Analysis of the Impact of Technological Innovation on Healthcare Services

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Abstract

Technological innovation is generally recognized as an important driver of performance in major service sectors. This article argues that evidence of such a relationship is much more diffuse in healthcare services. Moreover, the concept of technological innovation in healthcare is very broad when new medical equipment, new pharmaceutical products, new forms of contact with patients and new work processes are considered. Therefore, this study contributes to the identification of technological innovation in healthcare. It also explores how to evaluate the impact of technological innovation in different sectors of the healthcare industry.

Keywords: healthcare services, technology innovation and performance.

Introduction

The importance of the healthcare service industry is increasing. Like other service industries, healthcare relies heavily on technological development. However, (Banta and Oortwijn ,2000) stated that "while health care has become increasingly effective during the last decades, evidence has gradually emerged of substantial ineffective technology, as well as overuse and inappropriate use of health technology".

If we try to analyses the impact of technology on some service industries, we will probably find a positive relationship between technology investments and several performance indicators, such as service quality. In terms of healthcare services, this relationship is difficult to establish, because their performance indicators are generally more difficult to establish (Yasin and Yavas, 1994).

Another aspect that could bring additional problems when attempting to relate technological innovation and organizational performance in healthcare services is the ownership of the organization. There are several types of ownership: private, public (government-owned) and mutual organizations (both profit and non-profit-oriented). Since these different ownership structures imply different models when assessing performance, healthcare services may vary significantly from one organization to the next.

This article identifies sources of technological innovation and their meaning in terms of healthcare services. It aims to establish a preliminary relationship between technological innovation and organizational performance. In Section 2, it discusses the concept of technological innovation and links it with healthcare. In Section 3, healthcare services will be characterized as complex and ambiguous, mainly due to the fact that human beings are their main object, which contributes to additional barriers to the customization of operations. Section 4 then analyses different types of health technologies. Finally, the article proposes directions for future empirical research that aims to study the relationship between technological innovation and performance, with particular focus on the ownership of healthcare providers.

Technology:

This has greatly impacted in the changes within the health care sector over the pastrvb10 years. In this case the improvements in the computer generation has been involved where the treated and the diagnosis of the various diseases are well managed by the use of the services (Clegg & Sparrow, 2007). Technology change has resulted to the increment in the remote diagnosis and the monitoring of divers links that can be attributed to the settings within the hospitals. It is evidence that there has been a tremendous saving of the life owing to the implementation of the computer technologies that are able to resuscitate the patients on the conditions.

On the other hand, there have been changes that have occurred as a result of the shifts of the hospitals that are acute to the primary care and other new recovery centers aspect that gave eases the delivery of the services to the patient who is in desire need of the stipulated medication and treatments. The introduction of primary care has offered easy access of the medical services to the patients and the communities therefore reducing the overall gap that existed in the health care system where the patients had to be attended to on the existing hospitals that were intact.

The implementation of day surgery has also impact on the changes through the implementation of the minimal invasive techniques that are entirely making greater changes in the health care practices. This aspect involves the distribution of the various service to the specialized primary care professionals who intern relay the same services to the patients therefore making this services closer to the homes of the patients.

Impact on healthcare:

The resultant impact of technology has been felt tremendously in all the medical field this in essence has contribute to the cure of advanced diseases such as cancer through chemotherapy and the monitoring of the patients ongoing process with proper accuracy. The efficiency of the delivery of services in the health care system has greatly improved.

Technological innovation:

An innovation is more than just an invention. It relies particularly on new knowledge that will be developed on a technological basis. This development may be led by disruptive discoveries or incremental changes caused both by competitive pressure and customer needs. Ultimately, customer needs will support the future commercialization of new products, services or processes. Common sense tries to explain innovation using expressions such as a 'big idea' or 'great invention', which perhaps does not represent a large portion of innovations, such as the small ones that affect our lives every day. In other words, "some of the most famous inventions (…) were invented by men whose names are forgotten; the names which we associate with them are the entrepreneurs who brought them into commercial use" (Tidd et al., 2001).

Innovation may be seen as the development and initial commercialization of a new technology. In terms of diffusion, innovation is the application of readily available and transferable technologies. Nevertheless, diffusion also includes a process of continuing incremental change after the initial acquisition of a technology. Sometimes, diffusion bears some similarity to innovation, because incremental change may be seen as pure innovation.

In service industries, changes can come from different processes, kinds of knowledge, information technology and equipment, human resources, working methods or a combination of two or several sources. In any case, these changes must bring a significant degree of novelty both for consumers and sellers (Figure 1).

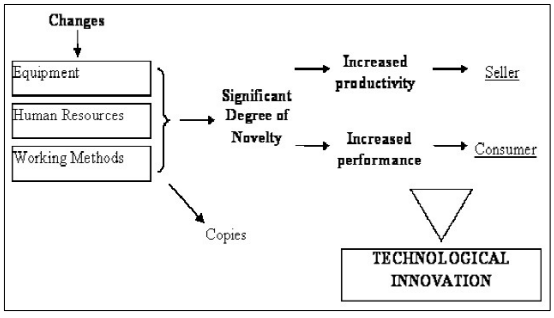


Figure 1: Technological innovation dynamics

(Porter ,1990) included improvements in technology and better working methods in the concept of innovation. He believed that innovations could be product changes, process changes, new approaches to marketing, or new forms of distribution. He also stated that "much innovation, in practice, is rather mundane and incremental rather than radical".

Technological development and innovation can also be seen from a network view. (Ford, 2002) stated that "these processes [invention and innovation] occur between firms and not solely within them". This perspective emphasizes that the role of networks within and around healthcare organizations is crucial in the innovation process.

Technological innovation in healthcare services, particularly the role of the internet and the development of clinical information systems, has a vast impact. It could be argued that we live in a period of major change dictated by the fact that "consumers of health care services are ahead of the profession in their embrace of electronic means of getting information" (Coddington et al., 2000). It is expected that processes in healthcare services will be recreated with great speed and impact, sometimes without any human touch.

(Jonsson et al.,2002) established their concept of technology when connected with healthcare as "broadly defined to include the drugs, devices, medical and surgical procedures used in health care, as well as measures for prevention and rehabilitation of disease, and the organizational and support systems in which health care is provided".

To conclude, technology will be a driver of change in healthcare services. It is expected that people will demand more achievements and a higher quality of life. Probably, technological innovation in different areas (e.g., the interface between healthcare providers and patients, life sciences such as biogenetics and genomics) will provide an answer to these demands.

Before discussing technological innovation in healthcare services, we will discuss the concept of healthcare services.

Healthcare services:

Defining healthcare services is not an easy task. The designation 'healthcare services' embraces a great variety of services such as nursing, pharmaceuticals, surgery, etc., establishing a large-scale mixture of services under this umbrella term. These and other healthcare services are identified in Figure 2. Some of them are relatively new, while others will lose their importance due to technological obsolescence.

As can be seen in Figure 2, one traditional way of classifying healthcare services comes from the simple idea of primary care and secondary care. The role of primary care is becoming more important, especially in terms of prevention, aid in the community and immediate help. Secondary care is much more connected with surgical centers and specialized clinical care, normally in hospitals.

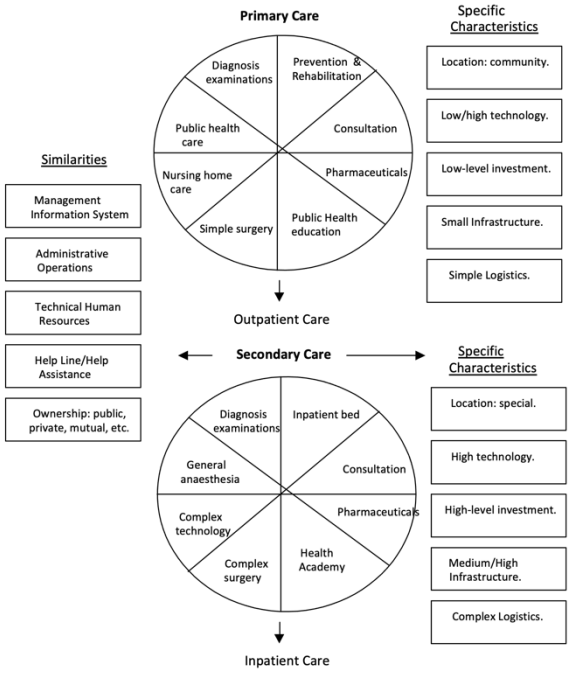
The distinction between core services and supplementary services is also crucial in defining healthcare services. For instance, (Lovelock et al.,1999) defined the core product of healthcare insurance as including a personal advisory team, a health information line and immediate access to private healthcare treatment. The supplementary services of healthcare insurance that they mentioned concerned the nature and extent of subscriber coverage, as different plans vary on such factors as inpatient and outpatient treatment, the use of private ambulances, home nursing, overseas medical care, psychiatric treatment, dental coverage and so forth.

In this view, healthcare providers are associated with several outsourcing suppliers or contractors of services such as laundries, food services and housekeeping. Nevertheless, in spite of their importance in terms of patients' perception of quality, these are supplementary services for core healthcare services. Thus, although they require a high level of control from the management of the healthcare provider, they are not core healthcare services.

The Baldrige National Quality Program (2002) defined healthcare services as "all services delivered by the organization that involve professional clinical/medical judgment, including those delivered to the community". This clearly demonstrates that the involvement of professional clinical/medical judgement in defining healthcare services is crucial.

Different approaches to healthcare services may emerge, depending on whether the provider is the government, a private company or a mutual, non-profit-making organization. As the Agency for Healthcare Research and Quality (2001, p.8) noted, "such judgments, which involve complex tradeoffs between public dollars and private ones, and between saving lives by improving patient safety versus doing so by investing in other health care or non-health care practices, will obviously be critical". Specifically, in healthcare, the quality of services can also be seen from the viewpoint of ownership.

Figure2: Healthcare service boundaries



A state-owned hospital possibly has a different concept of the quality of healthcare provided to patients than that of a private, a mutual or a religious hospital. These different views of the same concept could be the trigger to determine a different relationship between technological innovation and performance. Thus, it may be more difficult for a private hospital to invest in high-tech solutions without taking the necessary economic view than it is for a non-profit-making healthcare

organization, despite the fact that both have patient satisfaction as their main objective.

The adoption of new technologies in healthcare services is far from being made exclusively based on scientific evidence (Dennis et al., 2002). Based on four case studies, (argued that the decision to adopt new technologies is often based on nonlinear relationships within organizations, particularly the institutional and political forces involving interests, values and distribution of power within the organization.

Aiming to measure healthcare performance, (Leys, 2003) referred to three major activities: health technology assessment, evidence-based medicine and clinical practice guidelines. In a different view, (Harten et al., 2000) emphasized the extreme difficulty of evaluating and comparing different types of hospitals, particularly concerning the type of technology, the timing of the evaluation and the sociodynamic reality of the organization.

The evaluation of healthcare organizations is a complex subject as mentioned by (Yap et al., 2005), particularly because of the wide differentiation between existing types of healthcare organizations, such as hospital systems, hospitals, long-term facilities and national healthcare organizations. The study by these authors, concerning the evaluation of healthcare organizations in Canada, covered different types of indicators, such as system integration and change management, clinical utilization and outcomes, patient satisfaction and financial performance.

To conclude, the measurement of innovation and technology in healthcare services is an open and interesting research topic that deserves further investigation. In spite of its difficulty, it does not preclude the measurement of its key dimensions of processes and outputs (Smith, 2004).

Health Technologies:

The importance of health technologies in terms of healthcare effectiveness and costs is expressed by the European Commission's support for the creation of the EUR–ASSESS project. This project intends to establish a coordinated European policy for health technology assessment in order to accomplish the following objectives (Banta and Oortwijn, 2000):

to contribute to the effectiveness and efficiency of healthcare in Europe through improved technology-based health assessment

to contribute to the development of institutions for healthcare technology assessment in Europe

to strengthen the coordination of healthcare technology assessment in Europe

to contribute to the development of methods of information transfer between European countries

to guide the European Commission on how to strengthen and aid the coordination of technological health assessment activities in Europe.

According to the Office of Technology Assessment (1978), the evaluation of the benefits of each technology needs to be targeted to its specific focus. For example, concerning curative technology, the analysis of its effectiveness is related to the direct causal relationship to a positive patient outcome. Concerning diagnostic technology, it is necessary to evaluate its benefits at five different levels:

1. the technical capability of the device
2. the accuracy of the diagnoses
3. the potential impact of the device, which can even replace other existent procedures
4. the results of the device
5. the improvement of the health of the patient.

(Jonsson et al., 2002) pointed out that "health technology is an indispensable part of any nation's healthcare system", noting that "during the past 50 years, all member states that comprise the European Union have increased their technological base for health care, both in terms of knowledge and by investments in equipment, devices, and pharmaceuticals". Woolf and (Henshall, 2000) focused on costs, noting that "a major contributor to rising costs is the rapid emergence of new and expensive technologies (e.g., medical imaging, gene testing and therapy, and new drugs)".

One important development in health technology within the European Union was the creation of the European Collaboration for Health Technology Assessment/The European Collaboration for Assessment of Health Interventions and Technology in 2000. This broadly intends:

to disseminate information on health technology issues across European countries

to develop and promote best practices in technological assessments

to identify and share successful approaches to technological assessment and health indicators and the connection with healthcare decision making.

The Health Technology Assessment process is a policy research that intends to improve health and to the enhance effectiveness and efficiency of the technology (Banta, 2003).

(Hagenfeldt et al., 2002) expressed the need for a technology-based health assessment network organization:

"the development and diffusion of new pharmaceuticals, diagnostics, clinical procedures, and medical equipment are advancing at an accelerating speed. The supply of fragmented scientific information about medical innovations, and increasing public awareness of that subject, puts pressure on policy makers and health planning systems, especially where restrictions on healthcare funding are in place."

Having started to explain the importance of health technologies, it is now important to develop an appropriate approach to each health technology, because there are many different technologies (e.g., drugs, devices, clinical databases, diagnosis equipment and preventive self-care equipment). We will now turn to an analysis of medical technologies, prevention and rehabilitation technologies, and technological systems for organizations and their support.

Medical technologies:

Medical technologies are probably one of the most innovative areas of healthcare services. They are also the most representative in terms of increased costs (Herzlinger, 1997). In contrast to other industries, innovation technology in healthcare services is not about reducing relative costs or increasing revenues more than costs. As mentioned above, medical devices, drugs or pharmaceuticals, as well as the procedures used in medical and surgical operations, can be included in the category of medical technologies.

According to (Siebert et al., 2002), European Directive 93/42/EEC defines a medical device as:

"any instrument, apparatus, appliance, material or other article, whether used alone or in combination, including the software necessary for its proper application intended by the manufacturer to be used for human beings for the purpose of: i) diagnosis, prevention, monitoring, treatment or alleviation of disease; ii) diagnosis, monitoring, treatment or alleviation of or compensation for an injury or handicap; iii) investigation, replacement or modification of the anatomy or of a physiological process; iv) control of conception, and which does not achieve its principal intended action in or on the human body by pharmacological, immunological or metabolic means, but which may be assisted in its functions by such means." (p.735)

Medical devices are the subject of constant incremental product innovation, which means their product life cycle is very short, from 18 to 24 months (Siebert et al., 2002).

The incremental improvement of medical devices brings a serious problem in evaluating the efficiency of constantly updated devices, because people who work with them must have a period of learning and training in order to make full use of their features and potential. Then, when the technical staff has learned enough to use the new medical device efficiently, the manufacturer launches a 'new' or improved version of that device, which means the 'older' device can be abandoned.

It is difficult for technical staff and patients to be constantly evaluating new devices and new technologies. Moreover, a manufacturer will use the first-step usage of new devices to make some adaptations and corrections according to the first

trials, which means that treatments – even for the same patient – will not have a constant 'output'.

The process of evaluating new devices is a complex one, because there are at least four different entities that decide on its efficiency and efficacy:

the government, which normally pays for the new technology

the technical staff who actively work with new technologies

the manufacturers, the main risk investors in the entire process and possibly the main financial beneficiary

the patients, who have a difficult dual position – first as the object of the new innovative product, secondly as the ultimate payer for the new technology (either as a taxpayer or as a customer who pays directly for the service).

(Siebert et al., 2002) concluded, "failure to reward innovative medical technologies will inhibit the further development of new life-enhancing and lifesaving technologies that patients need". This means that the authorities are always faced with a complex decision, because they need to combine medical effectiveness and benefits to patients with cost efficiency.

(Herzlinger,1997) described several types of new technologies that have brought enormous advantages to the patient, reducing pain and adding comfort. He assumed that "the key innovation came from a most unexpected source – the plastic industry", explaining that:

"plastics revolutionized surgery with small plastic rods that are inserted through catheters (tubes) into natural body cavities – such as the mouth, penis, vagina, and nose – or into small holes punched into the body. These rods are fiber-optic light sources that illuminate the surgical site for the miniature cameras (endoscopes) and small surgical instruments that are also inserted through catheters. When these lights and cameras reach the surgical site, the surgeon can spring into action, using small instruments to operate, while watching the image of the site on a screen."

(Coddington et al., 2000) are enthusiastic supporters of the use of new technologies in healthcare, establishing "technology as one of the two or three most important factors influencing health care costs and quality over the past two decades". They explained the idea through the experience of a physician: "these new technologies (computerized tomography scanning, magnetic resonance image and ultrasound) cut down on the need for explanatory surgeries and enable physicians to do a better diagnostic job", which suggests a better quality of life for the patient and possibly lower costs.

Nevertheless, the authors referred to pharmaceuticals as another high-level factor to impact on healthcare, mentioning the case of a doctor of internal medicine: "The most important development in medicine in his years of practice – thirty-five years – has been effective drugs for treating hypertension." In terms of their significant impact on healthcare costs, they see pharmaceuticals in the same way as medical devices.

Several observers mention the major innovations in genetics and biotechnology. For instance, (Lemonick ,1999) reported that gene therapy and gene-based drugs are two ways we could benefit from our growing mastery of genetic science. However, there will be others as well, including new kinds of vaccines, new sources of transplant tissue, even techniques that doctors may someday use to stave off the ageing process.

A report by the Boston Consulting Group (1999), cited by (Coddington et al., 2000), revealed that "drug products reaching the market today often experience only 50% to 80% average efficacy, and experts estimate that as many as 20% to 50% of prescriptions written today are either ineffective or only marginally effective for the person taking the drug". This opens the door to new research. According to (Egger,1999), genomics could help eliminate the estimated 20% to 50% of ineffective prescriptions.

(Coddington et al.,2000) presented four different scenarios for future developments in healthcare services, placing a constant focus on two major change drivers: consumers and technologies.

According to the study, consumers will demand greater efficiency from health providers, while technologies will be a major source of radical or incremental change in improving the quality of life and life expectancy. They also noted that advances in medication and drugs may reduce the need for some types of surgery, such as open-heart surgery.

Another area that has undergone major technological development in the last decades is medical procedures. Laparoscopic surgery was one of the most revolutionary changes, particularly because of widespread use of the procedure and its immediate impact on quantitative figures. For instance, more than a half million laparoscopic gall-bladder operations had been performed in the USA (Coddington et al., 2000). The laparoscopic procedure also started being used in different parts of the human body with several surgical applications such as the thoracic, pediatric, gynecological, urological, orthopedic, plastic, and ear, nose and throat areas (Eubanks and Schafer, 1996).

New procedures made it possible to increase patients' quality of life and allowed a different usage of infrastructures. As explained by (Herzlinger ,1997) an increasing number of these out-of-the-hospital surgeries are conducted in doctors' offices.

Prevention and Rehabilitation:

Preventive care, in terms of eating less, not smoking and taking regular exercise, is part of public health education programs. These programs may be able to expand more through new means of communication such as electronic kiosks and the internet. Public and private healthcare services are investing more in new incentives to encourage the use of preventive care, mainly because early intervention is beneficial, bringing cost savings and a better quality of life. In many countries, it is now possible to have certain special medical devices at home to control some basic, but fundamental, information on self-care.

Another important technological issue is the availability of systems to manage available data on personal preventive care in order to acquire more up-to-date information and to store larger amounts of data. Nevertheless, the use of information systems in primary care, and particularly in prevention, is not so widespread (Coddington et al., 2000).

Increased life expectancy is creating generations of elderly people all over the world. This leads to new needs and new knowledge in the fields of prevention, self-care and self-diagnosis. People know that prevention is beneficial, but general medical expenses are increasing, leading patients to use their knowledge and some simple procedures and devices as the first step in creating a better quality of life.

The increasing power of patients is also introducing more variables to healthcare. People are demanding more information on health, a fact that offers new opportunities for the launch of new communication media.

Like prevention, rehabilitation is also part of primary care, even though it is closely connected with secondary care. Rehabilitation is also the subject of a high level of technological innovation, not only regarding medical equipment and devices (such as those related with orthopedics), but also in relation to some human functions such as listening and seeing, and even psychological aspects.

Organizational and Support Systems:

Companies operating information-based services are seeing the nature and scope of their businesses totally transformed by the advent of electronic delivery systems, including the internet (Lovelock et al., 1999). Information systems are vital for every healthcare service provider, not only because of general business requirements, but also because healthcare services are subject to intense external supervision from regulatory authorities, insurance companies, consumers and legal organizations, and from every type of media.

The information generated by organizational and support systems requires two types of reports. The first is regular business information such as patient numbers, a breakdown by type of the medical treatment received, a breakdown of costs by type of expenses (medical fees, drugs, medical equipment, etc.) and the level of patient satisfaction and/or dissatisfaction. The second type of report is

requested by external bodies, which could demand very wide-ranging and in part unexpected information. This category can include databases covering the history of every patient's object of assistance; records of all technical and nontechnical staff, in terms of professional and public liability; and usage of medical equipment, devices and drugs.

Conclusions

Analysis of technological innovations in different parts of the healthcare services industry reveals the real and significant impact of such innovations. Magnetic resonance imagers, laparoscopic surgery, selective painkillers, computerized axial tomography, complex information systems and the internet are some of the greatest recent technological innovations in the entire healthcare system, offering real added value for patients in terms of quality of life and life expectancy.

While some of the best-known technological innovations are related with inpatient care, we can also find dramatic innovations in outpatient care. The increased importance of prevention, self-care, self-diagnosis, rehabilitation and long-term care have been made possible because technological advances make knowledge available everywhere, and common people also have access to some devices in a very user-friendly way.

It may also be concluded that major research into medical technologies happens in inpatient care situations, particularly in terms of major investments in new medical devices and new medical procedures. Nevertheless, some of the most innovative technologies appear in outpatient care, where it is possible to mass market the innovative product or process.

Future research is required to evaluate the real impact of technological innovation on healthcare services. In particular, this must focus on the relationship between technological innovation and performance.

Research should also concentrate on one specific part of the healthcare system, examining organizations with similar types of ownership. For instance, it would be interesting to select exclusively private healthcare organizations with inpatient and outpatient care operations in order to avoid unreliable comparisons with state-owned institutions.

Such research could equally focus on technological innovations related to medical technologies. This area of healthcare services may be rather complex to evaluate, mostly due to the higher level of investment required and the high risk involved in new technologies. Medical technologies possibly represent one of the most challenging aspects of healthcare in terms of investment and in terms of the actors involved.

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په روغتیايې خدماتو کې د تکنالوجۍ د نوښت اغیزې او تحلیل

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لنډیز

تکنالوجي په عمومي توګه د خدماتو په لویو سکتورونو کې د اجراتو د یو مهم څخونکي په توګه یو تخنیکي نوښت پیژندل سوی. دا مقاله د تکنالوجۍ او روغتیايې خدماتو ترمنځ چې کومې اړیکې دي روښانه کوي. په روغتیايې برخه کې د ټکنالوجۍ د نوښت مفهوم ډیر پراخ دی کله چې نوي طبي وسایل، نوي د ودانۍ محصولات، د ناروغانو سره د اړیکو نوي بڼې او نوي کاري پروسې په پام کې ونیول سي. له همدې امله، دا څېړنه په روغتیايې برخه کې د تخنیکي نوښت په پیژندلو کې مرسته کوي. دا د روغتیايې صنعت په مختلفو برخو کې د تکنالوجي د نوښت اغیزې ارزوي.

کلیدي کلیمې: روغتیايې پاملرنه، تکنالوژي ابتکار او سرته رسونه.