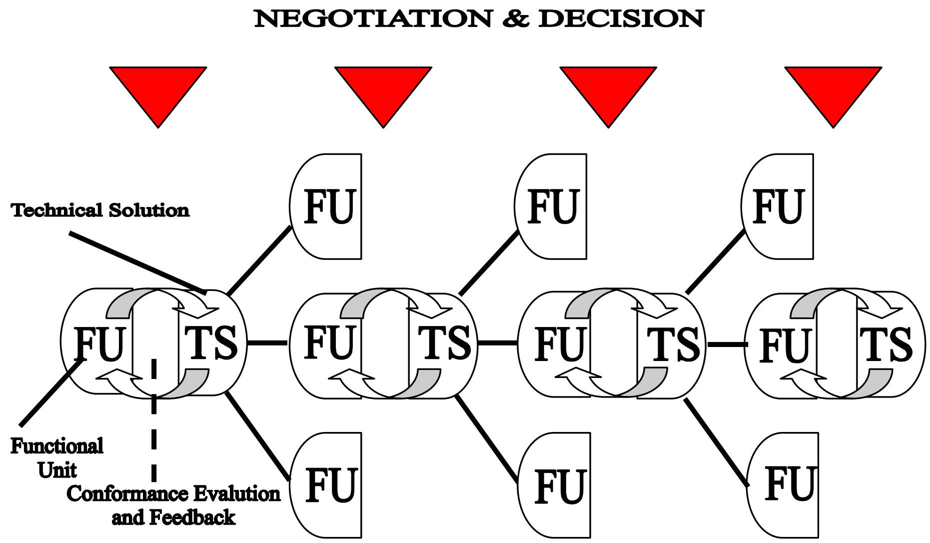

Figure 37 – The Flexible Way (Source: ROADCON Project, 2003)

Typically system starts with a global functional unit for which has required properties. Then; system searches for (alternative) technical solutions that match those requirements. If one can buy such a solution (as a "product" or "service"), no more details are necessary. If no direct TS exist there is a design problem: The required TS have to be defined and decomposed into a set of interrelated sub-FUs which on their turn …etc. That is, the original black box has to become a white box.

If IT can handle this kind of structures it will be much easier to collaborate because the communication needs will drop: only the essential performance properties have to be agreed (like in performance-based contracts). This principle is especially relevant in the beginning of the lifecycle that is in the interaction with the client who wants to have performance-based benefits from the product he will get. However, FUTS alone is basic but not enough. Especially for client-added value, more support is needed like: performance measures, conformance-testing procedures, advanced simulation & visualization techniques; and in general a change attitude from cost to value. In a sense TSs have associated costs where FUs have associated values (ROADCON Project, 2003).

5.1.3 Strategic Level: IT Solutions

Collaboration: The trend is distributed virtual teams combine best competences regardless of organizational or geographic boundaries. If the main IT applications like CAD, Cost Estimation and Time Scheduling tools are accepted as "enablers", the idea is that there is a need for a complementary top-down applications like Web Places, Work-flow Management (WfM) and Electronic Document Management (EDM) and other collaboration software tools to enforce/empower people from a project management perspective to work more closely together internally and externally (ROADCON Project, 2003)

The most well known form of collaboration is between people and their supporting IT applications over the different product lifecycle phases. This collaboration goes downstream and upstream: downstream flow of information for more efficiency by reuse and upstream for more effective solutions. The same principle applies to the supply chain involving the typical supply-chain parties (clients, contractors, sub-contractors, suppliers and manufacturers). The need is a functional integration of interrelated disciplines like modeling, (regulation) checking, cost estimation, time scheduling and (actual) construction for several product aspects.

Enhanced Functionality: The trend is more functional IT software applications really targeting and supporting the end-user (practitioners) needs throughout the building product lifecycle making him more productive by allowing reuse of information avoiding errors, automation, improved decision support and visualization (like VR-techniques). Often, IT applications are divided into three layers: Business Logic, Storage/Persistency and Visualization. The storage part is getting more important not just storing data but also covering reusable basic application logic. Key point in the business logic is the support of modeling the end-users world in the right way: not too little (being complete), not too much (hide unnecessary details) and powerful enough supporting all generic abstraction mechanisms. This trend is closely related with another trend referred to as "Model-based applications".

Model-based Applications: Now applications can "understand" not only pixels, lines or boxes but also the real-world objects behind them in the form of walls, columns, beams and ceilings. A set of object definitions is often referred to as an ontology or a taxonomy. Agreement on such an ontology is seen as the holy grail of software integration. All in all, model-based is equivalent to added semantics or meaning to the information that IT handles.

The trend is smarter software (applications and information) that better understands the building objects of interest and can support the all end-users of this IT in more intelligent ways without manual interpretation and re-entry.

Information Sharing: The trend is that, all products and process information is available to all stakeholders, over the whole life cycle in the latest version from one logical source. The Internet makes it possible to store all needed information in one logical place referred to as a project or product model and access this information from any internet-based device. Information could be physically distributed but logically linked. The essential feature of information sharing is that no information is "owned" by a specific IT Application. The black boxes are opened (obtaining white boxes) and data is moved from one place to the other (data transfer) or to a neutral place where all applications can access and manipulate it (data sharing). It is important to note that these definitions not only hold for "data" as information but also for "functionality". In that sense it can be said that the trend is towards shared data via shared functionality or shared objects (if combined with the object orientation trend). Another recent term for this final situation is Server-Based Computing (SBC) as a modern version of the good old telnet sessions (ROADCON Project, 2003)

Object Orientation: The trend is the integration of functionality & data in objects with behavior. Instead of isolated functions or information, “intelligent objects” with state and behavior inherently integrate these two aspects. It seems as if data and applications servers will merge in the future towards object servers. Ideally this OO-approach should address occurrence specification, type specification and definition of objects from both a conceptual and an implementation perspective.

Adaptive / flexible systems: The trend for systems is self-learning from their own use and user behavior, and adapting to new situations without manual configuration, maintenance and support. Self-adaptation is a general concept that covers a broad spectrum of technologies and standards. The idea is that the IT systems should get more intelligent and have the possibility to adapt themselves to changing environments and user behavior so that they continue to provide solutions even when the problems change. The idea is to have more flexible systems that can do more then solving a static problem and are able to handle a whole range of potential problem. This not only holds for specific performance but also for the environment the system works in i.e. have to integrate with. The key word here is Self-X where X stands for all currently time consuming human tasks like configuration, customization, integration, learning and healing (repairing).

Flexibility is a trend that comes in many favors. First, people did not like the dependencies with respect to the operating systems they used. Flexibility is also required when requirements and/or the operating environment changes. Especially in construction this is seen as a trend because of the dynamics in the grouping of stakeholders and their associated IT systems.

Finally all forms of embedded systems can be classified under this trend. IT is not only used to support the construction processes but more and more also becomes part of the result of these processes. Smart Buildings and Infrastructures are a good example here adapting themselves for a wide range of aspects including access, security, communication, comfort and efficiency (ROADCON Project, 2003).

.1.4 Strategic Level: IT Enablers

Open Standards: The trend is integrated IT systems expected to require open communication and integration providing interoperability. The general assumption is that there will never be one IT Vendor who can deliver all software functionalities in the best possible (optimal) way, each vendor has to concentrate to be good in his core business/expertise/competence and a complete IT system will always be multi-vendor, consisting of software modules from different vendors. But this is completely wrong.

Especially in construction where projects always involve external communication, open standards are therefore crucial and it is not difficult to see that agreements on communication between software components.

Web-based Processes: The Internet and the future Next Generation Internet (NGI) or Semantic Web will be the information infrastructure backbone for all communication. Currently web-based systems serve mainly human communication but its next generation, often referred to as the "Semantic Web" will connect not only humans but also IT applications and all web-based devices running this software in a model-based way.

Ambient Access: Ambient access means that people and/or IT applications can always have reliable (i.e. anytime in the right quality) and fast communication from any place ("universal") to any other place: "unlimited range" or wide area. For this trend, mobility (the possibility to "roam") and wirelessness (WiFi, Bluetooth) play an increasingly important role (ROADCON Project, 2003). The trend is to be able to access reliable information while on the move not connected via any wire, via the most appropriate device (mobile phone, laptop, PDA, TabletPC, etc.). 4G telecommunications, ubiquitous broadband, is closely related to this theme.

5.1.5 Key Trends for Turkish Construction Industry

Within this study, six key trends are selected which are thought to have the most influence. They form in a sense the backbone of the IT vision in Turkish Construction Sector. These key trends are:

- Knowledge Reuse
- Model-based Applications
- Information Sharing
- Object Orientation
- Open Standards, and
- Web-based Processes

These key trends indicate that the future for Construction IT is essentially towards "Open, web-based, knowledge-sharing and reusing, object oriented and model-based where "information" and "knowledge" both cover data and functionality (or "intelligence") aspects."

All these trends together, if harmonized well, strengthen each other and are able to fulfill the vision on the future of Construction IT.

The results for all these initiatives are missing synergetic effects. One approach should try to standardize results of these key initiatives. The right IT trends and choices should be analyzed for Turkish construction industry and the key IT opportunities should be harmonized and integrated.

Too often the design and build phases of the construction product lifecycle is chosen as primary interest. However, there should be more effort in getting improvements in the eyes of the clients. Improved efficiency in the process will lower costs and (maybe) the price. What really counts in the end is how the result of this improved construction process is more highly valued by the client. In constructing houses there should be sufficient concentration on the making of the house, the house as end-product or even better the living process as required by the client.

5.2 KEY IT OPPORTUNITIES

A large set of IT-related opportunities can be identified for the trends as follows (ROADCON Project, 2003);

- IT Solutions
    - IT Architecture

- Collaboration: Web Places, Workflow, Document, Transaction Management

- IT Applications
  - Enhanced Functionality: Model-based 3D CAD, 4/5/nD Modeling, Simulation, Virtual Reality (VR), Froogle
- IT Infrastructure
  - Middleware (Data/Application Services, APIs)
  - Intra-, Extra-, Internet (Base Infrastructure: Ethernet, TCP/IPv4/6, HTTP, URI, HTML)
  - Model-based: Semantic Web,
  - Information Sharing: Application Programming Interfaces (SDAI, XPath, IFC API), smart merging
  - Object Orientation: Web Services
  - Flexibility: UML, Java, Ontologies, Adaptive Systems, Embedded IT
- IT Enablers
  - Open Standards: ISO STEP, ISO/DIS PAS 16739 IFC 2x Platform specification, IAI IFC 2x 2 nd Edition, ISO/DIS PAS 12006-3, IAI XM7 Project, eConstruct/eCognos bcXML
  - Web-based: XML, XSD, XSL(T), SOAP, WSDL, SVG/X3D, UDDI, RDF(S)/OWL, BPEL4WS
  - Ambient Access: GPRS, UMTS, Bluetooth, WiFi, Satellite, Gigabit Ethernet, ADSL, Cable, Firewire-800, GPS
  - Generic Tools: EAN-UCC, ebXML, RDIF, GDL, OpenDWG

Among all those IT opportunities, the most important IT opportunities have been highlighted, that enable the key trends selected above.

1. Basic Processing/Communication/Storage for the Knowledge Sharing & Re-use trend
2. Mobile Communication Technologies for the Knowledge Sharing trend
3. Froogle for the Web-based trend
4. Semantic Web (SW) for the Model-based trend
5. Web Services (WS) for the Object Orientation trend

6. IAI IFC for the Open Standards trend (for "specifications")
7. ISO 12006-3 for the Open Standards trend (for "definitions")
8. ISO-STEP for the Open Standards trend (for "transition")
9. XML (-based technologies) for the Web-based trend
10. Open DWG for Open Standards trend (for "transition")
11. Positioning Technologies for the Knowledge Sharing trend
12. EU 5th FP IST (eConstruct/)e-Cognos for the Web-based trend
13. GDL for the Web-based trend
14. EAN-UCC for the Web-based trend and Open Standards trend

5.2.1 Basic Processing/Communication/Storage Technologies

Today, both workstations and mobile computers seem to offer for most applications enough processing power for the current IT applications. Additional devices communicate faster and faster. A good example is the Universal Serial Bus (USB). Of course processors, memories and interfaces will improve but this is just seen as nice-to-have than essential for successful IT application in construction.

Today most companies have fast Ethernet networks (100Mbps) available. In the short and middle term future these will be replaced by 1 to 10 Gbps (Gigabit) Ethernet connections.

Also storage potential (both fixed and mobile) has increased so much that it will not form a bottleneck for IT in construction. Especially on the mobile site (re)writable DVD like DVD+RW will in the sort term replace (re)writable CDs and offer plenty of storage requirements. In the middle term these might be replaced with blue ray alternative that offers storage in the order of 100 GB per disk.

In the future performance with respect to storage, processing and communication of construction information / knowledge will play a less critical issue.

5.2 2. Mobile (Wireless Connection) Communication Technologies

WWAN – Wireless Wide Area Network: After 2G generation GSM, GPRS is taking over as 2.5 G intermediate technology before deployment of so-called third generation (3G) UMTS networks. However many investments are still necessary and introduction is slow in a bad economic climate.

Also there is a chance that UMTS will never take off in case broad coverage of systems like WiFi emerges (imagine all companies, shop centers, airports, train stations, gas stations, homes etc. become WiFi access points (i.e. wireless providers); why then do we need UMTS? Clearly UMTS would be "everywhere" providing for a higher roaming level. (WiFi would provide for e.g. Internet access, and also some phone-functions over IP, but UMTS at the moment is the new-generation 'phone' network with more mature functions for billing, user-identification and roaming, etc. (ROADCON Project, 2003). In Turkey there are currently 2 GSM900 and one GSM1800 network, all supporting GPRS data transfer, but there are no immediate plans for rollout of UMTS networks.

WLAN – Wireless Local Area Network: Wireless Fidelity (WiFi) is one of the key players here. Many access points now deliver dual-band support. Although it is fine for certain situations, mobile networks are still very slow compared to the 1 GB/s wired networks of today. Security has been a major issue since the introduction but has been improved steadily. Currently 802.11.i is in development applying AES (Advanced Encryption Standard) to improve security issues. AES is the chosen follow-up of DES (Data Encryption Standard) allowing a longest & strongest key-length of 256 bits (ROADCON Project, 2003). In Turkey, public WiFi (wireless LAN) is spreading slower than western countries. With a few exceptions, hot-spots are limited to high-prestige areas like Istanbul Ataturk Airport and Beyoglu in Istanbul (April 2004).

WPAN – Wireless Personal Network: Bluetooth radio waves are completely taking over INFRARED (IRDA) connections in this area. Bluetooth adapters for USB now already connect (Bluetooth enabled) mouses, keyboards, Personal Digital Assistants (PDA) s, mobiles phones, printers, scanners etc. An older ETSI (European Telecommunications Standards Institute), standard used for Handies (cordless phones with limited roaming) is DECT (Digital Enhanced Cordless Telecommunications) (ROADCON Project, 2003).

Even the near future for these technologies is hard too predict. To what extent can wireless technologies take-over wired connections? General conclusions are hard to draw but for certain applications the trend is set. Good chance however is that we will have a mix of all these technical solution optimizing for each application area on aspects of roaming capability (coverage), energy needs, device cost and of course performance (esp. speed). Chips are currently available that combine GSM, Bluetooth and WiFi. It is not hard to see future chips combining UMTS, Bluetooth and WiFi that enable a very flexible application layer in a multi-wireless (i.e. (capable of switching from one wireless standard to another) environment.

5.2.3 Froogle

Google (http://www.google.com/) is a well-known and well-used general Internet search engine. Speed and simplicity are the basic design principles that are seen as its key success factors. Froogle is a new service from Google that makes it easy to find information about products for sale online. By focusing entirely on product search, Froogle applies the power of Google's search technology to a very specific task: locating stores that sell the item you want to find and pointing you directly to the place where you can make a purchase.

The semantics added is just: Commercial products offered (consumer products only), products per classification category (search within), only price range as a property that can be specified

However, because of its current critical mass these are developments to follow closely. They might in future start exploiting semantic web technologies and become the Microsoft of semantic searches over the web.

5.2.4 Semantic Web Opportunity

The Semantic Web is a mesh of information linked up in such a way as to be easily processable by machines, on a global scale. IT can be thought as being an efficient way of representing data on the World Wide Web, or as a globally linked database. It is an extension of the current web in which information is given well-defined meaning, better enabling computers and people to work in cooperation (ROADCON Project, 2003).

The majority of the current web is based on HTML, CSS and Javascript, and to a lesser extent server-technologies like CGI, which is typically for human communication. Computers or other devices have no way of interpreting this information. The semantic web structures the information making it also accessible and comparable for software applications. XML can be used to express this information but more is needed to define it semantics. The Semantic Web approach develops languages for expressing information in a machine processable form. For this OWL (Ontology Web Language) is offered. This language can be used to define the objects that will be communicated. With OWL both data structure and actual data can be described together with their interrelationships. OWL provides with a very flexible way to organically describe both structure and content.

The problem with the majority of data on the Web is that in this form at the moment it is difficult to use on a large scale, because there is no global system for publishing data in such a way as it can be easily processed by anyone. So the Semantic Web can be seen as a huge engineering solution. But it is more than that. As it becomes easier to publish data in a repurposable form, more people will want to publish data, and there will be a knock-on or domino effect.

The semantic web can do what ISO STEP technology never did; the built-up of enough critical mass to share a common syntax and grammar makes the data structure and content interoperable and integratable. IAI IFC and ISO 12006-3 semantics can be brought into this framework in the form of high potential ontologies that can be reused by many applications in a more flexible way than existing today.

5.2.5 Web Services Opportunity

"Web Services" are seen as the next Internet hype. They offer a web-based way of having software functionalities use/call each other over the web. Just as the Internet is not a product, but a means of doing things on a global scale, Web services are standardized way of passing a wide variety of information and processes between different systems (ROADCON Project, 2003).

With the Web services technologies, application servers get a new type of channel for information exchange, adapted to Internet communication, as based on XML. Moreover, the economical development model of Web services brings to enterprises standardized means to perform any type of exchange with great simplification and speed of interconnections and collaborative work. This is a key-point in a context requiring providing flexible and lean organizations with state of the art communication, especially taking into account the specificity of the building sector, and its unique network of SMEs.

Web Services are essentially a combination of three specifications that all share an XML-syntax: UDDI – Universal Description, Discovery and Integration of Web Services (who provides?), WSDL–Web Services Description Language (what service is provided?) and SOAP (over HTTP) – Simple Object Access Protocol (how is it communicated?)

Web services are perceived as future powerful instruments of deployment of new enterprise applications with a substantial business logic, i.e. one can publish any application over the Internet like a Web service with the description of its interfaces (via WSDL), ways of publishing and finding it as a resource (through UDDI), providing means for remote requests (through SOAP), and coordination (through workflow protocols, e.g. WSFL). These should allow ease of access by other Web applications, and simplify future EAI (Enterprise Application Integration).

However, link is required with the so-called "Semantic Web". “Web Services” are for “functionality” like what the “Semantic Web” is for “data” on the web. Combined (WS/SW) in the right way they will form the future backbone of any IT Infrastructure providing the agreed basis for construction data and intelligence management, transfer and sharing.

5.2.6 IAI IFC Opportunity

The Industry Foundation Classes, IFC, aims to become an industry standard in the construction sector for transfer of product model data among information systems. In order to achieve this, IFC has to be adapted to flexible product design and support exchange of information structured according to ISO 12006-2 and different national and regional systems based on this standard. For the exchange to be complete, a correspondence between the classes of the sending and receiving systems are needed (ROADCON Project, 2003).

The standard is developed through the International Alliance for Interoperability, IAI, whose members are software developers or users (IAI,1999). The IAI mission is to provide a universal basis for process improvement and information sharing in the construction and facilities management industries, using (IFCs).

The purpose of IFC is to establish a common way of describing data for different applications, both with regard to conceptual content, terminology and exchange format. The purpose is to achieve interoperability, i.e. information transfer without information losses and without the need for intermediary human interpretation and that is not limited to unique software vendor or system.

IAI has fixed a “core” as platform and defined a way to extend this core IFC model with standards from specific disciplines numerous ways. IFC moved a step closer to full international support as a common language in construction. Platform specification was registered as a draft international standard (DIS). This means that at the end of the committee draft (CD) stage, the International Organization for Standardization (ISO) approved this publicly available specification (PAS). Although this draft standard is not one that building industry practitioners would necessarily refer to, it is still significant that IFCs are a practical tool for sharing information electronically.

5.2.7 Open Standard - ISO 12006-3 Opportunity

ISO DIS 12006-3: Building construction – Organization of information about construction works – Framework for object-oriented information exchange. This draft international standard developed within ISO TC59/SC13/WG6 specifies an information model which can be used for the development of ontologies, defining concepts of interest and their relationships for the construction industry, in a language independent and computer interpretable way. Vocabularies based on the standard should provide common, cross-language definitions, which can be referenced from classification systems, information models and object libraries (ROADCON Project, 2003).

5.2.8 ISO Standard for the Exchange of Product Model Data (STEP)

STEP, the Standard for the Exchange of Product Model Data, is a comprehensive ISO standard (ISO 10303) that describes how to represent and exchange digital product information. It is the original initiative to solve interoperability problems for any industry sector. Digital product data must contain enough information to cover a product's entire lifecycle, from design to analysis, manufacture, quality control testing, inspection and product support functions. In order to do this, STEP must cover geometry, topology, tolerances, relationships, attributes, assemblies, configuration and more. STEP is international, and was developed by users, not vendors. User-driven standards are results-oriented, while vendor-driven standards are technology-oriented. STEP has, and will continue to, survive changes in technology and can be used for long-term archiving of product data.

To accomplish this ambitious goal, STEP has been developed as a multi-part ISO standard. The most important aspect of STEP is extensibility. STEP is built on a language that can formally describe the structure and correctness conditions of any engineering information that needs to be exchanged. Although generic supporting technologies like the EXPRESS language (ISO 1 0303-11) for the grammar and STEP physical File format (ISO 10303-21) for the syntax were widely used, the semantic aspects were completely taken over by the IAI with their IFC schema. From IAI perspective EXPRESS and the STEP physical file format are still used as primary representations but XSD (XML Schema Definition language) respectively XML are gradually getting more and more attention. Currently a common EXPRESS-to-XSD mapping has been agreed between ISO STEP and IAI IFC to make the transition into the world of XML easier. More semantic development for the construction sector is not expected from STEP since the IAI now also will get ISO status for their IFC schema.

5.2.9 XML (-based technologies) Opportunity

The next generation XML-based Internet provides a new opportunity for the Building and Construction industry to improve its ability to communicate project information over the Internet. eXtensible Mark-up Language (XML) will be the used format (syntax) for structured data on the future web.

XML is a subset of SGML (Structured Generalized Markup Language) and is similar to HTML, but much more structured and much wider in scope. The author of HTML documents can only use the standards tags. In XML the tags are not predefined, rather the developer creates his own tags to organize and describe data (ROADCON Project, 2003).

Based on XML many other XML-based technologies were developed like: eXtensible Schema Definition (XSD), eXtensible Stylesheet Language (XSL), Resource Description Framework (RDF) and Ontology Web Language (OWL) for defining semantics (meaning) of XML files, Web Service Description Lange (WSDL), Simple Object Access Protocol (SOAP) and Universal

Description, Discovery and Integration of web services (UDDI) for defining all aspects of Web Services. And many more (XLink, XForms, X3D, etc. etc.) They are often successful because of their relatively fast development process and inherent flexibility.

ebXML

The ebXML (Electronic Business XML) organization's mission is to provide an open XML-based infrastructure enabling the global use of electronic business information in an interoperable, secure and consistent manner by all parties. ebXML (Electronic Business using eXtensible Mark-up Language), sponsored by UN-ECE/CEFACT (United Nations/Economic Commission for Europe/United Nations Centre for Trade Facilitation and Electronic Business) and the Organization for the Advancement of Structured Information Standards (OASIS), is a modular suite of specifications that enables enterprises of any size and in any geographical location to conduct business over the Internet. Using ebXML, companies now have a standard method to exchange business messages, conduct trading relationships, communicate data in common terms and define and register business processes. ebXML is built on the experience and strengths of existing EDI knowledge. ebXML was started in 1999 as an initiative of OASIS and the United Nations/ECE agency CEFACT. The original project envisioned and delivered five layers of substantive data specification, including XML standards for business processes, core data components, collaboration protocol agreements, messaging, registries and repositories .Using the strengths of OASIS and UN-ECE/CEFACT to ensure a global open process, ebXML develops technical specifications for the open ebXML infrastructure with the world's best experts by collaborating with other initiatives and standards development organizations.

ebXML goals:

- To provide the only globally developed open XML-based Standard built on a rich heritage of electronic business experience,
- To create a Single Global Electronic Market,

- To enable all parties irrespective of size to engage in Internet-based electronic business. Provides for plug and play shrink-wrapped solutions,
- To enables parties to complement and extend current Electronic Data Interchange (EDI) investment,
- To expand electronic business to new and existing trading partners,
- To facilitate convergence of current and emerging XML efforts.

5.2.10 Open DWG

The Open Design™ Alliance is an association of CAD customers and vendors committed to promoting Autodesk's AutoCAD DWG drawing file format as an open, industry-standard format for the exchange of CAD drawings. As a result, CAD data will finally be fully-accessible; CAD software will work better with existing DWG files; and developers will be able to concentrate on building products instead of reverse-engineering solutions. While OpenDWG is designed to provide as near to perfect compatibility with DWG as is possible, it has several advantages that have made it a safe choice for even mission-critical applications. First and foremost, it is documented, with no hidden encryption, and no obfuscation. Second, it is supported, with a dedicated team of technical professionals focused on fixing any problems that may crop up from time to time. Third, OpenDWG software libraries are clean, written in object-oriented C++, and designed to impress even the most fastidious commercial software developers. And fourth, OpenDWG software libraries are updated, providing compatibility with all versions of DWG (ROADCON Project, 2003).

The database world suffers greatly from having no structure standards such as the OpenDWG standard for CAD drawings so that different application software can deal with the same data. An open database structure standard will allow for a better understanding of how, what, why, and where an end-user should be able to deal with the data he needs to operate with.

5.2.11 Positioning Technologies

Logistics play an important role in construction because the product is typically built or at least assembled on-site. Basic requirement for any planning and control in the "build stage" is to know where things are. Over the next five years, the European Union (EU) and the European Space Agency (ESA) plan to deploy Galileo, Europe's new civilian-managed Global Navigation Satellite System (GNSS). Successful deployment of a second fully operational GNSS named Galileo will more than double the number of GNSS signals in space available to users. This large increase in satellites will benefit not only single-point accuracy but also position reliability (ROADCON Project, 2003).

Until positioning technologies like General Positioning Systems (GPS) will offer cheap enough one-chip solutions, other more local systems will have to be used (like Radio Frequency IDentification (RFID).

5.2.12 EU 5th FP IST (eConstruct/)e-Cognos bcXML(2)

The objective of the European eConstruct project is to develop, evaluate and demonstrate how the Next Generation Internet can be used to improve meaningful electronic communications in the European Building and Construction industry, supporting future eCommerce and eBusiness. The project aims to develop, implement, demonstrate and disseminate a new Communication Technology (CT) for the European Building and Construction industry, tentatively called Building and Construction (BC) extensible Mark-up Language (bcXML). This Communication Technology will provide the European BC industry with a powerful and low cost communication infrastructure (ROADCON Project, 2003).

Besides the Communication Technology, eConstruct also aims to develop and demonstrate a number of applications that use the CT.
The following applications of bcXML will be developed and demonstrated in the project:

- bcXML support for supply-side information providing, i.e. catalogue building.
- bcXML support for shopping and buying of individual components.
- bcXML support for project related procurement involving design/engineering.
- bcXML support for Computer Aided Selling.

The next generation XML-based Internet will remedy the problems with the current HTML based Internet, it will be safe, fast and much more structured. The basic principle is that XML makes a distinction between content and mark-up. The content can be made very BC specific, i.e. the computer knows what it is meant by column, beam, floor plan, height, weight and such. The partners expected to be able to develop the required Internet-based communication technology, together with a number of applications, and to demonstrate electronic meaningful communication over the Internet, over the national borders (in various native languages), with graphical support, and without the pitfall of international standardization and vendor implementation. By providing a cheap but powerful Internet technology and a mechanism to communicate over different taxonomies, countries and disciplines the partners hope that gradually an electronic Information System will replace BC's paper-based Information System. The main outcomes of e-Cognos will be a set of semantic models, an e-COGNOS construction specific API and an integrated IT infrastructure comprising proprietary and commercial KM services.

5.2.13 Graphical Description Language (GDL)

GDL is a technology developed by Graphisoft. The mission at Graphisoft is to establish GDL as the standard description language for building components. Today, some international manufacturers in the building industry are already publishing iCatalogs with GDL objects describing real-life building components. It illustrates very well the object-based principle for the building product level (ROADCON Project, 2003).

5.2.14 EAN-UCC

The American UCC (Uniform Code Council inc.) has developed UPC (Universal Product Code). They harmonized it with their European counterpart EAN International via the EAN.UCC system. Both UCC and EAN focus on "item identification". Typically these EDI-organizations are giving input to ebXML the XML-version of their offerings. One of their main results is the Global Data Dictionary (GDD). These commercial data elements definitions will form essential semantics in any transaction-oriented eCommerce system in the future. EAN International and the Uniform Code Council, Inc. (UCC) created the Global Standards Management Process (GSMP) to support standards development activity for the EAN.UCC System. The GSMP was developed to maintain standards-based solutions for global trade using EAN.UCC System technologies (ROADCON Project, 2003). The GSMP uses a global consensus process to develop supply chain standards that are based on business needs and user-input, bringing together users from all industries, from anywhere in the world, to allow for a uniform approach and methodology for global standards management.

Besides this natural semantic shift also technologies will change drastically. Bar codes will eventually (when chip prices drop) be replaced by RFID, enabling further automation with respect to localization and thereby state of items. Main barrier for both bar codes and RFID remains the fact that they identify types of items and not the individual occurrences of those items. For construction industry, item identification is seen as an important aspect of modeling construction parts and products on the level of type and occurrence specifications and definition.

5.3 A GENERAL IT ARCHITECTURE SKELETON

Intensive inter-enterprise collaboration and information sharing is a fundamental characteristic of construction, and it will be even more in the future. Figure-38 below shows a high level view of target IT architecture in a multi-enterprise environment. In this figure the IT system components are grouped on 7 layers (Globemen IMS Project, 2002), and the figure shows the logical and functional architecture while the physical architecture can be implemented in numerous ways.

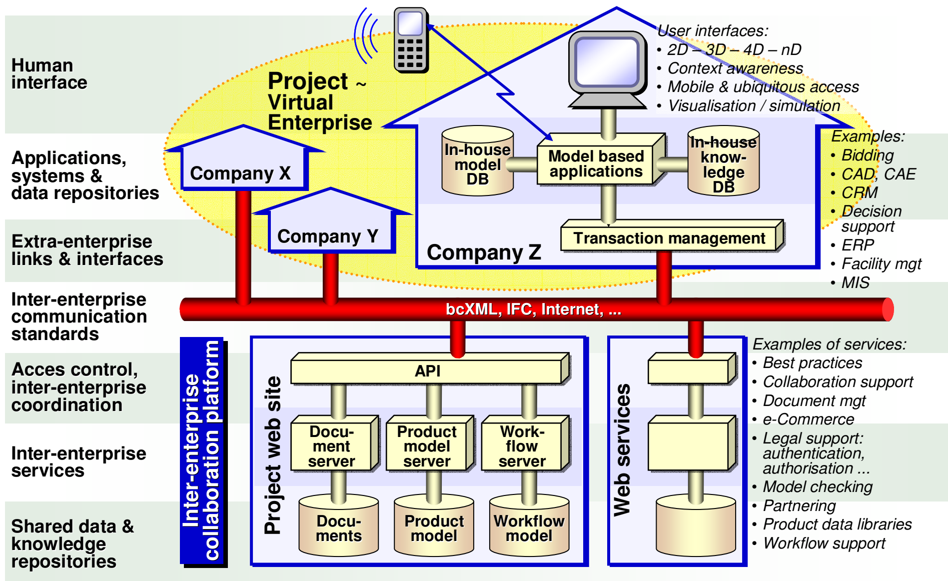

Figure 38 - A Global Target IT System Architecture for Collaborative Processes in Construction (Source: Globemen IMS Project, 2001)

The topmost 3 layers describe the internal IT environment of a company. Interfaces to external systems are determined on the 3rd layer. Otherwise, an organization has a high level of independence to decide what kind of IT solutions it uses. The middle (4th) layer is basically the Internet and related protocols and standards. This is especially the case in construction where dynamic business relationships make commonly available and standardized communication means (i.e. the Internet) highly preferable compared to any proprietary IT network solutions.

The 3 bottom layers describe the inter-enterprise collaboration platform. It consists basically of services and shareable information that are accessible by standardized interfaces (APIs). These can be complemented by a variety of additional services as needed. The services in this layer can be provided e.g.

by external service providers (e.g. of "project web sites") or by the collaborating companies themselves (ROADCON Project, 2003).

Envisaged IT tools, systems and platforms:

Human interfaces: The human interface is what a human user sees and interacts with. General-purpose web browsers are increasingly used at this layer. The user interface provides:

- User specific view e.g. 2D – 3D – 4D –5D – nD,
- Context awareness,
- Mobile & ubiquitous access,
- Visualization of analysis/simulation results etc.

Applications & systems: This layer provides tools and databases that are available within an organization but are not accessible to other organizations. A large number of end-user tools can be identified:

- Analysis, Automation, Bidding, CAD, CAE, CRM, Decision support, Design, Engineering, ERP, Estimation, Evaluation, e-Commerce, e-Negotiation, e-Work, Facility Management, Knowledge Management, Learning, MIS Simulation, Smart buildings, Web services, etc…

The applications are related to construction process stages and actor roles. It is anticipated that for the foreseeable time companies will prefer to "own" applications and systems for daily core activities. This covers "outsourcing" to external service providers on a long-term basis.

Inter-enterprise interface: In order to achieve cross-company interoperability at project level it is necessary that in-house systems be provided with an open external interface. This layer will provide controlled transaction and communication with other organizations. In most companies hardly more than a firewall exists today. Ad hoc means like e-mail, collaborative web sites etc. are frequently used for inter-enterprise communication. The main problems are that individual employees are expected to learn and use varying external systems directly (with web browsers) and the organization has very little control of in- and out-going information flows. It is envisaged that much flexible support will be provided in the future in order to integrate internal and external workflows in a transparent manner while assuring security.

Proper implementation of this layer will protect a company from being imposed e.g. by a dominant customer, to use other IT tools than those that it is familiar with. Some functionalities at this layer are: Encrypting, Digital signing, Filtering, Firewall, Event logging (audit trail), Messaging, Packaging, Transaction management etc.

Inter-enterprise communication technologies and protocols: At this level the construction sector must mainly rely on publicly available networks (the Internet) and open standards:

- bcXML, IFC, Internet protocols, etc.
- Underlying standards for distributed systems are e.g.: IFC, LDAP, PDM schema, SOAP, STEP, UDDI, XML, WSDL, etc.

Access to inter-enterprise collaboration platform: A main issue here is management of role-based access. Companies working together in a project will have contract-based rights and obligations. Typically each company assigns corresponding roles to its employees. The same persons will have different roles (i.e. rights) in different projects. The inter-enterprise collaboration platform should enable role-based access in a transparent manner.

Web services: Key services are: document/file management, collaboration support, product model management and trust management.

These can be complemented by a variety of additional services as needed e.g.: Best Practices, e-Commerce, e-Contracting, e-Learning, e-Litigation, e-Market places, e-Negotiation, Notification, Partner & supplier databases, Product & material data libraries, Schedule / process / workflow synchronization, Standards-compliance checking etc.

Shared repositories: This layer simply provides the persistent storage of the data, which is shared between collaborating companies.

CHAPTER 6

THE NATIONAL IT STRATEGY FOR TURKISH CONSTRUCTION INDUSTRY

An efficient and profitable construction sector is a key fundamental for national success. It has a major influence on the economic wealth, the societal well-being, and sustainability of the built environment. Companies must recognize that the full benefits of an IT project can only be realized as part of an overall business strategy (Bruce, 1995). However construction organizations are often slow to formulate strategies that recognize the role of IT and result in corresponding IT strategies.

There is a clear need for a framework that enables all parties to communicate and exchange information on possible IT tools in a form that is readily recognizable within the culture of the construction sector. Up to now, the specific needs of the construction sector with regard to this issue have been hindered by the lack of an appropriate sector-specific tool to deal with some aspects of sector-specific language and culture.

Developing a coherent and consistent strategy to provide Turkish construction industry with the tools necessary to realize its true potential in the years ahead requires careful consideration and foresight. The strategy should be based on how the future seems to take shape. There are trends that can be anticipated with a reasonable degree of certainty. There is little doubt that advances in IT have changed the rules of the competitive game;

construction market is increasingly international, and as a result, Turkish construction industry must be able to compete on a global basis.

Turkish construction industry must be in a position to rise to technologic challenges and keep pace with the information revolution. But to do so, using strategies and solutions, which brought success in the past, is a potential recipe for disaster. The drawback is that traditional methods do not afford sufficient collaboration, flexibility, integrity, intelligence and innovation. Therefore, Turkish construction industry, on a national level, is a natural hub for IT development. This is a fast-changing area, thus the government should have a good grasp of both the opportunities and potential problems a massive national movement to IT would present to the Turkish construction industry. Besides, the national strategy should be treated as a living document and reviewed regularly. A tried and tested procedure should be implemented, as explained in Figure-10 at the end of Chapter I.

A national IT policy has to work within the framework of a wider economic and social policy. If such policies are not conducive, IT policy alone cannot have an impact. In order to be effective policies on IT, they should be harmonized and integrated with other socioeconomic policies for national development. A successful IT policy must be consistent with overarching national goals and objectives and grounded in the reality of the state of IT at the time.

In view of the importance of IT in business processes, as well as a support for national economic and social development in general, a national policy for Turkish construction industry is required to chart the direction and provide a framework for acquisition and effective use of IT. Today's work environment is a complex and interdisciplinary one requiring skill, knowledge, judgment, and new tools to provide a supportive information infrastructure. All software in use and marketed in Turkey should be analyzed, described and published for a national platform for IT-communication within the construction industry. Adopting an IT-strategy has been many organizations' starting point to implement IT. As more persons and professions are to be involved in managing the process it must be crucial that almost everyone shares the holistic view.

Sustainability is an important element of the overall construction strategy. As described at the previous chapters, the major aim of developing a national IT strategy for construction industry is to achieve sustainable construction and then sustainable cities and consequently to take a huge pace towards a sustainable nation. Government policies help to bring about change to stimulate action by individual businesses to set, and monitor their progress towards targets for more sustainable construction, which require continuous improvement.

“Construction companies who work smarter, not harder, will gain a definite competitive advantage in selling their construction at home and abroad." (Anderson, 2000)

To achieve improvement; the role of a national IT strategy for Turkish construction industry is;

- Shortening the IT innovation cycle by acting at the level of the preparation for the business integration process. This means being able to take quick and good decisions or preparing the right business integration process the first time.
- Increasing the business benefits through the development of an efficient business integration strategy enabling the most efficient usage of a targeted IT solution leading to a significant added value relatively to the enterprise business objectives.
- Bringing together clients and all involved in the construction supply chain, in innovation, best practice, or research, who are committed to change and innovation in construction
- Providing leadership to share experience and work together to create an open, co-operative, no-blame, non-adversarial, team approach to innovation.

- Reducing the risk of failure by mastering carefully all the critical change issues / factors and facilitating delivery of the enhanced performance targets
- Promoting the changes needed to create an industry in which the norm will be committed leadership, a focus on the customer, a process and team integrated around the product, a quality-driven agenda, and a commitment to and respect for people, through sustained improvements and innovation.

IT tools has been introduced in the construction process since the end of the 1970s. Isolated digital islands have been created for design (2D/3D CAD, visualization, engineering calculations), construction (quantity take off, resource management), maintenance/use (hire administration, facility management), and recycling (components/material databases). To this; access to external vendor product information, regulations, and community information should be added. The complex project organization of the building industry together with higher international involvement will take great advantage of the future advanced IT tools. Therefore; integration can summarize most of the main identified construction industry requirements, such as (Hannus et al., 2003);

- Integration of all **activities** to the value chain, including the on and off-site activities: the model must have the potential to be as complete as the reality, but allowing flexibility so as not to impose a unique highly complex model structure.
- Integration of **actors** in cooperation under the facility owner leadership
- Integration of **workspaces** going beyond standardization or even interoperability
- Integration of the **human** dimension (knowledge, culture, training), the **infrastructure** dimension (IT hardware and software), the **business** dimension (global and project processes).

So; as being a business integration strategy enabling the most efficient usage of a targeted IT solution, the national IT strategy for Turkish construction industry is composed of the harmonization of the below listed strategic area solutions to allow industry maximum integrity, flexibility, interoperability, collaboration, intelligence and innovation to reach sustainability.
Besides, in formulating the plan, the maturity of IT in the industry, the organizational structure and IT literacy of staff are important factors that will influence the implementation. To obtain realistic milestones, the strategies are divided into steps with clearly defined goals. Strategies, short-term and long-term goals need to be scheduled on a common level for the whole industry. This implies that consensus has to be reached between a lot of different actors in order to agree on which areas to focus on and in what order.

6.1 STRATEGIC AREA: KNOWLEDGE MANAGEMENT

We are witnessing a new era of economic growth in which the rate of knowledge accumulation rivals that associated with the industrial revolution.

“Knowledge Management is a strategy to transform company know-how into dynamic and distributed competencies, to extract, standardize, share, knowledge in order to support decisional processes in more and more dynamic context and to create a real competitive advantage based on intellectual capital. The aim is to teach the companies, from managers to workers, to generate and use competencies as a collective entity. (Murray, 1997)

In order for Turkish construction industry to truly embrace integration it must undergo the transition from ‘Computer Management’ to ‘Knowledge Management’ where data are perceived as a corporate asset to be shared by all for the benefit of the industry. Generalization of reference information warehouses and best practices for future knowledge based systems aiming at supporting any construction project and national exchange of information on contractors' compliance with the Code of Practice are decisive requirements.

Given knowledge management topics, the higher relevance and importance have been given to all the topics related mainly to knowledge standardization, sharing and integration with all problems related to security and IPR, which, if not solved, can compromise a full adoption of the knowledge management approach. Another very important and almost new topic is the knowledge about the customer which drives the selection of the future products and which is a key for competitive success. Other important topics are related to knowledge extraction, competencies management and best and worst practices management.

The overall aim is to provide the construction industry with information to facilitate enterprise business planning to shift from a project focus to a more strategic and longer-term perspective. Capturing of knowledge with QA systems, so that data is recorded frequently and can be managed and generalization of the digitalization of (along with improvements in access to) relevant information and knowledge throughout the lifecycle (standards, regulations, specifications, products, etc.) facilitate the development of a knowledge-driven decision support system. Turkish construction industry is in an urgent need for the integration and automation of project information and the integration of data from the construction site into project information management systems.

The knowledge management strategy framework applicable to Turkish construction industry can be summarized as in Figure-39 below:

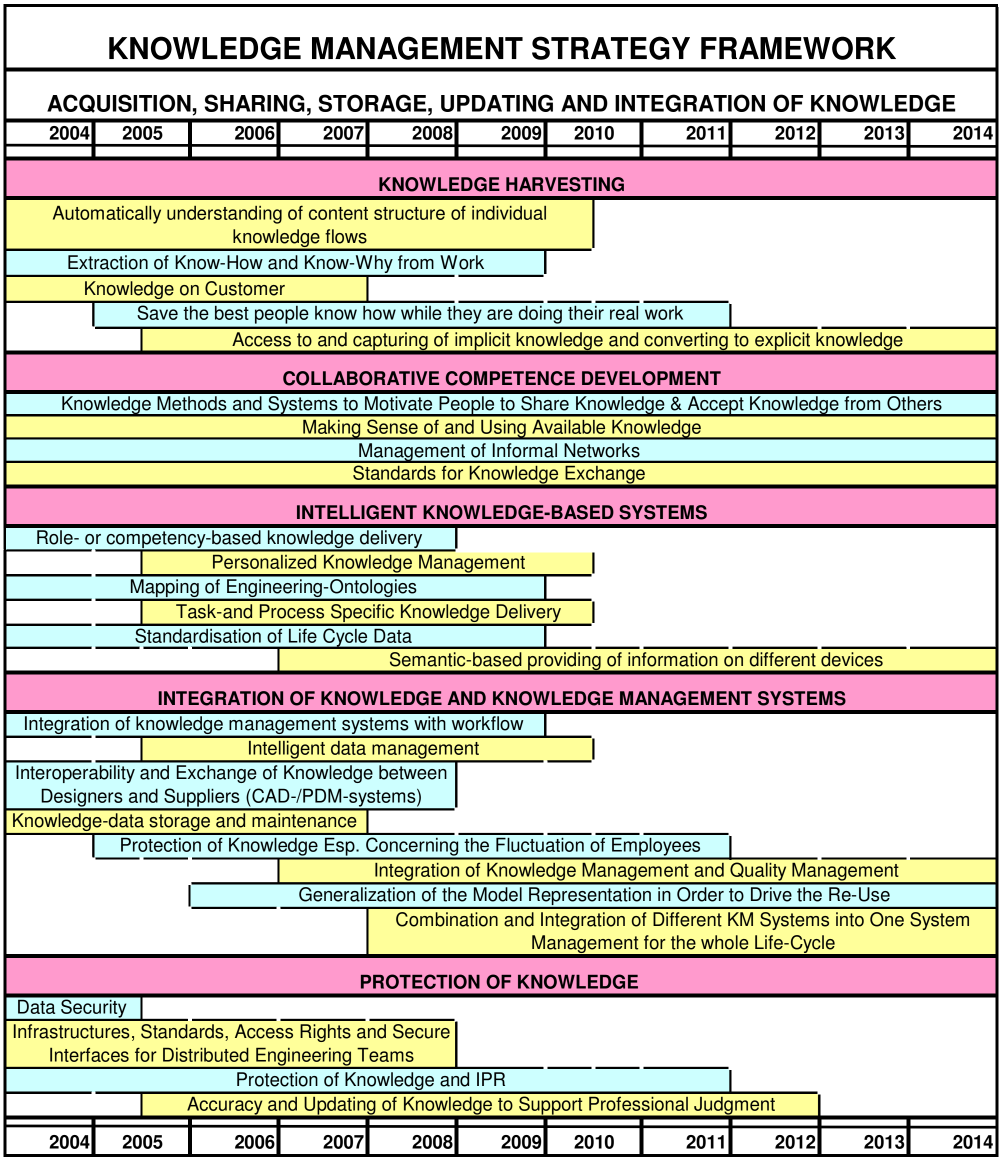

Figure 39 – Knowledge Management Strategy Framework

6.2 STRATEGIC AREA: UBIQUITOUS COMMUNICATION&COMPUTING

In Turkish construction industry, computing has been done during the last two decades on personal computer workstations and laptops. Interacting with computational artifacts and networked information has been largely a desk experience. This is now changing in a big way.

Ubiquitous Computing is a term for the strongly emerging trend toward:

- Numerous, casually accessible, often invisible computing devices
- Frequently mobile or embedded in the environment
- Connected to an increasingly ubiquitous network infrastructure composed of a wired core and wireless edges

Computation is now packaged in a variety of devices. Smaller and lighter laptop/ notebooks, as powerful as conventional personal computers, free us from the confines of the single desk. Specialized devices such as handheld personal organizers are portable enough to be with us all the time. Wireless technology allows devices to be fully interconnected with the electronic world. Cell phones are really networked computers. This is the beginning of being able to support collaborative work among people in shared physical locations. Interconnected computing devices, large and small, along with various sensing technologies, from simple motion sensors to electronic tags to video cameras, are being used to make physical rooms and buildings "intelligent." We are being carried in this direction by several related strands of research, beginning with Weiser's (1991) vision of "ubiquitous computing". New research communities and programs have formed around the notions of "augmented reality" (Mackay et al., 1993) "tangible interfaces" (Ishii, 1997), "wearable computers" (Bass et al., 1997) "cooperative buildings" (Streitz, Konomi, and Burkhardt, 1998), and so on. What these technologies have in common is that they move the style of interaction beyond the desktop and into the larger real world where we live and act.

Wireless communications and the Internet are converging towards an integrated scenario where both traditional and novel services should be ubiquitously accessible, independently of the mobility of users, terminals, resources and service components. Mobility-enabled service provisioning introduces several challenging issues to address: from client/server location change at provision time, to wide heterogeneity of access terminals, and to unpredictable modifications in accessible resources.

Value created through human interactivity depends on good governance—on resolving conflicts in a civilized and socially productive manner. The industry thus needs at least minimal government interference to protect the public interest. To this end the government has an enormous degree of power and authority to establish a computer-integrated construction environment, based on open standards for the representation, access, exchange, use, visualization, and archiving of information. With these standards implemented in software systems, Turkish construction industry will be able to achieve its goal of seamlessly circulating information throughout its life-cycle work processes, all taking place in a loosely coupled, distributed, heterogeneous environment.

An appropriate digital environment would allow every activity across distributed areas to cost-effectively create, store, access, collaborate, manipulate and/or exchange data digitally. The national information network shall be developed in nationwide scale with high bandwidth, speed and good quality with a low price so that it will help increase the number of Internet users reaching the normal rate in comparison with other countries in the world. Government has a key role in raising awareness and demonstrating the benefits of doing business online, emphasizing that electronic commerce is more than simply having a web presence. To be truly competitive in the information economy, Turkish construction organizations need to regard electronic commerce as an integral part of their commercial operations. Developing a legal and regulatory framework to facilitate electronic commerce is a vital step in building the confidence of business and consumers that online transactions are authentic, private, secure, legally sound and that there are redress mechanisms available.

Designers, specifiers, and consumers should have rapid access to comparative data on product costs, features, limitations, and availability in formats that can easily be compared, selected, and incorporated into CAD plans. Applications and plans have to be submitted electronically without the need for applicants to travel to the permit office or wait in line. Accurate, up-to-date design details, manufacturers' instructions, safety data, component specifications, and similar information should be available to workers and field superintendents in real time. Change orders, customer option choices, plan revisions, and unforeseen delays have to be entered once, then accommodated seamlessly into revisions to working documents and process schedules, with updated information propagating to all affected parties. All required inspections for regulatory approvals or loans have to be performed on demand, without suspending work or scheduling an inspector's visit to the site. Builders/developers will know the status of their applications at all times, and approvals will be returned in electronic form.

With a number of upcoming mobile multimedia applications, ease of use becomes one of the most important aspects. One way to improve usability is to make devices aware of the user's context allowing them to adapt to the user instead of forcing the user to adapt to the device.

This approach can be taken one step further by not only reacting to the current context, but also predicting future context, hence making the devices proactive and intelligent by monitoring the user context and act accordingly. The major challenges are that context recognition and prediction should be embedded in mobile devices with limited resources that learning and adoption should happen on-line without explicit training phases and that user intervention should be kept to a minimum with non-obtrusive user interaction. The objective is to guide the multidisciplinary team in charge of the change project in its innovation roadmap and provide it the right information and supporting tools at the right time according to its specific goals. Enabling technologies for ubiquitous computing include recent and future developments in hardware and software, and also the wireless networking options described in section 5.2.2. As mentioned there are no immediate plans by any of the Turkish telecom operators to rollout 3rd generation (UMTS) networks (an understandable economic strategy), but wireless and telecoms are probably the fastest developing sectors in the world. By optimization of bandwidth use, existing GPRS access can be quite useful. Furthermore, it is very likely that a technology like Wifi (wireless LANs), in the existing IEEE802.11 or a newer form, or an emerging technology like WiMAX could become widespread in Turkey. The main constraint will be the cost of these technologies. The ubiquitous communication and computing strategy framework applicable to Turkish construction industry can be summarized as in Figure-40 below:

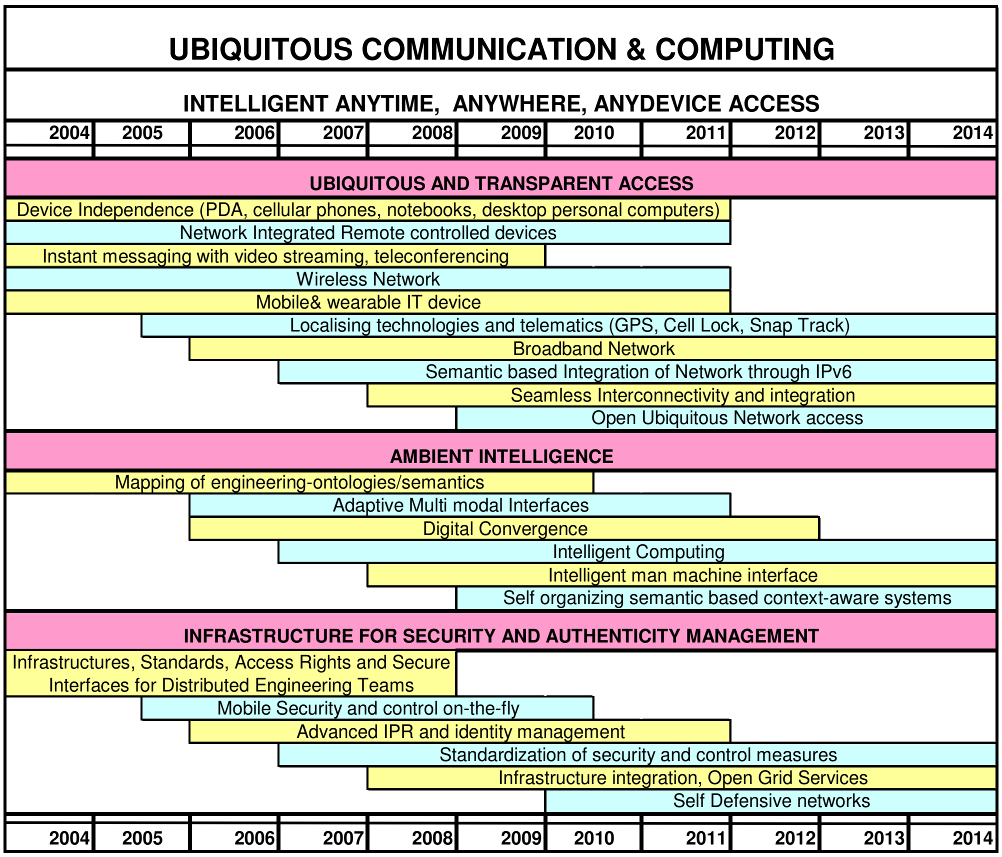

Figure 40 – Ubiquitous Communication and Computing Strategy Framework

6.3 STRATEGIC AREA: COLLABORATION

Collaboration is defined as multiple organizations working together to coordinate processes and optimize logistics asset utilization. Distributed team members should collaborate across organizational, geographical and time boundaries as if they were co-located. Single global virtual workplace for all project and business applications including the construction site is a powerful strategy for joint management, control, and improvement of a supply chain. Significant cost reductions are possible if inefficient manual processes are reduced, shipment visibility is increased, and asset utilization improved (all of which are possible through collaboration).

Turkish construction organizations need to start internally and develop the ability to share accurate and timely data. Next, they should work toward integrating important activities with their critical supply chain partners and finally, focus on collaboration with the goal of increasing visibility, efficiency, and communication in internal as well as external networks.

Tele-engineering combines shared documents and tele-presence to support engineering at a distance. Although the value of video tele-conferencing has not been firmly established, it is clear that the computer and telecommunication industry are on the verge of making video tele-conferencing ubiquitous. At this point in time, a simple form of videoconferencing is already possible with some mobile phones..

An important aspect of making the strategy work is to improve information management and closing the information gaps between organizations. The information technology providers offer a host of tools that can shrink the critical information gap between organizations and their trading network partners. Challenges exist, but they can be overcome through coordinated efforts, cooperation with supply chain partners, and the use of information technology service providers with real collaboration functionality.

Shared engineering models based on object-oriented and relational databases are the next major step in collaborative engineering. With the transition to model-based engineering and high bandwidth network access, geographically dispersed virtual teams will be able to work together on the same engineering model.

These would lead to new way of working and cooperating new organizations that will reduce time to market for a product, non-quality and cost-effective, supporting;

- collaborative work
- concurrent engineering
- 3D models as reference (digital mock-ups)
- Virtual Enterprise (different partners sometime involved in the same projects and sometimes competitors)
- Integrated Enterprise : access to all the information of enterprise and exchange/sharing between different disciplines
- Extended Enterprise: better integration of supply chain partners

IT is the only tool that can manage the abundant data that exists across the supply chain, conduct sophisticated analysis of these data, and create a greater understanding of supply chain performance and opportunities. Collaboration and networking enable organizations to extend, and thereby improve, their outreach abilities in order to serve as many target groups and individual beneficiaries as possible. Lack of collaboration entails the duplication and repetition of projects that may already have failed. Effective coordination can be ensured if the collaborative strategies implemented are directed at different administrative levels. For this reason, Turkey needs umbrella strategies at the national level and more specific strategies to coordinate activities at the operational level.

Successful cross-sectoral application of IT requires a degree of standardization in technology. Promoting the use of shared databases among consultants and contractors, Turkey should involve in the International Committees on Interoperability (IAI), Industry Foundation Classes (IFC) etc. Once engineers are working in shared models, software can automatically detect engineering conflicts between virtual team members. Although unlikely to have encoded the engineering judgment to resolve the conflicts -engineering judgment will always be needed - information technology can assist in detection and tracking of the conflict events earlier than otherwise possible.

The networked collaboration strategy framework applicable to Turkish construction industry can be summarized as in Figure-41 below:

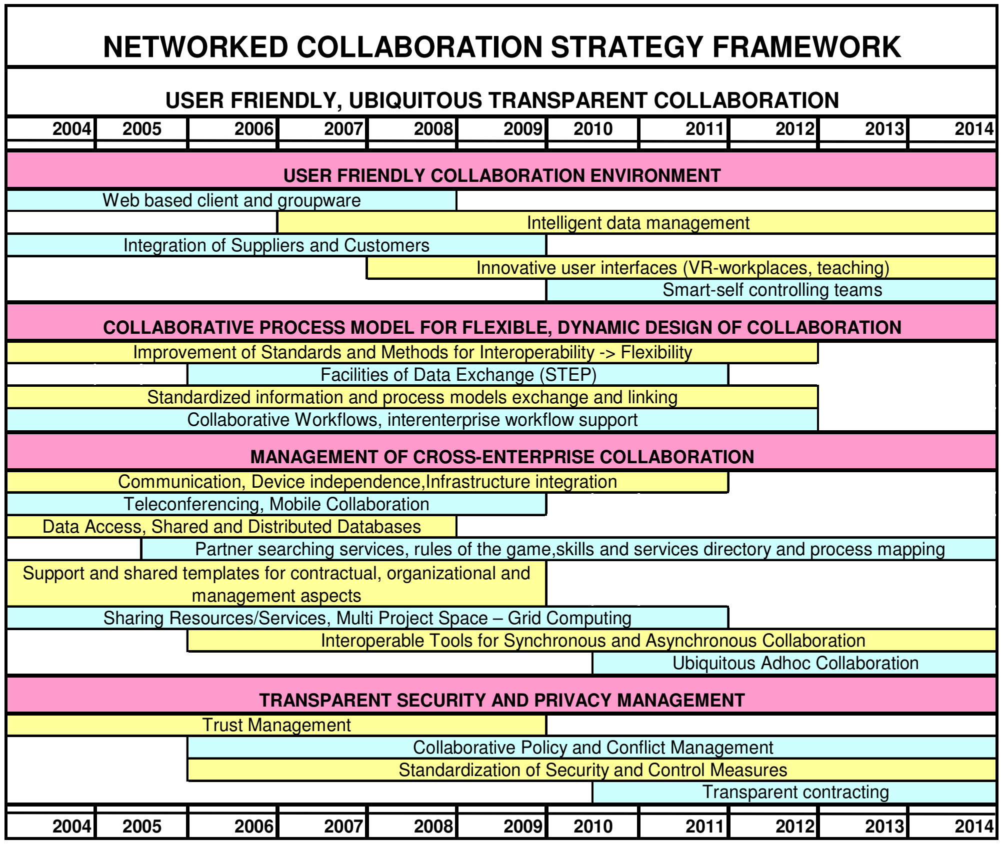

Figure 41 – Networked Collaboration Strategy Framework

6.4 STRATEGIC AREA: MODEL-BASED ENGINEERING

Techniques for Object-Oriented analysis and design are improving the ability of engineers to create and use models of physical and abstract engineering systems. Object database technologies are finding their way into both CAD integrated and stand-alone products.

Turkish construction industry has to shift their focus on drawings back to the model, which is a better base for design and communication. In the evolving model-based paradigm, instead of building engineering models based on project documentation, engineers will have tools that can interact directly with models created by other disciplines, automatically generating more detailed models as needed, and creating additional model information to pass on. Documentation and graphics will be generated from the model as needed by each discipline, but the format of these views may change to be targeted to specific uses.

One of the greatest payoffs that the move to model-based engineering will deliver is an increased capability for virtual teams engaged in engineering enterprises across organizational and geographic boundaries. Thus, one phase of the building life cycle that is rapidly moving towards model-based engineering is Computer- Aided Facility Maintenance and/or Asset Maintenance Management.

Besides, standards efforts such as STEP have been energized in the facility field by the industry-led International Alliance for Interoperability (IAI) Industry Foundation Class (IFC) effort. The emergence of distributed and platform independent languages and protocols such as JAVA and CORBA promote the development of code that is portable and interoperable, even when developed by those from different disciplines. Finally, network technology by World Wide Web servers and browsers, promotes the ease of use and readiness-to-hand required by truly useful engineering tools.

Model-based engineering is also much more conducive to the use of visualization for communication. Visualization will be an important technological theme in future, but it has been hindered largely by predominant use of traditional 2D drawings and also lack of suitable tools.

There is a genuine need in Turkish construction industry to explore the use of interactive computer modeling and simulation environments to improve client briefing and design reviews. Such environments can then be used to capture the client's needs and to ensure the compatibility between the client's vision of the project and the resulting product.

The model-based engineering strategy framework applicable to Turkish construction industry can be summarized as in Figure-42 below:

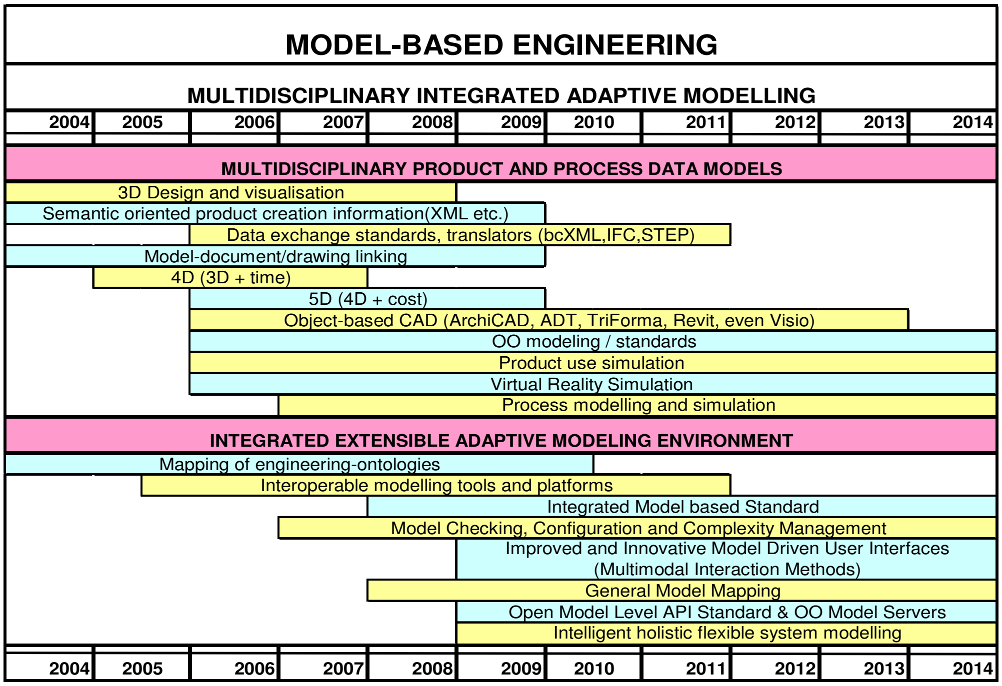

Figure 42 – Model-Based Engineering Strategy Framework

6.5 STRATEGIC AREA: VIRTUAL PROTOTYPING

Like most industrial fields the construction industry should engage in making use of product model technology to create the next generation of CAD-tools. When all information, geometrical as well as properties, about a building part is connected to the same object in the database there are vast possibilities to use that information intelligently.

The Virtual Workspace, VW, is the new design room designed to fit new and existing design routines. VW may well be a mixed reality environment. Acting as a communication space with project information support in adapted appearances, the VW will host all design partners from project start with different access and visibility (for persons and groups) in space and time to the project, and will promote building up shared values in projects.

Virtual teams, using network-based technologies (project web pages, electronic mail, shared whiteboards, chat rooms, CAD and GIS servers, internet telephony, and video teleconferencing) will have the ability to rapidly model and analyze engineering subsystems on a virtual team.

Integration of virtual and physical prototyping is the solution in the long perspective. It will need to be based on international standards such as STEP and it will take at least another 10 years to get this established.

With the combination of Virtual Environments and Simulation Environments our strategy will include:

- improving the co-ordination and communication between the different project partners and stakeholders around a visual, and thus intuitive, 3D representation of the planned construction;
- evaluating the design, earlier in the process, in regards to different constraints (architectural, technical, financial, environmental, etc.) since VR tools allow the design team to quickly gain insight, resulting in high quality feedback on the project;
- displaying what-if scenarios during the detailed design phase, in order to assess the proposed solutions from different technical points of view (acoustic, thermal, lighting, etc.);
- bridging the gap between design and engineering on one hand and construction on the other hand.

Furthermore, such interactive technology can be used to consider lifecycle issues such as concept and detailed design, environmental impact, space planning, facilities management, emergency evacuation, security and constructability during design reviews.

The virtual prototyping strategy framework applicable to Turkish construction industry can be summarized as in Figure-43 below:

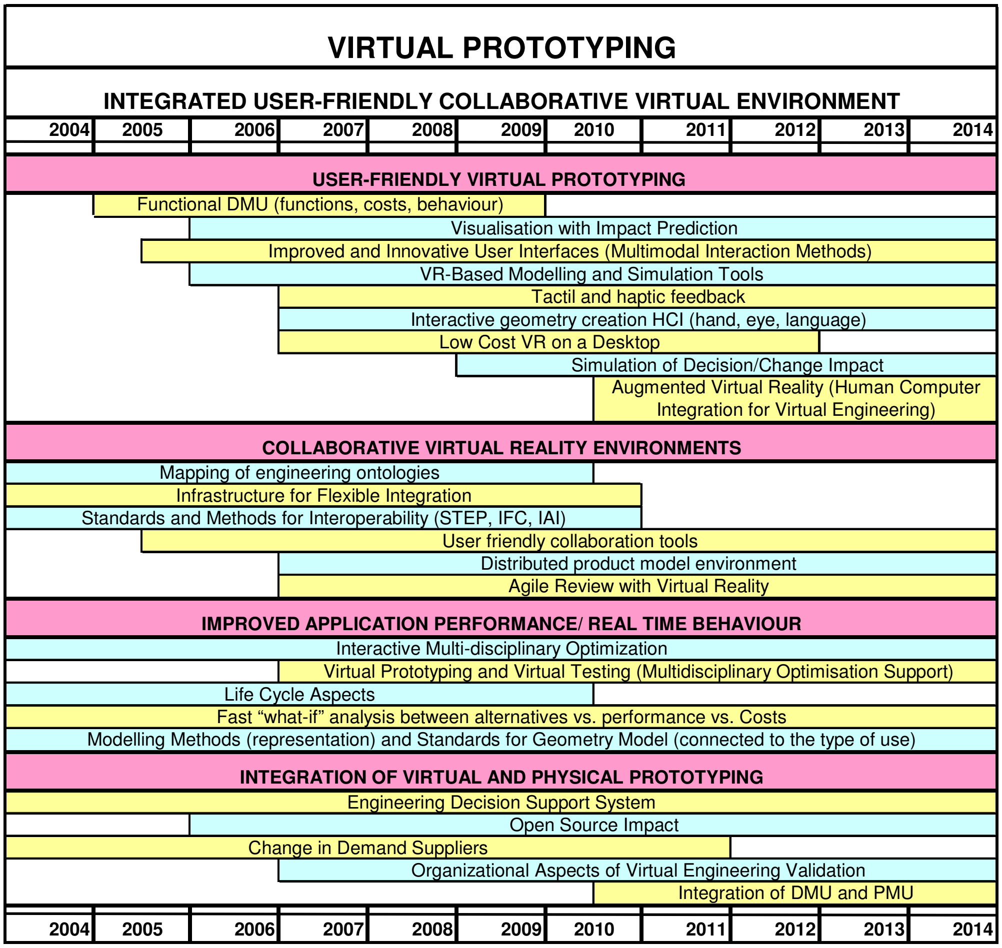

Figure 43 – Virtual Prototyping Strategy Framework

6.6 STRATEGIC AREA: INTEROPERABILITY

The Isolated digital islands that have been created for design, construction and maintenance were mentioned in the beginning of this chapter. These islands occurred for a number of reasons; isolated software development efforts (lack of standardization) and a very fragmented construction process. Such isolated islands mush be eradicated and united. The solution lies in integration and IT interoperability.

Interoperability can be achieved in multiple levels;

- inter-enterprise coordination
- business process integration

- semantic and contextual application integration
- syntactical and behavioral application integration
- physical connectivity integration

Enterprise interoperability can accordingly be defined as providing services to enable multiple users working in different locations, projects and settings to share knowledge, information, data, software, solutions and IT resources.

Interoperability in the shared information architecture should be broad and sustainable at a strategic level. Process model interoperability enables connectivity and cooperation to perform process model tasks as they emerge, supported by an intelligent infrastructure. It supports networked organizations with fast and simple task execution and process and management views. Work in progress monitoring provides traceability from business vision to implementation. This is the first step towards holistic process interoperability. At the business process level interoperability of enterprise systems enables to operate across company boundaries and therefore facilitate, coordinate, and automate the exchange of business data.

Each software vendor usually concentrates to be good in his core business /expertise/ competence. In construction processes, different software modules address, however for a large part, the same kind of information hence has to communicate about the same objects. This generates the powerful need for a complete multi-vendor IT system for the construction industry. This multi-vendor IT system consists of software modules from different vendors providing the shared use of the same kind of information in different phases for different purposes. The solution arises with interoperability offering interaction of all software functionalities in the best possible way. But this requires complete standardization of information and process models across the industry. Furthermore, construction projects always involve external communication, thus a wider the scale of national as well as international agreement for information, semantics and functionality exchange standards is crucial. For Turkish construction industry; the first step to prepare for a multi-vendor IT environment should be to adapt easily accessible, flexible, extendable and open standards (STEP, IFC, bcXML etc.).

Besides, interoperability tools offer more cost-effective solutions to leverage existing IT investments while taking advantage of the innovation. Supported by classifications, ontology and patterns for semantic alignment, interoperability shifts the semantics from applications to the infrastructure layer. Interoperable software available from a multitude of vendors will ensure incremental realization of the identified IT vision for Turkish construction industry.

The vision is, that by 2014 Turkish construction organizations will be able to seamlessly interoperate with others. Managers will govern and manage values, strategies, investments, tasks, resources and risks in on-demand business opportunities. Systems engineering will be enhanced to solutions engineering, building solutions from active knowledge models, adaptive architectures and standardized services. SME's and larger companies will participate in knowledge sharing and business collaboration on-demand and on more equal terms. Enterprise architectures and intelligent infrastructures with services for architecture adaptation and extension, workplace generation, application and database integration will be developed and offered.

A common language will allow dynamic, two-way flow of information instead of today's static, disjointed, one-way transmission of information. A lexicon (vocabulary) and open standards enabling interoperability will allow customer-friendly interface, yet build in sufficient flexibility to serve the varied needs of the different users. So, Turkish construction industry should agree one form of syntax, semantics or both for information and functionality by involving in the International Committees on Interoperability (IAI), Industry Foundation Classes (IFC) etc. Although international standards take a long time to develop (need a lot of consensus) and are no guarantee for a good standard (often too much democracy resulting in bad compromises), the wider the scale of agreement the better for globalization. Apart from adapting international ones, Turkey should create a mix of national, European and worldwide standard minimizing interoperability problems.

The interoperability strategy framework applicable to Turkish construction industry can be summarized as in Figure-44 below:

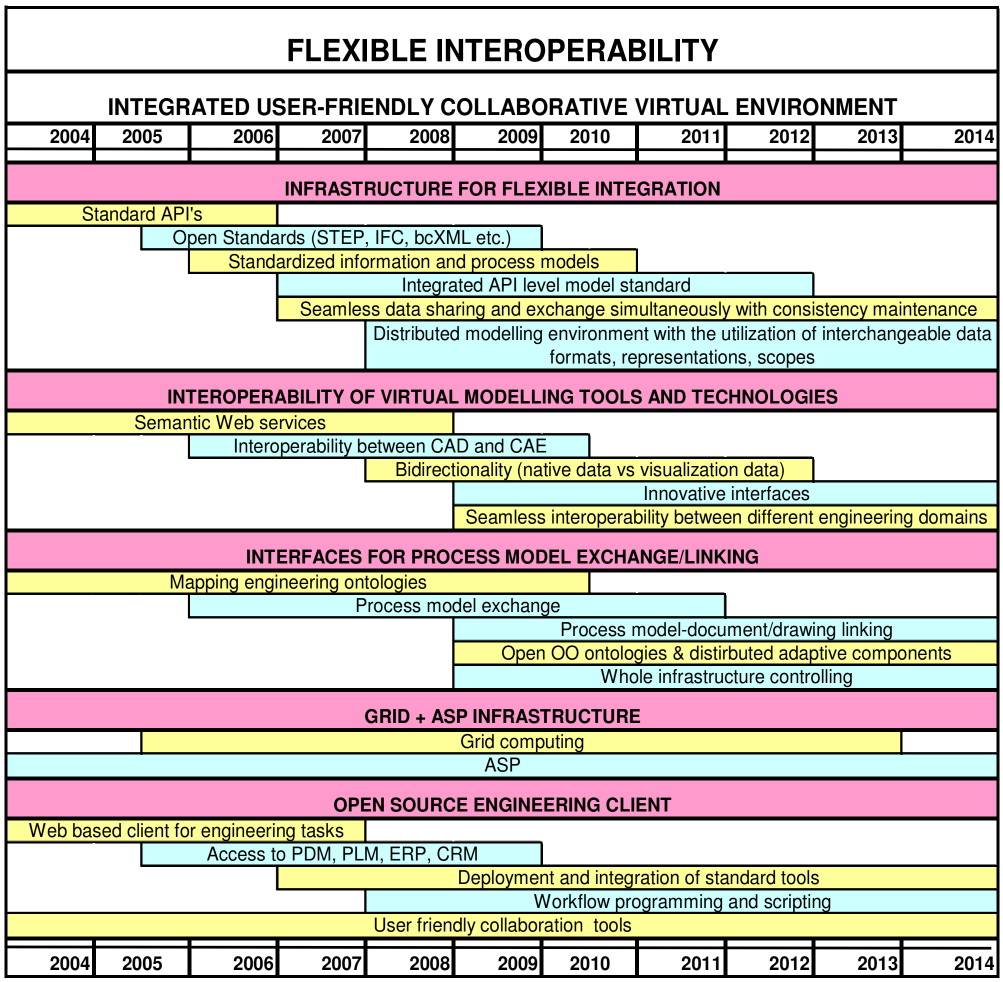

Figure 44 – Interoperability Strategy Framework

6.7 STRATEGIC AREA: CONTEXT-AWARE SYSTEMS

Context information is useful only when it can be usefully interpreted, and it must be treated with sensitivity. Several years ago there was a special issue of Human-Computer Interaction on Context in Design (Moran, 1994). It discussed the notion that the design of computing artifacts must take into account how people draw on and evolve social contexts to make the artifacts understandable, useful, and meaningful.

A system is context-aware if it can extract, interpret and use context information and adapt its functionality to the current context of use. It involves application development that allows for collection of context and dynamic program behavior dictated by knowledge of the environment. Researchers are increasing the ability to sense the environment and to process speech and video and turn those signals into information that expresses some understanding of a real-life situation. In addition to dealing with raw context information such as position, a context-aware application is able to assign meaning to the events in the outside world and use that information effectively.

Today, users must specify everything at the symbolic and syntactic levels rather than at the semantic level, resulting in time and energy being spent on "translation" tasks. The strategy for Turkish construction industry is to develop systems automatically keeping track of the social and knowledge networks of their users, suggesting appropriate references and contacts that may be useful in a given situation. Information should be made available, on a "push" basis, to users, prioritized according to the user's interests, which are determined from their roles, previous history of information use, and the urgency and importance of the situation, through whatever medium is most appropriate at a given time. The system gives users early warning of areas that may require attention, based on pattern recognition and uncertain reasoning. Furthermore, in the long perspective, the strategy includes adaptive self-configuring IT systems learning from their own use and user behavior, and able to adapt to new situations, locating and incorporating new functionality as required.

Software agents are computer programs that can monitor data - in construction industry an example could be changes in engineering models - and proactively initiate analytical programs, coordinate changes in the model with other disciplines, or offer specialized advice as design decisions are being made. With roots in the field of expert systems, the potential for software agents is in areas such as checking engineering models and running energy or seismic analyses at appropriate times. With more widespread use of engineering models, it will become possible to create software tools that are more proactive and modular. Research prototypes have demonstrated a variety of software agents that can check building codes and automatically generate construction schedules. Before these models can realize their potential to assist architects and engineers, however, the profession must make the paradigm shift to model-based engineering.

Developing and deploying adaptive mobile applications requires middleware solutions capable of providing mechanisms, tools and strategies to manage dynamically service provisioning context. The Secure and Open Mobile Agents (SOMA) middleware is specifically targeted to the support of adaptive service provisioning in ubiquitous environments.

The context-aware adaptive systems strategy framework applicable to Turkish construction industry can be summarized as in Figure-45 below:

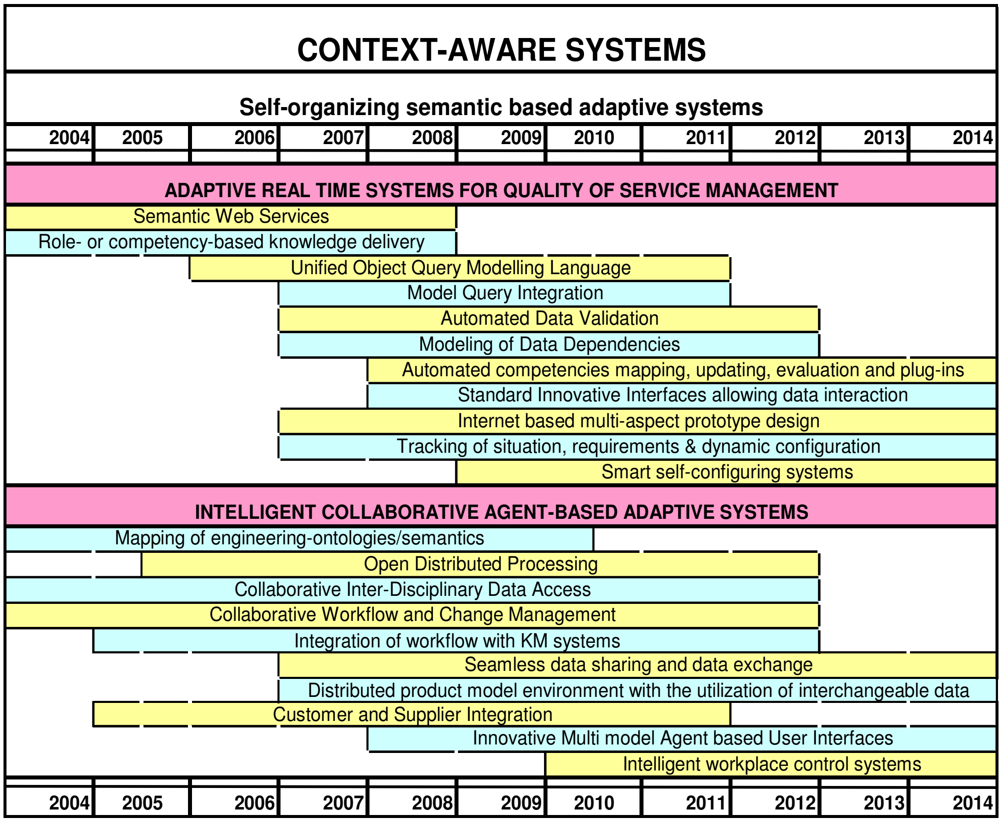

Figure 45 – Context Aware Systems Strategy Framework

6.8 STRATEGIC AREA: LIFECYCLE MANAGEMENT

Re-engineered process supported by innovative IT allows taking into account different objectives and addressing time of delivery, cost and quality issues from a global point a view. The main idea is to have a single, integrated technology system to help a company manage the product, or a facility, from the time it's built to the time it's destroyed.

Information lifecycle management is a strategy that uses people, processes and technology to store and tap critical business data throughout its lifespan of value. If it is done right, it is proactive and dynamic, and helps companies plan IT growth to match their anticipated needs. A key aspect of information lifecycle management is the ability to match storage resources to the value of business data at any given point in time. Once classified, information lifecycle management matches infrastructure to the value of the data.

By tightly integrating designers and suppliers, this strategy gives the ability to secure early validation of key components, comprehensive tracking and expediting, and engineering change management throughout the complete project lifecycle. The solution also incorporates business partners' knowledge into the design, management, and maintenance processes, resulting in higher quality and greater flexibility to meet customer needs. The expected total lifecycle performances are defined at the beginning of the design phase and used, as inputs, to optimize different technical domains. Planning and cost estimations are conducted concurrently with the design and simulation is used extensively to test "what-if" scenarios and to assess feasibility and buildability.

Key functional areas include program, project, and audit management, engineering change management, order change management, CAD interfaces, document management, expediting and project-oriented material management.

The total lifecycle management strategy framework applicable to Turkish construction industry can be summarized as in Figure-46 below:

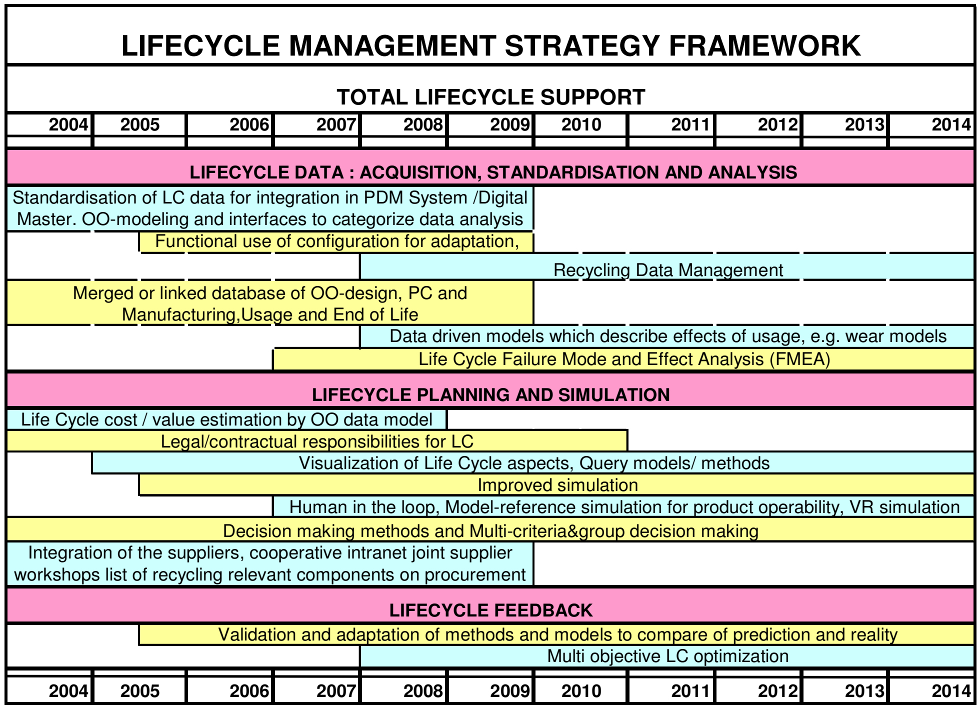

Figure 46 – Lifecycle Management Strategy Framework

6.9 STRATEGIC AREA: PERFORMANCE MANAGEMENT

The performance approach is concerned with what a building is required to do, rather than prescribing how it is to be constructed. A major aim for any building project should be to add architectural value, for instance in terms of cultural, aesthetic, functional, engineering, economical value etc., for all stakeholders. The management of architectural value is of essential importance to all in the construction industry as it provides the gates to a comprehensive process-approach. This approach is particularly important when trying to achieve a successful implementation of performance-based building.

The performance concept is applied to both building procurement and building regulation. In the case of innovative building production, more economical and better performing buildings are expected due to the freedom encouraged in design and construction. Performance regulations, which focus on intended outcomes, are intended to encourage innovation and trade by better expressing what regulations are intended to achieve. Application and implementation of the performance concept throughout the building process is of worldwide growing interest. It provides a flexible and technically non-prescriptive framework for building design and construction. Its application in building consists of translating human needs to user requirements (for serviceability, safety, security, comfort and functionality within the building's spaces, and for an adequate life expectancy of the building and its parts); transforming them into technical performance requirements and criteria; implementing them in the various stages of design, to enable cost-effective construction of buildings that provide long term satisfactory performance.

It is now well recognized that the language of performance can become the basis for harmonization and globalization of the building market. The application of the modern performance approach in the building market, by which requirements are established according to functionality, opens the road for the development and application of new materials and building methods. Turkish construction industry should move in this direction and implement performance-based building regulations but unfortunately, in many cases, user requirements are not well understood which necessitates the urgent need for requirements engineering. A change for emphasis from political influence to using performance information based best value selection process is required.

Professional design services should focus on performance in terms that can be measured. Differentiation can also be achieved by implementing one of Mintzberg's Generic Competitive Strategies such as: differentiation by marketing image, by project design, by project quality, or by project support (Coulter, M., 2002).

The Government should reward high performance and provide incentives for enterprises, which show significant improvement. Supporting industry forums on the advantages of using IT for value-added as opposed to cost performance-based IT strategies, developing key performance indicators, and developing performance prediction tools, standards, and practices for structures that are subjected to extreme loads from earthquakes, winds, fires, and blast will encourage a performance-based, value-added focus for IT use in Turkish construction industry. By applying regulatory changes to the adoption of IT-based value added strategies by the industry Turkish government should encourage industry participants to commit to long-term continuous improvement, to re-engineer and better integrate the management of the design and construction phases of project delivery.

In addition, Turkey is highly vulnerable to natural disasters, especially earthquakes and floods. It is important to concentrate on institutional and cultural changes by making further progress in adopting EU environmental standards, introducing sound practices for structural design, air, water, solid waste, soil and forestry management. But unfortunately, the unsound urbanization heritage makes it seemingly more important to strengthen the country's capacity for emergency preparedness to mitigate the impacts of future disasters/ failures as Turkey continues to experience consecutive earthquakes.

Developing the modeling and simulation tools necessary for evaluating the structural performance of conventional and innovative systems under extreme loads, providing the underpinning measurements for developing and validating those models, making recommendations for performance standards, and conducting post-disaster and structural failure investigations to document structural performance should also be given high priority for the health of Turkish construction industry as well as the whole nation.

The performance-based engineering strategy framework applicable to Turkish construction industry can be summarized as in Figure-47 below:

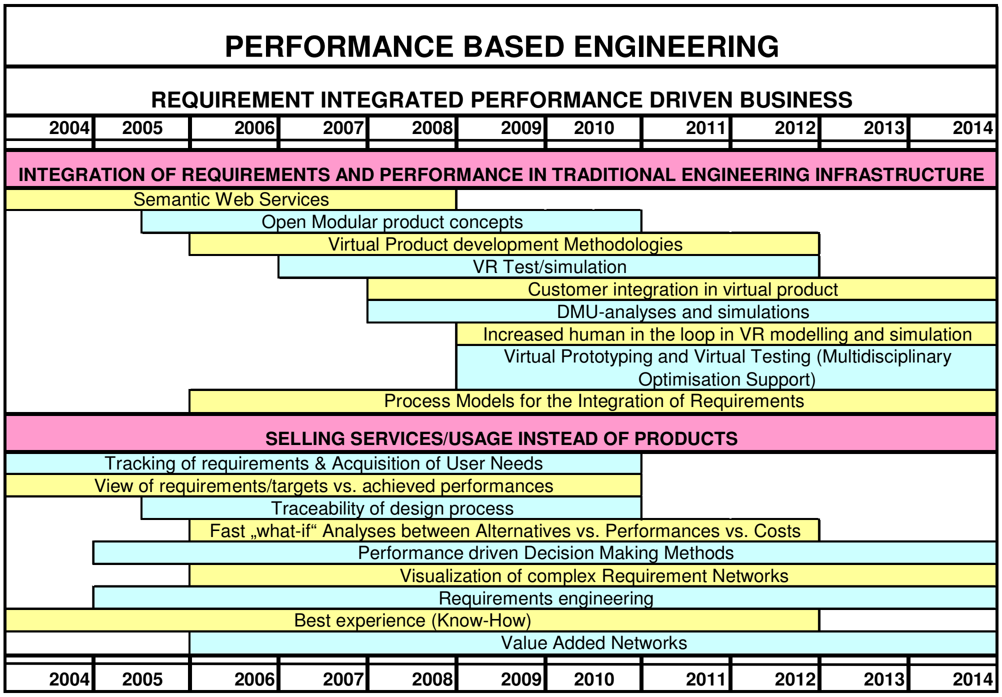

Figure 47 – Performance-based Engineering Strategy Framework

6.10 STRATEGIC AREA: IT SKILLS AND AWARENESS

Constant IT innovation makes technical skills short-lived and continual training imperative for competitiveness. It will be a world where people could become useless or marginalized, not because they are less valid, but because they do not have the necessary skills and training that the new environment demands. In order to manage, critically analyze and make full use of IT; as a citizen, consumer and employee the individual requires new skills, good feedback channels, indicators and incentives, as well as constant alertness to changing needs which can be improved with the introduction of renewed procedures. All students and professionals should receive education / training that give to them the skills to use state-of-the-art IT. Higher education and the inclusion of a compulsory IT course module in civil engineering faculties provide deep understanding of the underlying theories, models and methodologies of IT applications for the construction sector.

Many of today's concepts in education will become obsolete with the creative incorporation of the new information technologies. Training will no longer be something that one undergoes at a specific time in one's life, but will extend throughout one's life and access to this lifelong training will be much easier and attractive than with traditional methods. Educational institutions, business enterprises and other work communities can engage in closer cooperation with a view to knowledge transfer and the utilization of information reserves. Learning environments using distance learning, information networks and electronic services must be developed, while reserves of public information, especially library catalogues, must be made available on the information network to facilitate the acquisition and utilization of information.

E-learning makes specialized education and professional and vocational training more accessible in terms of affordability and availability. The learning process is enhanced by the provision of interactive learning material and tests that aid effective learning, and by helping individuals to keep abreast of cutting-edge industry developments. To fully realize its potential and raise the skills level within the sector, an e-learning program should be designed to the highest standards, both in terms of content and the technological platform. The setting up of virtual institutes for distance education in various parts of Turkey and twinning of Turkish universities with centers of excellence in IT in developed countries will also improve ubiquitous life-long e-learning for a collaborative digital world. Besides, user-friendly intelligent tools reduce the need for learning, and provide built-in learning support when needed.

One of the key factors in encouraging people in Turkey to make full use of the opportunities provided by developments in informatics is the existence of an adequate variety of content in Turkish languages and reflecting local culture. Apart from the development and application of IT, it is important to convert and refine various cultural and information contents into an accessible and commercially feasible form. Developing and distributing case studies, supporting a web-based help desk on current best practice and available support will facilitate a new IT culture moving from automation to strategic transformation in the construction industry.

Human development is critical for Turkey's ambitions for EU accession and the reduction of inequality. The strategy should aim to promote informatics awareness, computer literacy and the mass dissemination of the benefits of IT among Turkish construction industry, by providing information services, educational programs and mechanisms to stimulate the use of technology. Increasing awareness of, and skills to implement, IT-based strategic change gives wider encouragement to improvement of industry business practices to ensure that standards of behavior embody the highest ethical principles and increase stakeholder confidence that their business objectives will be achieved. Thereby, the negative perceptions throughout the world about the technological level of Turkish construction industry will be changed to "Being a Turkish construction organization is synonymous with being well trained, open to the world and having a solid intellectual preparation for the needs of modern technology"

The upgrading of IT awareness and skills strategy framework applicable to Turkish construction industry can be summarized as in Figure-48 below:

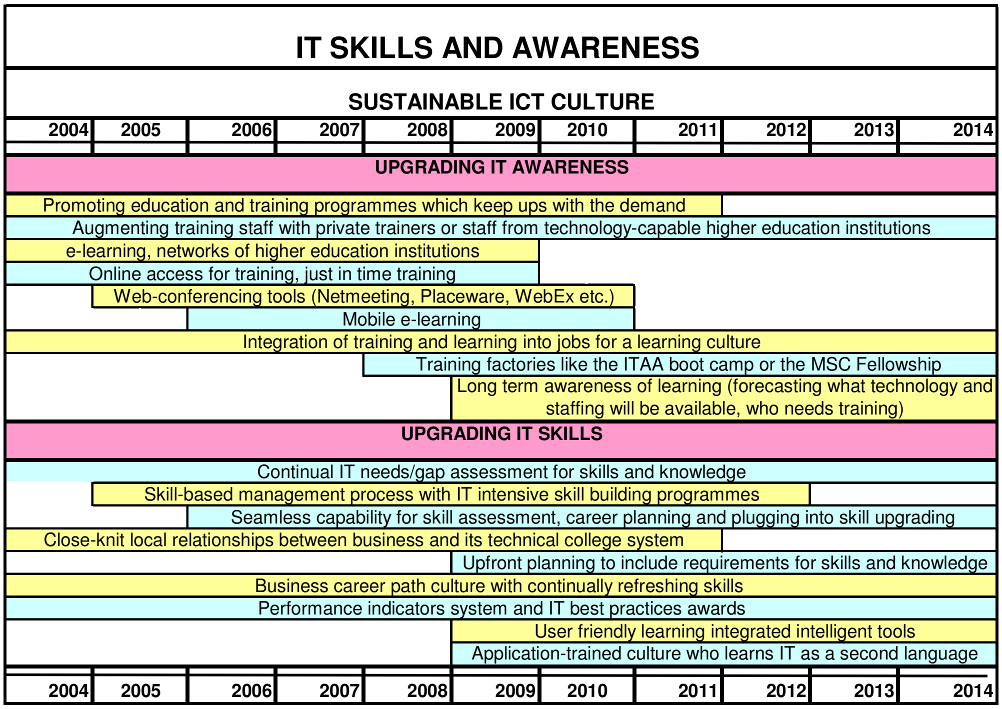

Figure 48 – Enhancing IT Skills and Awareness Strategy Framework

6.11 STRATEGIC AREA: LEGAL ASPECTS OF IT

In Turkish construction industry the legislation to support technology has not been adopted by contractual practices. Transaction management for electronic exchange of information and documentation should ensure a defined level of legal validity (e.g. within an IT contract) security (e.g. digitally signed) and trust.

The information society must be a safe and secure place to be. People and businesses must be able to prevent the unauthorized tapping of communication, forging of documents and use of false identity. Technologies such as encryption and digital signatures will secure this. Reform of the law is deemed essential in the areas of computer related crime, data protection, intellectual property and in the area of electronic data interchange (EDI). Such provisions should ensure that electronic data are protected against loss, damage or modification, and against unauthorized use or disclosure, whether accidental or deliberate. The law also should include provisions regarding the dissemination of data and rights of access. Public authorities should supply to other such authorities any data, which they are legally entitled to store, process and use, upon request and free of charge.

Protection of intellectual property rights and copyrights in the IT field, particularly for software products, should be respected in order to create a healthy environment for the development of IT in Turkey. Yet without effective protection, rights holders will be unwilling to make existing works available online or to create new media content.

Besides; freedom of information and access shall also be acknowledged, guaranteed and defended in conformity with the national laws, ensuring affordable access to basic telecommunications and broadcasting services. Specific provisions in this regard allow freedom of data traffic via computer all over Turkey, within the legal framework, while transborder data flow will also be lawful insofar as it will cause no damage to human rights and liberties, to civil obligations, to the secret and confidentiality required for national security defense.

Considering all, Turkish government should own the role of providing a legal and regulatory framework that ensures the information economy is safe, secure, respectful of personal privacy, certain and open. The information property and confidentiality rights of individuals and well as social and economic organizations should be legally elaborated. To prevent the criminal sabotage of technological progress, it is essential to ensure the security of computer transactions. The public sector must take responsibility for data security in society and, together with enterprises, ensure that all critical systems function under all circumstances.

The need to provide 'digital access to public information for the citizens and industry' can be considered in the context of open government. The strategy should provide for the central, regional and local public administration to offer access to public information on record and to offer methods of gathering administrative information by electronic means, on an equal footing with other procedures.

Legal barriers such as legal admissibility of emails, CAD drawings, use of ASPs, ownership of information, company vs. project information and legal issues of objects (such as IFCs) should be overcome by specifying an IT-related contract governing these issues. E-contracting, contract configuration and on-line negotiation tools are used to develop such IT-related contracts. A virtual negotiation room on the internet is used to negotiate the contracts and exchange digitally signed versions. The IT contracts specify the IT environment to be used. Different security levels are imposed on all transactions using digital signatures, third party certification authorities, biometric systems, smart cards and/or digital notaries.

Removing the barriers to access to information is of little value if undue restrictions are placed on what information may be created, transmitted, stored or used. Ensuring equity of access to the opportunities online is critical if we are to avoid a social polarisation between the so-called 'information-rich' and 'information-poor'.

The legal governance of IT strategy framework applicable to Turkish construction industry can be summarized as in Figure-49 below:

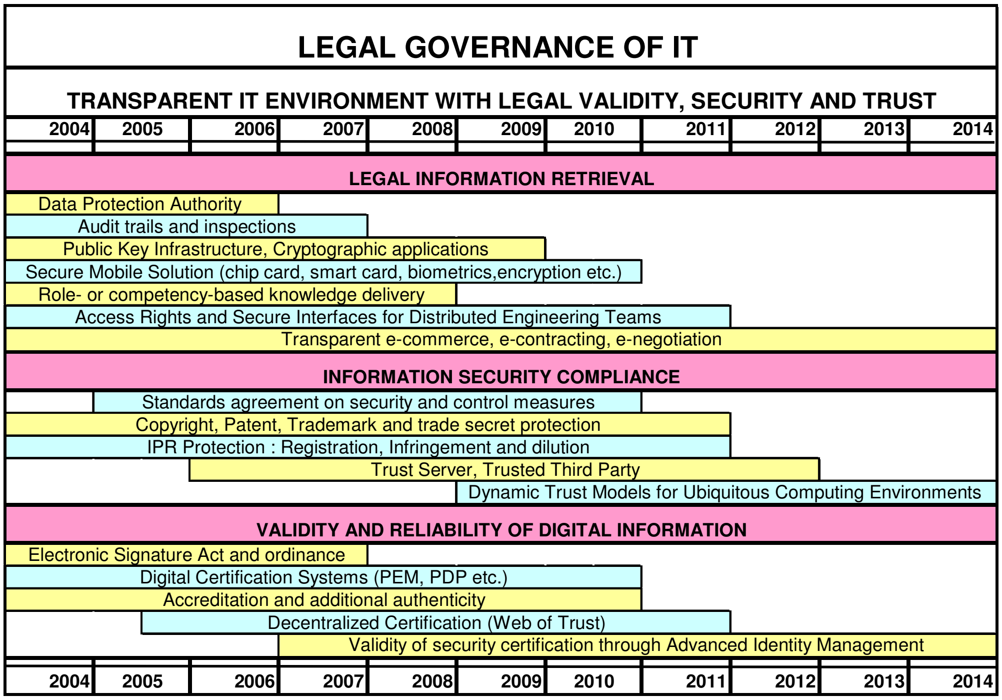

Figure 49 – Establishing Legal Governance of IT Strategy Framework

Once the plan has been formulated, it must be communicated. On a company level, the successful implementation of an IT strategy requires continuous sponsorship and involvement from senior management. The strategy has to include all phases and stakeholders in the construction and facilities management process. Additionally, software houses as well as end users have to be engaged and the results must be publicly available.

One of the key questions surrounding the development of national policies for informatics in many countries is who should be responsible for formulating and implementing such policies? Should these tasks be the exclusive preserve of governments, or should the private sector - or even private individuals - also be involved?

The rational transfer and application of IT requires that some guidelines be set down for service providers, distributors of equipment, and end users alike. Such guidelines must have the backing of government to be effective. The role of the public sector in Turkish construction industry IT strategy must play as a catalyst in introducing new technologies and financing research, and there should be active participation of the private sector improving technology and increasing productivity with the government, serving as an initiator.

There is no silver bullet. Many of the implementations of the strategies contained in this report will cost money, and there is a fine line being trod by the Turkish government to create a budget surplus, cement long-term low-interest rates and as strong a currency as possible while being inundated with requests for spending. Yet it is difficult to see any more compelling area than the IT industry that justifies growth-oriented investment today, if Turkey wants to create employment, improve the competitiveness of industry and address a growing current account deficit. Government may often need to serve as the "anchor tenant" for new investments in infrastructure, and may also need to update intellectual property policy to adjust to the new realities of an information-based world. Besides, tax reform is essential, and CGT reform, which favors risk-based investment, is mandatory.

The Government should work with industry to identify the industry's workforce development needs and encourage greater investment by industry stakeholders. Innovation is critical for knowledge-based industries and economic development. Developing an economic agenda that highlights innovation and establishing a funding mechanism to promote private sector development at the user end of the value chain of information services in order to stimulate sustainable market development that would effectively utilize the new or enhanced supply of information services is critical factors for the strategy implementation. This will enable the industry to respond to changes in client buying practices, increasing global competition and anticipated rapid advances in information technologies. This is only one example to prove that an IT policy has to work within the framework of a wider economic and social policy; otherwise it alone cannot have an impact.

Turkish construction industry needs a bipartisan approach to ensure it does not miss the information revolution. But mostly what it needs is people of vision and clear persuasion in the right position of power to support the necessary reforms, with some sense of urgency. It is difficult to envision achieving this goal with the current efforts. Turkey needs to create a national construction IT agency to address all these IT-related issues staffed by people from the industry, universities as well as the government. Good decisions will depend on good leadership. Turkish construction organizations need help in understanding what is possible, in clarifying sustainable values, in uncovering win-win opportunities, and in resolving conflicts. Fundamentally, it needs to push for transparency and well-balanced progress. This agency must be empowered to make decisions and spend money, and given the mandate to help resolve many of the IT-related issues.

In addition to all, IT application should be increased in every sector. It must become one of the most important factors of socio-economic development and must ensure national defense and security. In fact, Turkey has an undeniably productive software industry with well-qualified programming staffs having a great potential of creativity. They continually offer valuable products for different sectors, but unfortunately the strategic directions of Turkish IT industry are still limited on company basis. Raising the Turkish software industry into a key economic sector with a high growth rate will lead to significant contribution to the modernization and sustainable development of different socio-economic sectors. From construction industry point of view, development of user-friendly software products on international as well as Turkish standards for serving the design and construct of complicated works such as multi-story buildings, large scale bridges, airports, harbors, sport complexes etc. will eliminate all the social and cultural barriers for IT development and such kind of technical support will provide the necessary IT culture sooner than expected. When such an IT culture is adopted by the major contractors, it will permeate to mediums-size and smaller construction organizations, through the project value chain (by involvement in projects and joint ventures with large contractors), by observing the advantages and by necessity to be able to communicate with other partners. The IT culture will then have spread to all types of construction projects, large or small.

By successful implementation of the identified national IT strategies; Turkish construction industry will achieve sustainable improvement in productivity and quality across the industry, and result in agile, model-based/knowledge-driven sustainable Turkish construction industry having the following characteristics;

- Ubiquitous provision of integrated seamless services with high value, integrated and sustainable solutions through the whole lifecycle
- Financially robust, efficient and profitable industry with skilled human potential and flexible workplaces
- Intelligent and innovative processes through continuous improvement culture with the ability to respond today's requirements as well as tomorrow's demands
- Environmentally responsible industry with the ability to create cities as living organisms, consuming renewable resources, decreasing pollution and supplying efficient and clean energy.

Intelligent usage of natural resources and effective development of national land will provide the development of sustainable cities and consequently this will be a great pace for global sustainable development of Turkey as described and scheduled in Figure-50.

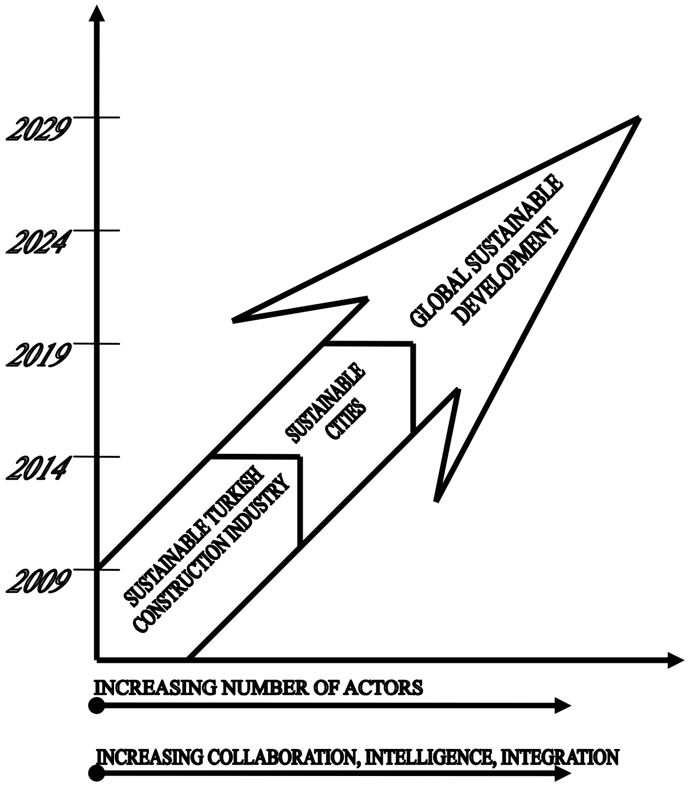

Figure 50 – Resultant long-term vision by the Implementation of National IT Strategy within Turkish Construction Industry

CHAPTER 7

TURKISH PRACTICE, WORLD TRENDS AND OTHER COUNTRY IMPLEMENTATIONS

7.1 TURKISH PRACTICE AND COMPARISONS

With the advent of IT, countries have encountered a new era of both development and competition. Companies and governments are investing more in IT than before to increase their productivity, gain competitive advantages across the global markets and make the provision of public services more efficient and transparent. The objective of having a knowledge-based economy and boosting economic growth via IT has become the major driving force for global competition (SPO, 2003).

Although IT sector in Turkey had been negatively affected by the 2001 financial crisis, there are signs that the sector is recovering very rapidly and targeting even higher growth rates than expected. The new government, which came into force in late 2002, has managed to change the outlook of the economy in 2003 and is giving additional optimistic signs for future economic advancements. The Government is aware of the opportunities that IT sector offers and launched e-Transformation Turkey project in order to accelerate Turkey's transition to information society. It was launched as part of Turkey's commitment to join the European Union and to leverage Turkey's potential to become an important player in the global arena.

PC penetration has increased across all Acceding and Candidate Countries since the launch of eEurope+ and countries such as Cyprus, Malta and Slovenia have penetration rates close to the average rate of the EU-15. However, as shown in Figure-51 below, the average rate of penetration across the Acceding and Candidate Countries remains significantly below the EU-15 average, and Turkey is also below the Acceding and Candidate Countries' average.

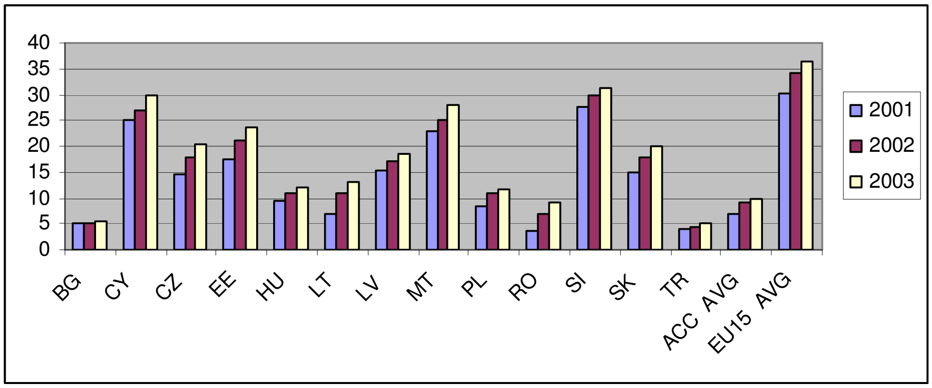

Figure 51 – PC's per 100 Population (Source: eEurope+ Final Progress Report, 2004)

"In the framework of the Hungarian" National Information Infrastructure Development Program" (NIIF) for the research and education (R&E) communities and the community of public collections (over 700 institutions and more than half a million users), R&E networking is a driver for broadband. International access speeds to 10 Gbit/sec were implemented in 2003. Within the wide range of development results, the ClusterGrid subproject has built a high performance grid infrastructure which has become fully operational in 2003, it provides several hundred nodes and teraflop computing power."

As soon as the previous government took place in December 2002, public institutions started to take necessary measures to remedy long-term problems and they combined the most needed actions in Urgent Action Plan (UAP), which takes place in the core of 58th and 59th Governments' Programs. As part of Urgent Action Plan's Public Management Reform Section, information society is declared among the highest priority issues. In this context, e-Transformation Turkey Project was launched to foster the evolution and to coordinate information society activities.

Responsible institution for this specific project is identified as State Planning Organization (SPO), which is affiliated to the Prime Ministry. A Prime Minister's Circular, dated February 27, 2003 has been issued to clarify the objectives and principles of the project as below;

- Policies, laws, and regulations regarding IT will be re-examined and changed if necessary, with respect to the EU acquis; eEurope+ Action Plan, initiated for the candidate countries, will be adapted to Turkey.
- Mechanisms that facilitate participation of citizens to decision-making process in the public domain by using IT will be developed.
- Transparency and accountability for public management will be enhanced.
- Good governance principles will be put in place in government services through increased usage of IT.
- IT diffusion will be promoted.
- Public IT projects will be coordinated, monitored, evaluated and consolidated if necessary in order to avoid duplicating or overlapping investments.
- Private sector will be guided according to the above-mentioned principles.

In order to realize these objectives and to ensure the success of the project, a new coordination unit, Information Society Department, within SPO is established. This Department is responsible for the overall coordination of the project. To increase the participation and the level of success, an Advisory Board with 41 members has been established. This consulting body consists of the representatives of public institutions, non-profit organizations, and universities. The Board had its first meeting at the end of May 2003 to discuss and elaborate the Short Term Action Plan, which covers 2003-2004, for implementing specific tasks with the following main topics;

- Legislation regarding regulatory and legal framework,
- Technical infrastructure and information security,
- Education and human resources for planning of required human capital,
- eGovernment for introducing electronic services to citizens without bureaucratic barriers,
- Standards for integrated and interoperable services,
- eHealth, which is one of the important thematic issues in eEurope,
- eCommerce for the development of eBusiness environment, especially for SMEs (SPO Information Society Department, 2003).

7.1.1 Information Society

First action of STAP is the determination of an "Information Society Strategy", which encompasses every part of society and maximizes national benefits and value added. This strategy will enlighten Turkey's transformation from labor-intensive society to information society, and from traditional production-consumption economy to knowledge economy.

Turkey is an associated candidate country for the 6th Framework Program for Research and Technological Development of European Community. Ten countries - Cyprus, the Czech Republic, Estonia, Hungary, Latvia, Lithuania, Malta, Poland, the Slovak Republic, and Slovenia are set to join the Union on 1st May 2004. They are referred to by the term "Acceding Countries". Of the remaining three Candidate Countries, Bulgaria and Romania hope to become members by 2007, while Turkey wishes to begin negotiations of its membership at that time.

In Romania, a number of global objectives are being pursued in order to reach the information society and to prepare for joining the European Union. By 2005, 'societal informatization' in Romania is expected to be sufficiently *complete as to enable the integration of Romania into the European information society. Romania will participate in European projects on the Information Society and support the IT-based integration of education, research and culture into the European and world value systems. It will set up the legal framework for the use and development of information technologies to guarantee the infrastructure of the new information society, including new laws relating to the National Strategy for Informatization and Fast Implementation of the Information Society.*

Noting that 'Finland is progressing towards a knowledge-based society', a study by the Finnish National Fund for Research and Development (Sitra) on 'Quality of Life, Knowledge and Competitiveness: premises and objectives for strategic development of the Finnish information society' emphasizes that, "In the information society, knowledge forms the foundation for education and culture and constitutes the single most important production factor. IT promotes interaction and exchange of information between individuals, business enterprises, and other organizations, as well as the provision of, and access to, services.

The point of departure for developing Finnish society should be people's needs. The national vision is a society which develops and utilizes the opportunities inherent in the information society to improve the quality of life, knowledge, international competitiveness and interaction in an exemplary, versatile and sustainable way."

Furthermore, as one of the smallest country in the world, in Chile, proposals for the development of information networks call for the creation of a National Committee for the Development of a National Information Infrastructure to analyze the social, political and economic implications of the entry of Chile into the information society and to propose policies, initiatives, laws, programs and all instruments favoring the development of a Chile able to profit from the opportunities created by the digital society and able to overcome the new challenges imposed by the birth of a society based *on knowledge and supported by digital methods of processing and transmission of information.*

Main coordination activities of Turkey information society department are as follows:

a) IDA: EU's IDA (Interchange of Data Between Administrations) Program will enable us to actively participate and share best practices in eGovernment projects among EU member and candidate countries.

b) eContent: The European Commission has signed memorandums of understanding with the some of the candidate countries, including Turkey, allowing them to participate fully in the eContent Program. eContent is a market oriented program, which aims to support the production, use and distribution of European digital content and to promote linguistic and cultural diversity on the global networks, supporting innovative and viable content projects involving multinational and cross-sector partnerships; accompanying measures addressing best practice, concertation, awareness and dissemination etc.

c) eEurope: European leaders set, at the Lisbon Summit, the ambitious objective for Europe to "become the most competitive and dynamic knowledge-based economy in the world capable of sustainable economic growth with more and better jobs and greater social cohesion by 2010". Then candidate countries committed themselves to take up this challenge.

The EU's eEurope Action Plan launched in Feira on 19-20 June 2000 aimed at bringing Europe closer to meeting the Lisbon objectives. It provided for concrete actions and targets aimed at making Internet use cheaper and faster, providing modern public services online and progressing a dynamic, e-business environment to attain these goals. In order to meet this challenge and to help accelerate reform and modernization of their economies, encourage capacity and institutional building, the then 13 Candidate Countries launched a collective action, mirroring this Action Plan, on the occasion of the Göteborg European Council in June 2 001, known as the eEurope+ Action Plan (SPO Information Society Department, 2003).

The results presented in the first eEurope+ Progress Report in June 2002 showed that the Information Society is very much present in the Acceding and Candidate Countries and is the subject of considerable political commitment.

The eEurope+ Progress Report of June 2002 highlighted the importance given by the governments of Acceding and Candidate Countries to the legal framework for the development of the Information Society. EU's initiatives and common goals have affected member and candidate countries positively in terms of stepping up the efforts and collaborating on specific issues. To fulfill the objectives of e-Transformation Turkey Project, there is a strong emphasis on eEurope 2005's goals and harmonization of Turkish legislation to EU acquis. During the preparation of STAP, priorities of eEurope 2005, such as broadband, security, eInclusion, eBusiness and public services are all taken into account, and each of them has been covered with several actions.

Turkey has speeded up the efforts to make Turkey an information society as it joined eEurope+ together with candidate countries. Programs like IDA, eContent, and F6P are all related programs of EU and eEurope Action Plan, and Turkey strives to participate in these activities.

The eEurope 2005 objectives represent ambitious targets for all EU Member States. For the Acceding and Candidate Countries to join eEurope 2005 part-way through the process and aim at achieving its policy goals will prove to be a significant challenge. Continued political focus is vital to ensure that the objectives of implementing an Information Society continue to be addressed and placed high on the political agenda, even after accession has taken place. The end of eEurope+ is by no means the end of the story. Moving to eEurope2005 raises the stakes: the Action Plan aims to stimulate services, applications and content, covering both online public services and e-business. It also addresses the underlying broadband infrastructure and security matters.

Other than cooperation with EU, Turkey is a member of ITU, WTO, and OECD, and participates in studies of these organizations. As these international organizations' activities regarding IT policies affect national commitments, domestic markets, and investment environment, Turkey acknowledges the value of international cooperation (SPO Information Society Department, 2003).

7.1.2 Information Technology Research

The Scientific and Technical Research Council of Turkey (TUBITAK) is the supreme organization put in charge of promoting, developing, organizing and coordinating research and development in Turkey, in line with the national targets of economic development and technical progress. Technology Monitoring and Evaluation Board (TIDEB) monitors the research projects of industrial establishments aimed at developing new products, production methods and innovative technology including new information technologies. It also plans supportive studies to enhance technology development capability and devise policies to increase cooperation between universities and industry.

"The Informatics Development Program of Mexico considers research to be a fundamental component of the information infrastructure. One of the objectives of the Program is therefore to stimulate scientific and technological research in the field of informatics. The private sector will be encouraged to make greater efforts to finance research and technological development, while public investment will also be increased, ensuring that resources are allocated to innovative projects, which are linked to social demands and contribute to training skilled personnel."

Technology Development Foundation of Turkey (TTGV) is an independent nonprofit organization with a private sector majority Board. The foundation's aim is to have Turkey reach the level of developed countries by increasing the competitive advantage of Turkish enterprises through research, technology development and innovation with the objectives of creating awareness among Turkish enterprises, helping development and implementation of national RTD policies and strategies.

TTGV is a member of TAFTIE (The Association for Technology Implementation in Europe). TTGV continues to be represented on TAFTIE Board and Working Group and in this way; TTGV will strengthen the established close relations with organizations executing industrial technology development in many countries. Such efforts will be continued providing information exchange, benchmarking and establishment of best practices as well as ensuring international recognition. Study tours and staff exchange to TAFTIE member organizations will also reinforce these attempts. Other member organizations/countries are ANVAR (France), CDTI (Spain), ENEA (Italy), FFF (Austria), ENTERPRISE IRELAND (Ireland), IWT (Belgium), NUTEK (Sweden), OMFB (Hungary), RCN (Norway), SCOTTISH ENTERPRISE (UK), SENTER (Netherlands), TECHNOPOL (Belgium), TEKES (Finland), VDI/VDE-IT (Germany), DATI (Denmark). TTGV has been participating in task force, networking and ad hoc group studies of TAFTIE regularly.

There are three institutes in the area of information technology. The institutes develop new information technologies, which have a strategic importance for public interest and conduct commercially and publicly funded projects both at national and international level.

Information Technologies Research Institute (ITRI) of Marmara Research Center, (MRC), in Istanbul, tries to contribute to the competitiveness of the Turkish IT industry, and to the transformation of Turkish society towards information society.

National Research Institute of Electronics and Cryptology (NRIEC), also located in MRC Campus, conducts activities in the fields of information security and advanced electronics technologies.

Information Technologies and Electronics Research Institute (BILTEN), of TUBITAK, located in Ankara, has developed digital certificate tools for public and private interests. The products and the capabilities developed by BILTEN are utilized in the first commercial public key infrastructure (PKI) applications of Turkey. Some government agencies such as National

Intelligence Agency of Turkey, Ministry of Work and Social Security, TUBITAK, and National Academic Network have been using digital certificates. Social Security Agency (SSA), Istanbul Stock Exchange (ISE) and Capital Markets Board of Turkey (CMB) are partners of ongoing information security based projects.

Another technological standard development project, which has been conducted by Ministry of Finance and BILTEN, is data transfer standard for all the financial documents. According to the Turkish Law, all firms need to keep their financial records on paper. Ministry of Finance planned to receive these documents in electronic format in order to both reduce the paper burden on firms and to be able to audit them more easily.

In official government plans and programs, it is stated as a task to make necessary changes in the old Public Bidding Law to realize a public procurement strategy that promotes R&D. Partially covering this task; a new law on public procurement was adopted in January 2002 and subsequently amended in June 2002 and entered into force in January 2003 aligning the Turkish legislation to the European Community Legislation. The new law is providing additional transparency, accountability, competition, and aiming to ensure more effective and efficient utilization of public resources. A few e-Procurement projects are underway in Turkey. DMO, Government Supply Office, is aiming to constitute much more open and competitive bidding process by forming a separate section for both national and international tender announcements at its website. It is aimed that by announcing its "Annual Provision Program" at the site, related trading and industry institutions will be informed and get prepared for the bids under equal conditions.

In the mean time, Public Procurement Authority has another project as Public Procurements Tracking and Query System ensuring to handle the entire procurement process from tender notices to result notices as a whole and in a systematic way so as to form a robust infrastructure and to pave the way to e-procurement.

To increase the number of online public services available, introduction of online services to citizens is stated as a priority in STAP. Interoperability, common standards for the provision of services, funding models for e-government projects, current status of e-government projects, e-teams at each public institutions, strategy development for and architecture of e-government portal are among the important topics covered in e-Government Section of STAP. There are about 200, big or small, e-Government projects underway. The following projects are among the biggest in Turkey (SPO Information Society Department, 2003) :

- National Judicial Network Project (UYAP)
- Accounting Offices Automation Project (say2000i)
- Central Census Management System Project (MERNIS)
- Internet Tax Office Project (VEDOP)
- National Police Network Project (POLNET)
- Government Supply Office's Electronic Sale Project (e-Sale)

"The Romanian National Electronic System (SEN) is a governmental one-stop-shop that provides citizens 160 administrative forms available for download and 5 online services for companies: deduction regarding VAT, declaration regarding the payment obligations to the state budget, quarterly and annual balance sheet for the most important contributors, declaration regarding nominal record of insured employees and payment obligations towards national insurance budget and the electronic collection system of statistical information. 465 public institutions are involved and it received the award for digital content at the WSIS in Geneva. New electronic services are now ready to be launched in the system. By the end of 2004, it is expected that the system would be extended to offer approximately 15 online services."

7.1.3 Telecommunications Infrastructure

An indispensable element of any attempts to develop the information infrastructure or the information superhighway is a well-developed telecommunications infrastructure. Take-up of broadband is essential if citizens and enterprises are to take full advantage of the Information Society and if the Lisbon target of Europe being the most dynamic and competitive economy in the world by 2010 is to be met (SPO Information Society Department, 2003).

Main policy of the government in the telecommunications sector is to establish a competitive market structure in all segments in order to help increase service quality and number of innovative and value-added services while reducing costs. Turk Telekom, Turkey's biggest telecommunications operator, is the last public-owned enterprise in telecommunications markets among OECD countries. It enjoyed to be a monopoly for years and held exclusive rights on voice transmission and infrastructure. Privatization process is underway; however, it is believed that it is going to take more time than expected to end up the state ownership in Turk Telekom. For affordable communication services for all, the only way is to fortify the competition in the market. There are 3 GSM operators in the market, Turkcell and Telsim which are GMS900 and in the market since 1994 and the third, consisting of merged Aria and Aycell GSM1800 newcomers, in the market since 2001. The GSM market is still growing and the number of GSM subscribers has exceeded the number of PSTN subscribers in 2002 (23,4million as of 2002). All the GSM operators are introducing their data services on GPRS networks, and mobile internet connection is believed to be a rival to traditional dial-up connections in the mid-term. Third generation mobile (3G) through WCDMA/UMTS is not planned by any of the operators, and wireless LAN through IEEE 802.11 is not part of their business either.

To foster the competition in the electronic communications market, there is a need for a comprehensive law, and this need for a new Telecommunications Law has been recognized both in Urgent Action Plan and Short Term Action Plan of e- Transformation Turkey Project. The objective of this new law is to renovate the structure of old laws, namely Law No:406, Law No:2813, and some other amending laws, and to cover all needed areas of regulation for electronic communications market, such as interconnection, licensing, universal services and numbering, in line with the new regulatory framework of the EU.

In a broader context, perhaps, the most significant impact on IT would come from the fully liberalized telecoms sector starting from January 1, 2004. Turk Telekoms exclusive rights on voice transmission and infrastructure expired on this date. As stipulated by the law, other operators can operate in every segment of telecoms sector by obtaining a license from the Telecommunications Authority (TA).

There are a number of Organized Industrial Zones (OIZ) projects, jointly conducted by Turk Telekom and OIZ administrations in order to provide broadband access to SMEs. There are currently 70 OIZs and 47 of them are connected to Turk Telekom's broadband infrastructure. Besides, a new project is planned with EU financing to increase the number of SMEs with broadband access in these OIZs. However, wide pick-up of broadband is dependent on an ultra-affordable technology, predominantly ADSL and cable networks, but country-wide these have very poor penetration in Turkey compared to EU countries.

"In Spain, a government order of September 1993 created a Group of Telecommunications Users in Public Administration as a national commission of the Higher Council on Informatics. One of the main aims of this Group is to provide a national forum to ensure the effective coordination, organization and management of the Spanish components of European telematics networks for public administration. The Group is also responsible for promoting the rational use of telecommunications in public administration, taking account of questions of both services and costs within the framework of a global strategy. It promotes the adoption of national, European and international telecommunications standards in telecommunications projects in the field of public administration, and provides guidance on the specification, selection and commissioning of telecommunications equipment and services"

"A broad base network of 30 public telecenters has been deployed in Bulgaria and another 30 will be established to provide services to the widest possible range of users in small or economically underdeveloped communities. A goal is to encourage citizens to use more up-to-date information services, among them online contact with administrative authorities and administrative services. "

7.1.4 Internet

According to OECD Communications Outlook 2003, the number of internet hosts is one of the most commonly used indicators of Internet development. The fastest growing ccTLD was .mx (Mexico), with the number of hosts connected increasing 86% per annum. One of the fastest growing ccTLDs over the July 1998 and July 2002 period is .tr (Turkey, 56% p.a.), compared with .it (Italy, 74% p.a.), .pl (Poland, 65% p.a.), .es (Spain, 62% p.a.), .jp (Japan, 59% p.a.), and .pt (Portugal, 56% p.a.). In the same Outlook, another survey mentions Turkey as one of the top countries in terms of growth of number of Web servers. While average growth rate in OECD countries between July 2000 and July 2002 is 36% per annum, Turkey ranked among the top with 68% per annum for the same period, compared with Germany (97% pa), Denmark (86% p.a.), Netherlands (69% p.a.), the United Kingdom (64% p.a.), France (57% p.a.), Poland and Hungary (52% p.a.) (Candidate Countries with the assistance of the European Commission Information Society, 2001).

Although growth rates are glimmering, Turkey's figure for web sites per 1,000 inhabitants, which is mentioned as a more accurate indicator of relative national content development, is really low. In July 2002, there was an average of 31.4 Web sites per 1,000 inhabitants across OECD countries. Germany (84.7 Web sites per 1,000 inhabitants) ranked first. Turkey had less than one web site per 1,000 inhabitants.

"Acceding and Candidate Countries have undertaken specific actions to put in place Public Internet Access Points. The Estonian Public Information Act

states that everybody must have free access to public information in all public libraries, where people can access information via the Internet free of charge. This is supported by the Look@World Foundation's mission to increase the quality of life in Estonia and improve the country's competitiveness by supporting Internet usage. The aim of Polish "Ikonka" Project is to open PIAPs in local libraries and community centers across Poland, especially in small towns and villages and provide free Internet access and computer training. "

7.1.5 Electronic Commerce

For acceleration of the IT diffusion to businesses, Undersecretariat of Foreign Trade, Ministry of Trade and Industry, and KOSGEB are working together to develop pilot projects, to prepare reports and necessary changes in the legal infrastructure. Preparing a digital registry system for private firms, promotion of e-document and e-commerce by proper financial instruments, producing e-commerce statistics are among the issues.

The Ministry of Industry and Trade's (MIT) industry portal, "sanayi.net" has a mass reaching interactive structure. The Ministry's information exchange with Union of Chambers of Commerce, Industry and Maritime Trade and Commodity Exchanges and Chamber of Commerce of Istanbul is a significant step for the sharing of information between public and private sector.

Limited companies transactions, which formerly were in the context of MIT Services, and specialty companies, which are still in the context of MIT Services, will be examined by secure connections and companies in MIT's concern will be kept in the sanayi.net database. Certificate of guarantee, visa, consumer problems and advertisement complaints, industry zones, industrial registry certificates supported by the information are all based on company databases. Document circulation in MIT's central units and transactions related with cooperatives are done via internet. Information about different cooperatives (construction coo., consumption coo., motor vehicles coo., etc.) is also in the context of sanayi.net project (SPO Information Society Department, 2003).

In Australia, the 'Strategic Framework for the Information Economy', assigns three of its ten strategic priorities to different aspects of e-commerce. The first of these priorities is to 'increase significantly the use of electronic commerce by Australian businesses. In this connection, the report notes that:

"*So far many Australian businesses have been cautious about embracing electronic commerce. Governments have a key role in raising awareness and demonstrating the benefits of doing business online … governments need to emphasize that electronic commerce is more than simply having a web presence – to be truly competitive in the information economy, business need to regard electronic commerce as an integral part of their commercial operations. A second priority in this area, closely linked to the first, is to 'develop a legal and regulatory framework to facilitate electronic commerce', which is a vital step in building the confidence of business and consumers that online transactions are authentic, private, secure, legally sound and that there are redress mechanisms available. The third strategic priority related to electronic commerce is to 'influence the emerging international rules and conventions' in this field – a role which Australia is well equipped to play as 'a sophisticated online market and policy environment."*

Likewise, there is an urgent need to stimulate the development of interactive, multi-media rich, multi-lingual content as this is one of the most important drivers for broadband deployment. Access to public sector information is also a key driver for take-up and should therefore be promoted.

"In October 2003 Government Open Source Policy in Slovenia formalize its positive attitude towards open source. The policy recognizes the importance of open source; especially with regards to data exchangeability, economy, independence, code adaptability and reuse, as well as permanence of ownership. The policy is an important element of its legal and policy framework."

KOBINET(or SME-Net in English), which is the Information Network among SMEs, was established in April 1998 as a part of "Go Digital" initiative, aiming to digitize the SMEs.

Main objectives of KOBINET are as follows:

- Help increase Turkish SMEs' performance by using new services and information supplied with the help of IT.
- Assist Turkish SMEs with the internationalization process.
- Become the leading sustainable Internet Portal for the Turkish SME sector, connecting to qualify existing EU networks and to key EU Partners.
- Guarantee integration and synergy with the Turkish e-Commerce and e-Government strategies, which are included in the e-Transformation Turkey program as well as ensuring that IT instruments are included in the SME Strategy Paper.
- Provide a standardized, Quality Assured system for main SME development and promotion initiatives and SME services in Turkey under one brand name, which forms an accelerator for innovation and competitiveness.
- Develop sectoral and regional market places for e-commerce in Turkey (SPO Information Society Department, 2003).

Part of KOBINET, Euro Info Correspondence Center (EICC) was established as a national contact point in Turkey in 1996.

TOBB, the Union of 359 Chambers of Commerce & Industry and Commodity Exchanges of Turkey, has developed an online international marketplace (TOBBIOS) for helping SMEs do business. TOBBIOS establishes the link between the firms who wish to buy or sell products or services domestically or internationally, announces foreign commercial, technical, and financial requests in their web pages and national and international tenders with an online announcing system.

"The Slovenian Chamber of Commerce along with a group of major Slovene companies is undertaking a project called ESlog in order to introduce e-business to Slovene companies. Since e-business interoperability is a key issue, the project delivered XML documents for payment order, payment cancellation, credit advice, debit advice, banking status and financial statement to enable companies to use e-commerce not only with other companies, but with the public administration and financial institutions as well. Tax Office and Bank of Slovenia also cooperate in this project, the results of which are freely accessible and are already in use by a number of large companies."

7.1.6 Standards

Turkish Standards Institution (TSE) follows up the studies of ISO, IEC, ISO/IEC Joint Technical Committee, which prepares the standards in the area of information technology, and European Standards. The studies are continuing for the reflection of certifications to the information technology and promotion of widespread usage of all sector standards as in the other industrialized countries.

STEP is revolutionizing the whole basic approach to the initial definition, and subsequent whole-of-life-cycle use, of data for manufacturing, marine and offshore, building & construction, mining and associated industries. Technologically driven companies need to be involved with this new protocol, which will be as basic as today's use of the Internet, Windows, UNIX or SQL. Without STEP literacy, organizations will not be able to work or communicate effectively in leading edge, competitive industries. However, it will take time for industry and the professions to come to grips with this new technology. Australia's trading partners (and competitors) are already well advanced in becoming familiar with STEP with the advent of the AUSAP project .Whilst industry and their associations will need to develop strategies to meet the challenges and reap the benefits of STEP, the Federal and State governments are playing a facilitating role in their financial support of the AUSAP project.

"Standards Australia committee IT/6/1 has an on-going brief to monitor and vote on the various parts of the developing international STEP series of standard: ISO 10303, 13584, 14959, 15531 and 15926. The committee consists of about 20 persons, who meet together in four different locations - Sydney, Melbourne, Perth and Brisbane - and have a quarterly teleconference link-up. Standards Australia also has a statutory role in making these international standards available within Australia and to the first 15 parts of STEP have been published a Australian Standards. Eventually STEP could well have over 100 separate parts and currently only 17 have full IS (International Standard) status. Some 40 others are at various stages of development but there are many others yet to get properly off the ground. Just one of these is for Rapid Prototyping, and there are currently five RP centers operating in Australia which offer such a service. Another is in the plant design area and Australia is represented on the newly formed international PIEBASE (Process Industry Executive for achieving Business Advantage using Standards for data Exchange) group. However, continued Australian involvement with these initiatives will depend very much on the commitment of both industry and government, as well as on the availability of resources and funding"

7.1.7 Security of Information Systems and Networks

It is vital to create an environment which will encourage personal initiative and so promote private investment; it is the responsibility of the public sector to develop a legal and cultural environment that permits this.

"Denmark as an information society is today a reality. The strategy adopted up till now for proliferation of IT usage in all parts of society has been successful. The overall IT policy strategy for the Government should have as its starting point that information technology is already widespread in society, and should identify on the basis of a critical analysis of the positive and negative social consequences of information technology what key areas Denmark should aim at - where it is crucial that we should still be at the

forefront, also seen in an international perspective, and where this can only be ensured via political initiatives.

The Danish Government's IT Policy Action Plan 97/98 emphasized four areas of concentration, namely:

1. citizen's rights in the information society
2. the existence of IT literacy on all levels
3. revitalizing interaction between citizens and the administration to realize the vision of an open public sector
4. developing security solutions to encourage electronic commerce and other communications requiring top-level security."

Tr-CERT (Turkish Computer Emergency Response Team) is a newly established specialized group to effectively handle the computer incidents. Its basic purpose is to provide service to its constituency, which is Turkish Governmental Organizations. It continuously analyzes the attack trends and latest security holes, and makes forensic research for technical improvement. Another function is dissemination of security related information nationally to inform constituencies as well as individuals.

Furthermore, Tr-CERT aims to be a member of international CSIRT organizations like FIRST and TF-CSIRT. The future plans of Tr-CERT also include informing all the Turkish computer users through its Web site with the advisories, vulnerability and fix reports.

An information technology security evaluation laboratory, called OKTEM, was settled two years ago in National Research Institute of Electronics and Cryptology (UEKAE), TUBITAK. The main aim of this facility is making security evaluations according to an international standard named "Common Criteria" which is accepted by TSE as a national standard. At the end of July 2003, Common Criteria Management Board confirmed Turkey's membership. This membership will be a step forward for Turkey, in order to produce internationally recognized certificates (SPO Information Society Department, 2003).

TUBITAK-UEKAE, in coordination with the Turkish Standards Institute, is going to prepare a report about smart cards, PKI, security test standards and their implementation in public services. Another action for TUBITAK-UEKAE is developing a pilot project for testing and provision of network security for public networks. Both of these actions are due December 2004.

The right to privacy in respect of data controlled by the public service in Spain is guaranteed by a Royal Decree which regulates the use of electronic techniques, informatics and telematics by the government. The law also provides that security measures must guarantee the integrity, authenticity, quality, protection and conservation of documents stored in electronic formats.

7.1.8 Intellectual Property Rights

In 1995, as part of Turkey's harmonization with the EU in advance of the customs union, the Turkish parliament approved new patent, trademark and copyright laws. The government has declared that it intends to have a TRIPS compatible IPR regime in place as soon as possible. Amendments to the Copyright. Law designed to meet this goal were approved by Turkey's Parliament in late February 2001. The Parliament enacted amendments to the copyright law, which provide retroactive protection, expand the list of protected items and increased deterrent penalties against privacy. These amendments brought Turkey into compliance with the WTO Agreement on Trade Related Aspects of Intellectual Property Rights (TRIPS). The Ministry of Justice's "Effective Enforcement of Intellectual Rights Project" is approved by the European Commission for funding, offers high skilled human resources and support infrastructure for the effective enforcement of intellectual property rights and sustainable IT network, is of strategic importance to Turkish commerce and industry as well as to the proper functioning of the customs union with the European Union.

While enforcing the IPR legislation in Turkey, it should be remembered that Turkey is not party to the twin treaties of WIPO (World Intellectual Property

Organization), which provides tools for IP protection on internet. The first one, WIPO Phonograms and Performances Treaty (for protecting against internet piracy) entered into force on May 20, 2002 and the second one WIPO Copyright Treaty (for protecting author's rights on the internet) entered into force on March 6, 2002 (SPO Information Society Department, 2003).

"In Mauritius, the National Information Technology Strategy Plan notes that The Government has taken the necessary measures to introduce the required legislation to protect intellectual properties in Mauritius by enacting the Copyright Act of 1997"

"A separate Brazilian law (Law no. 9.609, 19 February 1998) makes detailed provisions with regard to intellectual property rights in computer software and the commercialization of software within Brazil. Author's rights in software are protected for a period of 50 years, and apply also to authors living abroad, providing that their country of domicile grants equivalent rights to both Brazilian and foreign software authors living in Brazil. These rights are protected whether or not the software is registered; but the law provides for the establishment of an official registration system."

"Electronic Signature Law" prepared by the Ministry of Justice is being discussed in the Turkish Parliament recently and published in the Official Gazette in Jan 23,2004. It is planned to for the law to enter into for in Jul,23 2004. In this context, electronic signature meeting certain requirements is considered legally same as hand written signature and is accepted as proof in legal proceedings (SPO Information Society Department, 2003).

"Estonia has a national identification card that can be used for electronic identification and giving digital signatures, where a digital signature is equivalent to a handwritten one. A universal system, DigiDoc, has been developed to assign and verify digital signatures. Over 360,000 Idcards have been issued as of 13 January 2004 and additional applications are underway."

7.1.9 Education

According to the 8th Five-Year Development Plan, there will be significant gap between supply and demand of IT professionals by 2005, and the need for new IT-related education programs is highlighted as a priority in this Plan. Electric-Electronics, Computer, Mathematics, Physics, and Industrial Engineering Departments and 2-years Vocational Training Programs need additional quotas for closing the IT professional gap in the years to come.

Under the Education and Human Resources Development Section of STAP, there are 8 actions, and the Ministry of Education is responsible for six of them. Developing an education portal, computerizing the schools, and improving the curricula for computer education are among these actions.

As for the diffusion of internet access to the universities, UlakNet (National Accademic Network)'s new project is underway. UlakNet is connecting all state universities, several public institutions, and Armed Forces R&D departments since 1997. In November 2002, the new improved UlakNet infrastructure started to operate. With this project, international capacity increased 10 times, from 64 Mbps to 620 Mbps, all the university branches at rural areas are covered and an initial connection to European Academic Network (GEANT) with 155 Mbps is launched.

KOSGEB, as the main public institution responsible for development of SMEs, conducts projects for the purpose of demonstrating IT benefits and use. Events to be set up with partners of the MEDFORIST National network include courses in different programs including initial training, post-graduate, vocational, executive courses, seminars or small conferences with intermediaries like chambers of commerce, professional institutions, and also with public institutions (SPO Information Society Department, 2003).

"It is noted that Cyprus, Czech Republic, Hungary and Malta have achieved the eEurope+ targets for the provision of computers to tertiary level students. Since December 2001, Hungary has almost tripled the number of computers available (7.2 to 20.5 PCs per 100 students) and Malta has almost quadrupled the number (6.0 to 22.8 PCs per 100 students)."

"In Hungary, a new, high-tech service center, Student Information and Resource Centre, has been opened for Hungarian higher education. The Centre offers the possibility of acquiring the skills and competencies in IT so that it becomes an integral part of the daily life of students, professors and researchers."

"In Malta, The national SchoolNet program connects all primary, secondary and tertiary schools to one educational network through which each student and teacher has access to the Internet via broadband. Besides, a widespread digital literacy and IT awareness program – myWeb - was launched in 2003 mainly targeted at the 45+ age groups with no IT-background. It provided 20 hours of training in basic computing operations, the use of the Internet and e-mail. It is estimated that by the end of 2004, 10% of the adult population will be trained under this initiative."

In November 2001, Educational IT-Based System (SEI) was started in Romanian schools. The ADLIC project was also initiated to support national admission and distribution of elementary school graduates in high schools and vocational schools. This project was awarded the "Very Best Practice" label at the e-Government Ministerial Conference held in Brussels in 2001.

7.1.10 Overall Assessment

To make an overall assessment and evaluation of IT policies and programs and their impact, several issues that would have impact on IT development in Turkey should be considered.

First of all, monopolistic structure of telecommunications still prevails in Turkey. Providers of service, data, content, and application are all mostly using the same infrastructure, and this dependence appears to be the hardest obstacle for infrastructure and new value-added services development.

Although there are no legal barriers to be a player in the telecommunications services market, except voice transmission, the lack of regulation framework make domestic and international firms who are willing to gain access to one of the last few untapped markets in the world would prefer to delay investing in Turkey's emerging markets.

Second issue is government's involvement in such programs. Until recently, there was not a clear approach to IT policies and programs on the government side. There are still many areas yet to be analyzed, and developing comprehensive policies for these areas comes first. Public leadership seems to be essential in some areas, but so far chronical macroeconomic instability of the Turkish economy and the lack of thorough analysis caused time loses and redundancies. IT in education, health, government affairs, regional development, environment and R&D are such areas and need further studies.

National IT innovation and diffusion to businesses also needs further improvements. Policy-makers and implementing and investing agencies should work closely, and university involvement in R&D activities in IT needs to be redesigned.

7.2 NATIONAL R&D PROGRAMS RELATED TO IT IN CONSTRUCTION AND OTHER COUNTRY EXAMPLES

AUSTRALIA

CRC - Cooperative Research Centres
CRC-CI - Cooperative Research Centre - Construction Innovation [15 M€, 2001-07-01...2008]
AACI - Australian Agile Construction Initiative
SEED - Software Environment to support the Early phases in building Design. (US-Australian project).
STEP Demo Project - Presentation of results from the Industry Information Group (IIG)

DENMARK

Digital Construction - owner requirements,standards & technologies, best practices [12 M€, 2003...2006]

FINLAND

ePROM - Network of e-Exellence in Real Estate Cluster - Promoting the implementation of Vision2010 [2002-03...2004-12]
INFRA - Construction and Services Tecchnology Programme [24 M€ budget, 2001...2005]
ProIT - Deployment of product model technology in the construction sector [2002.06...2004.12]
SARA - Value networks in construction [33 M€ budget, 2003...2008]
TEKES - Many major national programs supported by the Technology Development Agency
UTT - Networked and on-line busines models in a number of industries. [59M€ funding, 2000.01...2004.12]
VERA - Information Networking in Construction Process. [42M€ budget, 1997.05...2002.12]
Visin2010 - Finnish Real Estate and Construction Cluster's vision for 2010 [2001...]
VIRIL - Applications of Virtual Reality Technology for Building Construction Delivery
Construction IT projects at VTT - Contains several EC projects
ProBuild - Progressing building process technology program (1997-2001)
50
Remontti - Building renovation (1992-96)
iWELL - Wellbeing and health (e.g. in buildings?)

FRANCE

ProMICE - Product&Process Models Integration for Concurrent Engineering in Construction (U Loughborough&U.Savoi)
DRAST - Direction de la Recherche et de l'Action Scientifique et Technique. CSTB research programme [4 M€, ...]
PUCA - Plan Urbanisme Construction Architecture [0.9 M€, ...]

GERMANY

BMBF - Bundesministerium für Bildung und Forschung
BMVBW - Bundesministerium für Verkehr, Bau- und Wohnungswesen
BMWA - Bundesministerium für Wirtschaft und Arbeit
GAEB - Common Committee for information technology in building and construction

ICELAND

eProCon - e-Products for Construction (Nordic project) [0.5 M€,2002/11-2004/12]

JAPAN

House Japan - Project by Research Association of House Technology Development for Creative Life
CALS - Continuous Acquisition & Life-Cycle Support - A project for construction industry.
SCADEC - Implementation of STEP CDS

NORWAY

AIS - Advanced Internet Collaboration
POSC/Caesar - A standardisation initiative to reduce life cycle costs and development time of oil and gas facilities
SiB - Samspillet i Byggeprosessen (Cooperation in building process) - Process, networks, etc

PORTUGAL

SIP - STEP -based Integration Platform

RUSSIA

STEPCASE - Advanced CASE solutions in conformity to STEP information standards and models
IFC MANAGER - Product Data Management System for Architecture, Engineering and Construction

SINGAPORE

CORENET - Construction and Real Estate Network - The National Computer Board (NCB)

Figure 52 – National RTD Programs related to IT in Construction

SLOVENIA

EASY - Multimedia learning tool about earhquakes failures

SWEDEN

CB - Competitive Building
IT-BoF - IT Construction and Real Estate 2002
BAS*CAAD - Building and user Activity Systems modelling for Computer Aided Architectural Design
MOPO - Models for the construction process

SWITZERLAND

CIP - Integrated Planning in Consruction - ETHZ
ICCS - Information, Communication and Collaboration System for the Swiss AEC Industry
ZIPBau (alt) - Integrated Planning and Communication in the Building Process

THE NETHERLANDS

ConstrucTable - Process and System Innovation in the Building and Construction Industry (PSIB)
PAIS - Platform for Agreement of Information-technical Structures
BAS - Integration of building specifications, product model & cost estimation, STABU
GROUNDSS - Modelling the effects of ground condition on the construction process using artificial intelligence (site under
NOBI - National Development Programme for Building Informatics
VR-DIS - Virtual Reality - Design Information System

UNITED KINGDOM

CBPP - Construction Best Practice Programme
CEE-IDAC - Concurrent Engineering Environment for Integration of Design and Construction
CIRIA - Research association concerned with improving the performance of all involved in construction and the environment
CITE - Construction Industry Trading Electronically
Construct IT - The National Network for the UK
COMMIT - Construction modelling and methodologies for intelligent integration of information
CPD - Construction Process research at BRE
CRISP - The Construction Research and Innovation Strategy Panel
IMCR - Innovative Manufacturing&Construction Research Centre (Looughborough University, supported by EPSRC) [19.7
ITCBP - *IT Construction Best Practice*
ICON (alt) - Integration of Information in Construction
ISoCCCrates - Improving Supply Chain Communications in Construction
Link IDAC 82 - The Development of Decision-Making Tools for Controlled Innovation in Construction.
LEXIC - A contribution to the Integration of Concurrent Engineering in Construction
From 3D to nD Modelling
OOCAD - Object Oriented CAD
OSCON - Open Systems for CONstruction, U Salford
ProMICE - Product and Process Models Integration for Concurrent Engineering in Construction (UK - France)
Process Protocol - University of Salford, 1995-2001
PII - Partners in Innovation [8.1 M€, ...]
RC - Rethinking Construction
SCRI ? - Salford Centre for Research and Innovation [4.3 M€, ...]
SIENE - The Network on Information Standardisation, Exchanges and Management in Construction
SPACE - Simultaneous Prototyping for An integrated Construction Environment

USA

e-AEC - e-AEC Research, Center for Integrated Facility Engineering, Stanford University
CaribCad - Collaborative Approach to the Realisation of Internet Based CAD (GaTech)
CALS - Computer-aided Acquisition and Logistic Support (CALS).
CICE - Computer Integrated Construction Environment Testbed (NIST)
CSCM - Construction Supply-Chain Management - CIFE
DA VINCI - Computer support mechanisms for enhancing distributed engineering design change negotiation
ENGEN - Enabling Next Generation Mechanical Design.
OCAI - Open CAD Architecture for Interoperability
SEED - Software Environment to support the Early phases in building Design. (US-Australian project)

Figure 52 – National RTD Programs related to IT in Construction (continued)

7.2.1 Singapore

In early 1998, Singapore announced that it aims to become a global information technology and knowledge hub via a revamp of its National Computer Board (NCB), which oversees the country's strategic IT directions. The NCB will aggressively promote local initiatives such as the Singapore ONE broadband network infrastructure and the Electronic Commerce Hotbed project overseas, and will market Singapore as a good place for large-scale technology trials. The NCB has set up an internationalization office to establish links between Singapore and other countries, and to look for opportunities for collaboration to accelerate the country's strategic IT projects. It has also established a number of competency centers to promote value-added IT work, and track technology trends and developments worldwide. The centers will cover areas such as IT security, the Internet, Java, networking/communications and process innovation (Hayward, R., 1998).

CORENET (COnstruction and Real Estate NETwork) is a major IT initiative led by the Ministry of National Development and driven by the Building and Construction Authority in collaboration with other public and private organizations. Objective of CORENET is to re-engineer the business processes of the construction industry to achieve a quantum leap in turnaround time, productivity and quality (CORENET, 2004).

Figure-53 below describes the basic topics covered by CORENET;

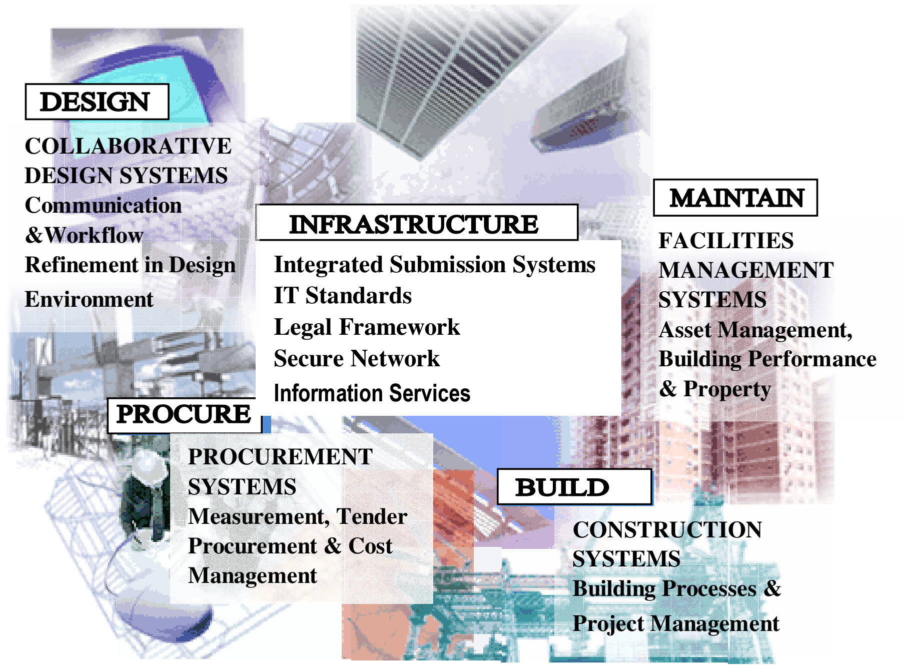

Figure 53 – Singaporean National RTD Program - CORENET (COnstruction and Real Estate NETwork), related to IT in Construction.

Currently, the effort is focused at developing a set of infrastructure and industry projects in order to:

- Provide Government to Business infrastructure to facilitate electronic building plans submission, checking and approval processes;
- Provide Information Services to allow businesses to speed up business planning and decision making processes;
- Provide a set of standards to improve business communications;
- Provide a series of promotions and training to create awareness and encourage adoption.

CORENET e-Submission system (eSS) is a G2B (Government to Business) internet-based system that enables industry professionals to submit project related electronic plans and documents to regulatory authorities for approval within a secured environment. The benefits of eSS include:

- Providing One-stop convenience to both private and public sectors;
- Providing One-stop point for submission of plans from qualified persons to multiple approving authorities from anywhere, at any time;
- Providing One-stop access for qualified persons to check submission status online;
- Providing One-stop billboard for approving authorities to post submission status online.

The CORENET e-Information System (e-Info) is one of the many supporting IT application systems under CORENET. It aims to be the central repository for building and construction related information that is accessible anywhere, anytime via the Internet. e-Info repository adopts the industry standard known as extensible mark-up language, XML in short, to structure and harmonize the information resources. Information resource currently available through e-Info includes codes, regulations, guidelines, standards, FAQ, product catalogue, contractor performance and Singapore standards. It is a quick, user-friendly, timely and one-stop electronic access point to the latest codes, regulation, building and construction information that reduces the need for hard copy storage space and expensive contents management system. To date, it has the support and contributions from 12 regulatory departments spreading across 8 Ministries (CORENET, 2004).

It also forms the sub-module to provide the foundation in support of the Integrated Plan Checking Systems. Several government agencies are currently working together on a integrated plan checking project to deliver a single plan-checking tool to check building plans submitted by Architects and M&E Engineers for compliance of the various authorities regulations. Key Participants are Building and Construction Authority (BCA), Central Building Plans Unit of National Environment Agency (CBPU), Housing & Development Board (HDB), Land Transport Authority (LTA), National Parks Board (NParks), Singapore Civil Defense Force (SCDF), Public Utilities Board: Drainage Department, Sewerage Department & Water Department (PUB) (CORENET, 2004).

The BCA is a statutory board under the auspices of Singapore's Ministry of National Development. It was established on 1 April 1999 as a result of the merger between the Construction Industry Development Board (CIDB) and the Building Control Division of the Public Works Department (PWD).

The primary role of BCA is to develop and regulate Singapore's building and construction industry with the mission as "to develop an advanced and competitive construction industry amongst the best in Asia ". Its corporate objectives are:

- To improve construction quality and productivity to levels comparable with those in developed countries
- To raise capabilities and professionalism of firms and personnel in the industry, and promote the export of construction services
- To ensure building safety, well-managed and maintained buildings, and administer a progressive regulatory framework
- To be the technical authority and government's advisor on structural and civil defense shelter engineering
- To build an organization that fosters teamwork and innovation and develops staff to their maximum potential

In order to achieve these objectives, the shared values of BCA are stated as I CARE as follows;

I – Innovative Spirit (We are innovative and creative)

C – Cohesiveness (We work together as a team)

A – Advancement (We advance through continuous learning)

R – Responsibility (We are responsible towards our staff, community and environment)

E – Excellence (We strive for excellence in our service)

IT Department, BCA promotes IT standards used in the industry. The Department coordinates the efforts of the various professional bodies of the industry to draw up users' requirements and standards to enable interoperability in the local construction industry. Performance-based Building Regulations will come into force in this year (CORENET, 2004).

A Memorandum of Understanding ("MoU") was signed on 29th September 1998 to develop the National Standards for Information Exchange in the Construction Industry.

- Singapore Standard CP 80 : 1999
  CODE OF PRACTICE FOR Classification of construction cost information
- Singapore Standard CP 83 : 2000-2001
  CODE OF PRACTICE FOR Construction computer-aided design (CAD)
- Singapore Standard CP 93 : 2002
  CODE OF PRACTICE FOR Classification of Construction Resources Information
- Singapore Standard CP 97 : 2002
  CODE OF PRACTICE FOR Construction Electronic Measurement Standard (CEMS) - Part 1: Standards Method of Measurement (SMM) for building works

These standards were developed under the ambit of Construction Industry IT Technical Committee (CITC) - an industry-led committee comprising members from various professional bodies and leading firms in the industry.

To keep Singapore abreast on the IT developments in the world, IT Department, BCA serves as the Secretariat to the Singapore Chapter of the International Alliance For Interoperability (IAI).

IAI(S) is represented by major construction bodies in Singapore, including BCA, HDB, IES, JTC Corporation, DSTA, REDAS, SCAL, SIA, SISV and URA. IAI(S) members also include Institutes of Higher Learning: Ngee Ann Polytechnic, Singapore Polytechnic, Temasek Polytechnic and National University of Singapore, as well as Vendors: Autodesk Asia Pte Ltd, Collaboration Technologies And Services (Asia Pacific) Pte Ltd and NovaCitynets Pte Ltd. IAI(S) is admitted into the Construction IT Standards Technical Committee, a member of the Singapore National IT Standards

Committee, to endorse and define common standards to be used in the Singapore building industry (CORENET, 2004).

The training arm of BCA is Construction Industry Training Institute (CITI) providing technical, supervisory, professional and management training as well as skills training, testing and certification programs for construction personnel. Since founded in 1984, CITI has been expanding and enhancing its role as the major construction training provider for Singapore's construction industry by conducting periodic seminars and industry briefings to motivate and assist the industry on IT implementation and/or upgrading. Conferences and seminars keep the upper and middle management updated on the latest technology know-how's and know-what's, and on understanding, implementing and managing technology (CORENET, 2004).

7.2.2 Sweden

Sweden is a small country and the Construction and Building Management Industry is a small sector from the IT software producers' point of view. International cooperation is therefore crucial if the industry wants to have IT adapted to its own special conditions (Klercker, J., 2002).

The Swedish Building Centre is the information company of the construction industry. The Centre draws up, disseminates and classifies information within the construction sector. The Swedish Building Centre collaborates with many Swedish and foreign companies, authorities and institutions within the areas of research, standardization and implementation. The Centre endeavors to bring about rational and appropriate construction by carrying out research and providing information services and information products geared to the needs of the users.

The activities of the Centre now cover the whole country and comprise:

- exhibition of building and building services products
- the Building Products Catalogue and the Building Products Register
- publishing, specialized in the construction field

- development of AMA (General Material and Workmanship Specifications)
- literature and information service
- training
- information systematics, for instance document co-ordination and responsibility for the development and administration of the BSAB system.

Employers and employees founded the Development Fund of the Swedish Construction Industry, SBUF, jointly in 1983. SBUF is the construction industry's organization for research and development with approximately 3,000 affiliated companies in Sweden. Founding members of SBUF are (Development Fund of the Swedish Construction Industry, 2004):

- The Swedish Construction Federation
- The Swedish Employers Association for Plumbing, Heating and Refrigeration Contractors
- The Association of Management and Professional Staff
- The Swedish Builders Workers Union
- The Union of Service and Communication Employees

SBUF aims to promote development in the building process to create more businesslike conditions for contractors enabling them to make use of research and conduct development work.
Further aims are:

- to improve the effectiveness ranging from raw material to complete product and from idea to destruction by means of development and collaboration,
- to promote collaboration for development with specialized contractors in order to improve the effectiveness in the entire building sector,
- to stimulate and support research at the technical universities on questions vital to contractors and,

- to support development of methods and equipment making construction, service and maintenance more attractive and better adjusted to construction workers,
- to support research and development being the basis for performance-oriented public rules and standards (Development Fund of the Swedish Construction Industry, 2004)

The Division of Construction Management, at Lund University is dealing with the construction process and its participants (from design to property management), both in undergraduate education as well as scientific research. The link between education and research is strong. Outward sectors of the construction industry have close collaboration with the development growth at the division. Some examples of ongoing research projects:

- Construction process efficiency and effectiveness
- New reforms for co-operation encouraging innovative procedures
- Competition in the construction process
- Evaluation of construction methods
- Innovation process

Besides, The Swedish Research Council for Environment, Agricultural Sciences and Spatial Planning, is a governmental research-funding agency under the ægis of the Ministry of the Environment. Formas promotes ecological sustainable growth and development in society as well as international research co-operation. The Construction Counsel in Southern Sweden, is an association that supports the co-operation between the university and the construction and real estate business. The aim is to support the research and education in this field.

SBUF takes part in several larger research programs based on cooperation with companies and technical universities as listed below;

- Competitive Building (1998-2007)
- The industrial program Infrastructure (1996-2005)
- IT Construction & Real Estate 2002

- Sustainable Building (1997-2002)
- The Building and its Indoor Environment (1998-2003)
- The Healthy Building (1998-2003)
- Centre for Management of the Build environment, CMB
- Centre for research and education of maintenance of infrastructure, CDU
- Swedish Deep Stabilization Research Centre
- The Moisture Research Centre

Among them, the most important and IT-related ones are Competitive Building and IT Construction & Real Estate 2002.

Competitive Building (1998-2007) is working towards strengthening Sweden's building sector, by promoting competence in its workforce and improving industrial competitiveness through a more efficient process. Competitive Building represents a unique collaboration between industry and universities to create agents of change - people who are able to think strategically. Industry-aware researchers are recruited to join Competitive Building's competence building program to focus on resolving problems of significance to any individual organization, as well as the sector at large. There are four research themes: Industrial building for good living standards and rationalized property redevelopment to suit tenants' requirements; Moisture design in the building process; Energy efficiency in buildings and in operational processes.. A scientific school is included in the program.

IT Construction & Real Estate 2002 (1998-2002) is a sector wide program for implementing IT in construction and facilities management. The program is managed by an industry owned consortium and supported by public research funds. It formulates a national IT strategy and has its vision as an integrated, model-oriented and digitalized information and production process: planning-construction-real estate business. The goal is to provide a common IT platform for Swedish construction and real estate companies which will make it possible for the companies to increase the benefit to the customer through improved market communication, greater efficiency, higher quality and lower costs. This is achieved by using IT to help change construction and management processes through the introduction of new forms of work and new technology.

The program requires active co-operation between all the parties in the construction and real estate sector, universities and colleges. Co-operation has also taken place with the school for researchers planned within the Competitive Building R&D program.

The basic aim of the R&D work has been to help the industry to increase its competitiveness by renewing and improving the development of knowledge concerning a property, within the companies and in the industry as a whole. The R&D program has supported this basic aim through the following five target areas and each of the target areas has been the subject of studies with the aim of formulating relevant research and development efforts within the framework of the program.

1. **Communication and the Supply of Knowledge Strategy**: The industry has to use public, physical networks and the available technology to provide simple, reliable and coordinated access to both industry-wide information and project information.

   Research and Development Projects;

   - Information on building products and materials on the Internet
   - Inter/intranet-aided learning with project simulation
   - Inter/extranet-aided document handling for CAD
   - Information handling costs in construction projects
   - Extranet -damage-prevention feedback for facilities managers(development project)
   - Groupware, Inter- and Intranet for knowledge development and knowledge transfer

2. **The Man-Machine Interface Strategy**: One task for national efforts is to influence development by making clear to the IT industry what the special needs of the construction and real estate sector are, and by

explaining how national characteristics may be of importance with regard to functionality.

Research and Development Projects;

- 3D-models in project simulation
- Virtual buildings
- Communicating with CAAD
- Interactive visual presentation for customers

3. **Product, Process and Other Computer Models Strategy**: Strategy: All information management requires a simplified portrayal of reality, irrespective of whether the information is used for planning, production or management. In the future, models may also be used to enable different parties to share information throughout the entire process. The aim of computer models is that it should be possible to exchange information created by different parties and in different systems. Process models are central to co-operation, especially in new and flexible forms of organization and can be used to simulate and visualize the proposed reality in order to achieve the intended qualities.

Research and Development Projects;

- Simulation of workflows and material flows in building production
- IT planning for lightweight building techniques in wood
- Generic construction process model
- Generic facilities management model
- Modeling of operations and buildings
- Facilities Management documents 2000/process analyses (development project)
- Integration of energy calculations
- Building product model for comfort and energy calculations
- Design and product modeling

4. **Classification and Standards**: In Sweden there is a strong national tradition with comprehensive classification systems for construction and

buildings. The BSAB system, with its tables for building elements and products, is perhaps the most well known. It is important for the industry as a whole that the Swedish construction and real estate sector commands the resources required to take initiatives in the field of standardization and play an active part in the ongoing standardization work in the area.

Research and Development Projects;

- The facilities management information structure
- Design documents in a facilities management perspective
- Theoretical bases for building classification
- Swedish experience in connection with the BSAB system and the international work within ISO/STEP and IAI/IFC continually provide ideas for research issues which are handled under main area 3.

5. **Implementation and Changed working methods:** Greater know-how on IT as a means of developing projects and companies is needed. IT provides the preconditions for new forms of work and new patterns of co-operation within and between companies. These new opportunities may provide the basis for completely new types of operations. The industry must be prepared to deal with changes on the market, many of which may be difficult to predict.

Research and Development Projects;

- Modeling of the distribution of responsibility and work in construction projects
- New construction logistics with EDI and other forms for greater IT support
- More efficient construction and facilities management processes with IT
- Design@Work
- IT strategies in construction companies
- Telecommuting in the construction sector

- Computer-aided program work
- Substitution of meetings in the construction process with IT
- IT support for focus on the customer' s customer
- Measurement methods for IT benchmarking in the construction sector
- Process changes resulting from the building product model technique

Some project examples of the program are listed below;

- IT Barometer – a Survey on the Use of IT in the Construction Sector.
- W78 Conference within CIB in Stockholm, June 1998.
- Seminar on the theme of 3D and virtual reality interfaces to design and process information
- IT Security – for Project Management and for the Exchange of Information – the Development of Sector Practice.
- Electronic Signatures, Traceability, Handling of Original Documents.
- Digital, Long-term Archive Management – Technology, Law etc.
- Internet and Extranet in Co-operation with Project Databases for Construction Projects
- The Millennium Change Problem in the Construction Sector
- Product Models – Information on IAI, IFC, STEP etc
- Process Models – Seminar on Tools and Projects such as CONCUR, CONDOR etc
- Dissemination of Information on Bygghandlingar 90, BSAB, ISO-stock-keeping etc
- Document and Drawing Management - BPM-(Building Process Messages)
- Electronic Trading and Materials Administration
- Supply Processes – Transportation in the Future
- Invoice-Free Payments
- Information on Electronic Trading – Benefits – Possibilities – Solutions

On the other hand, The Royal Institute of Technology, NCC and Tyréns are Swedish organizations participating in MOPO, one of the VERA projects. The MOPO (Models for the construction process) project aimed at developing IT-based tools for construction process analysis and planning as well as adaptable models which can be reused in a modular way as parts of company and project specific development efforts. The purpose of MOPO project was to develop models and methods, and computer-aided prototype tools for analyzing and planning of companies in the construction industry. Moreover, the purpose was to develop process descriptions, which can be used in company-and project-specific development projects. In addition to the company-specific results, a new generic construction process modeling method called GEPM was developed. It is based on earlier process modeling methods. GEPM was implemented on a Lotus Notes platform combined with MS Project 98, Vision 2000, and BPwin 2.0 tools. Another general result was PIIP (Process Information Integration Platform), which studies the management needs of processes and the use of IFC for modeling the construction processes. As part of PIIP-work, two preliminary prototype tools were developed.

Another national research project on Construction IT of Sweden is The BAS-CAAD project- Building and user Activity Systems modeling for Computer Aided Architectural Design. A new approach to product modeling in a design context is proposed as CAD-software must not only enable product modeling, but must also support product design. It discussed how product design and modeling can be based on a facetted approach to information modeling, and how a data model that supports the design process can be based on a framework for system information. The background for this research is the current development in the construction industry towards a computer integrated construction process.

7.2.3 Australia

The key aim of the Australian Agile Construction Initiative (AACI) is to facilitate the flow of information regarding current world best practice to the program's industrial partners. It is a program of research coordinated by the School of Architecture and Building with the objective of promoting increased competitiveness within the Australian Construction Industry. It also provides a forum for policy-makers, industry clients, practitioners, and academics to discuss the challenges currently facing the industry (ConstructionEducation.com, 2004),

Founded in 1975, Construction Information Systems (formerly NATSPEC Pty Ltd) has pioneered electronic information delivery for Australian building design professionals. It serves nearly two thousand organizations across Australia and overseas making it one of the industry's most significant information resources. Its 20 shareholder organizations represent nearly 100,000 members and employees.

Besides, the Australian Research Council is one of the sponsors of SEED: A Software Environment to Support the Early Phases in Building Design. SEED is intended to provide a systematic computational support environment for the rapid generation of designs with respect to recurring building types. Consequently, it is necessary to enable the storage and retrieval of past solutions and their reuse as prototypical designs in similar problem situations. In this respect SEED is an application of case-based design systems (Flemming, 1994). A module of SEED-Pro is responsible for the generation of functional requirements for design, conforming to a uniform problem specification theme based on certain object-oriented concepts used throughout the entire SEED project.

The Cooperative Research Centre for Construction Innovation is a national research, development and implementation centre focused on the needs of the property, design, construction and facility management sectors.

Established in 2001 and headquartered at Queensland University of Technology as an unincorporated joint venture under the Australian Government's Cooperative Research Program, Construction Innovation is developing key technologies, tools and management systems to improve the effectiveness of the construction industry (CRC Construction Innovation Building Our Future, 2004).

Having the vision is to lead the Australian property and construction industry in collaboration and innovation, underpinning Construction Innovation is the most significant commitment ever made to construction research in Australia. Its objectives are:

- To enhance the contribution of long-term scientific and technological research and innovation to Australia's sustainable economic and social development.
- To enhance the collaboration between researchers, industry and government, and to improve efficiency in the use of intellectual and research resources.
- To create and commercially exploit tools, technologies and management systems to deliver innovative and sustainable constructed assets to further the financial, environmental and social benefit to the construction industry and the community.

The research undertakings of Construction Innovation occur in one of three subprograms as shown in the Figure-54;

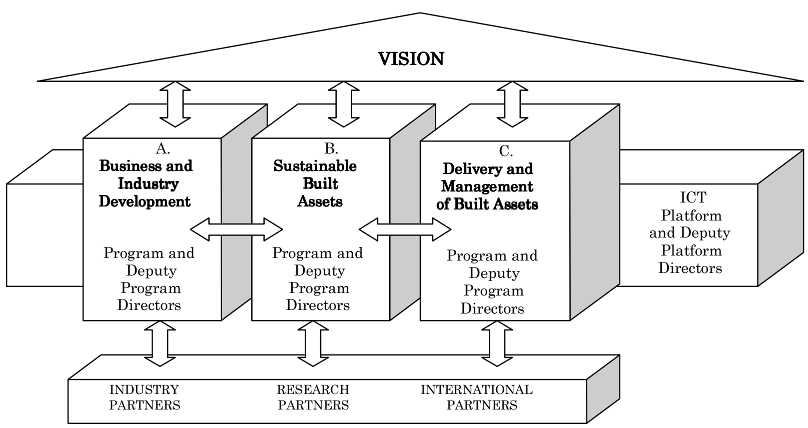

Figure 54 – Australian National Construction Innovation Programs (Source: CRC Construction Innovation Building Our Future, 2004).

The IT Platform acts as a driver for change and integrator across the Construction Innovation's Research Programs. Recognizing IT as the fundamental enabler of process re-engineering in the property and construction industry; the roles IT platform are;

- Promoting the vision of the integrated open systems approach to the Construction Innovation and property and construction industry.
- Working with Program Directors and Project Leaders to identify and coordinate opportunities within projects for the use and uptake of advanced applications and solutions of IT.
- Coordinate the contribution of Construction Innovation for the development of open standards for information exchange, using international leading edge approaches to integrate across the three core programs for effective management of built assets from inception for whole of life.

Collaborate with other international leading research groups to ensure Construction Innovation is at the forefront of IT development as it applies to the property and construction industry (CRC Construction Innovation Building Our Future, 2004).

Program A - Business and Industry Development: The objective of Program A is to improve the long-term effectiveness, competitiveness and dynamics of a viable construction industry in the Australian and international contexts through greater innovation in business processes, strengthened human relations and ethical practices, and more effective interactions between industry and its clients.

The operational strategy to achieve the objective is:

- To design and progress integrated research in order to develop state-of-the-art knowledge and the capability for future knowledge generation.

- To consolidate and strengthen collaboration within the industry to create and support an effective knowledge base.
- To bring together research projects and results in order to produce coherent results, supported by expertise and experience that will be strongly disseminated and implemented to achieve improved performance in the Industry.

The Program recognizes the need for a 'bigger picture' reflecting the industry's continuing shift towards accommodating the rigors of more customer-led thinking by adopting a more strategic, futures-orientated approach.

The priorities are set to capture knowledge, change culture, business innovation, and construction futures in the context of business development in order to respond to national and global market pressures for business innovation; the needs of the industry and its customers for business improvement and Government Policy.

Program B - Sustainable Built Assets: The objective of Program B is to drive healthy and sustainable constructed assets and optimize the environmental impact of built facilities through sound conceptual basis for economic, social and environmental accounting of the built environment, virtual building technology to examine design performance prior to documentation, construction and use and assessing human health and productivity benefits of smart indoor environments.

To satisfactorily address sustainability challenges of the built environment requires an integrated, whole-of-system perspective, where the key elements relate to whole of life performance, building and infrastructure systems, design, construction and management re-engineering and value-adding their performance and IT - which are specific to the needs of built environment objects (e.g. Industry Foundation Class) and processes (virtual buildings, collaborative design) and which are capable of embodying sustainability concepts and metrics in decision support systems. They are fundamental to the productivity and competitiveness of the economy, the quality of life of all its citizens and the ecological sustainability of the continent. Life Cycle Modeling and Design Knowledge Development in Virtual Environments is a project which will make available maintenance performance data to designers to enable more informed choice and design of materials and detailing at early design stage.

Program C - Delivery and Management Of Built Assets: The objective of Program C is to deliver project value for stakeholders for the whole-of-life through to ownership, asset management and reuse. Two projects, Managing Information Flows with Models and Virtual Environments, and Project Team Integration: Communication, Coordination and Decision Support, are concerned with developing IT to support the facility design phase and improve team integration. A third project Contract Planning Workbench is exploring the option of using Industry Foundation Classes (IFCs) as the basis for developing first draft construction schedules. This would speed up the process and may also permit interface with existing scheduling software to provide 4D visual presentation.

Current projects of the Centre with related program codes are listed in Table-20 below;

Table 20 – Current projects of the Australian Cooperative Research Centre for Construction Innovation

[2001-002-B] Life Cycle Modeling & Design Knowledge Development in Virtual Environments
[2001-003-C] Value Alignment Process for Project Delivery
[2001-004-A] Knowledge Management and Innovation Diffusion
[2001-005-B] Indoor Environments: Design, Productivity and Health
[2001-006-B] Environmental Assessment Systems for Commercial Buildings
[2001-007-C] Managing Information Flows with Models and Virtual Environments

Table 20 – Current projects of the Australian Cooperative Research Centre for Construction Innovation (Continued)

[2001-008-C] Project Team Integration: Communication, Coordination and Decision Support
[2001-010-C] Investment Decision Framework for Infrastructure Asset Management
[2001-011-C] Evaluation of Functional Performance in Commercial Buildings
[2001-012-A] Innovation Potential, Directions and Implementation in the Building and Construction Product System
[2001-013-B] Sustainability and the future Building Code of Australia
[2001-014-B] Automated Code Checking
[2001-016-A] Critical Success Factors for IT Mediated Supply Chains
[2002-004-B] Noise Management in Urban Environments
[2002-005-C] Decision Support Tools for Concrete Infrastructure Rehabilitation
[2002-010-B] Component Life: Delphi Approach to Life Prediction of Building Material Components
[2002-020-C] Tenant Risk Profiling
[2002-022-A] Value in Project Delivery Systems: Facilitating a Change in Culture
[2002-024-B] Team Collaboration in High Bandwidth Virtual Environments
[2002-035-C] Feasibility Study Linking Best-Value Procurement Assessment to Outcome Performance Indicators
[2002-043-B] Smart Building for Healthy & Sustainable Workplaces
[2002-052-C] Value in Project Delivery Systems - Project Diagnostics

Table 20 – Current projects of the Australian Cooperative Research Centre for Construction Innovation (Continued)

[2002-053-C] Way Finding in the Built Environment
[2002-056-C] Contract Planning Workbench
[2002-059-B] Case Based Reasoning in Construction and Infrastructure Projects
[2002-060-B] Parametric Building Development During Early Design
[2002-062-A] Ethical Behavior in the Construction Procurement Process
[2002-063-B] Sustainable Subdivisions: 1 - Energy Efficient Design
[2002-066-A] Internationalization of Construction Industry Design Firms
[2002-075-B] Integrated Sustainable Housing Development
[2003-037-C] Stage 2 - Managing Information Flows with 3D Models

Construction Innovation's Commercialization/Technology Transfer Program is designed to enhance the transfer of research outputs into commercial or other outcomes of economic, environmental or social benefit to Australia. The strategies in achieving this are:

- **Commercial Exploitation of Intellectual Property;** to ensure Intellectual Property (IP) management and strategies for commercialization are targeted to potential commercial opportunities
- **Technology Transfer to Industry, the Australian Community and Globally**; to transfer public good research outcomes to Construction Innovation partners, the construction industry and the broader Australian community
- **Smart and Streamlined Management Solutions**; to ensure that smart and streamlined systems are utilized to effectively manage research activities in a focused and targeted manner, allowing easy identification and exploitation of commercialization opportunities.

Construction Innovation's Education and Training Program will:

- enhance the value to Australia of graduate researchers
- be recognized as a significant contributor to enhancing the collaborative culture of construction
- attract students by the reputation of its education activities
- partner with organizations to develop educational and professional development courses, using outcomes from Construction Innovation's research.

The strategies in achieving this are;

- **Curriculum Development and Support**; to provide input to university, TAFE and VET curriculum development
- **Student Support**; to provide Scholarship funds and a focus of industry reference for high quality PhD and Masters Students
- **Research Project Education Dispersion**; to identify education and training opportunities from research projects and to develop greater appreciation and support from research teams for education efforts
- **Continuous Professional Development**; to provide opportunities for continuous professional development for industry and research personnel

While Construction Innovation will 'pack' information into texts, seminars, and conferences, it has identified significant downfalls in relying only on this type of knowledge diffusion. Alignment with the VET sector and partnering with associations such as Construction Training Australia is expected to increase the construction industry's uptake of research outcomes (CRC Construction Innovation Building Our Future, 2004).

7.2.4 Canada

The capability of the Canadian construction sector to deliver the most difficult projects, under the harshest of conditions, is as good as that of any nation in the world. Improving this record and integrating society's performance expectations into tangible products and services has not been possible within the traditional structures and approaches of the industry. There is widespread agreement that the sector is capable of much higher achievement in many areas, if it could unleash its full innovative potential. The National Steering Committee on Innovation for Construction (NSCIC) is a private-sector committee committed to creating an innovative construction sector that provides the best socioeconomic value for Canada. The vision of the committee is being a recognized leader in the development of a quality built environment through research, innovation and the creation of integrated solutions (National Research Council Canada, 2004).

To implement the strategy of being an enabler for the transition of the construction industry into the knowledge-based economy; the committee has established four Strategic Objectives:

- To develop the knowledge and technologies essential to the creation of a quality and cost-effective built environment.
- To provide integrated decision-making tools that enables the construction sector to respond to changing performance expectations.
- To develop construction process technologies critical to improved productivity of the construction industry.
- To become a responsive organization, well positioned to enable the transition of the sector.

Technological reviews and foresights within Canada and around the world provide insight into the types of technologies needed to enhance industry performance. These are identified in technology roadmap documents, technology forecasts and plans from major construction associations and research organizations including Natural Sciences and Engineering Research Council (NSERC) Centers of Excellence. Environmental and economic concerns and enhanced use of information technology consistently arise as over-riding background themes. Opportunities to enhance industry performance through new technologies include:

- Enabling knowledge (Tools for integrating the design, construction and operation processes, interoperability of software and business systems, validated decision making tools, and repositories of credible information will underpin applying information technology to improve industry productivity.)

- Sustainable materials and systems (Improved performance in specific applications and minimal environmental impact need both innovative materials – composites and nano-materials - and more effective use of existing materials and systems.)
- Design process (Design goals and methods will evolve to meet societal demands for health, comfort, safety and security, and adapt to increasing use of automation and manufactured assemblies. Renovation and adaptation are major challenges.)
- Life cycle of built environment (Environmental and economic sustainability, especially for infrastructure, will promote a focus on cost-effective performance across the life cycle, including operation and maintenance, rehabilitation, and reuse.)
- Advanced systems & services (Smart buildings and infrastructure will use integrated sensors and IT to enhance performance and monitor for maintenance; adaptation for effective retrofit may be a key issue.)
- Regulatory systems (Basic requirements for public confidence require advanced decision and support tools to establish acceptable levels of performance and risk.)
- Accelerated acceptance of new technology (Making IT work in practice requires economic and performance data, delivered via demonstration projects, credible product evaluation systems, and systematic knowledge transfer to the design and regulatory sectors.)

Since its beginnings in 1947 as the Division of Building Research, the Institute for Research in Construction (IRC) has evolved its focus in response to changing industry expectations. It has played a significant role in bringing together the industry to address a number of national issues (National Research Council Canada, 2004):

- Initially it assumed the challenge of developing a model building code that could be adopted by regulators throughout the country. Canada's building regulatory system is now fully endorsed by the provinces and territories and is among the best in the world.

- Building in the North created unique challenges that were tackled by IRC, such as determining the capacity of ice roads and developing reliable approaches for building foundations on permafrost.
- The energy crisis in the mid-seventies led IRC to develop and study new conservation technologies and to create a model code for energy conservation.
- Emerging health and other indoor environment problems resulted in the establishment of an integrated indoor environment program.
- IRC was among the first to identify the need for fundamental research into the maintenance and repair of Canada's deteriorating infrastructure and established the largest research team in North America to address these issues.
- Recognizing the worldwide move to performance-based regulations, IRC is supporting a national program aimed at moving Canada's code documents to an objective-based model – new codes will be published in 2005.
- Contributing to regional economic growth, IRC initiated the process of establishing a Centre for Sustainable Infrastructure Research in Regina to contribute to a larger cluster effort on "Communities of Tomorrow" in collaboration with the University of Regina, the city and industrial stakeholders.

Today, IRC's effort represents over 20% of the construction R&D in Canada. Working with industry, public sector and technical partners, IRC continues to respond to new issues affecting the construction sector through three closely linked main platforms:

- **Research and Technology Development**: Multi-party collaborative research with industry partners ensures IRC is responsive to market priorities. IRC assumes a leadership role on issues central to national competitiveness and public good, such as infrastructure rehabilitation, service life-cycle prediction, product evaluation and quality of the indoor environment. IRC works closely with IRAP to link industrial needs to technology sources and to deliver that technology to the widely dispersed industry.

- **Codes and Standards:** IRC plays a national leadership role in developing construction regulation. It produces model building and fire codes and guides of practice. It supports technical standards and it facilitates a uniform and streamlined Canadian code development process. Related work in IRC's other core competencies such as fire and building envelopes provides the technological solutions and expertise needed by the regulatory process, including risk/cost and life cycle cost assessments.
- **Information Management:** Knowledge and technologies are synthesized and disseminated to industry thus providing them access to international technology sources and simultaneously building international confidence in Canadian construction technologies and regulatory process and facilitating export opportunities.

IRC expand its roles in the construction sector to:

- fill the leadership void and foster an integrated industry that speaks with a united voice;
- develop a national strategy for R&D and innovation;
- address problems related to liability;
- capitalize on available knowledge and expertise, partner nationally and internationally with R&D organizations, industry associations, universities and other government departments;
- provide leadership in R&D-related to the integration of the design and construction processes, sustainability and green product evaluations;
- speed up transition of research to use, by encouraging innovation take-up, demonstrations and showcasing successes;
- promote life-cycle costing by enhancing public awareness, integrating it into procurement processes and creating an inventory of materials;
- help rationalize the regulatory system for new products, systems and ideas.

The response to these challenges will require a realignment of IRC's current core competencies in **Construction Materials and Systems Performance** and **Building Stakeholder Networks**. In addition, it will necessitate the development of a new core competency in **Construction Process Technologies** (National Research Council Canada, 2004).

Strategic priorities of IRC are described in Figure-55 below;

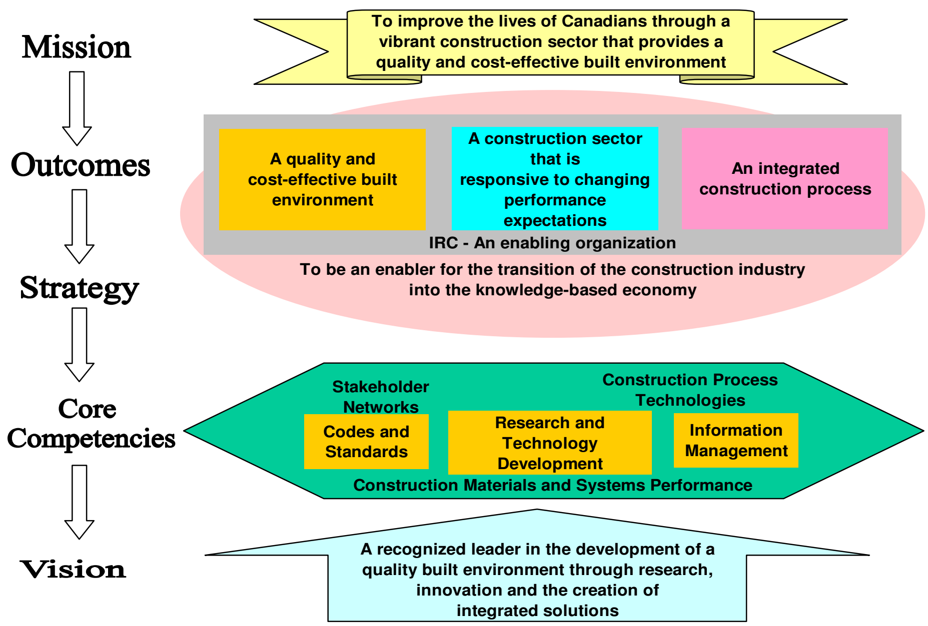

Figure 55 – Canadian Institute for Research Construction Strategic Priorities (Source : National Research Council Canada ,2004)

7.3 EUROPEAN R&D PROJECTS RELATED TO IT IN CONSTRUCTION

AdCoMS	Advanced Configuration Management System.
ADVANCE	Advancing Common Basic Services for Distributed Concurrent Engineering Applications.
ATLAS	Architectures Methodologies and Tools for Computer Integrated Large Scale Engineering.
BIDPREP	An Integrated System for Simultaneous Bid Preparation.
BIDSAVER	Business Integrator Dynamic Support Agent for Virtual Enterprise.
BISNET	BUILDING Information System Network.
BRICC	Broadband Integrated Communication for CONSTRUCTION.
BRIDGES	Bi-Lateral Research In Digital Global Enterprise Support
BuilDIC	Multimedia BUILDING Dictionary.
CaribCAD	Collaborative Approach to the Realisation of Internet Based CAD.
CAVALCADE	Collaborative Virtual CONSTRUCTION and Design.
CE-NET	CE projects List of Concurrent Engineering projects
C-ECOM	Cluster for Electronic COMmerce
CEDAS	Concurrent Engineering Design Advisor System
CEDIX	Concurrent Engineering Based Design for Integrated X-methodologies.
CE-NET II	The Concurrent Enterprising NETwork of excellence.
CEPRA	Concurrent Engineering in Practice.
CICC	Collaborative Integrated Communication in CONSTRUCTION.
CIMsteel	Computer Integrated Manufacruring for CONSTRUCTIONal Steelwork.
CIREP	Component Informaton Representation European Project.
COBIP	Improving the effectiveness of tele-working.
COCONET	Context-Aware Collaborative Environments for Next Generation Business Networks
COMBI	Computer Integrated Object Oriented Model for the BUILDING Industry.
COMBINE	Computer Models BUILDING Industry in Europe.
COMPETE	COMmon Platform for ExTended Enterprise
CONCUR	Concurrent Design and Engineering in BUILDING and Civil Engineering.
CONDOR	Technology and Processes for Integrated CONSTRUCTION Project Documentation and Management.
CONFLOW	Concurrent Engineering Workflow.
CONNET	CONSTRUCTION information service network.
CONSTRINNONET	Promoting Innovation in CONSTRUCTION Industry SMEs
CORE	CONSTRUCTION Companies Processes Reengineering.
COSMOS	Common Open Service Market for SMEs.
COVEN	Collaborative virtual environments.
COWORK	Concurrent project development IT tools for small-medium enterprises networks.
CROSSFLOW	Cross-Organisational Workflow Management.
CSCCM	Computer Supported Co-operative CONSTRUCTION Management.
DIVERCITY	Distributed Virtual Workspace for Enhancing Communication within the CONSTRUCTION Industry.
ECLIP II	Electronic Commerce Legal Issues Platform II
ECOBUILDING	Environmental assessment of BUILDINGs.
E-CONSTRUCT	Electronic communication in the BUILDING and CONSTRUCTION industry.
E-CORE	European CONSTRUCTION Research Network
E-CT	Electronic Calls for Tender
EI-IC	Enterprise integration - international consensus.
EIKS	Energy Impact Knowledge Based System in BUILDINGs.
eLEGAL	Specifying Legal Terms of Contract in ICT Environment.
eLexPortal.com	eCommerce Legislation and Regulatory Policy Portal.
ELSEWISE	European LSE Wide Integration Support Effort.
E-NTRY	Electronic Tendering, Bidding and Negotiation Real Time System
EPICE	Electronic commerce for programme management information sharing in the concurrent enterprise.
EPISTLE	European Process Industries STEP Technical Liaison Executive.
ESCN	European STEP centres network [Ep24883, 1997-99].
ETO	European telework online.
EVENT	European Virtual Enterprise Network.
EXTERNAL	EXTended Enterprise Resources, Network Architectures and Learning
FORM	Engineering a Co-operative Inter-Enterprise Management Framework.
FREE	Fast Reactive Extended Enterprise.
FRONTIER	Open system for collaborative design.
Future Workspaces	A Strategic Roadmap for Defining Distributed Engineering Workspaces of the Future
GEM	Generic Engineering Analysis Model
GEN	Global Engineering Network
GENESIS	Global Enterprise Network Support for the Innovation Process
GLOBEMAN 21	Enterprise Integration for Global Manufacturing in the 21st Century.
GlobEMEN	Global Engineering and Manufacturing in Enterprise Networks.
GOAL	Generic Object-Oriented Multi-Application Project Management System for Large Inter-Organisation
HPCN TTN	High Performance Computing and Networking Technology Transfer Nodes.
ICCI	Innovation co-ordination, transfer and deployment through networked Co-operation in the CONSTRUCTION
IMPPACT	Integrated Modelling of Products and Processes Using Advanced Computer Technologies
INNOCONS	Increasing the Awareness on Innovation in the European CONSTRUCTION
INTELCITY	Towards Intelligent Sustainable Cities
INTEROP	Interoperability Research for Networked Enterprises Applications and Software
IPL/E.COMMERCE	The Application of Private International Law in an Internet Environment
IPR-HELPDESK	Help on Intellectual Property Rights in EC contracted projects
IRMA	A configurable virtual reality system for multi-purpose industrial manufacturing application.

Figure 56 – European Research Projects on Construction IT

I-SEEC	Information Services to Enable European CONSTRUCTION Enterprises.
ISTforCE	Intelligent Services and Tools for Concurrent Engineering.
iViP	Integrated Virtual Product creation
JASMINE	Java Smart Integrated Networked Enterprises
KARE	Knowledge acquisition and sharing for requirement engineering.
KM	Forum The European Knowledge Management Forum
LicoPro	Lifecycle Design for Global Collaborative Production
M3D	Multi-site Cooperative 3D Design System for Architecture
MAGICA	Electronic multi-media catalogues based on software agents
MARITIME	Modelling and Reuse of Information over Time
MASSYVE	Multi-Agent Agile Manufacturing Scheduling Systems in Virtual Enterprise Industry
MASTER	Model driven Architecture inSTrumentation, Enhancement and Refinement
MATES	Multimedia Assisted distributed Tele-Engineering Services.
MICC	Mobile Integrated Communications in CONSTRUCTION.
MISSION	Modelling and Simulation Environments for Design, Planning and Operation of Globally Distributed
MODA-TEL	Model Driven Architectures for Telecommunications System Development and Operation
MOMENTUM	BUILDING management system.
MUSYK	Integrated Multi-Level Control System for One-of-a-Kind Production
NOTE	Nomadic Teleworking business Environment
OCTANE	Open Contracting TransActions in the New Economy
OII	The Open Information Interchange Initiative
OPAL	Integrated Information and Process Management in Manufacturing Engineering
ORBIT	Opportunities for re-engineering business processes through advanced IT.
OSMOS	Open System for Inter-enterprise Information Management in Dynamic Virtual Environments.
PACE	A Practical Approach to Concurrent Engineering
PEBBU	Performance Based BUILDING.
PIPPIN	Pilot Implementation of Process Plant Lifecycle Data Exchange Conforming To STEP AP221
PISA	Platform for Information Sharing by CIME Applications
PLENT	Planning small medium enterprise networks.
POEM	Process Object-oriented Engineering Methodology
PREMISE	PRomoting Electronic coMmerce Initiatives for SMEs in Europe
PROACTIVE	Process Adaptation by Configuration Technology In Virtual Enterprises
PROCURE	ICT at work for the LSE procurement chain.
ProDaec	European Network for Product and Project Data Exchange, e-Work and e-Business in AEC
PRODEX	Product Model Exchange Using step.html STEP
PRONET	Product Information system for business networks
PSI3	Personalised Services for Integrated Internet Information
RAPID-PDM	Rapid implementation of Product Data Management
RECITE	Remote Electronic CONSTRUCTION Industry Telematics Experiment
REMAP	Distributed Revision Management in Plant Design.
RISESTEP	Entreprise Wide Standard Access to STEP Distributed Databases.
ROADCON	Strategic Roadmap towards Knowledge-Driven Sustainable CONSTRUCTION
ROCCO	Robot Assembly System for Computer-Integrated CONSTRUCTION
SABARECO	Satellite Based Remote Multi-Project Reporting and Controlling in CONSTRUCTION Industry
SABLE	Specifying Architectural BUILDING components across Europe
SAVE	STEP and the Virtual Enterprise
SCENIC	Support Centres Network for Information Technology in CONSTRUCTION.
SCOPES	Systematic Concurrent Design of Products, Equipments and Control Systems.
SEASPRITE	Software architectures for ship product data integration and exchange.
SIMBA	Seamlessly Integrating Multimedia in BUILDING Automation.
SIMNET	Workflow management for simultaneous engineering networks.
STEPWISE	STEP with intelligence for software engineering
SUMMIT	Supply chain management in the CONSTRUCTION industry
SUPPLYPOINT	Electronic Procurement Using Virtual Supply Chains
TAPPE	Telematics for Administrations Public Procurement in Europe.,
THINKcreative	Thinking network of experts on emerging smart organizations
TNEE	Thematic Network on Extended Enterprise
ToCEE	Towards Concurrent Engineering Environment in the BUILDING and Engineering Structures Industry.
TRA-EFCT	Targeted Research Action - Environmentally Friendly CONSTRUCTION Technologies.
TRAIN-IT	Training of IT Innovators.
UNITE	Ubiquitous and Integrated Teamwork Environment
VEGA	Virtual Enterprises using Groupware tools and distributed Architecture.
VENICE	Virtual Enterprises Nurtured using Intelligent Collaborative Environments.
VENTO	Development of advanced Groupware tools supporting synergy among enterprises in the emerging global
VEPRIM	Virtual Enterprise Product Information Model
VIEW of the FUTURE	Virtual and Interactive Environments for Workplaces of the Future
VISAGE	Assessing new BUILDINGs using Virtual Reality
VISICADE	VIrtual Simulation environment for a seamless integration of CAD/CAE into VR
VISION	Towards Next Generation Knowledge Management.
VOMAP	Roadmap design for collaborative virtual organizations in dynamic business ecosystems .
WONDA	Worldwide Enterprise Data Interoperability.
XML/EDI	European XML/EDI Pilot Project.
ZIAVA	Advanced Management system for BUILDING CONSTRUCTIONs and civil works projects.

Figure 56 – European Research Projects on Construction IT (continued)

7.3.1 ROADCON

The ROADCON project is an Accompanying Measure - Action Line IST 2002 II.1.2: Strategic roadmaps for applied research - funded by the European Commission under the IST program (Information Society Technologies). Its aim is to develop a roadmap for the research and development of IT for the construction industry, in the short, medium and long term. It is promoting the model-based, knowledge-driven IT in the construction sector as the main enabler for the future achievement of important societal, environmental, industrial, and business priorities. The underpinning idea in future use of IT is computer-interpretable (model-based / semantic) information that will enable enhanced automation, integration and communication in Construction (ROADCON Project, 2003).

The general aims have translated into the following measurable objectives:

1. To establish a **forum** of key actors in the European construction sector (including its suppliers and IT vendors), such a forum consisting of members that are committed and capable to contribute towards the goal within and beyond Framework 6.

2. To achieve **consensus** on common research and development priorities realizing the most important tools, infrastructures and processes for briefing, design, construction and maintenance; and suggest practical measures for developing, agreeing and promoting **standards** to be adopted by the industry.

3. To develop a **vision** for agile, model-based / knowledge driven construction that addresses issues related to **barriers for implementation** and rapid take up of RTD results.

4. To develop a **strategic Roadmap from today to the year 2020** in relation to the use and deployment of IT (based on the vision from objective 3) to enable and promote a sustainable construction knowledge economy.

5. To suggest **methods for management** and how best to mobilize best resources and best practices from industry and service organizations to implement the ROADCON roadmap by supporting an integrated initiative

and developing a new way of project working and project management and co-ordination resolving IPR issues and using quality assurance.

6. To set up a mechanism by which **key indicators** are defined, and collected as part of a systematic, ongoing impact analysis of RTD projects included in the future Integrated Initiative.

In order to address the wide scope and specificity of a Strategic Roadmap, the ROADCON project has delivered its results with the expertise of European leading research centers and construction businesses, drawn from countries that are at the heart of the European dynamics and research in the building and construction sector: France, Finland, the Netherlands, the UK, Germany and Belgium. The selected partners (see Figure-57) within these countries, namely CSTB (F), VTT (FIN), TNO (NL), Garas Consulting (UK), University of Salford (UK), University of Loughborough/ECI1 (UK), Nemetschek (D) and BBRI (B), have demonstrated outstanding research capabilities within their field, and are leading actors in IT in construction in Europe.

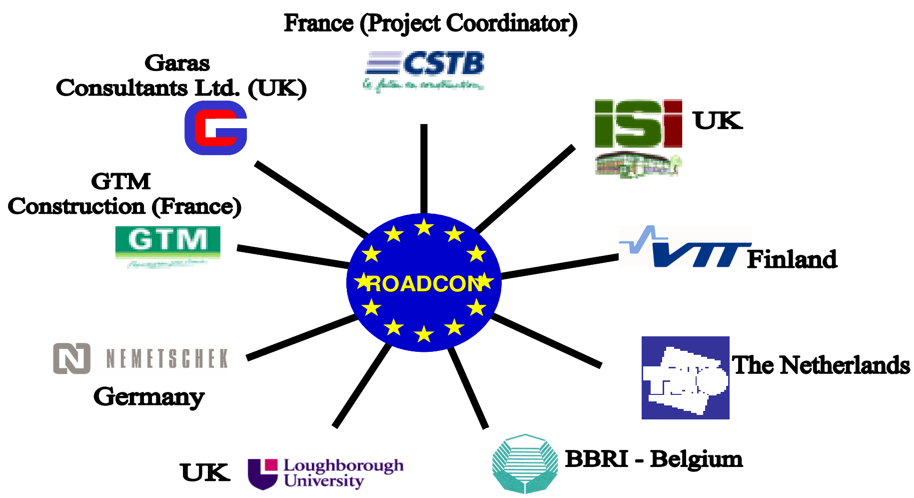

Figure 57– ROADCON Core Partners

ROADCON has built up on the wealth of available information from state-of-the-art research and practice from across Europe. This is through established contacts and support from a broad and yet focused spectrum of key actors and associations in the domain: national programs and support groups; standardization bodies and initiatives; key actors in IST research; construction sector organizations and associations; Global RTD actors; IST clusters and networks; and other IST roadmaps as shown in Figure-58 below;

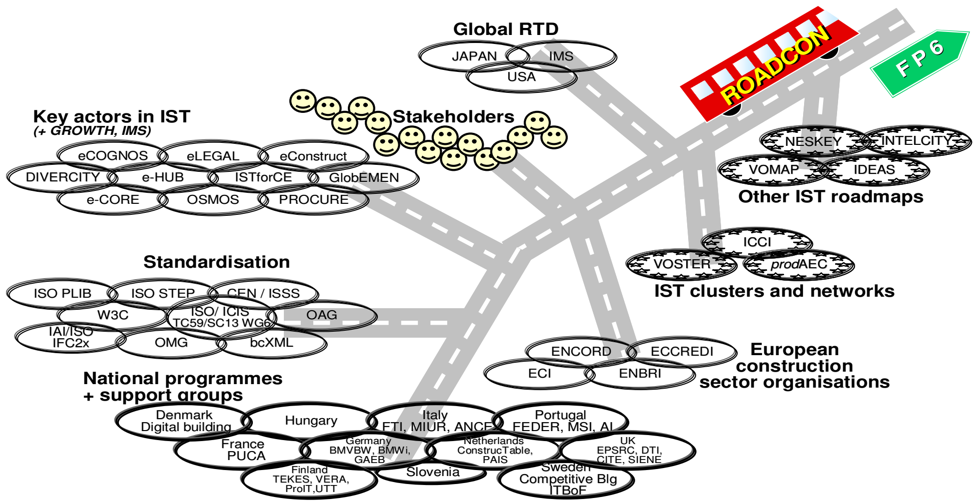

Figure 58– ROADCON Stakeholders and Relations

From an IT point a view, the ROADCON motto can be summarized as The "eConstruction"-future is essentially towards Integrated Model-based and Object Oriented(Company/Market) Knowledge Reuse &(Project) Information Sharing via Open Standards (e.g. IAI-IFC, ISO-12006-3, bcXML) over the Web (Semantic Web, Web Services).

The Figure-59 below shows the high level ROADCON roadmap.

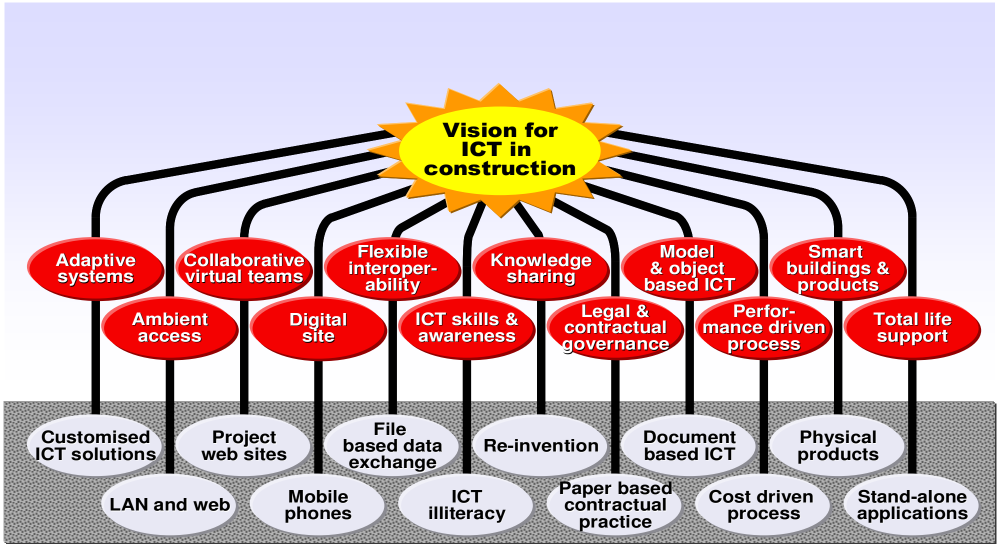

Figure 59: ROADCON Top level roadmap

The topics to be addressed are also illustrated in Figure-60 below;

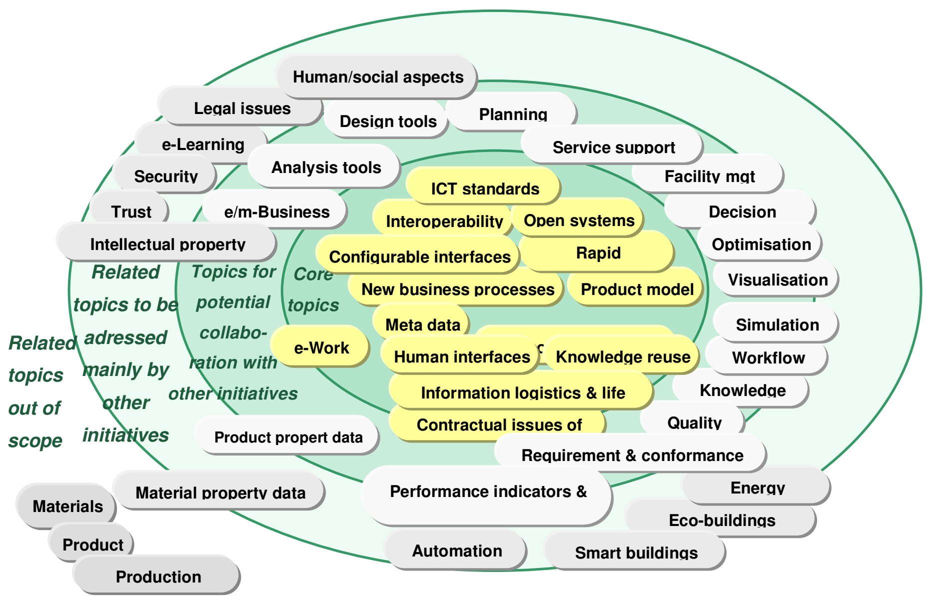

Figure 60: ROADCON Addressed Topics

The general conclusion is that most received suggestions focus on incremental development of specific, and often fragmented, problems. It is usually not possible or feasible to cover the whole innovation cycle in one RTD action only. Synchronization between interdependent actions must be planned in order to assure that the expected final impact will be achieved. Past RTD has often suffered from gaps in the innovation process whereby the path towards take-up and impact has been broken. The roadmap provides basis for synchronization of different, inter-related RTD actions towards a consistent whole.

All this entailed a feedback process through which the undertakings within the ROADCON project have been commented, validated, and endorsed by the various stakeholders. It is worth noticing that many stakeholders already signed, at the beginning of the project (or even before), commitment letters endorsing the direction that ROADCON was pursuing in addition to confirming their support for the same. This was seen as the first step towards realization of a common vision on IT in construction for the construction industry, and this has been pursued in the course of the project, leading to the creation of a critical mass of over 300 organizations from 30 countries throughout Europe in the so-called "ROADCON Support Group". The membership includes stakeholders from various European countries and NAS (Newly Associated States), and from Japan and US.

The conclusion reached and the topics focused on are more or less relates to the IT-related strategies of Turkish construction industry identified. Although ROADCON has introduced the current state at worst level in order to address a wider perspective, Turkey still has some deficiencies compared to this state-of-art definition such as project web-sites, 3D modeling etc. The most intelligent procedure for Turkey to take the first pace towards IT-enabled sustainable construction industry would be bridging the gap as soon as possible and getting the membership of such professionalized support groups. They would welcome Turkey if they became satisfactory about our efforts, decisiveness and stability about new ways to compete and reach sustainable development.

CHAPTER 8

CONCLUSION

It is suggested that technological IT enabling solutions will play a major role in achieving major improvements in a traditionally fragmented design and construction process. As shown in the previous chapters, many other countries, recognizing the importance of the Information Industry, are moving quickly to strategically implement it within their construction industries as being a central sector for sustainable development of their whole nation.

Today, the technological and strategic management of IT within the Turkish construction industry is given little attention. Investment in information technology is increasing, but many companies are waiting for concrete proof that this investment would add value and improve their 'bottom line'. In text document processing, the computer is used as an electronic typewriter. Even within the design and documentation process, computer aided drafting and design technology is still largely restricted to use as an electronic pencil. Its full potential for greater productivity is being lost. Therefore, Turkey must move quickly to become a strong participant in the rapidly evolving information industries and a number of IT solutions should be developed to act as drivers in the design and construction process. Models of success from other countries examined in this study indicate that participation will require strong direct or indirect planning and intervention by the government.

This study was concerned with how IT can provide long-term benefits to the industry. Specifically, these are achieved by both utilizing IT to create new ways of doing business and building value-added competitive advantages. This document gave a synthesis of well-identified Turkish construction industry requirements in relation to the future use and deployment of IT to support future business processes in construction, and formulated an IT vision and corresponding strategies for the sector. The study has been based, on the one hand, on existing R&D projects, studies, reports, and surveys, commissioned at a national level, as well as a wide consultation with construction industry key players in Turkey, keeping in mind and comparing with the information about the trends in world's best practice in relation to the use of IT in building and construction, variant forms of supply chain and the different ways companies adding value within them. Consequently, a number of IT requirements and trends of Turkish construction industry were identified as the main drivers for change. These requirements and trends were linked with opportunities offered by evolving IT and all combined, a vision for future IT in construction was defined and can be shortly formulated as follows:

"Turkish construction sector should be shifted into an agile knowledge-driven model-based industry, integrating IT enabling holistic support and decision making throughout the process by all stakeholders and becoming capable of rapid response to the more demanding performance expectations of the global market"

The main ideas behind this vision were;

(1) There must be process and IT alignment. The strategy frameworks presented in this report illustrates how IT could operate within each strategic area in such a way that the business processes become the driver and IT the enabler.

(2) IT can only be effective if it is based on synchronized process development. For example, the full benefits of an optimized implementation cannot be realized when the IT development is still at the ad hoc stages, and

vice-versa. Within these frameworks, it is anticipated that construction firms will move away from traditional ad hoc IT investments and move towards well-planned strategies. By doing so, large, as well as small, organizations would be able to identify opportunities for IT investments, evaluate their existing systems, identify the rate at which new IT applications are adopted, and work out the level of impact of IT on their firms.

The study concluded that realization of the vision requires advances in several key technology areas and the strategic management of IT within the construction industry should be developed and used as an enabler to the wider business, strategic and operational needs of the construction industry. Eleven main key strategic areas have been highlighted as essential for the strategy formulation as listed below:

1. Knowledge Management
2. Ubiquitous Communication and Computing
3. Collaboration
4. Model-based Engineering
5. Virtual Prototyping
6. Interoperability
7. Context-awareness
8. Lifecycle management
9. Performance-based Engineering
10. IT Skills and Awareness
11. Legal Aspects of IT

Addressing technological and organizational issues, together with the employment of appropriate methodologies is essential to successful implementation. Organizational change must accompany the implementation of integrated information systems within construction organizations. It was also evident that any systems implementation to apply this dramatic shift of Turkish construction industry could not take place rapidly. The implementation of an information system first required sub-division down into manageable, functional components. Therefore, the strategies described suggest steps in these technologies towards the vision by a descriptive framework for each strategic area. This conclusion clearly represents a policy document that the industry can review and act upon.

Finally, it is worthy to emphasize that it is inevitable to reach European IT maturity level for Turkey not only for construction industry but also for the whole nation to get the necessary respect for also economical and political targets. The sooner Turkey can catch the maturity level and coincide its targets with European level of performance, the more she will find opportunities and support for enhancement. However, according to the identified timeline for strategy implementations, it seems to achieve this level within 5 years. Getting the membership of EC and utilizing from their wider experience, opportunities and supports in implementation and dissemination of sustainable development, will guide Turkey from any implementation failure and provide the best direction and trust from global arena. The outcomes of the recommended strategies developed for the improvements for vibrant IT-enabled Turkish construction sector will provide a quality and cost-effective built environment, leading to intelligent usage of natural resources, effective development of national land and consequently the development of sustainable cities. Further, such a national development will lead the way for sustainable development of Turkey.

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APPENDIX

The survey conducted with 50 organizations throughout Turkish Construction Industry in order to develop IT state-of-art and identifying industry requirements is as follows;

Questionnaire on current situation and priorities for Construction ICT

Thank you for agreeing to participate in an interview to discuss your experiences in relation to the RTD priorities for construction ICT.
Please answer each question as accurately as you can on behalf of your business. The usefulness of the survey depends upon how closely your answers reflect the views of your business.

The purpose of this questionnaire

This questionnaire is conducted for analyzing the current situation and capturing the requirements, key trends, priorities and barriers of the Turkish Construction sector related to information and communication technologies
The results will be used to develop a "A National IT Strategy" to provide Knowledge-Driven Sustainable Turkish Construction Sector towards major impacts for the society and industry
The questionnaire is to be sent to about 50 organisations in Turkey.

Confidentiality of responses

The information provided by you, including your personal contact information, will not be used or disclosed for any other purpose than communication about the current situation analysis and determining priorities of Turkish Construction Industry related to information and communication technologies.Only summarized information will be published. The name of your organisation will be published subject to your permission:

- ☐ I approve that the name of my organization will be listed in public reports as a respondent in this inquiry.
- ☑ I approve that my organization can be mentioned in public reports as one of potential participants in forthcoming RTD activities.

1. Personal and organisation details

Contact person

Name — First name: ______ Last name: ______ Title: Mr

Email ______

Telephone ______

Fax ______

Organisation *(the department/business unit to which the answers apply)*

Full name of organisation ______

Address ______

Web site URL ______

Core business activity

Size of the organisation (unit): Number of people employed: ______ Annual turnover (M€): ______

Position you hold in your organisation: *(select one)*

☐ Consultant	☐ Procurement Engineer	☐ Facility manager	☐ Human Resources Engineer
☐ Constructor	☐ Site Manager	☐ BS/HVAC eng.	☐ Customer Relations Manager
☐ Structural Engineer	☐ Site Engineer	☐ Demolisher	☐ Specification Engineer
☐ Architect	☐ Financial Engineer	☐ Risk Manager	☐ Superintendent
☐ Planner	☐ Accounting Manager	☐ Strategic Manager	☐ IT Implementation Manager
☐ Cost Controller	☐ Manufacturer	☐ Business Developer	☐ MIS Manager
☐ Project manager	☐ Supplier	☐ Regulation checker	☐ Quantity Surveyor
☐ Contract Manager	☐ Estimator	☐ Renovator	☐ Structural Controller
☐ Other, please specify: ______			

2. Current Situation Analysis

Characterisation as a user/developer of ICT in construction compared to similar organisations: *(select one)*

☐ Pioneer ☐ Advanced Follower ☐ Average ☐ Below Average

What are the percentages of:

- In-House: Executive management team using computers? ______
- In-House: Office finance/accounting personnel using computers? ______
- In-House: Other office staff using computers? ______
- Field Operation: Project management personnel using computers? ______
- Field Operation: Jobsite finance/accounting personnel using computers? ______
- Field Operation: Superintendents using computers? ______

Do you have dedicated IT personnel Yes IT Budget as a percentage of revenue: ______

What brand of PC workstations does your company use? Have you standardized with a particular brand of computer?
If yes, which brand have you standardized with?

What's the average lifespan/amortization of your typical PC workstation?Please indicate the factors in your purchase decision.
(e.g. availability, brand name, price, reliability, support/service)

What is your primary method of upgrading your PC workstations? (e.g. buy new computers, upgrade current computers
(additional memory/disk space))

Have you standardized your OP? Please identify the Administration/Accounting, Project Design, Estimator PC workstations
operating systems used by your company seperately. (e.g. Apple, Linux, Windows 95/98/2000/NT/XP, Unix)

Are you using or planning to use wireless technology for your local area network (LAN)?

Does your network have remote access capabilities?If yes, which locations have remote access? (e.g. Branch offices,
employee homes, job sites, temporary locations) and what is your method of remote acces?(e.g. 802, ethernet, dial up,
virtual private network, wireless)

What types of security measures have been taken to prevent unauthorized network access? (e.g. Use of a dedicated firewall,
Password required authentication,Third-party information security assessment,Third-party 24-hour system monitoring,Third-party
vulnerability testing,Formal usage policies and procedures adopted, Application of latest security patches for all software)

Does your company have a published policy regarding security issues such as employee use of email and the Internet? No
Do you have a formalized disaster recovery plan (e.g., secure off-site data storage facility, written plan, etc)? Yes

Do have data redundancy/backup & recovery procedures? (e.g. data reparation/redundant disk, UPS)

How is back up accomplished?(e.g. Backup server, but rely on individuals to back up PC workstations , Enterprise-wide backup
– all servers & workstations on network)

What is your primary method of Internet connectivity? (e.g. Cable, DSL, frame relay, ISDN,Modem/Dial Up)

For which electronic services/communications do you use the Internet? (e.g.Accounting Access,Banking Services,Bidding
Corporate Intranet,Corporate Web Page,Email,Prequalifying Forms,Procurement,Project Collaboration,Project Management,
Project Web Sites,Research,Service Management)

What percentage of transactions are you conducting electronically with suppliers?

What percentage of transactions are you conducting electronically with customers?

Are you using any wireless or handheld devices (excluding cellular and radio) in the field? Yes

Are you using/planning to use Fleet Management GPS units? Yes

What are your means of field project data communications? (e.g.Fax,Handheld PDAs, Internet, Mobile Software, Remote Dial-in
WAN ,WAP - Web Enabled Phone)

Do you have a published policy regarding compliance with software license agreements? No

Please indicate the software programs currently being used in your company for;
Drafting Applications
Estimating
Accounting
Project Management
Project Scheduling
Fixed Asset
Imaging
Service Management
Customer Relationship Management (CRM)
Human Resources Management(HRM)

What methods do you use to produce Contractual Documents?(e.g. Accounting Software, AIA Forms & Software ,DocuBuilder
(AGC Contract Software),Project Management Document Software,Word/Excel)

Is production of Contractual Documents integrated with your Accounting and/or Project ManagemenSoftware?

Is there an automated exchange of information between your Project Management & Accounting software solutions? Yes

Do your Project Management personnel have on-line access to real-time job cost data? Yes

How do you currently generate financial statements?(e.g.Direct from accounting software,Downloading balances to spreadsheet
Manually entering data into spreadsheet)

Do you have a public corporate Web site?What's the primary purpose of your public corporate Web site?(e.g.Information Access,
Marketing,Remote Data Entry,Sales/E-Commerce)

Do you have a corporate Extranet site?What's the primary purpose of your Extranet site?(e.g.Collaboration with owners/customers,
Collaboration with vendors/suppliers,Project-specific collaboration)

Do you have a corporate Intranet site (available only to employees)? What's the primary purpose of your Intranet site?(e.g. Access
to job cost information,Access to other corporate systems,Employee access to HR information,Used for a safe file transfer location)

Please indicate which of the following advanced practices&technologies your organization uses or plans to use,
by ticking the boxes below:

		Not Relevant	We use	We plan to use
ORGANISATION	Written evaluation of new ideas in order to develop options for your organisation	☐	☐	☐
	Documentation and presentation of technological/organizational improvements in a common conceivable form	☐	☐	☐
	Written strategic plan	☐	☐	☐
	Quality Certification (e.g. ISO 9000)	☐	☐	☐
	Staff training budget	☐	☐	☐
	Collaborative spirit	☐	☐	☐
	Research and development budget	☐	☐	☐
	Material and resources synchronisation	☐	☐	☐

COMPUTERISED PRACTICES	Computer networks (LAN or WAN)	☐	☐	☐
	Computerized project management	☐	☐	☐
	Computerized estimating software	☐	☐	☐
	Computerized inventory control	☐	☐	☐
	Computer Aided Design	☐	☐	☐
	Digital photography	☐	☐	☐
	Innovator & ergonomic interfaces &devices	☐	☐	☐
	Ubiquitious environment	☑	☐	☐
	Inter-office video links or video conferencing	☐	☐	☐

Please rank the three advanced technologies or business practices which have contributed most to the success of your organization during the past three years:

1-
2-
3-

What was the main reason for the adoption of your first-ranked technology/practice?To what extend has it been important in improving the effectiveness of your organisation?

How do you ensure that your adoption of advanced technologies or practices adds maximum value to your organization?

What has been the biggest obstacle to your organisation adopting more advanced technologies or practices?

Now we move from looking at your adoption of existing technologies/practices, to investigating your organisational attitude and current organization culture towards ICT related technologies/practices. Please give a rough estimate of the percentage of revenue ICT related technologies (products/processes or services) and business practices bring to your organisation. Could you briefly describe your organizational strategy concerning ICT developments?

Please rate the importance of each of the following strategies you apply for the success of your organisation

Business Strategies	Not Applicable	Very low	Low	Moderate	High	Very High
Encouraging team working and knowledge sharing	☐	☐	☐	☐	☐	☐
Official and established ICT strategy including training policy	☐	☐	☐	☐	☐	☐
Preparing for organisational changes to implement ICT supported working practices	☐	☐	☐	☐	☐	☐
Cultural attitude favouring use of ICT	☐	☐	☐	☐	☐	☐
Data Flow Management	☐	☐	☐	☐	☐	☐
Collaborative works organisation between distributed teams using innovative interfaces	☐	☐	☐	☐	☐	☐
Ensuring employees are aware of business/community issues	☐	☐	☐	☐	☐	☐
Actively encouraging your employees to seek out improvements, improve and always find some way of getting "well done"	☐	☐	☐	☐	☐	☐
Improving business management methodology as the result of the feedback from the employees (employee feedback)	☐	☐	☐	☐	☐	☐
Rewarding employees for suggesting improvements and maintaining linkages with other industry participants with complementary skills	☐	☐	☐	☐	☐	☐
Ensuring that resources are available to support business imporevement priorities	☐	☐	☐	☐	☐	☐
Providing training and guidance to technical staff in the communication skills needed to present and disseminate data, ideas, interpretations and findings(e.g. creating and using intranet research websites, writing non-technical white-paper summaries of technical innovations, creating value-added intelligence reports on competitors)	☐	☐	☐	☐	☐	☐
Participating in apprenticeship programs	☐	☐	☐	☐	☐	☐
Increasing your understanding of customers' expectations	☐	☐	☐	☐	☐	☐
Improving business management methodology as the result of the feedback from the customers (customer feedback)	☐	☐	☐	☐	☐	☐
Providing a broader range of services to your clients	☐	☐	☐	☐	☐	☐
Enhancing your organization's technical capabilities	☐	☐	☐	☐	☐	☐
Introducing new technologies, new skills and competencies	☐	☐	☐	☐	☐	☐
Investing in local research and development	☐	☐	☐	☐	☐	☐
Participating in the development of industry standards and practices	☐	☐	☐	☐	☐	☐
Protecting your organization's intellectual property	☐	☐	☐	☐	☐	☐
Delivering products/services which reduces your client's cost	☐	☐	☐	☐	☐	☐
Seeking business outside Turkiye	☐	☐	☐	☐	☐	☐
Increasing your market share	☐	☐	☐	☐	☐	☐
When you make changes, measuring how well the changes have worked that is continual scanning/development	☐	☐	☐	☐	☐	☐
Deciding how to target and measure success with stakeholders	☐	☐	☐	☐	☐	☐
Following a written strategy to keep the loyalty of key experts within the business	☐	☐	☐	☐	☐	☐
When problems occur, looking for innovative long-term solutions rather than quick fixes	☐	☐	☐	☐	☐	☐
Maximizing the use of available best practice through well supported strategies	☐	☐	☐	☐	☐	☐
Archieving reports from projects in a form that makes them easily accessible to relevant personnel(e.g.in a library,within a structured database)	☐	☐	☐	☐	☐	☐
Assessing at the end of each project to identify factors effecting success or failure (e.g. failures in information flows, contextual information about suppliers, customers, collaboratives, equipment etc.)	☐	☐	☐	☐	☐	☐
Utilizing strategic cross-project reviews and contributing towards the evolving stocks of corporate knowledge (e.g. as a source of intelligence on internal capabilities, external technologies, markets, competitors)	☐	☐	☐	☐	☐	☐

For your organisation please indicate how strongly you agree or disagree with the following statements

Business Condition/Competetive environment	Strongly disagree	Disagree	Neutral	Agree	Strongly Agree
My clients' needs are easy to predict	☐	☐	☐	☐	☐
My competitors' actions are easy to predict	☐	☐	☐	☐	☐
My organisation has many suppliers to choose from	☐	☐	☐	☐	☐
Our organization receives high quality technical supprot provided by other organizations	☐	☐	☐	☐	☐
Our relationships with other organizations in the industry are assisted by a culture of trust	☐	☐	☐	☐	☐
Regulations impacting on our organization encourage improvements in product/services	☐	☐	☐	☐	☐
Technologies in office are changing rapidly	☐	☐	☐	☐	☐
Technologies on the construction site are changing rapidly	☐	☐	☐	☐	☐
The arrival of new competitors is a constant threat	☐	☐	☐	☐	☐
Materials and supplies quickly become obsolete	☐	☐	☐	☐	☐
My clients can easily find a substitute for my services	☐	☐	☐	☐	☐

Please rank the importance of the following drivers affecting you to adapt IT technologies?
(maximum five selections, 1=lowest, 5=highest)

- Efficiency/Productivity ☐
- Time/Speed ☐
- Quality ☐
- Cost ☐
- Technical Performance ☐
- Knowledge/Information ☐
- Accuracy ☐
- Human Resources ☐
- Clients ☐

In which processes of your future business activities do you see the greatest needs for more ICT support?
(maximum three selections, 1=lowest, 3=highest)

- ☐ New business processes enabled by ICT
  Please describe the process: ______
- ☐ Project management (performance indicators, measurement, feedback)
- ☐ Decision support
- ☐ Contractual practice & legal aspect of using ICT in construction
- ☐ Customer relationships management
- ☐ Knowledge management
- ☐ Other (please specify): ______

What new ICT skills do people need, please specify: ______
How do you think that the use of ICT can contribute to employee's empowerment and job satisfaction?
Please explain: ______

Additional Information in your own words: ______

Please rank the importance of the following strategies you take into account in selecting new markets?

Business Strategies	Critical	Important	Not Important
Reducing Inventory/working capital	☐	☐	☐
Closer integration with customer	☐	☐	☐
Improving customer service	☐	☐	☐
Finding new customers	☐	☐	☐
Improving sales effectiveness	☐	☐	☐
Understanding future strategies/ requirements of customers&suppliers	☐	☐	☐
Improving business flevibility to change	☐	☐	☐
Improving business process planning	☐	☐	☐
Improving market effectiveness	☐	☐	☐
Closer integration with suppliers	☐	☐	☐

3. Requirements for ICT support

Please write down your vision for Turkish property and construction industry to the YEAR 2020 and explain what is different about your vision in the Year 2020, compared with the industry today.

Based on your vision of the property and construction industry to the Year 2020, please RANK 10 GLOBAL TRENDS in terms of how they may impact on your industry vision for the future to the Year 2020. Besides, list what you think is distinctive about the Turkish property and construction industry compared to the global property and construction industry

GLOBAL TRENDS	**RANK**
Integration of computer and communication technologies	
Increased power of computers (eg: to undertake visualisation)	
Reduced size of computers (eg: handheld devices)	
Shift away from manual trades to service industries	
Changing demographic patterns influencing demand and work	
Knowledge sharing across national and organisational boundaries	
Drive to greater levels of national security due to terrorism, etc	
Increased work skills and industry capacity	
Increased globalisation of the property, design and contracting market	
Sensitivity to sustainable development	
New materials	
Improved process and management	
Information technology support, improving design collaboration, supply chain management, etc	

Focus on environmental sustainability and sustainable communities	
Whole-of-life management and analysis (offsetting long term ownership costs against upfront capital costs)	
Smart or intelligent buildings and infrastructure	
Less adversarial business relationships	
Increased private/public partnerships	
Improved health and safety on site	
Better evaluation of clients' needs	

	Select Time Period					Tick here if you are not familiar with this trend
	< 5 yrs	5-10 yrs	10-15 yrs	>15 yrs	Never/ unlikely	
Restructuring of the supply chain for greater efficiency	☐	☐	☐	☐	☐	☐
Improved management of design and construction	☐	☐	☐	☐	☐	☐
Improved asset management	☐	☐	☐	☐	☐	☐
Improved building performance meeting or exceeding client demand	☐	☐	☐	☐	☐	☐
Computer-based 'Business to Business' transactions including bringing the supply chain on-line	☐	☐	☐	☐	☐	☐
Virtual (computer) simulation of the design and construction process to 'test before you commit'	☐	☐	☐	☐	☐	☐
Automated sensing of built environments	☐	☐	☐	☐	☐	☐
Avoidance of adversarial relationships within the team	☐	☐	☐	☐	☐	☐
Fairer distribution of project risks in the procurement process	☐	☐	☐	☐	☐	☐
Design/contractor involvement for period beyond project completion	☐	☐	☐	☐	☐	☐
Environmental assessment and management throughout the development and operation cycle	☐	☐	☐	☐	☐	☐
Improved working conditions for site personnel	☐	☐	☐	☐	☐	☐
Greater off-site manufacturing	☐	☐	☐	☐	☐	☐
Collaborative design through the Internet or other computer-based networks	☐	☐	☐	☐	☐	☐
Three dimensional modelling of design of buildings and infrastructure in a CAD system	☐	☐	☐	☐	☐	☐
Virtual prototyping becomes the basis for design, procurement and asset management	☐	☐	☐	☐	☐	☐
Hand held devices become the norm for management and communication of design on-site	☐	☐	☐	☐	☐	☐
Knowledge grids where many computers act in unison to share knowledge and aid collaborative working	☐	☐	☐	☐	☐	☐
Remote sensing of buildings and processes to aid management	☐	☐	☐	☐	☐	☐
Triple bottom line (economic, social and environmental) reporting on balance sheets and project planning becomes the norm	☐	☐	☐	☐	☐	☐
Whole life analysis becomes the norm	☐	☐	☐	☐	☐	☐
Supply chain is rationalised, integrated and supported by information and communication technologies	☐	☐	☐	☐	☐	☐
80% of construction components are manufactured off-site	☐	☐	☐	☐	☐	☐
Skilled labour shortages change the design of construction assets	☐	☐	☐	☐	☐	☐
Energy becomes scarce and drives new forms of manufacture and design	☐	☐	☐	☐	☐	☐
Health, safety and welfare on-site is on a par with other industries	☐	☐	☐	☐	☐	☐
Climate change demands new types of construction	☐	☐	☐	☐	☐	☐
Pollution levels demand extensive regulation of the industry	☐	☐	☐	☐	☐	☐
Terrorism acts are factored into the design and construction of buildings	☐	☐	☐	☐	☐	☐
Other (please state):	☐	☐	☐	☐	☐	☐

Please rank the following future opportunities for ICT applications and integration do you think add value to your organizaton

Models: Opportunities related to modelling are about: *(maximum three selections, 1=lowest, 3=highest)*

- ☐ 3D CAD
- ☐ Semantics / product models (e.g. STEP, IFC, etc.)
- ☐ Parametric building / product descriptions
- ☐ Components / Part Libraries (product elements, materials, etc.)
- ☐ (Construction-oriented) Ontologies
- ☐ Process models
- ☐ Communication models
- ☐ Other, please specify ________

Knowledge-orientated applications and systems *(maximum three selections, 1=lowest, 3=highest)*

- ☐ Datawarehouses for re-use of Building products, materials, information on Construction projects, etc.
- ☐ Re-use of best practice
- ☐ Knowledge management systems for property operation & management
- ☐ E-learning & e-training systems
- ☐ Easy search and access to information over the Web
- ☐ Other, please specify ________

Standards *(maximum three selections, 1=lowest, 3=highest)*

- ☐ For semantics (e.g. STEP, IFC, ontologies, etc.)
- ☐ For classification (e.g. ISO-PAS 12006, etc.)
- ☐ For meta-information (e.g. Dublin Core, RDF, etc.)
- ☐ For communication (e.g. XML, SOAP, WSDL, etc.)
- ☐ For object-oriented interoperability (e.g. OMG/CORBA, IIOP, Java/RMI, etc.)
- ☐ For workflow (e.g. WfMC, W3C/WSFL, etc.)
- ☐ For components (e.g. EJB, Corba Components Model, etc.)
- ☐ Other, please specify ________

Performance-driven systems *(maximum three selections, 1=lowest, 3=highest)*

- ☐ Enriched Virtual environments
- ☐ Advanced simulation tools & Virtual testing laboratories
- ☐ Decision-making and/or support systems
- ☐ Collaboration platforms (for improved virtual teamworking)
- ☐ eCommerce / eBusiness platforms (for improved supply-chain management)
- ☐ Other, please specify ________

Solutions for ubiquitous access / computing *(maximum three selections, 1=lowest, 3=highest)*

- ☐ Advanced distributed ICT infrastructures
- ☐ Mobile / wireless computing and infrastructures
- ☐ Multi-modal "device adaptable" interfaces

☐ Virtual workspaces
☐ Security of data exchange between remote applications
☐ Other, please specify

Please indicate how important you regard each of the innovation motivation criterias
(maximum three selections, 1=lowest, 3=highest)

Productivity ☐
Service Enhancement ☐
Decision making/control ☐
Innovation ☐
Professionalism ☐

Please indicate how important you regard each of the following trends for construction sector.
Scale: 0 = can not say; 1 = none, 2 = low, 3 = medium, 4 = high, 5 = very high

From stand-alone specific engineering applications towards integrated **Total Life Cycle Support**.	
From physical products and (semi-)automated building services towards **Intelligent Products and Smart**	
From reinventing and use of personal/departmental experience towards **Re-use and Sharing of Knowledge** at enterprise and industry levels.	
From information access via company and project intranets and web towards **Ambient Access** to all relevant information anytime, anywhere regardless of physical location.	
From document (and drawing) based ICT towards **Model Based ICT** (i.e. computer interpretable information).	
From intrusive ICT ("humans serving computers") towards **Human Centered Environments** ("computers serving humans").	
From document & paper based contracts and procedures towards **Legal and Contractual Governance** of ICT usage within and between enterprises.	
From file based data exchange towards **Flexible Interoperability** between heterogenous ICT systems.	
From business processes driven by lowest capital cost towards **Performance Driven Process** driven by customer perceived values.	
From teamwork using email and project web sites towards **Virtual Teams**, able to collaborate seamlessly across organisational, geo-graph-ical and time boundaries as if they were co-located.	
From taylored and configured ICT systems towards **Adaptive Systems** that learn from their own use and user behaviour, and are able to adapt to new situations without manual maintenance, configuration and support.	
From limited ICT awareness of construction professionals towards the combination of enhanced **ICT skills** (via education, training) and built-in **learning** support within ICT systems.	

3.3. Top ICT & RTD priorities of the interviewee in free form
In your own words, what do you regard as top priorities for RTD on ICT in construction
1st Priority:

2nd Priority:

3rd Priority:

☐ Please tick here if you provide additional views on a separate sheet / form / email.

What in your opinion will be the key future ICT applications for business processes: CAx, PDM, ERP,SCM,CRM, XRM etc.?

What in your opinion will be the key ICT technologies for BPs: intelligent agents, web services or some other technology? Elaborate on your choice

What in your opinion will be the key future ICT tools for business processes: modelling (e.g BPMI, Enterprise Modelling, UML), actuation (e.g. WfMC-Workflow), implementation and control (PMI-Project Management)?

4. Anticipated Impact

What are the most important impacts that should be achieved by more advanced (use of) ICT?

Human aspects *(maximum three selections, 1=lowest, 3=highest)*
☐ Smooth / transparent use for end users of ICT applications at each stage of the Construction project.
☐ Increased skills of company's employees *(e.g. in Construction materials, or as a result of adopting a training programme in the use of ICT tools, for instance).*
☐ New forms of living / working / communicating *(at home, at the office, on Construction sites).*
☐ Improved trust and social cohesion in the workplace.
☐ New cultural attitude of the industry, or at least in your company.
☐ Other, please specify

Performance / Quality / Certification *(maximum three selections, 1=lowest, 3=highest)*
☐ Increased use of best options during the Construction Life-Cycle *(by means of decision support systems)*.
☐ Straightforward and contextual access to Building standards, regulations, specifications, and legislation.
☐ Increased availability and use of certified product and process information.
☐ Raised level of construction norms / regulations *(through the use of ICT)*:
  ☐ In general;
  ☐ Safety of workers on Construction sites;
  ☐ Health and safety in Building use & maintenance;
  ☐ Protection of the environment and saving of natural resources;
  ☐ Other, please specify

  (If you select this option, then select one or several suboptions)
☐ More effective / improved monitoring of progress at each stage of the Construction project
☐ Other, please specify

Legal & contractual issues *(maximum three selections, 1=lowest, 3=highest)*
☐ Assessment / clarification of liabilities in new ICT-based procedures *(e.g. in "electronic" public European Calls for Tender).*
☐ Legal accountability of all ICT transactions.
☐ *(Generalisation of)* Use of standard ICT-based systems for assigning and defining contractual

liabilities *(e.g. to accessibility of electronic data).*
☐ Other, please specify

Total Life Cycle Management *(maximum three selections, 1=lowest, 3=highest)*

☐ Adoption of a total lifecycle model-driven approach to information sharing and management on projects. *(through the use of industry standards)*
☐ Improved Total Life-Cycle Costs *(via use of decision-making systems).*
☐ Improved change management over total lifecycle *(by enhancing existing ICT systems)*.
☐ Inter *(between companies)* and intra company integration *(through the use of ICT systems).*
☐ Improved communication with project participants *(through the use of ICT systems).*
☐ Long-term business relationships between stakeholders from the industry, clients and Building users *(facilitated by the use of emerging technologies).*
☐ Other, please specify

Knowledge & creation transfer *(maximum three selections, 1=lowest, 3=highest)*

☐ Improved overall access to domain, corporate and project information *(through the use of advanced tools taking into account users' profiles and information needs).*
☐ Best Practice databases that capitalise on past successes and failures.
☐ Accelerated take-up of new ICT tools, methods and processes *(through implementation of deployment measures)*
☐ Other, please specify

What in your opinion are the main functions that will be provided by a business process network infrastructure? For example Collaborative forecasting and planning, collaborative product development, materials sourcing, inventory management, distributed order management, supplier relationship management, customer service and support, collaborative product maintenance, logistics management, collaborative product dismissal. If we have left any out please add. Prioritise!

What will be the key issues with collaboration and distributed decision making? For example governance.

What will be the main changes in organisational roles, corporate culture and required competencies when collaborating in a network?

What, in your opinion, are the industrial collaborative business models, for smart organizations (i.e. knowledge driven, adaptive and learning as well as agile in their ability to create and exploit the opportunities of an Internetworked economy) including SMEs, that you see emerging in the year 2008-2013 and beyond?

What do you see as the main driving forces for industrial partners to engaged in collaborative business besides profit making?

What new business processes do you envisage to support collaboration in non-linear enterprise networks? Please elaborate on your answer. For example:
- Multi-actor BPs: integration of humans, products, applications.
- Ambient Intelligence BPs: interacting with the surrounding environment.
- Knowledge-based BPs: implementing humans' judgements and organisations' policies.
- Psycho-Cognitive BPs: capturing, representing, profiling human behaviour & attitude. Self-learning BPs: learning from experience and past similar cases.
- Semantic-based BPs: multisectoral, multilingual and multicultural issues.
- Multi-modal BPs: accessing, actuating, implementing BPs at anytime, from anywhere

5. Involvement in Research and Development Initiatives

Please explain your current involvement in National and European Initiatives

Do you expect that your organisation is interested to participate in future RTD on ICT in construction *(select one)*

○ As a core partner in a management role (e.g. project coordinator)
○ As an active partner (allocating e.g. 1-2 full time persons to a project)
○ As a test site / pilot user (limited role to test results)
○ As an interest group member (provide requirements, undertake peer reviews, participate workshops etc.)
○ Follow up without direct participation (e.g. subscribe to newsletters etc.)
○ Not interested
○ Some other role, please explain:

The RTD priorities that you have expressed on this questionnaire are related mainly to what you *(select one)*

○ plan to do yourself
○ expect from others (e.g. software developers, researchers, standardization, legislation etc.)
○ Not applicable, please explain:

6. Barriers

Main barriers that prevent more advanced use of ICT: *(maximum three selections, 1=lowest, 3=highest)*

Organisational Barriers
☐ Business incentives ☐ IT strategy
☐ Training ☐ Appropriate ICT support

Legal Barriers
☐ Risks for liability ☐ Legal support for use of ICT
☐ Security of ICT transactions ☐ IPR issues for electronic information and documentation

People barriers
☐ Personal incentives ☐ Education / training / continuous professional development
☐ Cultural issues ☐ Conservative nature of (Reluctance to changes in) current business processes

Technology Barriers
☐ Difficulties in using new technology ☐ Lack of support from ICT providers (inc. IT department)
☐ Incompatibility / interoperability problems; lack of (use of) standards

Other barriers, please specify:
☐ Cost of Technology

Categories of ICT tools to which the previous barriers apply *(maximum three selections, 1=lowest, 3=highest)*

- [ ] Communication tools (email, internet etc.)
- [ ] Collaborative tools (ASPs, LAN's, project servers / web sites , document/file management, workflow support, data exchange etc.)
- [ ] Analytical tools (engineering analysis, simulation, virtual reality, etc.)
- [ ] Modelling tools (product modeling, visualization, virtual reality, data exchange translators etc.)
- [ ] Office tools (word processing, spreadsheet, presentation graphics, personal databases etc.)
- [ ] Design tools (CAD, etc..)
- [ ] Management tools (MIS, planning, cost control, ERP, FM, etc.)
- [ ] Other tools, please specify: ______

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