



Re-engineering Pre-employment Check up System in Egypt

A Model for Health Care Service Improvement



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Index

Topic	Page
Background	3
Aim	4
The Re-engineering Model	4
Development of the Model	5
The reengineering process - Productivity Analysis	6
Structure	6
Process development	7
Outcome	8
Outcome Measurements - Measures and Tools	9
Outcome Findings - Customers' flow	9
Booking System	10
Auditing	11
Customers' Satisfaction	12
Workflow and Customer Cycle Time	13
Waiting Time	14
Staff Satisfaction	14
Cost	15
Conclusion	16
Photos before & After reengineering	17
References	18

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Background

Health care business activity is facing serious challenges to providing care that is of consistently high quality in a rapidly changing and uncertain environment (Aiken *et al.*, 2002), and is influenced by a variety of internal and external forces. Forces may include changes in reimbursement, a shortage or excess of labor, changes in the political landscape, the economy, and others (Edens, 2005). In fact, the heightened cost pressure the healthcare industry has experienced has promoted radical organizational change (Walston and Bogue, 1999). Managers must be cognizant of the environment in which they function in order to anticipate and recognize the need for change and for facilities to remain viable entities (Edens, 2005). No business can be stagnant and expect to survive. An ongoing transformation process is the norm, and when business does not evolve with the environment, failure results. Workplace reengineering is one of the responses to internal and external factors exerting influences on the organization, particularly in this dynamic healthcare environment (Edens, 2005). Business process reengineering (BPR) began as a private sector technique to help organizations fundamentally rethink how they do their work in order to dramatically improve customer service, cut operational costs, and become world-class competitors (GAO/AIMD, 1997). Reengineering starts with a high-level assessment of the organization's mission, strategic goals, and customer needs (Wikipedia, 2010). Hammer and Champy (1994), the founders and leading proponents of reengineering, defined the process as the fundamental rethinking and radical redesign of process to achieve dramatic improvements in critical, contemporary measures of performance, such as cost, quality, service, and speed. Reengineering is the design of a completely new process, whereas variations on reengineering can deliver enhancement or improvement in an existing process or a response to an external stressor (Hammer & Champy, 1994).

The Ministry of Health in Egypt has initiated major reforms to substantially improve health outcomes and financial sustainability of Egypt's health care system. A key component of the reform is improving the provision of care at the Health Insurance Organization (HIO). The mission of the HIO is to become an effective health care services enterprise able to design, price, negotiate, contract, and pay for services covered under Egypt's social health insurance scheme and to ensure high-quality health care services for all Egyptians. For this mission to be accomplished, the HIO is working on service improvement in all its departments through different mechanisms including re-engineering. However, one of the key success factors for reengineering in health care organizations is the ability of health care leaders to redefine their organizations in terms of process (Prosci BPR, 2010) and in accordance with customers' needs.

One of the main services provided through the Egyptian HIO is the pre-employment medical fitness check up provided by specialized centers (known as medical committees). The general medical committees serve more than 2 million customers annually, through thirty four units distributed all over Egypt. The general committees include specialized subcommittees to provide the services, indicated by law, which are mainly pre-employment medical fitness check up, approving sick leaves for employees and assessment of partial and complete disabilities. The medical fitness subcommittees are responsible for pre-employment examination in both public & private sectors (labor law 12/2003, Act 216) and also for performing medical examination to employees before official travel.

Aim

The aim of this work was to develop a novel model for improving health services provided in Egypt. The model was intended to be applicable, effective and efficient.

Our main objective was to reengineer the pre-employment medical fitness check up system provided by the HIO in Egypt through an innovative model, and also to detect the impact of reengineering on:

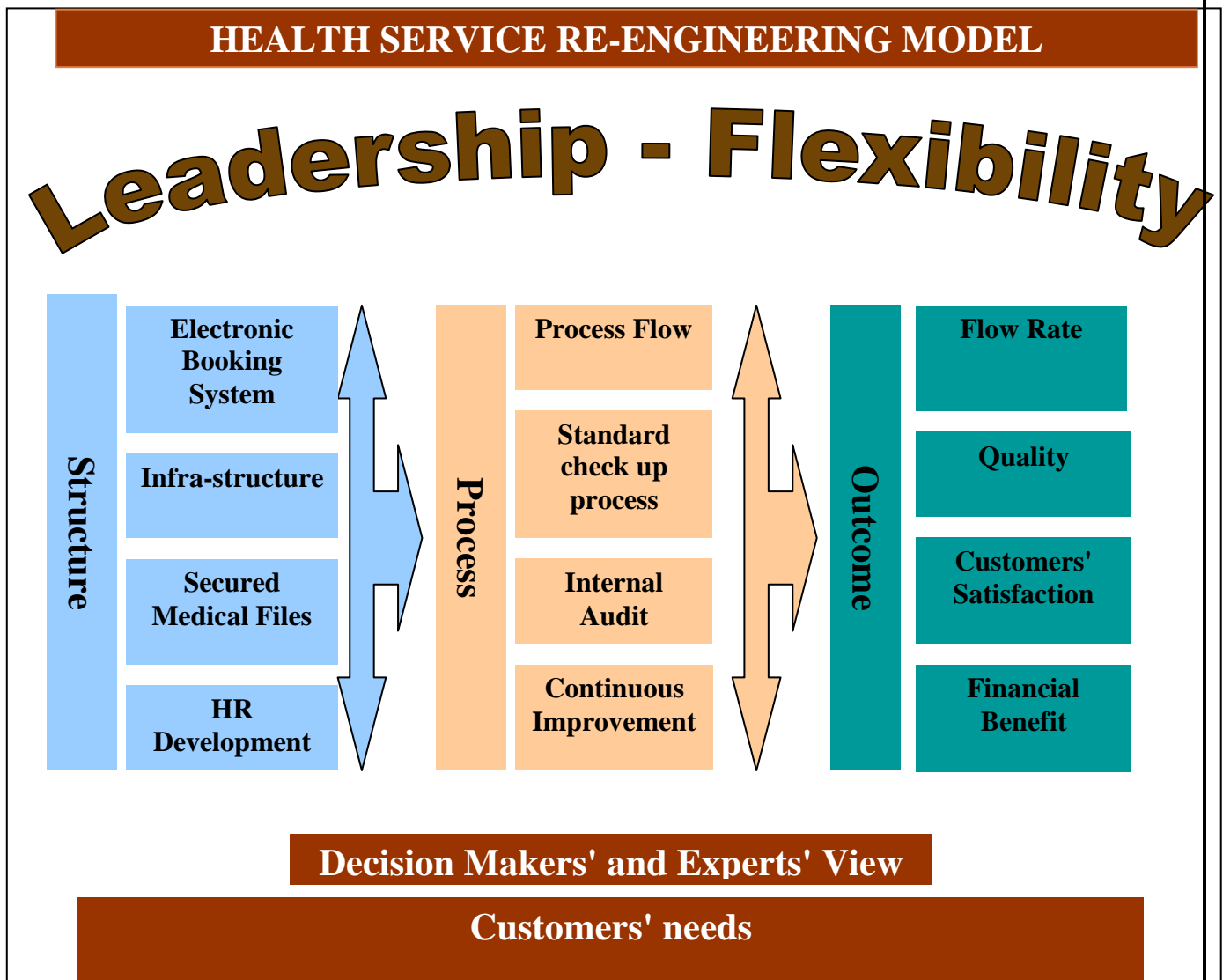
- a. customer compliance to booking system,
- b. service delivery time on site,
- c. appointment date,
- d. customer and staff satisfaction,
- e. financial outcome to the organization.

The Re-engineering Model

The model is based on six main components (Fig. 1);

1. a customer-focused booking system,
2. a standardized check up process,
3. a protected medical report document,
4. advanced archiving through electronic enterprise content management system (ECM),
5. infrastructure development, and
6. capacity building of staff.

Figure 1: Health service reengineering model



Development of the Model

Healthcare organizations have often participated in managerial innovations that have promised to revolutionize their operations. Rational choice theorists would predict that well-designed strategic changes can lead to significant organizational improvements and, thus, increased ability to compete and thrive. According to this perspective, firms change deliberately in an effort to improve their economic performance (Walston and Bogue, 1999).

HIO medical committees in Egypt, being established since 1976, were not exposed to changing the underlying processes and were not on the right way to achieving the desired impact. As part of a new strategic planning process, a review of how well the organization systems were supporting the strategic direction of the organization was launched. The review revealed that the old organization systems were in great need for radical transformation programs that involve the input, processes as well as the outcome. The following defects were the main driving forces that stimulated our change:

- The quality of services does not guarantee achievement of the HIO reform strategies.
- Customers' views were not seen as an essential pillar within the system.
- Time was not considered as important on the list of input.

- Technology, if ever used, tended to create problems rather than facilitating work processes.
- The concept of being centers of attraction, and hence improving income, seemed far from staff agenda.
- Defective staff training; both for the medical and managerial skills.
- Service providers were unhappy with the work environment and with the service achievements.

This work aims at development of a model for improving health services provided in Egypt, through reengineering the pre-employment medical fitness check up system provided by the HIO, based on five main components; an electronic booking system based on call center services, a standardized check up process, a protected medical report document, infrastructure development, and capacity building of staff. The model originates mainly from customers' needs and expectations that are tailored by experts and decision makers into priorities and intervention strategies. The model should be heavily supported by appropriate leadership and flexibility in application.

The reengineering process

Productivity Analysis

An initial productivity analysis was conducted as a first step to answer the following questions:

- Is the process or task necessary or not?
- Why are we doing what we are doing? And what are the objective and the outcome?
- Could we do it in a better way? And how?

To find answers, both quantitative and qualitative data were obtained as staff hours, patient load, patient satisfaction, staff satisfaction, and service outcomes. Brainstorming was conducted with stakeholders; decision makers, service providers and beneficiaries. Stakeholders' discussions were performed through six focus groups to discuss service defects and suggested ideas necessary to quantify what can be done to enhance productivity, define an action plan, and implement it.

The reengineering process was planned to be implemented into three phases to cover all the medical fitness committees. Phase 1 included 10 committees representing 30% of the total medical fitness committees working in Egypt, and serving 45% of the total medical committees' customers.

Our reengineering model adopts the system approach, hence focusing on all the three areas; structure, process and outcome. The model is based on customers' needs and expectations, obtained through focus group discussion, that were tailored by experts and decision makers into priorities and intervention strategies (Figure 1).

Structure

Structure was one of the first aspects of health quality to come under scrutiny. It is difficult to imagine effective health care in the absence of the essential infrastructure. Early quality improvement efforts focused on measuring the adequacy of the structural elements of health care available to clients in their communities. When absent, for example, in a country with an emerging economy, then monitoring structural variables is probably the most important means for “protecting and promoting the quality of care” (Stetcher, 2005). Since Avedis Donabedian, the pioneer in the field of health-care quality, has developed his basic framework health-care triad of structure, process and outcome (Donabedian, 1978), there is a robust evidence-base in the quality-improvement

literature on process and outcomes, structure has received considerably less attention (Meyer & Masagli, 2001). Donabedian believed strongly in the importance of healthcare structure, seeing it as a driving force for later care processes and ultimately for health outcomes. Glickman *et al.*, (2007) argued that Donabedian's commentary on structure focused on physical structure, facilities and provider qualifications, and most modern accreditation and quality organizations, such as the Joint Commission on Accreditation of Health-care Organizations have historically viewed the structure largely from this 'nuts and bolts' perspective.

In the current work, structure improvement include buildings renovation and repair, furniture and equipment replacement, establishment of maintenance system, establishment of computerized booking system and website, providing information resources, development of a manual including laws, regulations, policies and procedures and guidelines, development of a new medical examination form and customer service department, and HR development.

In a study aiming at identifying the most important components in primary health care that affect users' concern in Saudi Arabia, waiting area structure as well as environmental structure were two of the three influencing components. Environmental structure included building condition and design, furniture, equipment, cleanliness, technical facilities, staffing and working hours (Al Qatari & Haran, 1999).

It is not possible to find out which one of our interventions has the most powerful influence on improvement, it is rather the synergistic effect of every element in the reengineering process. However, Hammer and Champy (1994) argue that information technology is the key enabler for radical redesign and reorganization of an enterprise.

Development of the structure was mainly focused on the main infrastructure, thus started with renovation and repair of the buildings, furniture and equipment replacement and establishment of a maintenance system. Structure development extended to develop the information and communication systems where a computerized booking system was established based on customers' demands, a website for the committees was launched and all required communication and information resources were provided. Special emphasis was given to develop the medical fitness committees' manual that includes all laws, essential regulations, policies and procedures to facilitate service implementation and support decision making. A new medical examination form was developed, fulfilling standard criteria that ensure document security to be used only officially, ample space for recording of examination results and repeated visits as well as names and signature of doctors. Structure development also includes establishment of new services namely customer service department in each clinic. Human resources, being a cornerstone in organization development, were involved in the reengineering program through continuous training and development. Training involved the newly established information system (encoding system, computer skills, ECM). Necessary replacement for physicians (10%) has also taken place, based on better technical and personal criteria, and focusing on the deficient specialties; namely family medicine, psychiatry, radiology and clinical pathology. Staff selection has also changed where applicants have to pass both written examination to assess their medical knowledge, and personal interview.

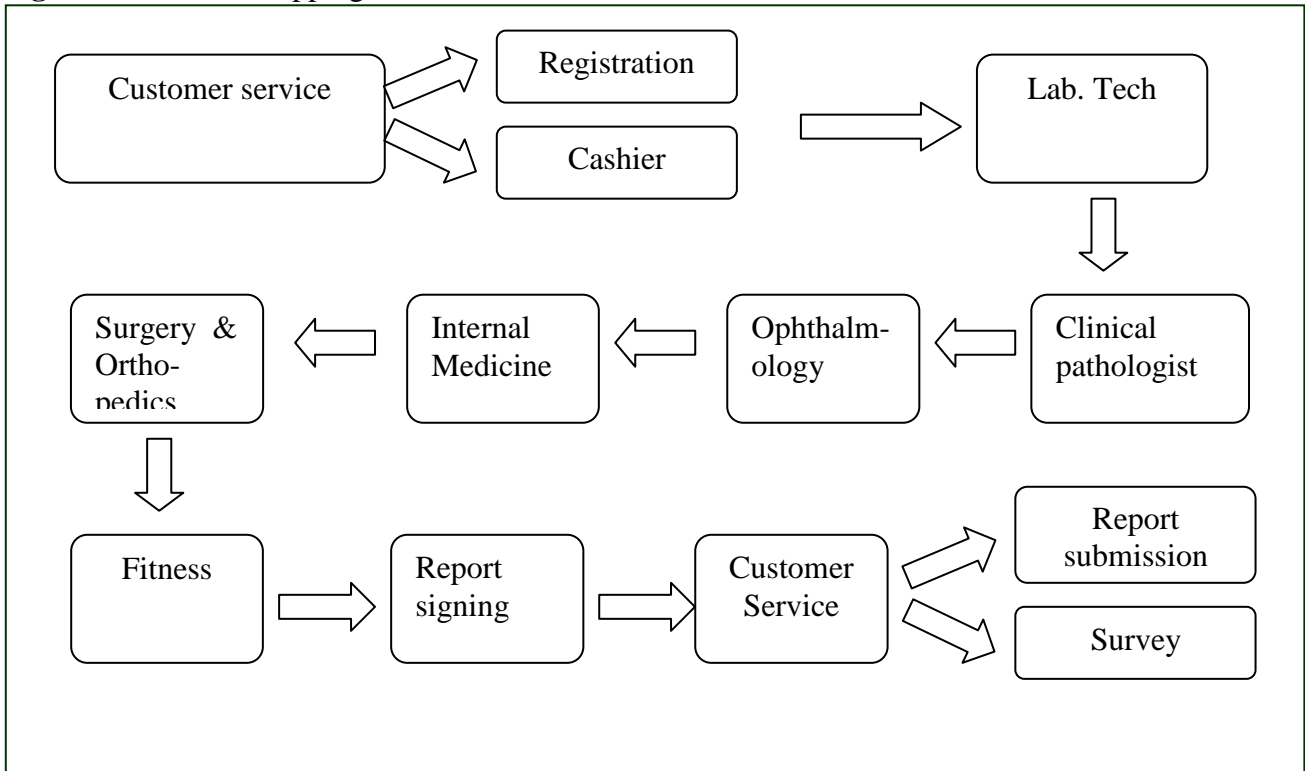
Process development

Process development includes upgrading and standardizing the medical check up process and putting the new services into action. The following interventions were accomplished:

- Operationalizing the customer service departments and the electronic booking system.
- Updating and standardize a customer-friendly process flow (Figure 2).
- Enforcing utilization of the new medical fitness committees' manual to standardize both the medical examination and the administrative procedures.

- Implementation of a new coding system for recording customers' data.
- Upgrading the monitoring system and development of a self audit mechanism for the clinics.

Figure 2: Process Mapping



Outcome

An agency has no way of knowing if the new process has produced the desired results unless it has meaningful performance measures. Good performance measures help to assess whether the process has actually achieved the intended results, examine services produced by the process and evaluate efficiency issues such as the cost of the process and the time it takes to deliver services to the customer. Ongoing performance measurement provides the feedback which is so critical for continual improvement and future successes (GAO/AIMD, 1997).

Performance measures of our reengineering model has been done through assessment of customer compliance to booking system, service delivery time on site and appointment date, internal audit, customer and staff satisfaction, as well as financial outcome to the organization. The model has considered the local context in terms of environment and overall health strategy in Egypt.

More concern has been driven to the service outcome in terms of:

- compliance to service standards and audit results,
- customer satisfaction and causes of dissatisfaction,
- staff satisfaction,
- staff training outcome,
- customers' flow rate,
- customers' compliance to booking, where compliance is defined as timely attendance or calling to cancel or modify appointment,
- customer cycle time,
- appointment date, and

- clinic income.

Outcome Measurements

Measures and Tools

Six centers were involved as reengineering targets, to be self compared to findings before the reengineering process.

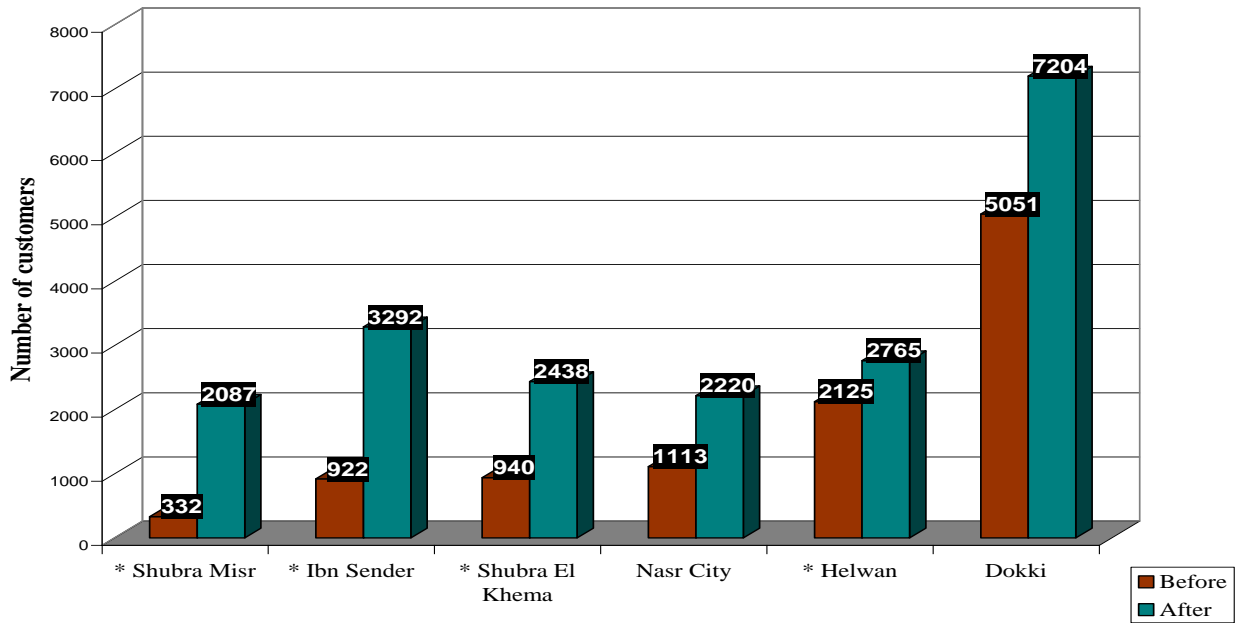
1. Records review for six months after the start of the reengineering process, and for the similar six months before reengineering, to detect customers' flow rates and trends.
2. Booking compliance was assessed for six months, to detect the rate and trend of non compliance, as well as the different variables that could be associated with non compliance.
3. Assessment of customer service time on site, and appointment date both before and after reengineering.
4. Assessment of customer satisfaction, before and after reengineering through a structured questionnaire that includes four parameters; service accessibility, staff communication, quality of medical services and housekeeping. Sample size for customer satisfaction was calculated to be 251 customers, considering a confidence level of 95%, a power of 90% and a minimum expected satisfaction of 50%. Customers were selected randomly from the six centers according to the relative frequency of customers' flow in each center. On the other hand, 63 control customers could be involved before the re-engineering process.
5. Assessment of staff satisfaction, before and after reengineering through a structured questionnaire carried out to inquire about staff view concerning process flow, administrative procedures, medical care, customers' crowdedness, housekeeping and financial benefits, as well as their insight regarding improvement after reengineering. One hundred and one staff members, representing 75% of the total staff in the six centers, participated, and 36 participated as controls. Doctors, nurses and administrative employees were involved.
6. Assessment of change in compliance to standards using a structured audit checklist that covers items related to the structure and process.

Outcome Findings

1. Customers' flow

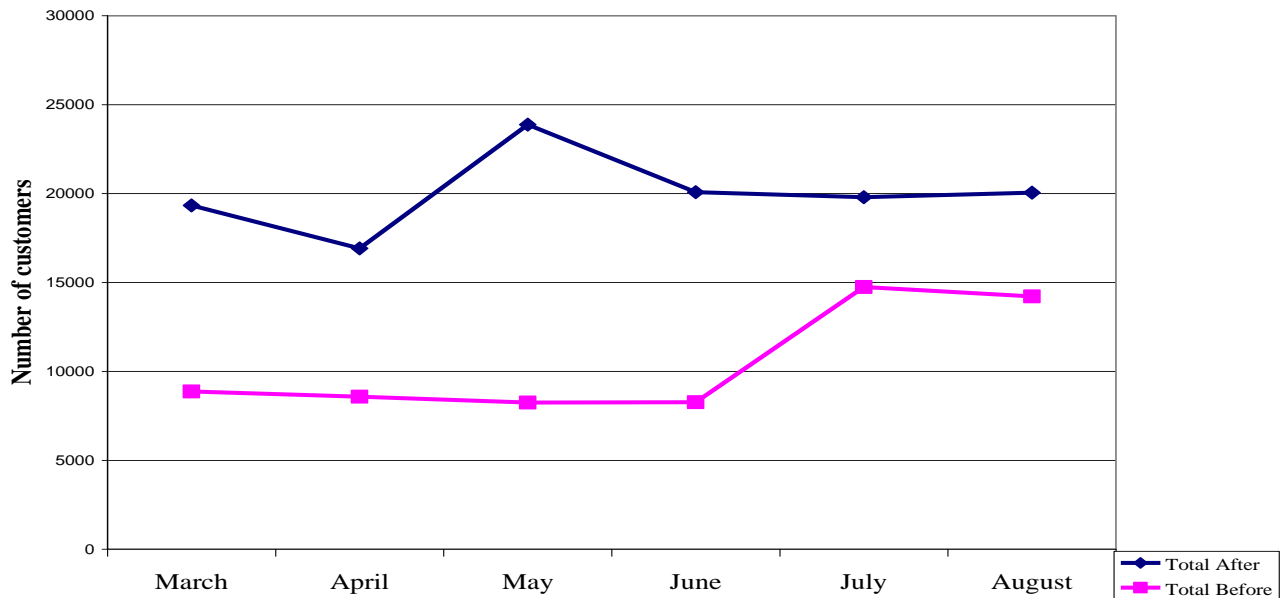
The mean monthly rate of customers' flow to the medical committees has significantly increased after re-engineering (3334.3 ± 1888.6 customers) compared to 1747.3 ± 1932.4 customers before reengineering ($P < 0.001$). Specifically four out of six committees have shown significant increase, as shown in figure 3. The six months-total post re-engineering customers' flow has exceeded five times that of the pre re-engineering in Shubra Misr, while Helwan Center showed the lowest percent change (30% increase) with an average percent change of 90.8% in the six centers.

Figure 3: Number of customers before and after reengineering



As regards customers' flow trend during the six months, figure 4 shows that increase in the rate of flow started slowly during the first three months, and then rapid increase appeared from the fourth month after re-engineering. There is a significant flow rise in the post reengineering curve in May (23873 customers). However, there is no apparent correlation between the flow trends before and after re-engineering.

Figure 4: Trend in customers' flow before and after reengineering



2. Booking System

In the pre reengineering phase, our centers with a monthly average of 1747.3 customers for each center, and working under traditional booking methods, were facing a challenge of work overload with a consequence of lowered service quality and unsatisfied customers and staff. Long clinic

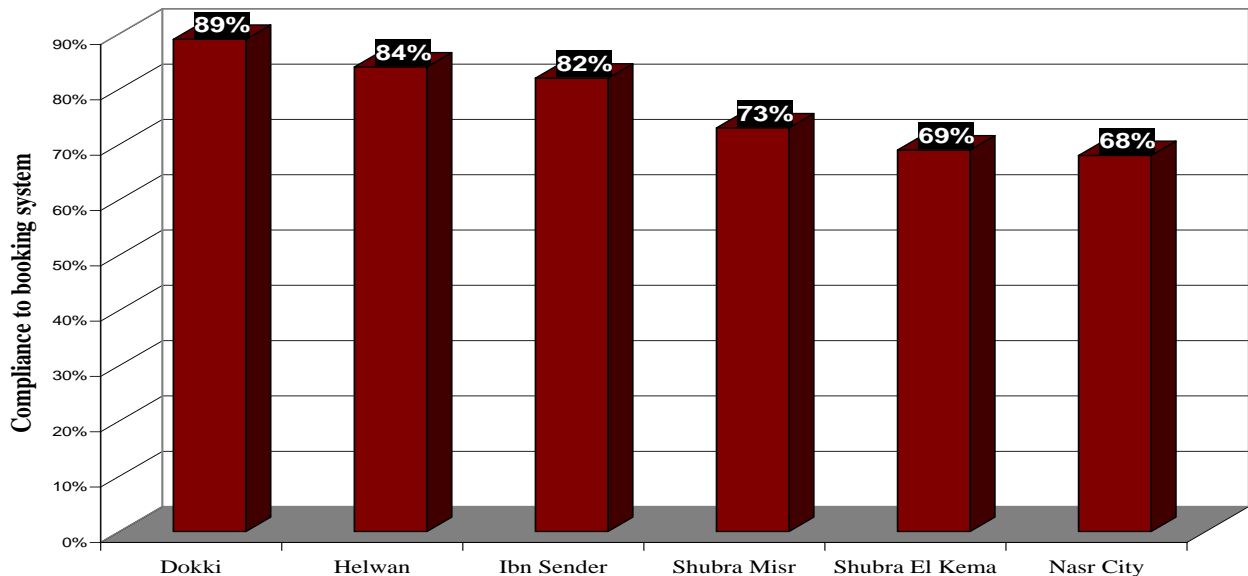
waiting time was a universal complaint by all customers. Since there has been an increased focus on making healthcare more patient-centered, in this context, a customers' booking system has been established in the early process of our reengineering to enable efficient scheduling of appointments, referrals and other patient activities with their implementation poised to support improved efficiencies.

Patient focused booking is a set of processes, procedures and principles to manage the waiting list through a dialogue with patients which introduces an element of choice about appointment dates; and a set of practices such as dedicated resources to provide a single and central point of contact for patients within the healthcare setting (NHS, 2005).

With the scheduling of appointments becoming an integral activity in re-engineered centers, the significant decline in customer cycle time and in appointment date delay after reengineering were evidenced as basic findings to the improvement process, with a very clear implication on the satisfaction of both staff and customers who showed a high rate of compliance to reservations.

Customers show good compliance to the newly established booking system, where the compliance rate ranges from 68% to 89% (see figure 5).

Figure 5: Customers' compliance to the booking system

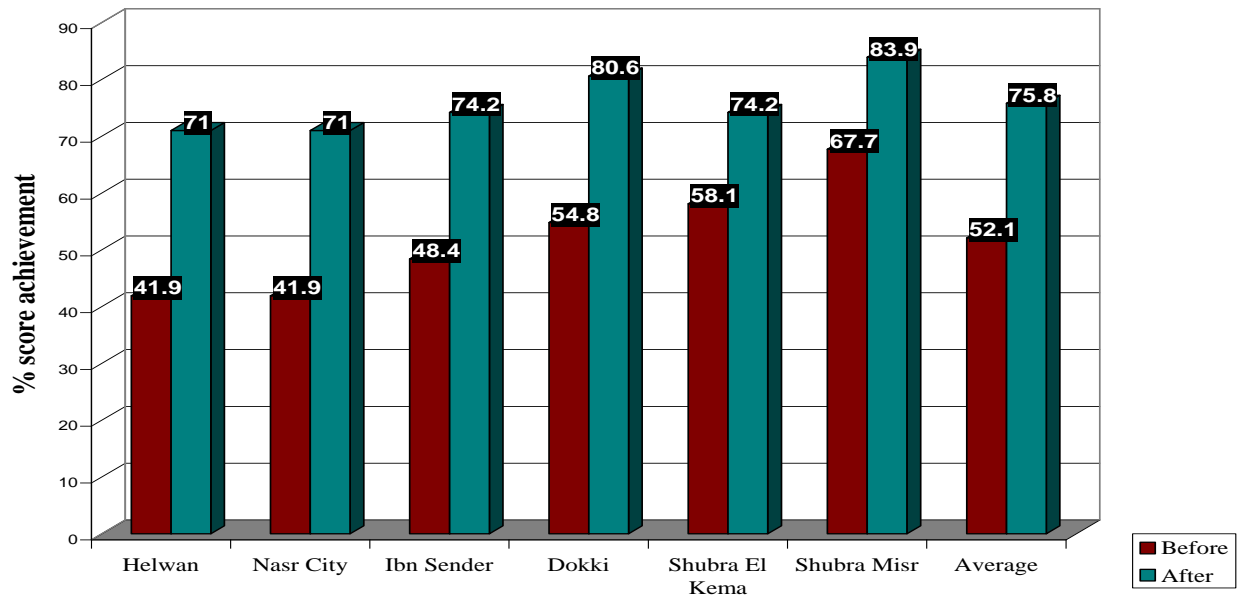


The majority of customers (84%) were satisfied with the reservation system. The 16% who were not satisfied attributed this to the long call waiting time (64% of dissatisfied customers), undocumented registration (20%) and delayed reservation schedule (16%).

3. Auditing

Internal auditing has shown marked improvement after re-engineering. The average compliance to standards increased from 52% before reengineering, for the six centers, to 75.8% after reengineering ($P < 0.001$). Percent change of compliance of individual centers to standards ranged between 24% and 69.5%, as shown in figure 6.

Figure 6: Internal audit score before and after reengineering



4. Customers' Satisfaction

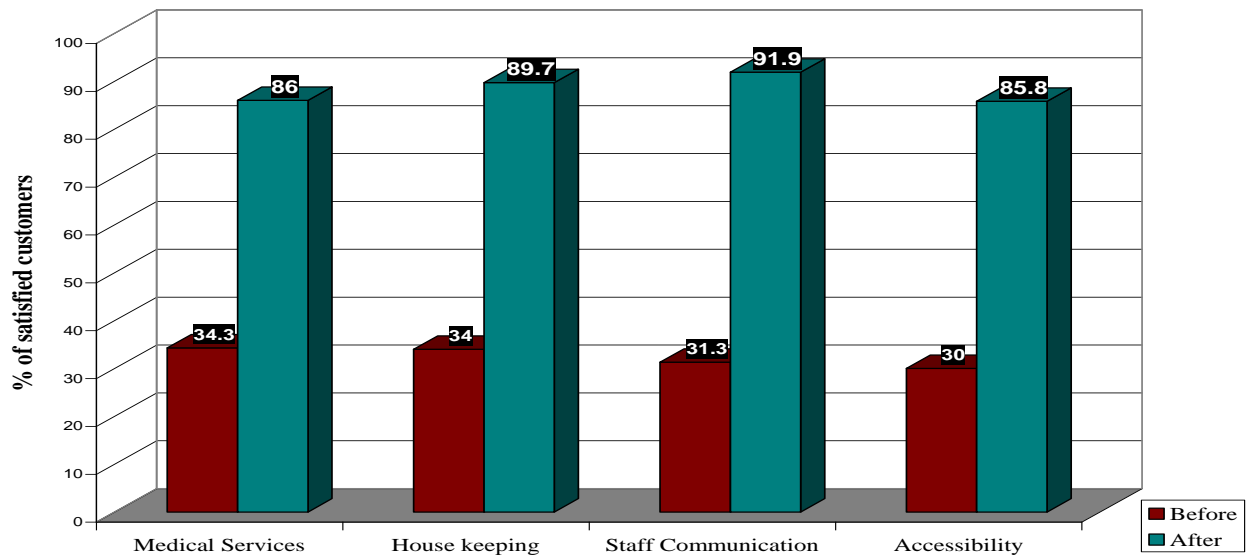
Practice success is linked to reengineering operations to offer consumers and patients greater choice, control, autonomy, and service. Patients and consumers want practices that deliver clinical and business services that meet the criteria of reliability, efficiency, service offerings, patient focus, enthusiasm, customization, and trust. They also want providers to avoid destructive and disruptive behaviors and conditions such as long waits, appointment delays, and staff rudeness. A successful patient-focused practice emerges when physicians and staff begin to look at the clinical and service experience through the patient's eyes (Aiken *et al.*, 2002).

In the current work, customers have shown significant improvement in their satisfaction to the services provided and the work environment. Customers' satisfaction significant improvement couldn't be attributed to a single factor but in fact is an implication of the overall re-engineering process. The significant shortening in patient cycle time could be one of the important causes for customers' satisfaction. Jiang and Giachetti (2008) argued that the patient cycle time is a major contributor to overall patient satisfaction. Not only was a significant improvement evidenced among external customers, but among internal customers (employees) as well.

In order for any relatively major changes in the working processes at public hospitals to be recommended, a number of organizational and human factors must be taken into consideration as aspects involved regardless of the methodological approach taken (Osorio Acosta & Paredes, 2001). Bengt (1999) reported that there is a strong correlation between job satisfaction and the weighted organizational focus score enhancement index, hence argued that staff perception should be used as an additional indicator of quality of care.

Customers' satisfaction has significantly improved after re-engineering concerning the four main parameters; medical services, house keeping, staff communication and accessibility (see figure 7), and in all the centers ($P < 0.001$).

Figure 7: Customers' satisfaction before and after re-engineering



5. Workflow and Customer Cycle Time

Business process reengineering (BPR) is the analysis and redesign of workflow within and between enterprises[I]. Service operations improvement through mapping service experience of customers offers an alternative orientation toward and an operational tool for service improvement that follow the customer-oriented management philosophy (Mitchell *et al.*, 1999). Without a clear understanding of the processes of care there is a risk of changing parts of a process which will not improve the service from the customer's perspective and will actually lead to more waits and delays for customers (Frost & Sullivan, 2006).

In order to capture customers' journey of care at every stage in our clinics, process mapping was developed to identify constraints, bottlenecks and unnecessary process steps. Understanding care processes from the customer's perspective is essential if customer-focused service improvements are to be made (NHS, 2005). Process mapping has also helped our staff to fully understand the whole service, hence modifications in the process flow came matching both customers' and staff expectations. Both technical and administrative steps were facilitated after implementing the modified process flow.

Danaher and Mattsson (1994) were among the first to look at customer cumulative satisfaction measurement, attempting to discover the service quality factors from the micro-customer processes. That work concludes that the result of the impact of different customer process stages on the overall customer satisfaction is of high managerial value for clarifying key (core) improvement orientation.

A significant improvement in the mean time spent per customer cycle after reengineering could be detected in table I, (mean time = 18.3 ± 5.5 minutes) compared to 48.8 ± 14.5 minutes before reengineering ($P < 0.001$).

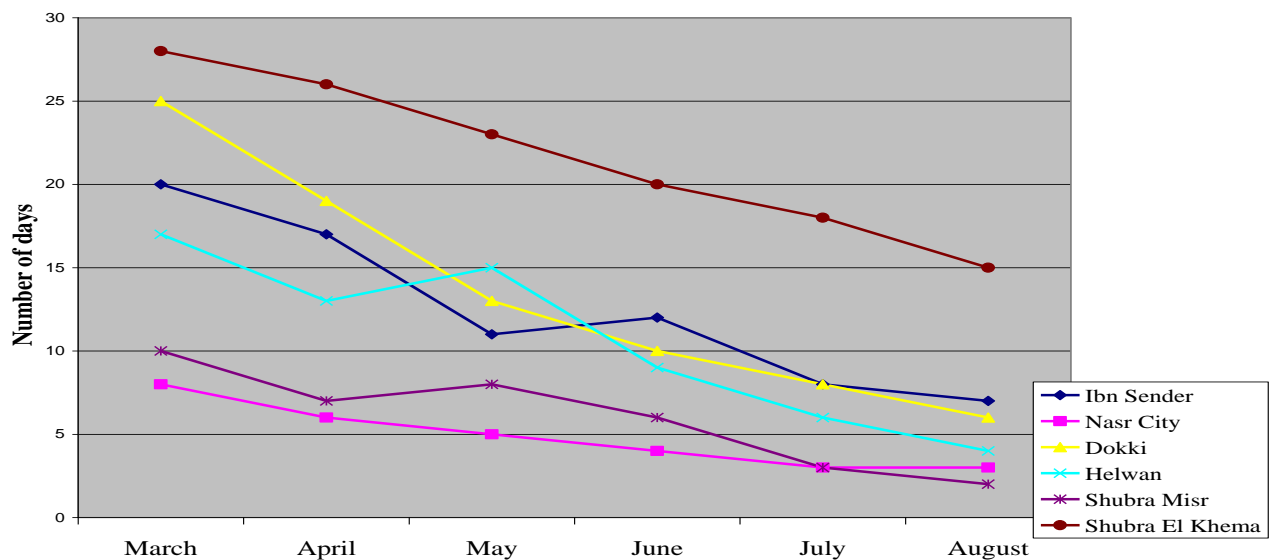
Table I: Mean time spent per customer cycle

	<i>N</i>	<i>Minimum</i>	<i>Maximum</i>	<i>Mean</i>	<i>Std. Deviation</i>
Before	63	30	80	48.8	14.5
After	212	15	30	18.3	5.5
t-test	24.79				
P	< 0.001				

6. Waiting Time

Reengineering process has also significantly improved the delay in appointment date; it decreases from 18 days in March to 6.2 days in August on the average for the six clinics (see figure 8).

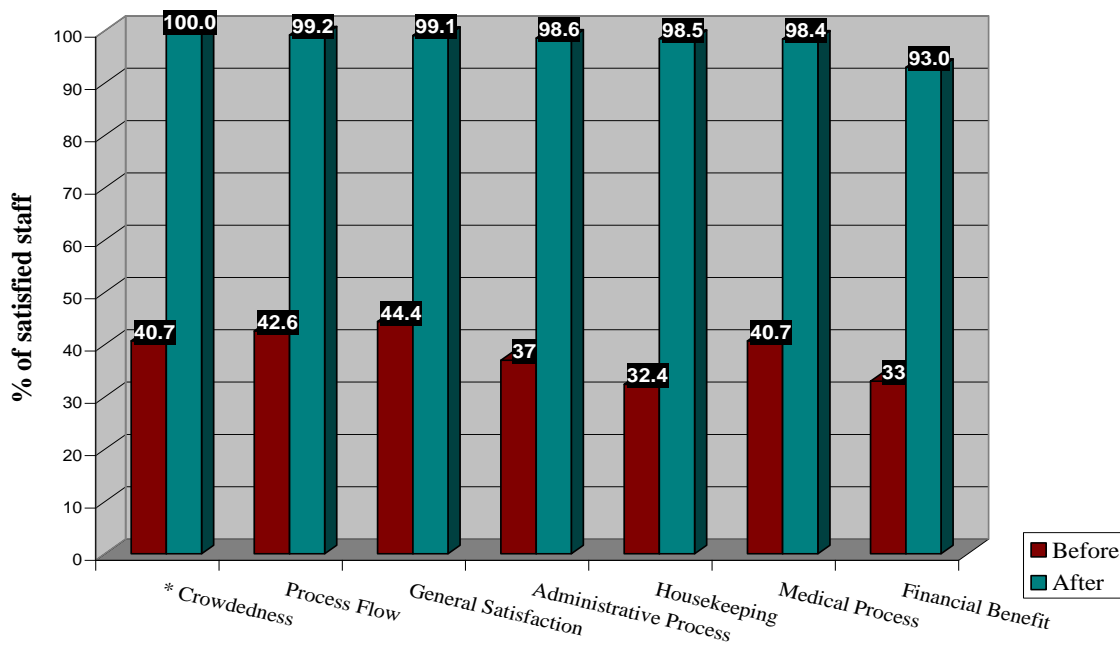
Figure 8: Trend in appointment dates in the six clinics



7. Staff Satisfaction

As shown in figure 9, staff satisfaction has significantly improved after re-engineering concerning their view towards process flow, administrative procedures, medical care, customers' crowdedness, housekeeping and financial benefits, as well as their insight regarding improvement after reengineering ($P < 0.001$).

Figure 9: Staff satisfaction before and after re-engineering



8. Cost

Probably the most influential internal force impacting facilities is lowered margins, as reimbursement has steadily declined over past years. Arguably, lowered reimbursement is external to the facility in most instances, but the use of dollars can be determined as an internal factor that must be managed (Edens, 2005). The role of the healthcare call center has become increasingly important in lowering healthcare costs, creating operating efficiency, and enhancing patient-provider communications (Frost & Sullivan, 2006). Reengineering has been predicted to improve the competitive position of an organization, yet in some situations, it may also result in "high costs with little return" (Hammer and Champy, 1994). Concerning our current experience the increase in income has covered the high costs of reengineering.

Concerning financial issues, expenses of reengineering, mainly spent for assets, training and running cost, was found to be covered by the increase in revenue. Worth mentioning that the monthly income was calculated to be increased by 84 % on the average in the six re-engineered clinics.








Conclusion

Health care business, though slow to catch in re-engineering strategies being a long, hard, and fraught service with possibilities for mistakes at every critical junction, still has a great potential for success provided the proper approach is being adopted. Our model for reengineering is based on customers' needs and expectations that are tailored by experts and decision makers into priorities and strategies for interventions. The model adopts the system approach focusing in the structure on information systems, supporting infrastructure and human resources development, while the process improvement is basically structured around standards and guidelines and focusing on improving process flow with a careful eye on continuous improvement and as a result outcome indicators are promising. Our model proves that the cost of re-engineering is exceeded by the increase in revenue that appears to be a secondary end product to customers' satisfaction. However application of this model necessitates appropriate leadership, and flexibility in implementation to fit with differences in context and environment. We strongly recommend health care organizations to implement this model for service improvement.

19806 Call Center



Examples before & After Reengineering

Before	After
 <p data-bbox="256 689 655 725">Fayoum Medical Committee</p>	 <p data-bbox="1070 689 1166 725">Now...</p>
 <p data-bbox="220 1115 692 1160">Fayoum Customer Service Before</p>	 <p data-bbox="783 1126 1465 1160">Customer Service at Fayoum Medical Committee</p>
 <p data-bbox="201 1451 711 1496">Damietta Medical Committee Before</p>	 <p data-bbox="879 1458 1369 1496">Damietta Medical Committee After</p>
 <p data-bbox="213 1742 703 1780">WC at Damietta Committee before</p>	 <p data-bbox="887 1742 1358 1780">WC at Damietta Committee After</p>

References

- Aiken, H., Clarke, S.P. and Sloane, D.M. (2002), " Hospital staffing, organization and quality of care: cross – national findings", *International Journal for Quality in Health Care*, Vol. 14 No.1, pp.5-13.
- Al Qatari, G. and Haran, D. (1999), "Determinants of users' satisfaction with primary health care settings and services in Saudi Arabia" *International Journal for Quality in Health Care*, Vol. 11 No. 6, pp. 523-531.
- Bengt, B.A. (1999), "Staff perception of the impact of health care transformation on quality of care", *International Journal for Quality in Health Care*, Vol. 11 No. 4, pp. 345–351.
- Danaher, P.J. and Mattsson, J. (1994), "Cumulative encounter satisfaction in the hotel conference process". *International Journal of Service Industry Management*, Vol. 5 No.4, pp. 69-80.
- Donabedian ,A. (1978), "The quality of medical care", *Science*, Vol. 200, No. 4344, pp. 856–864.
- Edens, P.S. (2005), "Workplace reengineering, reorganization, and redesign from nursing management: principles and practice", *Medscape Critical Care*, Vol. 6 No. 2.
- Frost & Sullivan (2006), "Promise of Enhanced Efficiency and Better Integrated Care to Boost Patient E-Booking Systems Markets", available at: <http://www.healthcare.frost.com> (accessed 22 January 2010).
- GAO/AIMD (1997), "Business Process Reengineering Assessment Guide". United States General Accounting Office, available at: <http://www.gao.gov/special.pubs/bprag/bprag.pdf> (accessed 18 December 2009).
- Glickman, S.W., Christopher, G. K., Eric, D.P. and Kevin, A.S. (2007), "Promoting quality: the health-care organization from a management perspective", *International Journal for Quality in Health Care*, Vol. 19 No. 6, pp. 341-348.

- Hammer, M. & Champy, J. (1994), "*Reengineering the corporation: A manifesto for business revolution*", HarperBusiness, New York.
- Jiang, L., Giachetti, R.E. (2008), "A queueing network model to analyze the impact of parallelization of care on patient cycle time", *Health Care Manag Sci.*, Vol.11 No. 3, pp. 248-61.
- Meyer, G.S., Masagli, M.P. (2001), "The forgotten component of the quality triad: can we still learn something from 'structure'?", *Jt Comm J Qual Improv*, Vol. 27, pp. 484–93.
- Mitchell, M., Tseng, M.Q. and Chuan, J.S (1999), "Mapping customers' service experience for operations improvement", *Business Process Management Journal*, Vol. 5 No. 1.
- NHS- Center for Change and Innovation (2005), "A guide to service improvement, measurements, analysis, techniques and solutions", The Scottish Executive.
- Osorio Acosta, J. and Paredes Alonso, E. (2001), "Process re-engineering in public hospitals: re-inventing of the wheel?", *Rev Esp Salud Publica*, Vol. 75 No. 3, pp.193-206.
- Prosci BPR Learning Center (2010), "Business process reengineering", available at: <http://www.prosci.com/reengineering.htm> (accessed 2 February 2010).
- Stetcher, B. (2005), "An educator looks at the quality improvement in healthcare", working paper, RAND education.
- Walston, S.L., and Bogue, R.J. (1999), "The effects of reengineering: fad or competitive factor?", *Journal of Healthcare Management*, Vol. 44 No. 6, pp. 456-474.
- Wikipedia (2010), "Business Process Reengineering", available at: http://en.wikipedia.org/wiki/Business_process_reengineering (accessed 5 January 2010).
- [I] Technology management strategies for the enterprise CIO (2009), "Business process reengineering" available at: http://searchcio.techtarget.com/sDefinition/0,,sid182_gci536451,00.html, (accessed 28 November 2009).