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A Case Study on National Quality Infrastructure in Iran and Its ranking in The Global Quality Infrastructure Index (GQII)

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Abstract

International competitiveness is the key to Iran's participation in global trade. Iran's success in achieving the goals of economic diversification and trade competitiveness will correlate highly with the coherence of its national quality infrastructure. A well-functioning quality infrastructure in Iran that helps firms in priority sectors meet the requirements of export markets and supports them in demonstrating conformity with the requirements in a holistic manner, will act as a catalyst to improve the competitiveness of Iran's economy, its ability to participate in global trade and increase the value of trade.

The aim of this study is to introduce the Iran National Quality Infrastructure (NQI) briefly and its position in the Global Quality Infrastructure Index (GQII) programme. The GQII plays as a good indicator to measure the growth and the performance of QI of any economy. It provides valuable data that can be used for different types of analysis by QI body representatives, policymakers and other leaders to informed business decisions making.

In this paper, first, the concept and overall framework of a national quality system is mentioned; then the Iran NQI system framework is explained in detail. Finally, based on the International ranking of Iran in GQII, strengths and weaknesses of the Iran NQI system are pointed and the possible solutions for improvement on the overall construction and each element of it are proposed. The study would be very helpful for the government agencies, industry, academia, and enterprises for future decisions and policymaking related to strong and robust QI.

Keywords Quality Infrastructure, Ranking, Global, Iran.

Introduction

International competitiveness is the key to Iran's participation in global trade, and quality, Iran's key to competitiveness. Without quality, there can be no competitiveness, irrespective of the sector, size and nature of firms. Only firms that produce quality products and services are able to successfully compete, gain access to markets and sustain their presence in international markets, [1,2]. In order to remain competitive, firms must reduce the costs associated with poor quality and improve productivity. While much can be achieved at the company level on this front, the ability to meet requirements of export markets is neither limited nor within the exclusive control of enterprises. There are fixed costs associated with exporting. These costs are incurred by Iran's firms in order to access a foreign market, such as market information costs (information on prevailing technical requirements), or the cost of adapting processes to comply with foreign technical

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requirements, for example for implementing standards and measures to fulfil technical regulations, and carrying out conformity assessment in a manner acceptable to markets. This fixed cost of exporting turns out to be critical in determining which firms will be able to access foreign markets and which firms will fail to do so, [2]. This fact is even more pertinent for efforts geared towards designing and implementing Iran's trade competitiveness strategy where concerted efforts could reduce these fixed costs collectively through coherent, consistent and non-divergent enabling policies, technical regulations and support mechanisms.

In general perception, enterprise-specific elements related to meeting customer requirements for a "good"-quality product or service, are relatively more well-known. The quality-related aspects that permeate beyond enterprises to the realm of institutions, services providers and policies, their roles and inter-relationships, frequently remain vague or are relatively less understood, sometimes even among practitioners. In fact, the entirety of this interlinked system comprising organizations (public and private) together with the policies, relevant legal and regulatory framework, and practices needed to support and enhance the quality, safety and environmental soundness of goods, services and processes is what is termed the Quality Infrastructure System (QIS), [3]. Beyond the quality management functions inside an enterprise, this QIS is necessary at a national level to define and develop quality requirements for products and services; enable value-addition by use of international standards; and demonstrate that products and services actually meet these requirements through internationally accepted conformity assessment procedures. Importantly, the availability and accessibility of such a QIS can reduce the fixed costs mentioned above that are associated with exporting, [4,5].

Xu described the foundation of a national quality and discussed the importance support of a NQI for a strong manufacturing, [6]. Choi et al. based on the total quality management, introduced an NQI evaluation system with standards, conformity assessment, and metrology, [7]. Many countries such as the United States, China, Sweden, India and the Philippines have carried out the implementation of NQI projects and put forward policy recommendations based on their own national conditions to improve the integrated development of their NQI, [8-14]. Iran's success in achieving the goals of economic diversification and trade competitiveness will correlate highly with the coherence of its national quality infrastructure system and the effectiveness with which it delivers standardization, quality management, conformity assessment, accreditation and metrology services to exporting companies. A well-functioning quality infrastructure in Iran that helps firms in priority sectors meet the requirements of export markets and supports them in demonstrating conformity with the requirements in a holistic manner, will act as a catalyst to improve the competitiveness of Iran's economy, its ability to participate in global trade and increase the value of trade.

The rest of the paper is structured as follows: Section 2 introduces the definition of a quality infrastructure system (QIS) and consequence NQI and following by the meaning of each component of it in details. The NQI system of Iran and the various elements of it is described in the end of section 2. In Section 3, an overview on the Global Quality Infrastructure Index program and the ranking of Iran on the GQII (2020) is presented. An overall analysis on the Iran's position and possible solutions to some problems in the process of NQI construction and some development suggestions are proposed in the sections 4 and 5. This will try to help the establishment and improvement the Iran NQI system and improve the quality system.

2. Materials and method

Quality is a critical element of competitiveness and by definition it means meeting or exceeding customer expectations, and applies to products, services, people, processes, and environment. Quality and standards underpin critical success factors for these initiatives in formulating the unique selling proposition of consistently offering goods and services with excellence built-in from the start, reducing the chances of failure, [2].

Implementing quality management systems and even simple quality improvement techniques can help stimulate business sector activity through higher employee engagement, ideation, and innovation to improve processes. Application of industry best-in-class practices and international standards can prepare domestic firms with limited exposure leading to increased confidence within the business community to face international competition, [2,15].

2.1. Quality Infrastructure System (QIS)

Quality Infrastructure (QI) is a critical element for sustainable development and wellbeing, it provides the economic development foundation for any country. A Quality Infrastructure system (QIS) guarantees and control quality criteria. The development of a QIS is closely related to the development of trade between countries. In many countries, various QI services are provided by public, private or even non-profit organizations. A Quality Infrastructure System makes trust between trading partners and promotes cooperation between enterprises and

stakeholders, [15,16]. The basis of a quality control chain and the three technical effected component is shown in Figure (1).

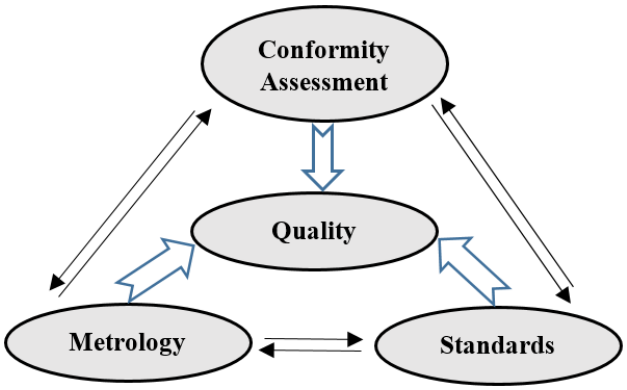

Figure 1: The basis of a quality control chain and the interaction and promotion of each elements on the others.

2.2. National Quality Infrastructure (NQI)

The National Quality Infrastructure (NQI) is the institutional framework and described as "a system composed of public and non-governmental organizations and policies, relevant laws, regulations, and practices required to support and improve the quality, safety, and environmental protection of products, services, and processes", [10]. The main components of a National Quality Infrastructure (NQI) system are Standardization, Metrology, Accreditation and Conformity Assessment via Certification, [17-19]. Figure (2) shows the main components of a NQI system.

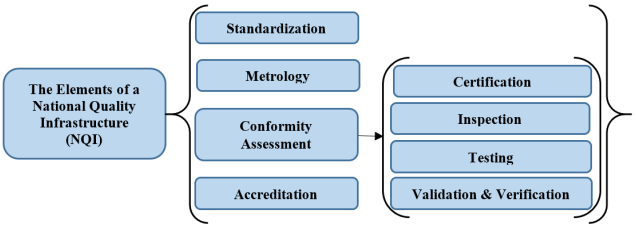

Figure 2 The elements of a National Quality Infrastructure System

2.2.1 Standardization

Standardization is the process of developing and implementing standards based on the consensus of different parties. This process can improve quality, safety, compatibility, interoperability and the other product or service features. Standards improve the suitability of products and services for the intended purpose. They facilitate technological cooperation between different stockholders and prevent the barriers to a fair trade, [16]. In general, each country has a national standards body organization (NSB) which is responsible and represents the economy in international standards organizations such as ISO, IEC.

2.2.2 Metrology

Metrology is the science of measurement and its application, it consists the both sides of experimental and theoretical aspect of sciences and determine the level of uncertainty in any field of science and technology. The main object of metrology focuses on the definition of internationally accepted units of measurement, the realization of measurement standards and the guarantee of international accuracy, consistency, traceability, and legality of measurements. The main role of a national metrology institute (NMI) is to conduct scientific metrology, and maintain primary national standards, [20].

2.2.3 Accreditation

Accreditation is a formal, independent review process by an independent third party to determine if a product or service meet defined quality standards, [21].

A national accreditation body (NAB) is an institution which attests to the competence and impartiality of conformity assessment bodies, according to international standards such as ISO/IEC. In some countries, there are more than one accreditation body.

2.2.4 Conformity Assessment

Conformity assessment refers to any activity that determines whether a product, system, service or body meets specified requirements and characteristics described in a standard or specification. These requirements can include performance, safety, efficiency, effectiveness, reliability, durability, or environmental impacts. Conformity assessment provides the necessary proof, based on standards and technical regulations by a third party. Conformity assessment controls quality and builds quality trust in the market.

The main forms of conformity assessment are inspection, testing, certification, validation and verification, [16]. Different types of conformity assessment bodies (CABs) can undertake conformity assessment activities. They can be public, private or even non-profit organizations, such as government agencies, national standards bodies, trade associations, consumer organisations, or private or publicly owned companies.

2.3 Iran's National Quality Infrastructure

Iran's quality infrastructure may be categorized along the following four themes:

1. Standardization, which includes "Supreme Council of Standards" and "Iran National Standard Organizations

(ISIRI)"
2. Accreditation System, which includes "National Accreditation Centre of Iran (NACI)" and other governmental accreditation systems.
3. Conformity Assessment, which includes Metrology and Calibration Institutes, Certification Services and Testing Labs, Inspection Services
4. Quality-related consultancy and training organizations
In addition to the above, there are number of quality related organizations and associations that contribute to the efficiency and effectiveness of Iran's quality.

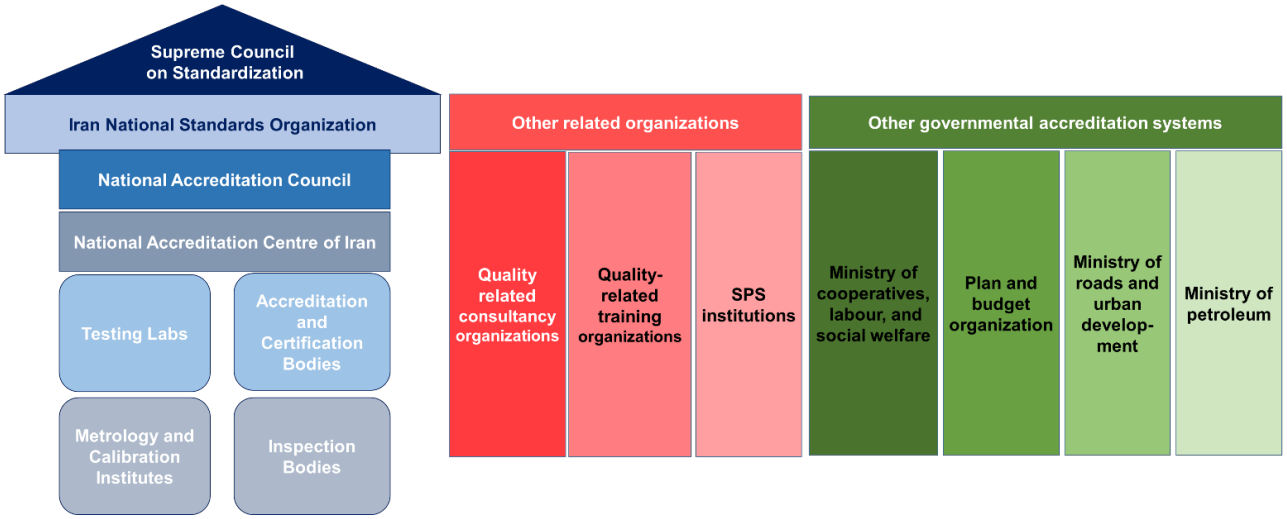

Figure 3 Iran's National Quality Infrastructure

2.3.1 Iran's NQI - Standardization

Standardization in Iran is established and sustained by its government. The two main governmental structures responsible for standardization are Iran's "Supreme Council on Standards" and "The Iran National Standard Organization (INSO)".

2.3.1.1 Iran's Supreme Council on Standards

Iran's "Supreme Council on Standards" is the highest authority for standardization, and decides on all related policies and which standards should be mandatory. The President of Islamic Republic of Iran is the Head and President of the Council. The President of INSO is Secretary of the Supreme Council on Standards. The following ministers, representatives and experts are the members of the Council.

- Ministers of Economic Affairs and Finance; Science, Research & Technology; Roads and Urban development; Reconstruction of Agriculture; industry, mine and commerce; Health and Medical Education; Oil; Energy; Labour and Social Affairs; Communication and Information Technology; Defence & Logistics of Armed Forces.
- Chairs of Planning and Budget Organization; the Department of Environment; the Prosecutor General; Inspection Organization Of Iran; Two representative of Iranian Parliament related to standard issues; The Iranian Chamber of Commerce, Industries & Mines; The Iran Chamber of Cooperatives; The Iran Chamber of Guilds; Four experts nominated by the INSO President and appointed by decree of the I.R.I. President; Chair of Islamic Republic of Iran Broadcasting; President of The National Accreditation Centre of Iran; Chair of Competition Council.

2.3.1.2 The Iran National Standard Organization (INSO)

While standardization work began in Iran with the adoption of the Weights and Measures Law in 1925, ISIRI was established as a national standards body in 1960 and joined the International Organization for Standardization (ISO) in the same year. Since 2011, ISIRI is under the direct supervision of the President of the Islamic Republic of Iran, before which it was under the Minister of Industry, Mines and Commerce. The underlying principle of ISIRI's work is that efficacy of research applied to productivity, safety, public health, and environment to improve living conditions, is the most important component of development.

In this regard, standardization and applying related rules and regulations forms an important approach to realize national objectives. ISIRI has developed more than 30,000 National Standards in different fields such as food

and agricultural products, chemicals and polymers, mechanics and metrology, automation and vehicles, quality management, etc.

Below some of the duties and responsibilities of ISIRI related to standardization are mentioned:

- Testing and sample conformance of goods and services with relevant standards,
- Identification, development and publication of National Standards except those on pharmaceuticals,
- Determining goods specifications and assessing them according to respective national standards except those of pharmaceuticals,
- Promotion of the International System of Units (S.I.) and calibration of measuring instruments
- Hallmarking of precious stones,
- Organizing the Iranian National Quality Awards to the best qualified selected companies
- National Standards Development,
- Participation in the development of International Standards.

ISIRI is a member to several regional and international organizations e.g. ISO, IEC, ILAC, IAF, OIML, BIPM, CODEX, WAITRO, PAC, SMIIC and cooperates mutually with other National Standards Bodies (NSBs). In order to participate effectively in the development of national and international standards several measures have been taken as follows:

- Establishment of National Mirror Technical Committees to follow up and hold related meetings at specified time intervals:
- Participating in ISO's General Assembly, Council, Technical Management Board and technical committees meetings;
- Participating in IEC's General Assembly, council, Technical Management Board and technical committees meetings at national level
- Establishment of coordination council of CODEX ALIMENTARIUS, National Codex Commission (NCC) and CODEX national mirror committees
- Preparing code of conducts and regulations related to contribution in development of international standards
- Preparing a database of participating members
- Creating an information system on ISIRI website
- Holding training courses for people in charge of technical committees
- Monitoring and supervising technical committees activities, especially in terms of timely responding to the international standards drafts
- Monitoring, supervising and coordinating receiving the comments for standards drafts and submitting them to ISO
- Identifying and involving the specialists throughout the country to collaborate in development of national standards
- Pursuing and implementing the Council's approvals
- Participation in regional programs of ECO member states and the Standards and Metrology Institute for the Islamic Countries (SMIIC)

2.3.2 Iran's NQI - Metrology

The first Weights and Measures Law in Iran was adopted in 1925 according to which the International System of Units (SI system) was announced as the official measuring system in the country. The Islamic Republic of Iran became a Member State of the International Bureau of Weights and Measures (BIPM) in 1975 and a Member State of the International Organization of Legal Metrology (OIML) in 1977. Iran signed the Mutual Recognition Agreement of the International Conference of Weights and Measures (CIPM MRA) in 2016.

The National Metrology Centre of Iran (NMCI) was established in 1975 as a sub-division of ISIRI, with the technical assistances of UNIDO, UNDP and UNESCO as the biggest centre of its type in the Middle East. In 2012, aiming to reach the development standards and innovative technological prowess of industrialized nations, the Metrology, Weights and Measures Centre of ISIRI initiated the development of a National Metrology Development Strategy program, using the latest scientific, academic, research and industrial capabilities.

2.3.2.1 The National Metrology Centre of Iran (NMCI)

Iran's Metrology, Weights and Measures Centre consists of scientific, industrial and legal metrology departments as the organizational structure of metrology institutes in developed and developing countries.

- Scientific Metrology Department is responsible for training, standardization, research and development in the field of measurement.
- Industrial metrology Department embodies four laboratory departments consisting of some 30 reference metrology labs of chemical, mechanical, acoustics, electrical quantities and optics.
- Legal Metrology Department comprises of 50 legal metrology sections responsible for controlling measuring equipment in trade, hygiene, medicine, road safety etc.

2.3.2.2 Responsibilities of the National Metrology Centre of Iran (NMCI)

As national metrology institute, NMCI is responsible for:

- Developing SI systems as the official system of measuring in the country,
- General policy making in scientific and industrial me-

trology area,
• Measurement traceability of all measurements in the country,
• Establishment, maintenance and updating National Reference Labs,
• Calibration of reference measuring equipment of the accredited labs in field of calibration,
• Developing National standards of measurement and participation in the development of International Standards,
• Conducting researches in the field of measurement,
• Managing annual verification of all scales, weighbridges, gas stations in the country,
• Seal marking of all weighing instruments in the country.
NMCI is collaborating with the following organizations at international and regional levels:
• BIPM (Bureau International des Poids et Mesures)
• OIML (International Organization of legal Metrology)
• APMP (Asian Pacific Metrology Program)
• SMIIC (The Standards and Metrology Institute for Islamic Countries)

2.3.3 Iran's NQI – Conformity Assessment

Conformity Assessment consists of Accreditation, Certification, Testing and Inspection. In Iran both the public and the private sector carry out conformity assessment functions.

2.3.3.1 Public Sector Conformity Assessment in Iran

ISIRI is responsible for conformity assessment of different products, and services, and issues the license for use of its standard mark on products. Moreover, there are some other governmental organizations which conduct conformity assessment on some technical products, and services.
ISIRI's duties and roles in connection with conformity assessment are:
• Surveillance implementation of products/ services standards at production sites and distribution centres
• Issuance, revocation, renewal and suspension of the license to use ISIRI standard mark
• Issuing products quality certificate prior the order of registration
• Surveillance implementation of standards at points of goods import and export to make sure about the quality of the products subject to compulsory standards
• Surveillance implementation of grade standards for precious metals
• Evaluation and preparing the reports for the qualitative yields of productions subject to compulsory standards
• Conformity Assessments of products which results in certification includes: technical inspection, sampling, test, inspection and issuing conformity certificate
• Determining the nature of importing goods and notifying the customs
• Surveillance implementation of standards for energy consuming equipment and processes
• Certification of compliance with energy consumption index
Some governmental organizations in Iran act as conformity assessment body for specific technical products, and services. These organizations are as follows:
• Iran Food and Drug Administration (IFDA)
• Ministry of Information and Communication Technology (ICT)
• Road, Housing and Urban Development Research Centre (BHRC)
• National Iranian Gas Company (NIGC)

2.3.3.2 Private Sector Conformity Assessment Bodies in Iran

There are number of organizations in the private sector which provide conformity assessment services. These organizations may be active in one or more services in the assessment of conformity. A large number of certification bodies (CBs) operate in Iran, some of which are foreign companies and some are Iranian and accredited by NACI. Services delivered by certification bodies vary according to their competencies and accreditation. These services cover different areas related to quality in different sectors, and according to relevant international or national standards. Picture 2 shows certification services available in Iran. Popular standards in Iran include, ISO 9001, ISO 14000, ISO 18000, ISO 27001, IATF/ ISO 16949 and HACCP and certification to ISO 9001 is the most popular. There are more than 1300 testing laboratories accredited to ISO/IEC 17025. These laboratories give a wide variety of services in different fields such as Electrical & Electronics, Wood & Wood Products – Packaging, Mechanics and Metallurgy, Food and Agriculture, Fertilizers and Pesticides – Chemistry, biomedical engineering, Petroleum and Petrochemical Products, Construction & Mining Materials & Products and Vehicle and propulsion. There are approximately 173 inspection companies in Iran with valid ISO/IEC 17020 accreditation. Inspection services available in Iran include advanced non-destructive testing solutions, packaging commodities inspection and material and goods inspection.

2.3.4 Iran's NQI – Accreditation System

Accreditation systems in Iran can be classified in two main categories. First, is National Accreditation Centre of Iran (NACI) and the second is other governmental accreditation centres.

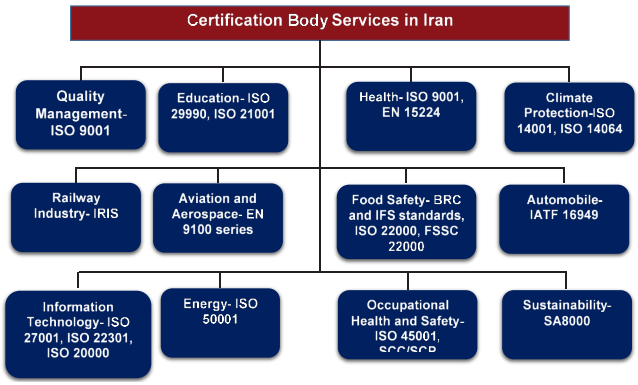

Figure 4 Certification Body services in Iran

2.3.4.1 National Accreditation Centre of Iran

Considering the need for international interactions and maintaining the interests of international relations of Iran in trade competitions either at national or international levels, the duties and responsibilities of assessing and accreditation of conformity assessment bodies are delegated to INSO. Recognizing the need for establishing an independent and impartial center delivering accreditation services, the government through Supreme Council of Standard vested the authority to INSO to act as an accreditation body in 1995. The Iranian accreditation council was originally established in 1996. During the joint meeting of International Accreditation Forum (IAF) and International Laboratory Accreditation Cooperation (ILAC) in 2003, IAS signed a MOU with the International Accreditation Forum (IAF) and became a member body to this Forum. Later, IAS joined the Pacific Accreditation Cooperation (PAC) and ILAC; however, the international eligibility of IAS to the mentioned forums is subject to signing MLA and MRA multilateral recognition agreement [3].

IAS changed its name to National Accreditation Centre of Iran (NACI) in 2009 and performs its responsibilities as an independent center under the direct supervision of ISIRI President since 2010. Based on the Multilateral Recognition Agreement (MLA) by the President of the National Accreditation Centre of Iran and the Head of the International Accreditation Council (IAF) at the IAF-ILAC Joint Meeting on 24 October 2016 & 19 July 2017, NACI gained international recognition for its accreditation services related to environmental management systems certification (ISO14001), Quality Management System Certification (ISO 9001) and food safety management (ISO22000) certification in more than 80 countries. NACI provides following services regarding accreditation:

• Accrediting Product Certification Bodies based on ISO/IEC 17065,
• Accrediting Management System Certification Bodies based on ISO/IEC 17021,
• Accrediting Calibration and Testing Laboratories based on ISO/IEC 17025,
• Accrediting Medical Laboratories based on ISO 15189,
• Accrediting Laboratories based on ISIRI procedure208/111,
• Accrediting Inspection Bodies based on ISO/IEC 17020,
• Accrediting Laboratories providing Proficiency Testing schemes (PT) as per ISO/IEC 17043.

To provide aforementioned services, NACI formed its organizational structure as shown in figure (5).

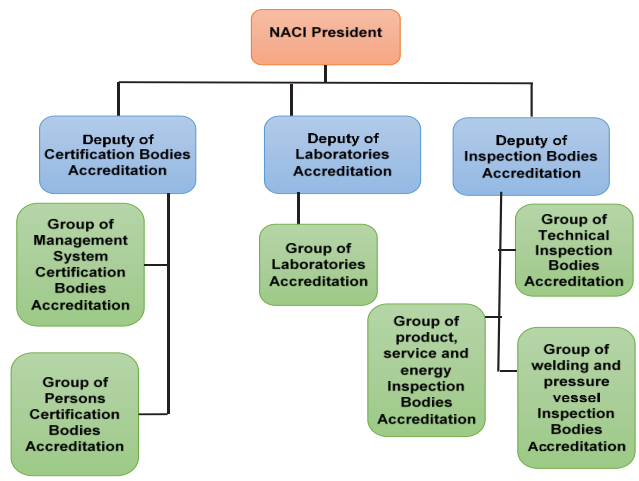

Figure 5 Iran NACI's Organizational Structure

2.3.4.2 Responsibilities of National Accreditation Centre of Iran

The role and responsibilities of NACI in Iran's accreditation system are listed below.

1. Implementation of legislation and regulations, including Section 7 of the implementing regulations of Article 33 of the Law on Amendment of the Law of the Fourth Economic, Social and Cultural development plan by ceding part of the tenure of the government bodies to accreditation and conformity assessment bodies, including the following bodies:

- Certification Bodies of Management Systems as per ISO/ IEC 17021,
- Testing and Calibration laboratories as per ISO/IEC 17025 including codes and related regulations,
- Inspection Bodies as per ISO/IEC 17020 including codes and related regulations,
- Products Certification Bodies as per ISO/IEC 17065,
- Bodies certifying persons as per ISO/IEC 17024,
- Laboratories providing Proficiency Testing schemes (PT) as per ISO/IEC 17043,
- Medical laboratories as per ISO 15189,
- Reference Material Production (RMP) as per ISO 17034,

- Delivering consultancy services according to the codes and related regulations.

2. Conducting research and collecting the required information regarding the terms and conditions for accreditation and conformity assessment and analysing them for the use in preparing the terms and conditions, designing and documentation and implementation of the required management system as per ISO/ IEC 17011 and international regulations.
3. Collaboration in preparation and development of needed relevant standards for accreditation of conformity assessment bodies by analysing the collected information and document and using them in developing the national standards in this field.
4. Providing necessary condition for becoming a member body to international forums and being accepted in International Multilateral and Mutual Recognition Arrangement MLA and MRA by creating and maintaining relationships, cooperation and coordination with regional and international organizations that are active in different fields mentioned above in part 1 and ISO/ CASCO.
5. Keeping interactions with other countries' accreditation bodies in order to share information, experience and collaborations in executive affairs.
6. National registration of accreditation certificates for Bodies, Laboratories and Consultants referring to item 1 above and publishing the relevant list in ISIRI website.
7. Conducting promotional and informative activities concerning terms and conditions and any other issue relating to accreditation of Bodies, Laboratories and Consultants mentioned in item 1 in the most effective way such as holding seminars, workshops and publications.
8. Submitting comments relating to draft international standards related to accreditation, participation in international meetings and forums in order to contribute in the development of international standards.
9. Availing the expertise and experience of the approved outside assessors and professionals in different fields according to national and international regulations as necessary.
10. Identifying and assessing the training needs of NACI staffs and approved outside assessors and professionals, making necessary arrangements for delivering related training and continuous updating of knowledge and capabilities [1].

3. The Global Quality Infrastructure Index (GQII)

The GQII is an open initiative programme to promote QI information transparency and measures the relative level of QI development in each country. The GQII follows a systemic approach to provide a composite indicator for the QI domain and so on ranking the development of Quality Infrastructure worldwide. This evaluation is built on publicly available data published in international and national QI organizations' websites. These data sources include The Key Comparison Data Base and the BIPM website, the ISO Survey and the ISO and IEC websites, the IAF and ILAC websites and the databases on accredited conformity assessment bodies' websites.

3.1 The GQII - Formula

The formula includes indicators on metrology, standardization and accreditation based on the simplifying assumption that three components contribute equally to the QI system. The GQII formula is dimensionless and normalized, so in it can serve as a ranking mechanism to comparison of the current status of the countries' QI. It will also allow us to analyze for each economy in which components they have relative advantages or lacking over other countries, [10]. The formula and key parameters is shown below.

$$GQII_i = \left(\overbrace{\beta_1 \times \frac{CMC_i/Pop_i}{max.\ value} + \beta_2 \times \frac{K\&SC_i}{max.\ value}}^{METROLOGY} + \overbrace{\beta_3 \times \frac{ISO_i/Pop_i}{max.\ value} + \beta_4 \times \frac{Tech.Comm._i}{max.\ value}}^{STANDARDIZATION} + \underbrace{\beta_5 \times \frac{CABs(9001)_i/Pop_i}{max.\ value} + \beta_6 \times \frac{CABs(17025)_i/Pop_i}{max.\ value}}_{ACCREDITATION} + \underbrace{\beta_7 \times \frac{Member_i}{max.\ value}}_{MEMBERSHIP} \right)$$

- Under assumption of equal weight: $\beta_1 = \beta_2 = \beta_3 = \beta_4 = \beta_5 = \beta_6 = \beta_7 = 1$
- $i = country_1; country_2; \ldots\ country_n$
- CMC: number of Calibration and Measurement Capabilities according to CIPM – MRA
- K&SC: number of Key and Supplementary Comparisons according to CIMP - MRA
- ISO: number of valid ISO standards issued (9001, 14001, 22000, 13485 and 27001)
- Tech.Comm. : number of Technical Committees' participations according to ISO
- CABs (9001): number of Conformity Assesment Bodies under ISO/IEC 17021 – ISO 9001
- CABs (17025): number of Conformity Assesment Bodies under ISO/IEC 17025 – Testing Labs only
- Member: membership of international QI system (CIMP, IAF, IEC, ILAC, ISO, ITU, OIML, WTO)
- Pop_i = Total Population for ith country

One of the challenges and limitation on the GQII database is the validity of that is limited to the availability and quality of the data provided by the QI organizations. Data have been used in this study, are taken from open access available data in each categories, where the major limitation is with the accreditation data which are available in a very complex and diversified form from country to country.

3.2 The GQII – Empirical results and Ranking

The GQII-Index 2020 ranks the 184 economies according to the relative development of their QI and based on their position in the three sub-rankings for metrology, standards and accreditation. A score is calculated based on the mentioned formula for each economy.

These data can be used as a baseline study in the project design of any countries' QI system, ability to assessing their current relative development QI status and allow

benchmarking and mutual learning between each other's. By looking at the table can find if a country has well-developed in three elements of metrology, standardization and accreditation, in consequence it is also generally well developed. The same rule applies to medium and low development. It should be considered, the position of any economy in the GQII ranking provides a rough view to the development status of QI. Table (1) demonstrate the results of GQII 2020, Global Ranking and Sub Rankings. The shadow colour scale of the table shows the relative level of development of the economies' QI from dark blue (highly developed) to dark orange (less developed).

Table 1 The GQII 2020, Global Ranking and Sub Rankings, (Cont.)

Economy	GQII 2020	Rank GQII 2020	Rank GQII Metrology	Rank GQII Standard	Rank GQII Accreditation
Germany	99,5	1	2	2	2
China	99,4	2	3	1	3
US	98,9	3	1	10	1
UK	98,8	4	6	3	5
Japan	98,0	5	4	4	13
Korea, Republic of	97,2	6	7	8	14
Italy	97,0	7	16	4	4
France	97,0	8	4	6	20
Spain	96,4	9	12	8	10
India	95,6	10	19	7	9
Australia	95,4	11	8	19	6
Poland	95,3	12	15	12	7
Czech Republic	95,2	13	14	11	12
Brazil	93,8	14	9	16	26
Netherlands	93,7	15	21	12	15
Canada	93,6	16	10	27	16
Switzerland	93,0	17	13	14	33
Mexico	92,6	18	16	40	8
Hungary	92,4	19	18	19	18
South Africa	92,3	20	11	30	22
Turkey	91,6	21	25	21	17
Romania	91,3	22	25	14	30
Sweden	91,2	23	19	17	35
Russian Federation	90,5	24	31	18	23
Austria	89,6	25	22	25	37
Indonesia	89,2	26	35	36	18
Finland	88,9	27	22	28	38
Slovak Republic	88,6	28	34	29	32
Thailand	88,5	29	24	24	44
Colombia	88,5	30	42	31	21
Singapore	88,0	31	25	44	31
Ukraine	87,9	32	28	48	28
Belarus	87,8	33	30	45	26
Greece	87,7	34	42	35	23
Portugal	87,6	35	32	23	46
Belgium	87,3	36	46	25	34
New Zealand	87,0	37	38	52	11
Bulgaria	86,7	38	39	33	39
Serbia	86,4	39	33	39	45
Malaysia	86,3	40	37	21	50
Argentina	86,2	41	29	31	49
Denmark	86,2	42	35	41	42
Norway	84,1	43	48	38	47
Egypt	83,9	44	41	43	48

Table 1 The GQII 2020, Global Ranking and Sub Rankings, (Cont.)

Economy	GQII 2020	Rank GQII 2020	Rank GQII Metrology	Rank GQII Standard	Rank GQII Accreditation
Chile	83,6	45	47	49	40
Ireland	83,3	46	49	42	43
Slovenia	80,4	47	44	54	54
Israel	80,1	48	55	33	65
Kazakhstan	80,1	49	44	65	25
Philippines	77,9	50	63	45	57
United Arab Emirates	77,4	51	62	53	51
Saudi Arabia, Kingdom of	77,2	52	58	45	72
Peru	76,8	53	56	55	61
Viet Nam	76,8	54	60	64	36
Iran	74,9	55	85	36	68
Pakistan	74,3	56	82	50	60
Lithuania	74,2	57	52	70	53
Kenya	73,8	58	53	62	64
Taiwan (Province of China)	72,6	59	40	114	29
Uruguay	72,2	60	50	73	63
Tunisia	71,7	61	59	63	71
Sri Lanka	71,3	62	74	60	59
Ecuador	71,0	63	57	76	56
Croatia	70,9	64	51	50	135
Luxembourg	70,3	65	88	57	66
Costa Rica	69,4	66	61	88	52
Hong Kong, China	68,6	67	54	115	41
Qatar	68,3	68	79	59	84
Morocco	68,1	69	65	67	86
Bosnia and Herzegovina	67,8	70	67	67	83
Nigeria	66,7	71	116	56	75
Cyprus	66,5	72	114	69	55
Algeria	65,9	73	122	58	73
North Macedonia	65,9	73	69	86	67
Oman	64,3	75	91	61	102
Bangladesh	64,0	76	82	82	70
Malta	63,9	77	98	81	69
Albania	62,6	78	75	105	58
Zimbabwe	62,4	79	80	94	76
Georgia	62,3	80	68	101	74
Mauritius	62,2	81	88	89	79
Uzbekistan	61,8	82	81	108	62
Ghana	61,3	83	97	89	80
Jordan	61,2	84	135	72	81
Ethiopia	61,2	85	94	86	87
Bolivia, Plurinational State of	60,8	86	87	95	90
Panama	60,6	87	78	82	109
Côte d'Ivoire	60,6	88	123	76	78
Estonia	60,3	89	76	66	137
Bahrain, Kingdom of	60,1	90	103	80	96
Azerbaijan	60,0	91	70	111	82

Table 1 The GQII 2020, Global Ranking and Sub Rankings, (Cont.)

Economy	GQII 2020	Rank GQII 2020	Rank GQII Metrology	Rank GQII Standard	Rank GQII Accreditation
Kuwait, the State of	60,0	92	84	93	101
Uganda	59,9	93	127	75	89
Tanzania	59,9	94	96	84	97
Mongolia	59,6	95	101	84	95
Namibia	58,1	96	85	108	92
Latvia	58,0	97	76	79	136
Iceland	57,9	98	132	78	99
Cuba	57,3	99	63	74	139
Lebanese Republic	57,1	100	155	91	92
Dominican Republic	57,1	101	119	102	77
Trinidad and Tobago	57,1	102	99	96	105
Jamaica	56,9	103	91	105	97
Paraguay	56,8	104	72	124	91
Moldova, Republic of	55,9	105	73	97	134
Iraq	55,9	106	71	71	143
Botswana	55,7	107	88	112	104
El Salvador	55,4	108	125	100	94
Montenegro	54,8	109	66	92	138
Sudan	54,5	110	102	99	122
Guatemala	53,3	111	114	124	88
Senegal	53,1	112	127	104	110
Armenia	53,0	113	137	98	115
Zambia	52,5	114	93	130	108
Rwanda	52,2	115	127	117	103
Cameroon	51,5	116	137	102	125
Democratic Republic of the Congo	51,4	117	137	105	117
Malawi	51,2	118	120	120	107
Suriname	51,2	119	104	124	111
Honduras	50,1	120	127	131	100
Seychelles	50,0	121	94	143	114
Gabon	49,6	122	127	119	125
Mali	49,2	123	137	112	129
Benin	49,0	124	123	122	123
Cambodia	48,8	125	132	128	113
Kyrgyz Republic	48,7	126	125	154	84
Macao, China	48,6	127	135	133	111
Angola	48,6	128	120	136	118
Bahamas	47,7	129	137	131	120
Mozambique	47,7	130	137	137	116
Eswatini	46,8	131	118	156	106
Guyana	46,3	132	104	150	123
Madagascar	46,2	133	137	141	120
Myanmar	45,9	134	157	120	132
Togo	45,5	135	137	143	125
Afghanistan	44,2	136	157	138	128
Liechtenstein	43,5	137	157	148	119
Barbados	42,2	138	104	115	151

Table 1 The GQII 2020, Global Ranking and Sub Rankings, (Cont.)

Economy	GQII 2020	Rank GQII 2020	Rank GQII Metrology	Rank GQII Standard	Rank GQII Accreditation
Syrian Arab Republic	40,9	139	100	118	160
Nicaragua	40,8	140	117	145	140
Saint Lucia	40,5	141	104	124	149
Cabo Verde	40,2	142	157	162	132
Nepal	40,0	143	157	110	146
Congo	39,8	144	157	164	130
Lesotho	39,8	145	137	171	131
Palestinian Territories	38,9	146	157	135	142
Burkina Faso	37,8	147	137	122	153
Venezuela, Bolivarian Republic of	37,3	148	156	150	141
Fiji	34,4	149	157	129	160
Burundi	34,3	150	137	140	160
Bhutan	34,0	151	157	134	160
Papua New Guinea	33,8	152	157	153	145
Brunei Darussalam	33,7	153	157	138	155
Dominica	33,6	154	104	157	160
Belize	33,5	155	104	173	148
Saint Kitts and Nevis	33,3	156	104	160	160
Libya	33,3	157	132	163	150
Niger	33,0	158	137	152	155
Grenada	32,6	159	104	173	152
Vanuatu	32,6	159	157	142	160
Mauritania	32,2	161	157	147	155
Lao People's Democratic Republic	32,1	162	157	146	160
Haiti	32,0	163	137	155	160
Tajikistan	31,9	164	137	159	155
Kosovo	31,7	165	157	181	144
Guinea	31,6	166	157	165	147
Yemen	31,5	167	137	166	154
Sierra Leone	31,3	168	157	149	160
Antigua and Barbuda	30,7	169	104	176	160
Saint Vincent and the Grenadines	30,5	170	104	178	160
Gambia	30,2	171	157	158	160
Chad	30,0	172	137	167	160
Maldives	29,9	173	157	161	160
Equatorial Guinea	29,2	174	137	171	160
Central African Republic	29,1	175	137	173	160
Liberia	28,2	176	157	168	160
Djibouti	28,1	177	157	169	160
Somalia	28,0	178	157	170	160
Guinea-Bissau	27,8	179	157	176	155
Samoa	27,3	180	157	178	160
Tonga	27,3	180	157	178	160
Solomon Islands	27,0	182	157	181	160
South Sudan	27,0	182	157	181	160
Timor-Leste	27,0	182	157	181	160

4. Results

The NQI is an important tool that can be utilized to improve competitiveness and facilitate global trade. Since GQII is considered as a good indicator of measuring and showing the growth and performance of QI in the country's economy, in this study, the reasons for achieving Iran's GQII of 74.9 and ranking of 55th among the other countries have been investigated, reasons for this backwardness have been analyzed and suggested solutions to achieve them were proposed.

Main factors affecting the GQII ranking are the membership acquired/obtained in international organizations linked to membership of international quality infrastructure systems, number of Calibration and Measurement capabilities, number of valid ISO standards issued, number of technical committees participating to ISO standardization, number of conformity assessment bodies under ISO/IEC 17021 and ISO/IEC 17025 and number of Key and Supplementary comparisons according to CIPM MRA.

Participating in Key and Supplementary Comparisons as a main parameters effecting GQII and QI needs ratification of National Metrology Center of Iran (NMCI) membership in the regional metrology organization APMP, peer evaluation from (NMCI) laboratories, participation of NMCI in mutual or multilateral comparison with other National Metrology Center of other countries, Approval of NMCI CMC's in APMP and submission to BIPM and register in Key Comparison Database. Finally NMCI taking part in key comparison to CIPM MRA. The countries with a stronger presence of QI like as European countries occupy the high positions in the GQII ranking.

As a parameter affecting the country's Quality Infrastructure, it is necessary to increase participation in ISO technical committees. Out of the total number of 252 technical committees of the ISO Organization, Iran is responsible for its secretariat in only 5 TC's. It is possible to improve the country's Quality Infrastructure through increasing participation in international standardization and therefore it will promote GQII.

The total number of conformity assessment bodies accredited based on ISO/IEC 17025 (testing and calibration laboratories) for our country is also limited and insufficient (Total number for testing laboratories approximately 1400 and for calibration approximately 200). Accreditation of more laboratories as a main important factor of conformity assessment activity to increase QI and its effect to GQII should be considered as a national necessity.

5. Conclusion

The GQII database is an obvious evidence on the promotion of QI system in each country. It provides valuable data that can be used for different types of analysis by QI body representatives, policymakers and other leaders to informed business decisions making. This is where the GQII data can provide valuable information. This study based on the GQII-Index 2020 ranks, confirms the strong correlation between QI development and investments with economic development. As expected, leading export economies with a well-developed QI are economically successful and also have higher rank in the GQII-Index ranking; inversely, that countries lagging behind in QI are economically less advantaged.

Export-related quality issues at policy, institutional, and enterprise levels often present a barrier for market access due to the technical complexities, scientific rigour involved, and lack of adequately qualified and skilled workforce. Among others, these issues relate to technical specifications, metrology, product and systems standards, test methods, inspection, certification, sampling, statistical methods, and risk management. While Iran would need concerted efforts and focused initiatives concerning quality and standards, these initiatives must not be viewed as a separate / discrete element. The ultimate beneficiaries and users of a strong QIS in Iran are enterprises. Therefore quality management activities would also need to be actively linked with programmed and activities developed to foster a strong entrepreneurship and innovation base among youth who are envisaged to create future enterprises and generate economic activity. In this regard, these two programmes could be seen as mutually reinforcing. This is to say, on one hand quality and standards related programmes can nourish entrepreneurship and innovation programmes to reinforce their quality orientation On the other hand, a QIS needs entrepreneurship and innovation to generate quality related service providers in the form of advisory, training and consultancy services – either as private entities or under the auspices of public bodies.

For having a high position in this ranking, a country should have a strong metrology and accreditation programmes besides a good adoption of quality standards. Governments have a central role in developing and upgrading of NQIS, to facilitate international harmonization and recognition. Below mention some development suggestions which help and improve the establishment and improvement the Iran NQI system.

- Increasing Iran's participation in international standardization activities at the level of ISO, IEC, ITU and Codex will provide opportunities for the country to influence the formulation of international standards and market technical requirements taking into consideration the needs of the local producers. Such participation will enhance experience sharing in the field of standardization and adoption of best practices and new technology;
- The number of conformity assessment bodies certifying

quality management systems for our country is limited and insufficient. Accreditation of more quality management systems certification bodies to increase QI and its effect to GQII should be considered as a national necessity;

- Regional cooperation via Mutual Recognition Agreements (MRAs) and Multilateral Recognition Arrangements (MLAs), promotes the mutual recognition of national structures (and standards) and thus breaks down technical barriers to trade;
- Innovations of the quality policy and harmonize it with the international standards and regulation of the quality and environment protection;
- Encourage awareness of the organizations and industries in the new standards and application of them;
- Training for interpreting/transposing and implementing the quality policy, through seminars, courses and the Quality School;
- Attract and mobilize STEM (Science, Technology, Engineering, and Mathematics) graduates for successfully deployment and retention in strengthening the national QIS for widespread compliance with relevant technical requirements in the priority sectors.

All of these actions will lead to improvement of the quality infrastructure of the country and ultimately increase the profile of Iran' ranking in the Global Quality Infrastructure Index. Government have a central role to play in the development and upgrading of National Quality Infrastructure institutions.

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Consent for publication

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