ENHANCING IT INVESTMENTS PRODUCTIVITY: INTEGRATING NETWORK QOS AND IT INDIRECT COSTS

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Abstract

Increasing productivity is considered one of the major driving factors for a successful business. From an Information Technology (IT) infrastructure perspective, obtaining an optimised performance of resources is expected to improve productivity. From a technical viewpoint, the introduction of Quality of Service (QoS) models have been perceived to optimise the performance of the organisation network backbone. These models aim to provide an acceptable level of service assurance to the newly introduced applications and services such as voice and video. From a management viewpoint, the proper management of IT investments indirect costs can lead to a reduction of the overall cost portfolio. Consequently, both benefits and productivity increase are likely to be realised. This paper introduces network QoS strategy within the hierarchy of business infrastructure. In addition, it aims to identify the relationship between network QoS and IT indirect costs. Such integration demonstrates how network QoS strategy can be used to control IT indirect costs as well as enhancing network performance.

Keywords: Indirect costs, Productivity, Network QoS.

1 INFORMATION SYSTEMS INDIRECT COSTS

In order to secure a bigger share of the market, organizations tend to invest substantial sums of moneys on IT investments. Yet, the costs of IT infrastructure continues to fall (Hamm, 2004), exerting more pressure on organizations to find other areas of savings to lower down their total investments costs. Organizations are required to find new areas of cost reduction beside the direct costs related to hardware and software. An area of cost reduction with lots of potential is that of the indirect costs associated with IT investments, where the indirect costs can be sometimes up to four times greater than the direct costs (Hochstrasser, 1992). This area could yet prove to be more difficult than the earlier, since indirect costs are not well identified and understood by managers in practice (Bannister *et al.,* 1999). This is due to the fact that the costs associated with IT/IS projects appear more tangible in nature because the assumptions and dependencies on which they are based are often not fully acknowledged, or poorly understood by management (Ghoneim and Irani, 2003). An IT project is a multi-stakeholders investment whose effect goes beyond the boundaries of traditional capital investments. Furthermore, almost all IT projects use and share existing resources both technical and human, and this gives rise to the question of cost allocation. Hence, IT projects frequently disturb other activities and these disruptions push the organization’s total cost bill by generating a variety of indirect costs.

The literature is somewhat vague when it comes to prescribing a comprehensive review of hidden or indirect costs, possibly due to the previous lack of interest by practitioners during the cash-rich era of the 1990s (Love *et al.,* 2006). Lederer and Prasad (1995) however confirm the increased consideration of indirect cost factors by project champions in their broader evaluation of the success of IS. Such conclusion has continuously been re-emphasized in the recent literature, notably by Love, Irani, and Fulford (2003), Irani and Love (2002), and Irani (2002). Nonetheless there is a lack of conceptual model that enables the identification of IT infrastructure indirect cost and hence, little guidance is offered to managers as to how to identify such costs during IT investments appraisal. This is confirmed by Powell (1992), who states that there is a need for a mechanism to identify and allocate IS costs. Li *et al.,* (2000) suggest that firms may only realize the significance of these cost factors once they start to develop an IT infrastructure. The implications of ignoring 'indirect' costs can have far-reaching consequences for companies (Love *et al.,* 2006).

2 NETWORK QUALITY OF SERVICE (QOS)

Over the last two decades, the Internet infrastructure has evolved and changed dramatically. This evolution has moved the internet from academia to wide-spread commercial usage. The concept of Quality of Service (QoS) within IP networks was introduced in the late 90's. The need for providing a level of service assurance to the end users and businesses became necessary in order to fulfil their demands and the requirements of the various newly introduced internet based applications.

The International Telecommunications Union (ITU) has defined the term *"service"* in an IP environment as (ITU-T Recommendation Y.1241, 2001):

"*A service provided by the service plan to an end user and which utilizes the IP transfer capabilities and associated control and management functions, for delivery of the user information specified by the service level agreements*".

While the term *"quality"* is defined in (ISO 8402, 1994) as:

"The totality of characteristics of an entity that bear on its ability to satisfy stated and implied needs".

The concept of QoS has been developed in three different approaches; the general model, the ITU/ESTI and the Internet Engineering Task Force (IETF) approaches. For the general model (Hardy W.C, 2001), it defines three different levels of QoS; intrinsic, perceived, and assessed. The Intrinsic QoS can be achieved through the technical designs of the transport network and their terminations, In addition to the provisioning of the network accesses, terminations and the switched links. The second level is the perceived, which is a result of the actual use of the service at the time the user is experiencing the effect of an intrinsic service. Finally, the assured level defines a particular service for which the user determines the perception of the quality of service whether it is good enough to continue using it or not.

The ITU/ESTI approach, which is based on defining a perceived QoS rather than an intrinsic one, defines a network performance notion that covers those technical aspects of the QoS. It defines network performance parameters which are maintained through an appropriate network design, configuration, operation and maintenance (ETSI ETR003, 1994).

ITU and ETSI distinguish four particular definitions of QoS to cover the various points of views (ITU-T Recommendation E.800, 1993):

- QoS requirements of the customer
- QoS offered by the provider
- QoS achieved by the provider
- QoS perceived by the customer

Finally, the IETF approach which is based on the intrinsic QoS and does not pay attention to the perceived one, relies more on the internet architecture and its development, dependability, and effectiveness. The IETF has adapted a new definition for QoS as (Crawley E. *et al*., 1998):

"A set of service requirements to be met by the network while transporting a flow"

The IETF has produced some new protocols and mechanisms which are able to provide and obtain different levels of service guarantee for different applications depending on their tolerance. Multi Label Switching Protocol (MPLS) (Xiao X. *et al.,* 2000), Integrated Services (IntServ) (Branden R. *et al.,* 1994) and Differentiated Services (DiffServ) (Blake S. et al., 1998) are implemented over networks to provide a certain level of QoS. Also, the IETF has defined some new QoS parameters to obtain more comprehensive IP-QoS architectures such as traffic meters, packet markers, droppers, or schedulers.

3 NETWORK QOS STRATEGY BUSINESS INFRASTRUCTURE

The Increasing demands on Internet applications and services such as Voice over IP (VoIP) and Video on Demand (VoD) within the organisational business units have created the need to provide an acceptable level of service assurance for employees. For example, in a (Customer Relationship Management) CRM business unit, a low quality of VoIP phone call between a customer and an employee will lead to consuming more time for the employee to resolve the customer's issue. Though, organisations have overlapped such problem through over provisioning network resources, and this produced extra costs. For mangers, concerns about increasing productivity and reducing costs are the one of the major issues for a successful business. On the other hand, resources within the organisation's network infrastructure are always limited and scarce.

Hence, network QoS is introduced as an integrator between IT infrastructure and management. Network QoS strategy aims to improve the performance of the organisation IT infrastructure. Such improvement in return will be reflected on the organisation employee performance and therefore productivity is improved. Figure 1 demonstrates how network QoS strategy can be integrated within the organizational hierarchy (adapted from Love *et al.,* 2006). Here, network QoS strategy integration is laid between the IT operational infrastructure and the business management layers.

In terms of functionality, network QoS strategy procurement procedures are implemented to enhance and optimise the performance of the available network resources. Optimising the organisation network resources is to be assisted by technical managers who are in a direct contact with administrators and network engineers who are responsible for obtaining network functionality. Managers aim to determine the procurement procedures required to increase the efficiency of network resources. While for administrators and network engineers, they execute such procedures.

Figure 1. Integrating network QoS strategy within business information infrastructure system layers

4 DEFINING IT BUSINESS INFRASTRUCTURE INDIRECT COSTS WITH NETWORK QOS IMPLEMENTATION

The sound adoption of network QoS has a dual benefit effect reflected on both the administration, and the end users of the network infrastructure. The implementation of network QoS during IT infrastructure development is expected to result in a more efficient planning, purchase and running processes of the required network infrastructure equipment. This facilitates proper management of the network infrastructure since only the required equipment would be implemented while assuring the optimal level of network performance. This affects the efficiency of the network infrastructure which is shown in the optimization of the network usage, thus delivering the desired performance level with optimal service quality. End users become assured that the Service level agreement would reflect the actual level of service that they would receive, which helps building trust between IT administration and business units as well as enhancing their communication and collaboration in future projects.

4.1 Network QoS Indirect cost factors

A review of the different IT related cost taxonomies (Ghoneim *et al.*, 2003, Ghoneim and Irani, 2003, 2005) resulted in the identification of a non-exhaustive list of indirect costs. The IT related indirect costs identified during the normative literature review aimed at investigating the indirect costs and their effect on the successful adoption of IT infrastructure investments. These indirect costs are triggered by the introduction of an IT investment and are not easily identified nor quantified in monetary terms. Due to the limited space of this paper the authors will only present and discuss those indirect costs that are affected by the network QoS in an attempt to highlight the effect of the sound adoption of QoS on the management and control of the indirect costs associated with IT infrastructure investments Table 1 presents and describes the indirect costs that are affected by the sound implementation of network:

Cost Factor	Description
Employee motivation	Maintaining employee's motivation in computer aided tasks
Employee time	Time spent to explore the potential of the new system
Productivity loss	Developing and adapting to new systems' procedures and guidelines
Strains on resources	Maximizing the potential of the new system
Moral hazard	IS managers using their decision rights to maintain their own interest rather than meeting organizational objectives

Table 1. Network QoS indirect related costs

Table 1 presents a truncated list of IT indirect costs that are affected by the adoption of the network QoS strategy during IT infrastructure implementation. Most of these indirect costs are attributed to the managers and employees involved in the implementation and usage of an IT infrastructure. Network QoS strategy adoption helps negate the moral hazard cost; as the development process is bound to the specifications implied by the network QoS. Hence investment decisions cannot be in the interest of a specific group since QoS is the determinant of the type and quantity of hardware equipment needed. As the demand on the services provided by the IT increase, so does the strains on resources. Embracing network QoS strategy assures the same level of performance delivery, especially during peak time when other non-QoS network platforms fail to deliver. The network QoS positively affects the employee time as explained before in section 3 in the CRM example. This in turn is reflected in the increase of employee motivation to be more productive; as the network QoS enabled infrastructure helps them to perform their tasks effectively and efficiently. Consequently, productivity loss is reduced as employees' time is efficiently used; due to the availability, timeliness, and reliability of network resources.

4.2 Network QoS Strategy Functionality and Architecture

IT infrastructure comprises of three main entities namely: 1.Implementation & Adoption (input), 2.Management & Administration (process), and 3.Service Provision (output). The authors strongly suggest that the proper administration of network QoS strategy positively affects the output of each entity. As shown in Figure 2, network QoS strategy when considered during the adoption and implementation of IT infrastructure investments have its effect on the three entities of the IT infrastructure.

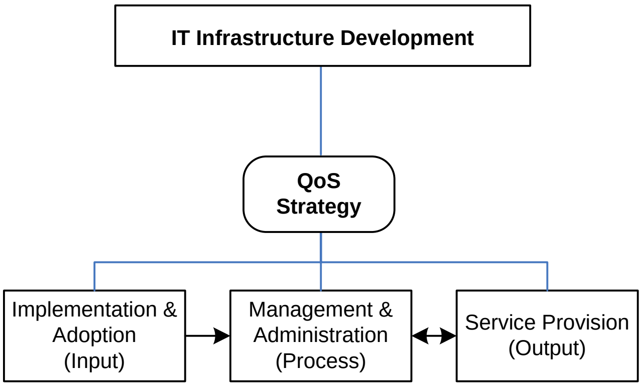

Figure 2. The effect of network QoS strategy on IT infrastructure development entities

Such designed procedure confirms that the adoption of network QoS strategy during implementation & adoption (input) leads to an enhanced service provision (output); which strongly suggests a sound management & administration entity (process). A case study on service approval ratios of Internet pricing models showing the effect of network QoS strategy on the service provision entity (output) presented in section 4.3.

The network QoS strategy when considered during the implementation and adoption of an IT infrastructure affects the type and quantity of hardware needed for the infrastructure. So, as the network QoS strategy would enable the identification of the required equipment at such stage, its consideration is primarily required to achieve the desired output of developed infrastructure. This in turn facilitates and enhances the management of the infrastructure; being optimized achieving the optimal performance at this point. As for the relationship between the administration and the users; users receive a reliable, timely, and predefined service. This is made possible by the network QoS strategy which ensures that the quality of the network service is not affected during peak time, as the network infrastructure is already designed to work efficiently and effectively thus providing an optimal and sustained level of service.

Table 2 maps the IT infrastructure components to each of the indirect cost factors presented in section 4.1 in an attempt to show the relation and effect of the proper conduct of the 3 entities on the sound management of the indirect costs. Hence, the adoption of network QoS strategy enhances each of the three entities. This enhancement is in turn is reflected on the sound management of IT related indirect costs.

	IT Infrastructure Development Entities		
Network QoS strategy indirect costs	**Implementation & Adoption**	**Management & Administration**	**Service Provision**
Employee time	√		√
Productivity loss	√	√	√
Strains on resources	√		√
Moral hazard	√	√	
Employee motivation		√	√

Table 2. Mapping Indirect Costs to IT Infrastructure Development Entities

4.3 Network QoS strategy Development Entities: Service Provision Case Study

In this section, a case study is introduced on service provision entity within IT infrastructure development model. The case study attempts to prove the enhancement and the feasibility of network QoS strategy implementation (with a focus on network QoS congestion pricing) within the architecture of a designed network through simulation.

During congestion, resources become more scarce and limited. The excessive usage of network resources leads to a substantial increase in service prices. The lack of network provisioning procedures and models result service requests rejected. Nevertheless, network QoS models implementation aims to achieve and improved system performance. Therefore, service approval ratio optimisation can be a significant factor in determining its efficiency and feasibility.

To illustrate, a comparison study on Internet pricing schemes is introduced. The study focuses on comparing service approval ratio optimisations between flat rate pricing (Anania L. and Solomon R. J., 1997), which does not provide QoS support and congestion-based QoS provisioned pricing scheme (El-Haddadeh R. *et al.*, 2006). Service approval optimisation studies the effect of the approval and denial of service requests on the overall system performance during congestion periods. This optimisation procedure will identify how the implementation of QoS models within the network infrastructure will help to organise such requests. In other words, it will verify whether network QoS will provide a better control on service requests in terms of the number of service requests.

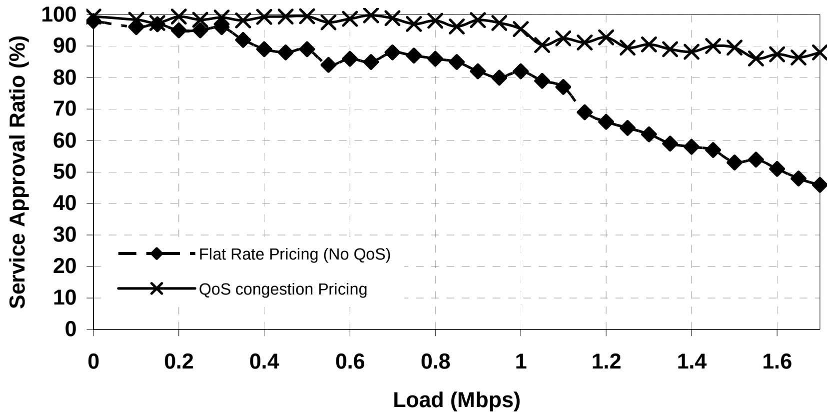

Figure 3 Service approval ratios performance for flat rate pricing and QoS congestion pricing schemes

In Figure3, service approval ratio optimisation analysis is presented for both Internet pricing models; flat rate and congestion-based QoS pricing schemes. In this graph it can be seen that congestion-based QoS provisioned pricing improves substantially system service optimisation compared to flat rate. Acting as a congestion control procedure, the pricing model prevents customers with smaller budgets gaining access to network resources. At the same time, it provides a better guarantee to customers' requests.

The case study results confirm the practicality of network QoS strategy as a mean to enhance service approval ratios within network pricing models. This in return refers to the optimisation of service provision entity within the IT infrastructure development. Consequently, management & administration entity is positively affected through the deduction of management procedures.

5 CONCLUSION

The work presented in this paper forms part of a continuous research investigating the relationship between network QoS and IT indirect costs. The adoption of the network QoS strategy has been introduced in order to provide guidance to mangers about how to enhance the development of a successful business infrastructure using network QoS. The paper positions network QoS strategy within business information infrastructure hierarchy. Also, network QoS related indirect cost factors have been identified. Furthermore, IT infrastructure development entities are identified and mapped to network QoS strategy indirect costs. Finally, a case study focusing on service provision entity is introduced in order to study the effect of QoS network implementation. The implemented simulation compares two different network pricing models from service approval ratios point of view. Obtained results confirm the practicality of network QoS strategy as a mean to enhance service approval ratios within network pricing models. It can be concluded that network QoS does not only improve the network hardware backbone resources, but at the same time it helps to improve the business management of the organization.

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