Technology - The Backbone of a Sustainable Growth (SG) & Competitive Integral System Model (CISM)

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Abstract: The aim of this paper is to highlight the important role of technology component in a sustainable growth and competitive position integral system model. The sustainable growth and competitive position can be achieved very efficiently and effectively if the three major components; Technology, Human Resource (HR) and Protocols / Documentation are strongly linked to work together in an integral system. All these three components of a system get their essence of power from a drive engine of TQM philosophy of continual quality improvement at the hub of the model. Optimization of these three components; periodic calibration, modification and up-gradation of technology, effective education, training and re-training of HR to make them competent and proficient in their skills and review / revision of protocols and updating documentation, are inbuilt characteristics of the system to attain higher growth and gain new competitive position with completion of each cycle of the transformation process. However, the role of technology to act as a leverage and catalyst for priming the system performance is outstanding. National and international businesses can be benchmarked to reach the world class position.
[Khan N, Khan M. **Technology - The Backbone of a Sustainable Growth (SG) & Competitive Integral System Model (CISM)**. *Life Sci J* 2013;10(2):540-547] (ISSN:1097-8135). http://www.lifesciencesite.com. 79

Key words: Technology, Human resource (HR), Protocols, Sustainable Growth (SG), Competitive Integral System Model (CISM), Benchmark

1. Introduction

Technology, Human Resource (HR), Protocols and Documentation are major components of any integral system of business of any nature and size. These three components of a system must be strongly connected to work integrally for efficient and effective outcome – quality and quantity (Sherman, 2010). This integral system work on the powerful philosophy of Total Quality Management (TQM) drive engine of Continual Quality Improvement (CQI) at the centre. The sustainable growth and competitive position can be achieved if all three components and their sub components work optimally in the process of transformation. Improvement is done with completion of each cycle of the input – output transformation process (Groover, 2004; Alan, et al. 1992). Calibration, upgradation, modification and replacement of technology, quality culture change, continual education and re-training of HR to meet the requirements of new assignments and review / revision of protocols and updating the documentation to make it simple, easy, smart and effective for working are inbuilt into the system (Eric, 2007). As such, the system shall be capable to attain technical efficiency, provide economical growth and gain new competitive business position with completion of each cycle (Khan, 2008). Target can be set on national and international businesses as benchmark to finally reach to the world class position.

2. Sustainable Growth (SG) & Competitive Integral System Model (CISM)

The genesis of a SG & CISM is visualized as shown in Figure 1.

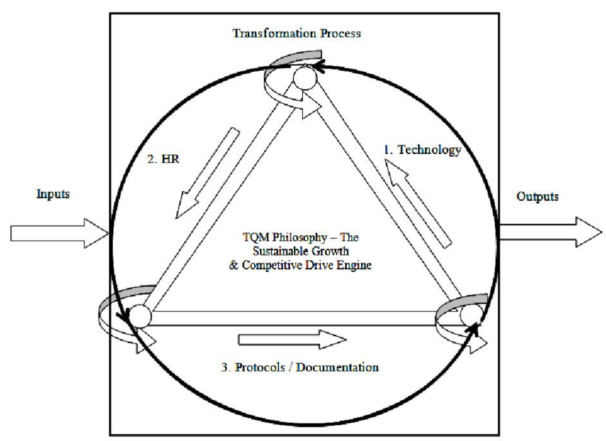

Figure 1: A Sustainable Growth and Competitiveness Integral System Model

This is a generic transformation model applicable to all types and sizes of businesses. Inputs are converted into output through processes of the integral system (Khan and Khan, 2011). The major running components of the integral system are a troika of technology, HR and protocol / documentation. These components get its essence of power from the TQM drive engine at the hub of the system model. This drive engine is available in the form of powerful TQM philosophy of CQI (Evan and Lindsay, 2005). Each component of the system has its importance but the system get its move from technology component which act as catalyst for the business growth which otherwise become difficult to attain and sustain (Heizer and Render, 2001).

3. TQM Philosophy of Continual Quality Improvement: The Drive Engine for SG and Competitiveness

CQI of all the three main components of the integral system model; technology, HR and protocols / documentation is the basis of sustainable growth to attain new competitive position in local and international market. Each component must work at its optimal. This is possible through implementation of TQM philosophy.

The TQM philosophy of CQI went through the evolution process under different labels. This is considered the most powerful philosophy of 20th century. Japanese took full advantage of it and is now leading the world through its applications (Khan, 2008).

3.1 View Point of Quality Experts

The term Total Quality Control (TQC) and Company Wide Quality Control (CWQC) were developed in USA and Japan respectively (Besterfield, et al. 1999). However, the literature claims that Nancy Warren was the first to use the term 'Total Quality Management' (Walton, 1990). Quotations from some prominent TQM gurus and advocates are presented here as a sample to show their views that TQM is a competitive quality philosophy of business for present and future. Quality gurus, advocates and researchers have defined TQM from different perspective of customers, suppliers, manufacturers and users. However, all of them aim at CQI (Khan, 1999). Oakland and Porter (1995 pp. 31) states about such a situation as "*All the gurus speak the same language but with different dialect"*. At another point, Oakland and Porter (1995) have presented their views about TQM as *"TQM is a comprehensive approach to improving competitiveness, effectiveness and flexibility through planning and understanding each activity and involve each individual at each level. It is useful in all types of organizations"*. Atkinson (1990 pp. 250) asserted that *"TQM is a means of achieving a strong competitive position"*. Ho (1995 pp. 4) remarks about the TQM are *"TQM is the totally integrated effort for gaining competitive advantage by continuously improving every facet of an organization's activities"*. At another point, Ho (1995 pp. 239) has asserted about the TQM as *"TQM is being adopted by companies around the world. It is a key element to the competitiveness of a company that intends to win in the market place"*. Berry (1991 pp. 5) has defined the importance of TQM philosophy is a single but most comprehensive sentence as *" Because it's a matter of survival !"*. Badri et al. (1995 pp. 36) states that *"Quality management is a key factor in gaining competitive advantages"*. Pheng and Ke-wei (1996 pp. 45) states about the TQM philosophy that "*TQM gives the competitive edge"*. Steele (1993) in his research study advocates that *"studies of many Japanese and American companies reveal that TQM can lead to huge competitive advantages"*. Wilson (1995 pp. 64) has discussed that *"Quality is now seen as a critical variable influencing an enterprise's competitiveness"*. Saylor (1992 pp. 13) states that "*Competition on a global scale is a fact of life: everyone is competing for the new global markets. With competition fierce in all aspect-Technology, Cost, Product quality and Service quality _ everyone must seek a competitive advantage. TQM is the proven approach needed to confront the challenges of the economic war and build victories upon victories today and in future"*. Powell (1995 pp. 31) concludes from a comprehensive and in-depth empirical study that *"The empirical results suggested that TQM can produce competitive advantages"*. Zubair (1996 pp. 12) has discussed the importance of TQM as a competitive business management philosophy as *"TQM is one of the most important management concepts which is central to the competitiveness and survival of organizations in global market"*. In the words of Juran, one of the gurus of the quality movement, *"Total Quality Management is a major phenomenon of this age""*. Ho and Fung (1994 pp. 24) have asserted that *"Total Quality Management (TQM) is a way of managing to improve the effectiveness, flexibility and competitiveness of a business as a whole"*. At another point Ho and Fung (1994 pp. 24) states that *"TQM is the theme for excellence for companies to survive and grow"*. Evans and Lindsay (2005) states that *"Today, total quality is a matter of survival"*.

A fair argument can be made here from these representative reviews and quotations from the studies and experiences that TQM as a CQI philosophy can lead to growth and competitive position (Khan, 2008).

3.2 TQM Implementation Successes Cases

The successful study reports of TQM philosophy is on increase and it includes all disciplines of business, manufacturing and services industries. A sample of quotations from some successful practices of TQM philosophy is presented here to highlight the competitive advantages gained. Tatikonda and Tatikonda (1996 pp. 5) states that *"TQM has helped many organizations (e.g Xerox, Motorolla, IBM) to improve their competitiveness and profit".* At another point Tatikonda and Tatikonda (1996 pp. 5) states that *"Globe metallurgy claims its TQM effort return $40 for every dollar invested. A study of U.S Baldrige winners shows that, on average, these companies achieved a 70% increase in return on sale and a 50% increase in return on assets".* Aiken et al. (1996) reports in his research work that using the TQM philosophy of team work in the form of GDSS (Group Decision Support System), has resulted in reduction of meeting time by 91 % and labour cost up to 71%. Kendrick (1993) research study of 30 companies shows that Total Quality Management philosophy has resulted in saving to the companies.

A fair argument can be made from the review of these research case studies and practices that successful implementation of TQM philosophy of CQI can result in achieving technical and financial gain and competitive business position. Failures, if any, have its routes to implementing partial criteria of TQM philosophy and hiring the inexperience consultant to implement TQM philosophy (Khan, 2008).

4. Technology – The Vital and Harder Component of a SG & CISM

Technology is the vital and harder component of an integral system which gives advantage to one system over the others in term of quality, precision, speed, accuracy, productivity, reliability, maintenance and cost. These advantages lead a business system to sustainable growth and competitive position (Sharif, 1992). Tarek (2000) has asserted that "technology can be defined as all the knowledge, products, processes, tools, methods and systems employed in the creation of goods or in providing service". The three significant component of technology identified by Tarek (2000) are:

- "**Hardware:** the physical structure and logical layout of the equipment or machinery that is used to carry out the required tasks.
- **Software:** the knowledge of how to use the hardware in order to carry out the required tasks.
- **Brain ware:** the reason for using the technology in a particular way."

4.1 The Vital Role of Technology

Both production and measurement technologies play a pivotal role in the integral system of quality production of products and provision of services. Initial focus is on monitoring, control and adjustment of machines, instrument and gauges to optimize the processes through application of TQM tools and techniques of CQI. Modification and replacement of machinery and equipment is the next stage. If further improvement is not possible, the only option available is the adoption of new and state of the art technologies. Technology is considered as the solution for partial problem of 'off centering (μ)' and total problem of reducing 'process natural variability (σ)'. The selection of technology is a tactical decision to be taken by the top management as it requires funds/ investment either for up gradation or replacement (Khan, 2008). Technology reduces process natural variations, thus can accommodate tight design specification (low tolerances and high precision) (Khan, 2008). Hence, technology provides the advantage of high precision, accuracy, speed, productivity and low cost of production (Cant, 1989). These elements lead to sustainable growth to attain competitive position to become world class (Khan, 2008). Chadha and Kalra (2010) have highlighted the importance of technology in use of six sigma quality technique and asserted that "if technology is not being used optimally, a company can't achieve its best results and become world class". Achieving technological sustainability involves passing through a series of stages, including (Khan et al., 2007; Cohen, 2004);

- Technology Assessment and Selection
- Technology Acquisition
- Technology Adaptation
- Technology Absorption and Assimilation
- Technology Diffusion
- Technology Development

5. Design Specifications

The relationship between 'Design Specifications and Process Natural Variability' shows process capability which is a major criterion for technology selection. Design specification includes;

Limits: These are the two maximum permissible values for parameters. The upper and lower limits are the largest and smallest permitted values respectively for that particular variable.

Tolerance: The tolerance on a parameter is the margin of error/variation permissible on it for reasonable inaccuracy in workmanship. The difference between the two limits of value (Upper and Lower Tolerance Limit) for a specific feature gives the tolerance. The greater the tolerance, the more easily and cheaply a product can be produced.

Accuracy: Accuracy is the closeness of agreement between the values observed and an accepted reference/ benchmark value. The lack of accuracy reflects a systematic/methodical biasness in the measurement for example a gauge out of calibration, worn or improper use by the operator.

Precision: Precision is the closeness of agreement between the results. Precision, relates to the variance of repeated measurements. A measuring taken by an instrument which has a low variance in its measurements is said to be more precise than the one which has a higher variance. Low precision could be due to the random variation that is embedded in the design of the instrument or in other words depends on the mechanics of the instrument, such as friction among its parts in the instrument which may vary non-linearly during different condition of measurements. This random variation is the result of a low quality design or less maintenance. Random errors are also present during manual measurements and associated with human participation in the measurement process which depends on the skill and knowledge of the person performing the measurements (Evans & Lindsay, 2005; Groover, 1996).

6. Process Capability

Process capability is significant to both designers as well as manufacturers. Knowing process capability allows the designers and manufacturers to estimate quantitatively, how a process will measure up to the design specification (control limits: upper and lower tolerance limits) and to specify necessary technologies (to control process natural variation – σ) and the level of process control (off centre - μ) necessary. In a scenario when a process is not capable of meeting the design specification of a product or service, then management has three possible options to decide; "(1) change the design specification, (2) measure each piece of production and either re-do the process or scrap nonconforming product, or (3) Develop a better process by investing in new technology" (Khan, 2008). These options are further elaborated as follows:-

- Changes in design specification may sacrifice fitness for use requirements and result in lower quality (precision) of the products.
- Scrap and rework are poor strategies, since labor and materials have already been invested in a nonconforming product or service. Also, inspection errors will probably allow some nonconforming products to leave the production facility and reach the customer.
- The technology option (modification or new) require substantial capital investment, which the firm may not be able to afford. Thus, these factors demonstrate the need to consider process capability when designing a product or accept any new contracts. Many firms now require process capability data from their suppliers before assigning a contract to them. Product design should not be carried out in isolation and contract should be awarded while keep in mind the process capability to follow the concept of 'Design For Manufacturing (DFM)' (Evans & Lindsay, 1999).

Process capability has three important components; "(1) the design specifications (2) the processes control by centering (μ) the process natural variation and (3) spread of variation (σ)" as shown in Figure 2 (Khan, 2008).

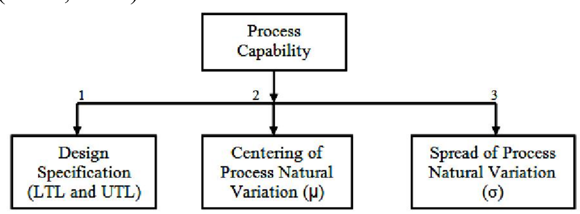

Figure 2: Components of Process Capability (Khan, 2008)

There can be four possible outcomes from the case when process natural variability (σ) is pitched against the design specification as shown in Figure 3 (Rawoof, 1999). It should be noted that six sigma is taken as acceptable quality threshold.

In Figure 3a, the design specification are wider than σ then it is expected that the process is always going to produce products conforming to the design specifications as long as it remains in control i.e. not off centered μ = 0. It could also be possible to reduce costs by investing in an inexpensive technology that will allow for a larger deviation in the process output σ.

In Figure 3b, the process natural variation and design specification are the same. A small number of unacceptable products could be produced, thus, close monitoring of the process is recommended.

In Figure 3c, σ has a larger range than the design specification. In this case, the process will not meet the required design specifications even if it is in control i.e. process is centered μ = 0. In a situation when the process is in control but the products cannot be produced according to the required design specifications, either the specifications should be reevaluated for any non-conformity or can the design specification should be relaxed in such as that it will not adversely affect the functionality of the product as an individual item or part of an assembly. If the specifications are representative of the product then the process needs to be improved by upgrading the equipment to the point where it is can produce consistently acceptable product within the design specifications (Rawoof, 1999; Chadha and Kalra, 2010).

Finally, the Figure 3d, the process capability resembles the one in Figure 3b except the process is off-centered i.e.µ is not zero. This could be sue to tool wear, disturbance of machine setup, or material variation due to the new batches of material etc (Rawoof, 1999). Part of the problem is the technology, which can be corrected by adjustment/ calibration of the system or setup. If no action is taken, a significant percentage of the products will not conform to the design specifications and result in high rejected rate, although the process has the inherent capability to conform to the design specifications (Evans and Lindsay, 2005).

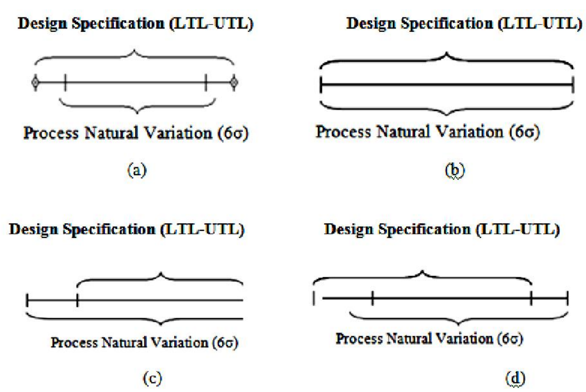

Figure 3(a-d): Design Specification against Process Natural Variability (σ)

6.1 Process Capability Indices

The process capability index (C_p) is defined as "*the ratio of the design specification width to the natural tolerance (6σ) of the process in a single quantitative measure*" (Rawoof, 1999).

$$Cp = \frac{Design\,Specification}{*\,Process\,Natural\,Variable}$$

$$= \frac{design\;Limits\;(LTL\;\&\;UTL)}{*\,6\sigma}$$

$$= \frac{UTL - LTL}{*\,6\sigma}$$

* Process variation from a large sample

Suppose that a process has a standard deviation (σ) of 1 and a tolerance spread i.e the difference of upper and lower tolerance limit of 8, and then the value of *Cp* is 1.33. Now if the tolerance limits are kept constant such that there is no change in design specifications and decrease σ i.e process variability is improved then *Cp* will increase as indicated in Table 1.

This task involves reducing the process natural variability using process improvement by minor equipment upgradation or modification and calibration or adopting new technologies. *Cp* depend on the supposition that the distribution of output of a large population has a normally distributed, which is not the case when output is affected by effects such as tool wear and shows a highly skewed distribution (Besterfield, et al. 1999).

Table 1. Improvement of *Cp* by Reducing σ through Process Improvement

UTL – LTL (Tolerance Constant)	**σ (Reduce Variability)**	**6σ (Multiple of Variability)**	**C_p (Improve Process Capability)**
8	1	6	1.33
8	0.8	4.8	1.66
8	0.67	4	2.00
8	0.44	2.67	3.00

7. Human Resource – The Softer Component of the Growth and Competitive Integral System Model

HR function represents the softer aspect of the integral system model. It has a major role to play, especially in supporting the cultural change aspects of the quality transformation using TQM philosophy. It is said that half the battle in changing to a quality environment is cultural. The other half is the technological aspect.

For any transformation process, culture change is a must which require clear understanding and changing the behavioral aspect of everyone in the organization. Change daily activities, change habits, change behavior lead to change the culture (Russell, 2011). The entire management team must take the lead role in making the transformation, but HR should provide lead staff support in training, personnel changes, changing of incentive systems, and discussions with labor unions. This is TQM approach to HRM (Henderson and Larco, 1999).

7.1 The Human Resource Management (HRM) Process

Figure 4 introduces the key components of an organization's Human Resource Management (HRM) process. It consists of eight steps that, if properly, efficiently and effectively done, will staff an organization with competent, high – performing employees who are capable of sustaining their performance level over the long term (Robbins and Coulter, 1996).

Notice in Figure 4 that the entire HRM process is influenced by the external environment which put constraints on management. These constraints are probably most severe in the management of HR. Although, governmental regulations have significantly helped to reduce discrimination, unfair employment practices, and unsafe workplaces in organizations, they have at the same time, also reduced management's discretion over human decisions.

There are several contemporary human resource issues facing today's managers. These include managing workforce diversity, sexual harassment, family concerns, AIDS in the workplace and downsizing. Managers must be fully conversant with these issues to manage the HR effectively.

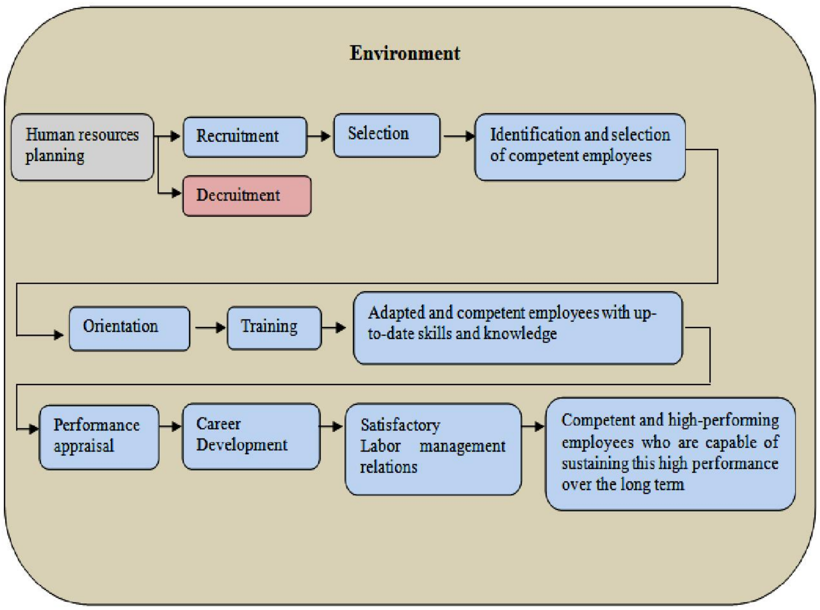

Figure 4: The Human Resource Management (HRM) Process

7.2 Teamwork – The Basis of Successful Implementation of TQM Philosophy

These are formal groups, made up of interdependent individuals, responsible for attaining a goal. Thus all; work teams are groups, but only formal groups can be work teams. Each has their own unique traits.

7.3 Types of Teams

Although there are many ways to categorize teams, one convenient way is to look at teams in terms of four characteristics: their purpose, duration, membership, and structure. Teams can vary in their purpose or goal. A team might be involved in product development, problem solving, as part of a re-engineering effort, or for any other number of work-related activities. The duration of a team tends to be either permanent or temporary. Teams may be classified as; Functional Department Teams, Temporary Teams include task forces, project teams, problem-solving teams, Short-term Team created to develop, analyze, or study a business or work-related issue, Self-directed or Self-managed Team and Cross Functional Teams.

Teams are used for the reasons summarized as follows (Robbins and Coulter, 1996):

- Creates Esprit de Corps
- Allows Management to Think Strategically
- Speeds Decisions
- Facilitates Workforce Diversity
- Increasing Performance

7.4 Developing and Managing Effective Teams

Effective teams have the following characteristics (Robbins and Coulter, 1996).

- Characteristics of Effective Teams
- To be effective, the team should have
- Clear Goals
- Relevant Skills
- Mutual Trust
- Unified Commitment
- Good Communication
- Negotiating Skills
- Appropriate Leadership
- Internal and External Support

Managers use the five basic management functions of planning, organizing, staffing, leading, and controlling to effectively manage the teams.

8. Protocols and Documentation: The Logics and Record Component of the SG&CISM

Protocols provide the logic (reasoning) for doing a work by a particular method and follow certain procedures /ways (sequence of events). Well written and followed protocols are essential for effective working and relationship to avoid confusion, conflict and delays. Managers are responsible for its formulation and implementation.

The main reason of documentation is that people come and goes, change jobs and may forget procedures and instructions. Documentation ensures that a record is maintained for continuity of a quality management system. The simple rule is that if all personnel involved in a given system were replaced, the new people could continue making products and providing services at the same quality level. The amount of documentation depends on the nature and complexity of a business (Khan, 2008). Documentation is the hard /soft book of record to be kept in safe custody of user. Updation and control is required. Well sort out archive contribute to the efficient and effective managerial working and function of the integral system model. Record is kept as evidence for specific times for traceability.

A hierarchical approach in documentation involves a few levels as evident from Quality Management System (QMS) standards documentation like, ISO 9000 standards (Khan, 2008).

- The Quality Management System Manual – presents an overview of the QMS being practiced in a company. It include quality policy, objective, Organogram, quality plan, corrective and preventive actions and improvement clauses which are in use in an organization.
- The Quality Management System Procedures – these are operational procedures or methods as to how the operations are being performed. There are minimum essential procedures required by a system.
- The Quality Management System Instructions – it explains how the complex tasks are to be performed in a systematic manner to avoid any mistake in the execution. These are specific to a particular job.
- The Quality Management System Reference Material – these include drawings, specifications or customer properties (sample, material, product etc) which can help in quality production of products and services and used as reference.

9. Conclusion

To conclude with, it can be simply said that all the three major components; technology, HR and Protocol/documentation of an integral transformation system are important in itself, however technology has the advantages of leverage and catalytic effect over the others to give boost to the system performance. The sustainable growth and competitive position can be achieved efficiently and effectively, if all three components of the integral system model are strongly connected and working efficiently and effectively at their optimum performance level. TQM philosophy of CQI provides the motto for ever improvement of all these components and their processes. Periodic review / revision of these components for improvement is a must so that the system can sustain growth and lead to new competitive position in local as well international market to become world class.

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9/15/2012