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# A Quality 4.0 Assurance Framework for the Higher Education Institutes

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***Abstract***

*This article presents a framework for the implementation of Quality 4.0 aspect in the higher education institute. Quality 4.0 is a major domain of Industry 4.0 revolution. Beside the industry, educational institutes are also embracing the new technology-based framework, which does not only revolutionize the educational system, but also impact their performance.*

*In this research, a comprehensive framework for the implementation of Quality 4.0 is presented. The enablers and the components of Quality 4.0 are discussed in detail. The article also discusses the implementation of the framework, consisting of big data analysis, SWOT analysis of the institute, implementation of documentation, digitalization and record management, ERP system and finally the key performance indicators (KPIs).*

*The framework is specially designed for the higher education institute for the consistency and standardization, through the latest technology and digitization.*

***Keywords:*** *Quality 4.0, Industry 4.0, Quality Management System, Higher Education Institutes, Outcome-based education.*

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## 1. Introduction

Core idea of Industry 4.0 is the ability to accumulate and analyze big data from industrial sources, and use this data to make decision for the higher productivities. Concurrent fields of Industry 4.0 are; Quality 4.0, Maintenance 4.0, Pharma 4.0 etc. Due to the advancement in industry and its concurrent fileds, it is the immense need of the era, to transform the quality assurance in higher education into the Quality 4.0 Assurance (Q4A). To address the current needs of higher education a comprehensive framework for the implementation of Q4A is highly needed. The current needs and requirements of the traditional framework of quality assurance and the latest trends of Quality 4.0 are need to be addressed. A comprehensive literature review has been conducted, which is presented below;

Implementation of quality assurance framework, challenges and solutions and the transformation to the new standards are presented in other research (Tufail and Lodi, 2006), (Tufail and Lodi, 2008), (Bhutto *et al.*, 2017), (Wasif *et al.*, 2018), (Shailh *et al.*, 2019a), (Shaikh *et al.*, 2019b), (Bhutto *et al.*, 2019). Rudzki *et al.* developed a generic strategic framework for the quality assurance in educational institutions and presented the components of it that can be implemented in any type of education institute (Rudzki *et al.*, 1995). Gopal *et al.* conducted a survey to assess the maturity of total quality management (TQM) in higher education. They highlighted the positive outcomes of implementing TQM within the higher education institute (HEI) (Gopal *et al.*, 1999). Fumasoli and Lepori presented a genetic strategic framework which can further be customized for the stage-wise standardization in structures and standards in HEIs in the specified environment (Fumasoli and Lepori, 2011). Teichler *et al.* presented their work on the possible risk analysis of globalization and overall impact on the higher education (Teichler *et al.*, 2004). Garrison *et al.* analyzed the issues related to the administration and leadership, for which the controls are developed to improve the blending learning approach (Garrison *et al.*, 2004). Ciolacu *et al.* improved the concept of Education 4.0 by incorporating the artificial intelligence over the big data of students progress (Ciolacu *et al.*, 2017). Wittayasin highlighted the problems in attaining the vision of the government for the Thailand 4.0 (Wittayasin, 2018). Puncreobutr highlighted that the need of communication, mobile app, big data analysis and use of AR/VR will increase the quality in HEIs (Puncreobutr, 2016).

It has been observed from the literature review that the Quality 4.0 implementation in HEIs are not new, although it has several challenges such as; quality of education at different academic levels and segmentations, availability of infra-structure, teaching methodologies and assessment mechanisms, knowledge and skill of faculty and quality assurance division and outcome of curricula. To address these issues, a Q4A framework for the outcome-based education has been developed, which is presented in the following section. A part of this framework has been implemented at the NED University which is discussed in detail.

## 2. Quality 4.0 Assurance Framework

The current framework is inspired by the philosophy of Juran, which states the concept of Quality 4.0 for the industry bifurcated into eleven axes, namely; data, analytics, connectivity, collaboration, app development, scalability, management system, compliance, culture, leadership and competency. These core axes are further divided into the components as used in the traditional quality assurance frameworks (Juran, 2019). This Quality 4.0 in generic and is quite applicable to the manufacturing industry, however a Quality 4.0 Assurance Framework (see Fig. 1) has been developed in the light of outcome-based education for the higher education institution.

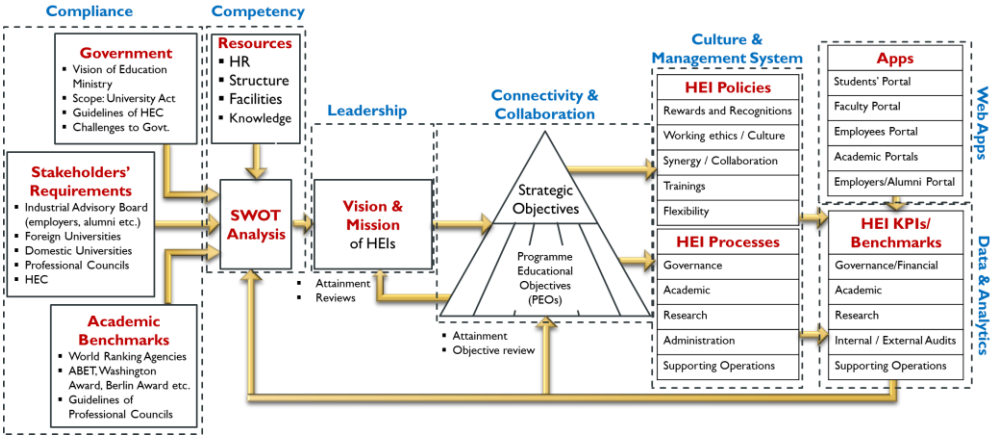


*Figure 1. Quality 4.0 Assurance Framework (Q4M) for Higher Education Institutes.*

### *2.1. Compliance*

To ensure the compliance, Quality Enhancement Cell (QEC) and Registrar Office gathers the requirements of stakeholders including the regulatory bodies. Qualitative data can be gathered in the form of relational database, whereas, quantitative data can also be gathered in the same way but acts as the benchmark for the further KPIs. Source of compliance data may be government, regulator bodies, funding agencies, collaborative institutions, professional councils, academic benchmarking agencies etc. Online bots and application can be written to continuously monitor the chan8ge in websites and new contents, which can further be added in the database for the further compliance.

### *2.2. Competency*

Resources of the HEI are also proposed to be converted into the quantitative form, so that it can be compared with the benchmark institutions for the SWOT Analysis. Another relational database can be developed to incorporate different types of resources. In SWOT Analysis,

strength and weakness of HEIs are analyzed based on the resources, such as; human resource, infra-structure, equipment, facilities, finances etc. SWOT analysis are also converted into the quantitative evaluation of SWOT, i.e. internal factor evaluation (IFE) matrix and external factor evaluation (EFE) matrix, which will be further used to developed critical profile matrix (CPM) comparing the competitors and benchmark HEIs. Competitive profile matrix (CPM) provide quantitative comparison and highlight the strengths and weaknesses in terms of scoring on Likert scale. Although an automated system for the competency is not currently developed but based on the SWOT analysis presented in the previous research (Shaikh *et al.*, 2019).

### *2.3. Leadership*

Leadership intuition is important to be incorporated to review vision and mission of the HEI. Based on the compliance (majorly scope) and the competency, mission of HEI can be reviewed highlighting the weak or strong areas. Using the ad optic strategy and SWOT analysis, vision of the HEI can be set which would provide a direction to the institution for the future betterment.

### *2.4. Connectivity and Collaboration*

Strategic objectives or long-term objective are the bridge between the mission and vision. Hence it is the core aim of this stage is to develop strategic objectives of the organization based on the vision and mission of the organization. Based on the strategic objectives programme education objectives (PEOs) of the academic programmes are developed. Hence a sample vision and mission statement along with the strategic objectives are presented in the following figure.

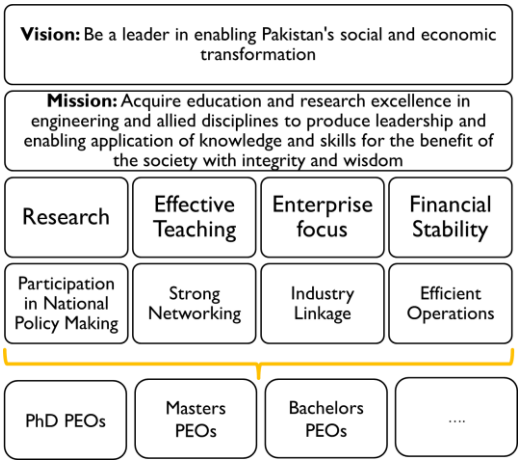


*Figure 2. Strategic and Programme Objective.*

### *2.5. Culture and Management System*

It is a difficult part of any organization to be captured in Q4M framework. Even though based on database comprising of situation, decisions and precedence, a enterprise decision support system can be implemented. Research qualification reward, ethical policy, environmental policy, quality policy and other high level policies would be developed. In NED University, a comprehensive Quality Management System has been implemented (Tufail *et al.*, 2006), (Tufail *et al.*, 2006). It is an integrated management system managed and updated through different portals, which are linked together to form a University-wide ERP system.

### *2.6. Web Apps*

Different web apps are developed at NED University, to integrate different processes and procedure together. These apps and portals are used to collect and disseminate information to the stakeholders, such as; Faculty Portal, Student Portal, Employees Portal, Chairperson Portal, Deans Portal, VC Portal, Registrar Portal, Directorate of Finance Portal, Procurement Cell Portal, Directorate of Projects and Planning Portal, Undergraduate Programme Portal, Post-Graduate Programme Portal, Admissions Portal, Rapid Notifier etc. Specialized dashboard for the monitoring and control of the NED UET functions are also accessible to the leadership of the university, such as; Vice Chancellor, Pro-Vice Chancellor, Deans and Chairperson/Head of the supporting departments. All portals are integrated to generate consolidated reports and information and are accessible to the leadership of the university. Integrated ERP system of the university comprises of these all portal, MIS system, database and other IT infrastructure. Fig. 3 shows the illustration of the integrated ERP system.

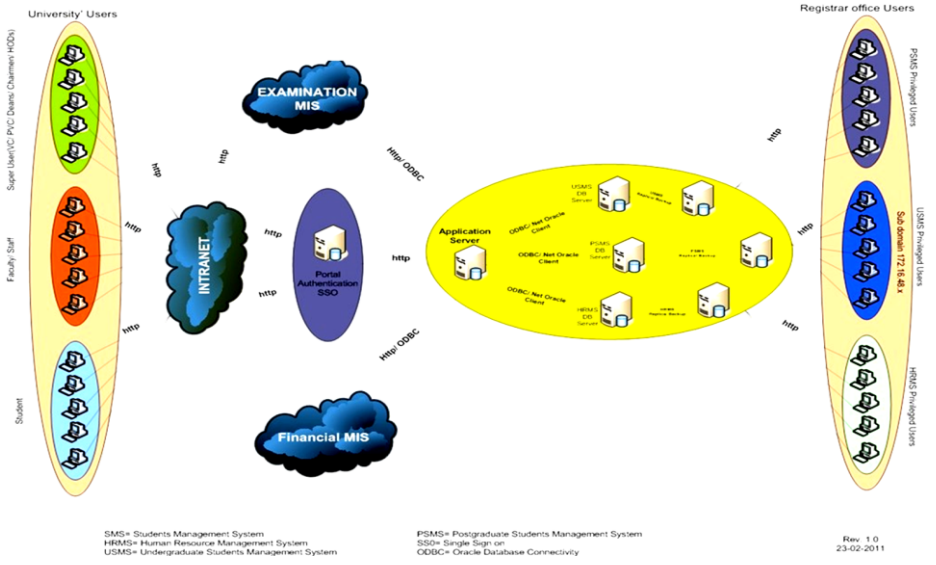


*Figure **3**. Integrated MIS System of NED University.*

### *2.7. Data and Analytics*

To assess the effectiveness of strategic and departmental objectives, data for the KPIs are analyzed periodically. Data is periodically collected from all the academic and supporting departments. Online forms have been developed for each department and division. Although data is gathered in all stages of the Q4A framework, but all the data is accumulated to convert into the Key Performance Indicators (KPIs). Any of the KPI below the benchmark may be intimated to the leadership of the university through the online management system.

### *2.8. Q4A Integration System*

This framework is largely depends upon the database generated through the compliance data, competency data, which are used to developed the vision and mission of the HEIs. Components of the vision and mission will used to develop strategic objectives and programme educational objectives of the academic departments. Based on the objectives, organizational culture and management processes can devised to meet the objectives. These objective would be measured through the KPIs for which data would be gathered through the web apps and portal from different stakeholders of the university. It is proposed in the Q4A framework that in case of lower KPIs than the benchmark, the SWOT analysis may be reviewed, based on the KPIs inflation, programme educational objectives and strategic objective can be reviewed for further benchmark. Based on attainment of strategic and programme educational objectives, vision and mission of the university may also be reviewed. This integrated Q4A framework may be implemented with intensive MIS systems which will be integrated together to form a comprehensive ERP system.

## 4. Challenges

In implementing the Quality 4.0 Assurance (Q4A) Framework, there are several challenges to be overcome. These challenges are mainly related to the culture, skills, infrastructure and compliance to the regulatory body. The main issue in implementing Q4A is the culture, that is stakeholders are not habitual of submitting data related to their profile in their respective portal. This is due to the complicated relational databases, which sometimes requires detailed information in their MIS portals. Although the stakeholders are also trained for the use of portals but major IT and database related skills are still needed. Due to lack of which, stakeholders are unable to realize the importance of the data and its refinement to be input in the system. NED University is shifted towards the Smart University having an integrated communication system which seems to be a strong infrastructure, but due to the lack of awareness about the IT tools, the effective communication is still a challenge to the HEI. Sometimes, compliance of regulatory bodies also difficult since the consolidated reports generated through the system are difficult to modify according to their need. Sometime, it becomes quite difficult to prepare reports and publications in the form of stakeholder

requirement due to unavailability of data. These the few challenges which need to be addressed for the effective use of Quality 4.0 Assurance Framework.

## 5. Conclusion

A Quality 4.0 Assurance (Q4A) Framework has been presented in the research which comprises of several components complying with the requirement of Quality 4.0 axes [20]. This work presents an integrated Q4A system which has been partially implemented at the NED University, whereas, the university is trying to completely implement the framework. It has been observed that the implementation of this framework improved the KPIs of the HEI. It also positively affected the culture and management system of the university resulted in the improved skill of employees, faculty and students in using ERP system, conversion of traditional university to smart university, dashboards for monitoring and control the processes and having consolidated reports and publications. It is recommended that implementing the Q4A framework with full spirit will result in an effective and efficient HEI competing in the global environment.

The main limitation of the proposed work is that the effectiveness of the framework is to be measured, which is only possible by implementing the complete framework in the higher education institution.

## References

Bhutto, M.A., Shaikh, A.A. & Wasif, M. (2017) Impact of Quality Enhancement Practices, *1st International Conference on Quality Assurance at Higher Education*, December 18-19, 2017, Khyber Medical University, Peshawar, Pakistan.

Bhutto, M.A., Shaikh, A.A., Wasif, M. & Riazuddin. (2019) Implementing Quality Assurance in Universities/HEIs by Ensuring and Promoting Stakeholders' Trust, *INQAAHE 15th Biennial Conference 2019*, March 25-28, 2019, Colombo - Sri Lanka.

Ciolacu, M., Tehrani, A. F., Beer R. & Popp. H. (2017) Education 4.0 — Fostering student's performance with machine learning methods. *IEEE 23rd International Symposium for Design and Technology in Electronic Packaging (SIITME)*, Constanta: 438-443.

Fumasoli, T. & Lepori. (2011) Patterns of strategies in Swiss higher education institutions, B. *Higher Education*, 61, 157-178. doi: 10.1007/s10734-010-9330-x

Garrison, D. R. & Kanuka. H. (2004) Blended learning: Uncovering its transformative potential in higher education. *The internet and Higher Education*, 7(2), 95-105.

Gopal, K., Kanji, K., Malek, A. & Tambi, A. B. (1999) Total quality management in UK higher education institutions, *Total Quality Management*, 10:1, 129-153, doi: 10.1080/0954412998126

ISO 9001:2015 Quality Management System – Requirements (2015) 5th ed. *ISO Central Secretariat*, Geneva, Switzerland.

Juran, *Quality 4.0: The Future of Quality?*, https://www.juran.com/blog/quality-4-0-the-future-of-quality/, June 15, 2019.

Puncreobutr, V. (2016) St. Theresa Journal of Humanities and Social Sciences, *St. Theresa Journal of Humanities and Social Sciences* 2(2), pp. 92-97.

Rudzki, R.E.J. (1995) The application of a strategic management model to the internationalization of higher education institutions. *Higher Education*, 29, 421-441. doi: 10.1007/BF01383961

Shaikh, A.A., Wasif, M. & Riazuddin. (2019) Excellence in Quality Education through Implementation of Strategic Framework and SMART KPIS in Higher Education Institute, *Proceedings of 174th ISERD International Conference*, 16th -17th October 2019, New York, USA.

Shaikh, A. A., Wasif, M. Bhutto, M.A. & Riazuddin. (2019) Risk based approach and Smart KPIs for the Quality Assurance in Higher Education Institutions, *2nd International Conference on Quality Assurance at Higher Education – PNQAHE*, April 23-25, 2019, University of Education, Lahore.

Stock, T. & Seliger. G. (2016) Opportunities of Sustainable Manufacturing in Industry 4.0, *Procedia CIRP*, 40, 536-541. doi: 10.1016/j.procir.2016.01.129.

Teichler U. (2004) The Changing Debate on Internationalization of Higher Education. *Higher Education*, 48, 5-26, 2004.

Tufail, M. & Lodi, S. H. (2006) ISO 9001 Certification for Higher Educational Institutions in Pakistan, *1st International Conference on Assessing Quality in Higher Education (1st ICAQHE, 2006)*, 11th -13th December, 2006, Lahore, Pakistan.

Tufail, M. & Lodi, S. H. (2008) Implementation of Quality Standard in Educational Institutions, *International Seminar on Higher Education in the Muslim World: Challenges and Prospects*, 24th – 25th March, 2008, Kuala Lumpur, Malaysia.

Wasif, M., Shaikh, A. A., Lodi, S. H., Bhutto, M. A. & Riazuddin. (2018) Implementation of Risk Management System to Improve the Quality of Higher Education Institutes, *ICHE 2018 : 20th International Conference on Higher Education*, June 25-26, Paris, France.

Wittayasin, S. (2018) Education Challenges to Thailand 4.0. *International Journal of Integrated Education and Development*, 2(2), 29-35.