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PII: S2352-9148(17)30025-4
DOI: http://dx.doi.org/10.1016/j.imu.2017.03.003
Reference: IMU36

To appear in: *Informatics in Medicine Unlocked*

Received date: 10 January 2017
Revised date: 27 February 2017
Accepted date: 15 March 2017

Cite this article as: Priya Vedhanayagam, S. Subha and Balamurugan Balusamy Analysis of performance measures to handle Medical Ecommerce shopping cai abandonment in cloud, *Informatics in Medicine Unlockec* http://dx.doi.org/10.1016/j.imu.2017.03.003

Analysis of performance measures to handle Medical Ecommerce shopping cart abandonment in cloud

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Abstract

The E-commerce zone is crowded with many Internet users. Medical E-commerce has had significant growth in part because of a great deal of growth in the Indian E-commerce field. Medical E-commerce sites use cloud computing to guarantee a high quality of service anywhere and anytime in the world. For online access, the customer's expectations are very high. Medical E-commerce retailers are directed towards cloud service providers based on their quality of service. During online shopping, impatient customers may abandon a specific medical E-commerce shopping cart due to slow response. This is quite difficult to endure for a medical E-commerce firm. The research described herein observed the effect of shopping cart abandonment on medical E-commerce websites deployed in cloud computing. The impact of the idle virtual machine on customer impatience during medical E-commerce shopping was also studied. The ultimate aim of this study was to propose a stochastic queueing model and to yield results through probability generating functions. The results of the model may be highly useful for a medical E-commerce firm facing customer impatience, so as to design its service system to offer satisfactory quality of service.

Keywords: Cloud computing, Queueing, Virtual machine, E-commerce, Cart abandonment, Quality of Service.

1 Introduction

Compared to 2015, the current year has a growth of 6.8% in accessing the World Wide Web and about 47% of the world's population will be associated with the Web before the year end. A large portion of the world's populace will be online in 2018 and before that year is over, 3.82 billion individuals or 51.1% of the populace will utilize the web. World Wide Web clients will beat the present world populace, evaluated at 7.3 billion, within next five years [1].

As per the current statistical data, India is the second-largest country in Internet usage with more than 460 million Internet users, in which it has more than 50 million of online shoppers and it is predictable to be 320 million in 2020 [2]. Increase in the usage of Internet leads to an increase in the number of online shoppers. Internet users are currently more aware of the different worldwide design and latest patterns and more motivated to allow these patterns in their everyday life. Simple online access enables people to become more aware of every product in the market. With the perpetually developing E-trade market, all brands have effortlessly entered to their homes and are fulfilling their needs without being present in the physical marketplace. Gartner's states some remarkably modest figures in their report, Indian E-commerce market, which is currently clinched at Rs 78,000 crore ($13 billion) is all set to cross Rs 5, 40,000 crore ($90 billion) by 2019, an increase of 700% in 5 years [3]. E-commerce has impressed the lives of millions of people and this gigantic growth leads new business models to enter in online business.

In recent times Indian government has propelled technology driven projects and initiatives like digital India. The objective of the Indian government is to make use of the welfares of the latest technologies to provide several services to Indian population. Healthcare is one of the sectors that have been targeted by these projects. E-health, m-health and telemedicine are the various fields which require devoted technology framework which is weakening in India. According to this concern, Indian government established National E-Health Authority (NeHA) of India [4]. NeHA is the nodal authority that will be responsible for the growth of an incorporated Health Information System which collaborates with healthcare providers, consumers, healthcare technology industries and policymakers.

To adapt to this digital transformation, medical E-commerce is the next step for the health care industry in connecting the medical profession with consumers and patients. Medical E-commerce shopping website can confidently create a transformation in reaching patients and developing sales in the online marketplace. Medical E-commerce portal offers extraordinary benefits for senior citizens, disabled folks to order right from their homes and for the children who are away from home. Customers upload the prescriptions in their respective account of the medical E-commerce portal. The products are delivered based on authentic and prescribed medicines with genuine invoices. These websites offers different ways of payment like cash on delivery, through debit cards or credit cards, net banking and Paytm wallet. Figure 1 clearly depicts the business service model of a medical E-commerce portal.

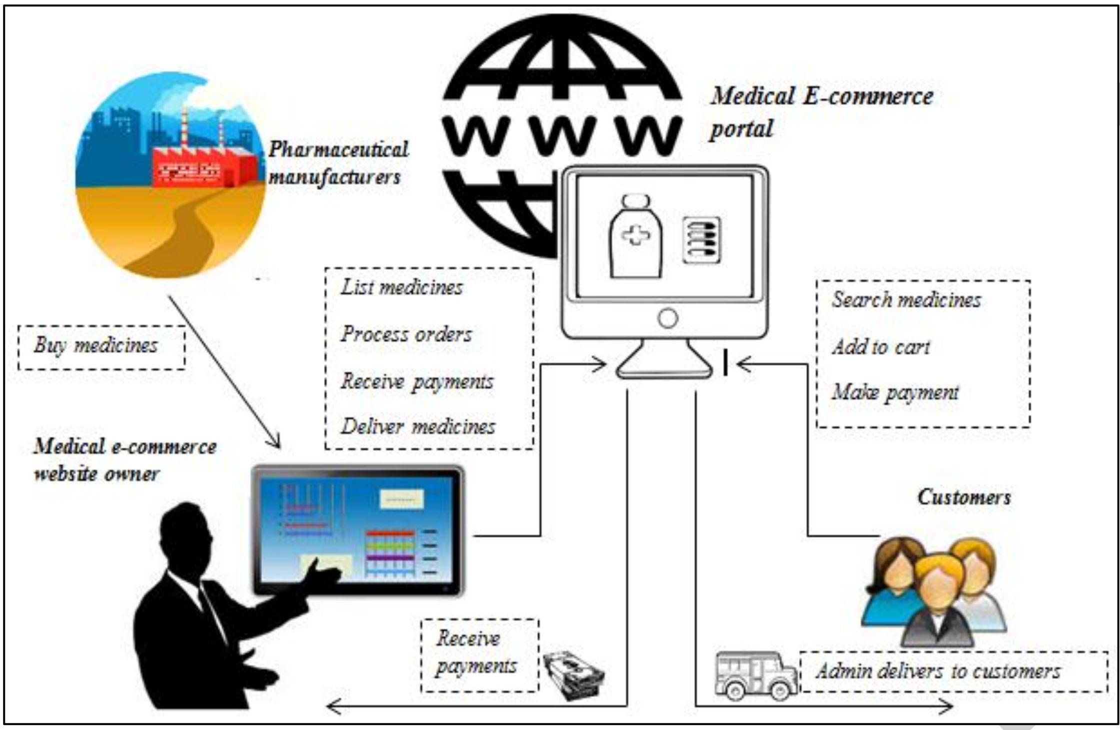


Figure 1– Business Service Model of Medical E-commerce portal

mCHEMIST.com, Netmeds.com, Merapharmacy.com, Medidart.com, Buydrug.in, Medplusmart.com and ApolloPharmacy.in are the few existing online pharmacies in India provide medicines, healthcare devices and surgical equipment's [5]. Indian government is in the progress of regulating India's Drugs and Cosmetics Act to modulate e-pharmacies in India. This will enable a benevolent environment for existing retailers and may also encourage more entrepreneurs to enter into medical E-commerce market place [6]. Medical E-commerce is one of the unexplored business models. It provides a unique opportunity for the entrepreneurs to hit into $30 billion industry, which is predictable to raise and become a $55 billion industry by the year 2020.

Cloud Computing benefits Medical E-commerce

Recent widespread survey research reveals that cloud computing can give great monetary benefits to the use of business endeavour E-commerce [7]. Cloud computing offers different cloud deployment models like public, private, hybrid and community cloud and offers leading services like Software as a Service (SaaS), Platform as a Service (PaaS) and Infrastructure as a Service (IaaS) [8]. Cloud computing is affecting the world quickly yet decidedly; every other week new dispatch with cloud innovation is approaching to privatize and this is never ceasing technology innovation. Generally E-commerce web sites frequently have tremendous fluctuations in their IT resource utilization, though rapid elasticity is a crucial characteristic of cloud computing. These attributes make the cloud a solid match for facilitating E-commerce sites [9].

In contemplation of withstanding the quality in E-commerce, large cloud service providers like Google [10], Amazon [11], IBM [12] and Microsoft [13] have their data centers over the world to assure reliability, scalability and offer flexibility of accessing the products and services at any place and any moment in the globe. The virtualization concept from the mainframe and the new multicore technology together allow multiple jobs to execute successfully on one physical host allowing autonomous configuration of operating systems, software, storage and memory on each single VM [14].

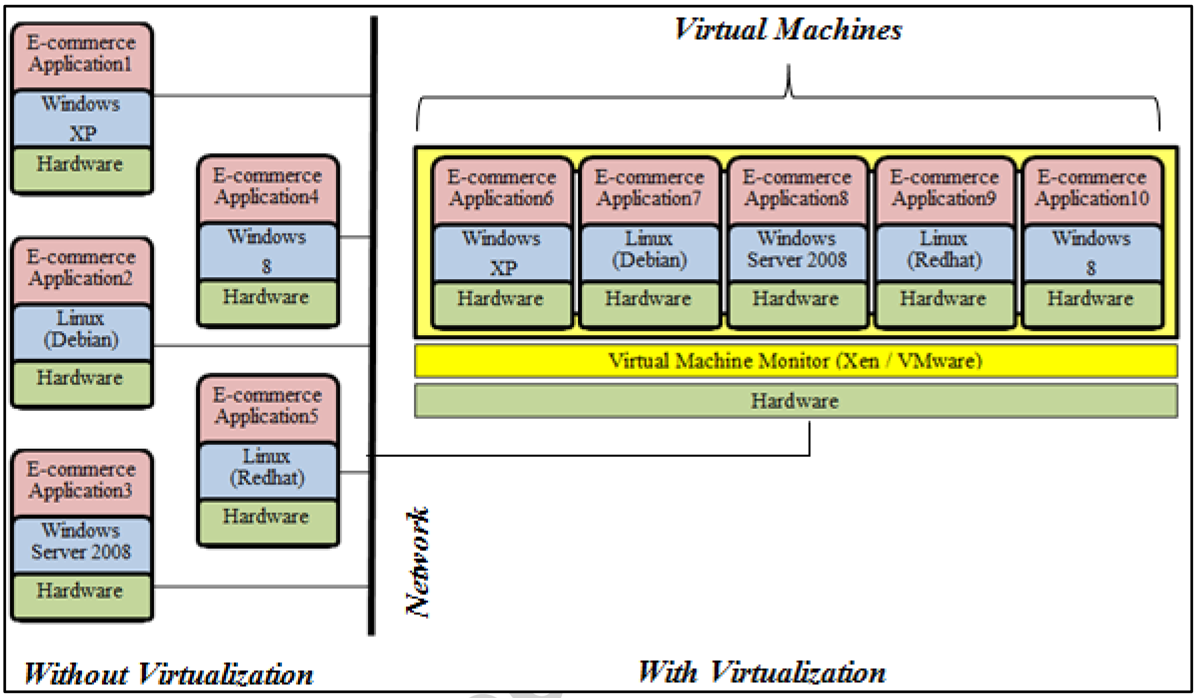


Figure 2– Different systems on a network with and without virtualization

Hypervisor or Virtual Machine Monitor (VMM) provides expected outcome same as the physical hardware. Multiple virtual machines may be installed on a solitary hardware but the VM is not reliant on the state of the physical hardware. Figure 2 illustrates running different operating systems on a single hardware on top of VMM and different operating systems without VMM [15]. Hence, virtualization lessens the entire cost of ownership and provides high performance and high availability.

Medical E-commerce owner can shift the organization to the cloud with minimal investment risk on a pay-as-you-go basis. For a medical E-commerce organization looking to expand into a new geographical regions or to test a medical E-commerce business model, cloud based medical E-commerce applications offer them flexibility, reliability and scalability at a nominal investment. Figure 3 depicts the overall model of the proposed cloud medical E-commerce architecture and it shows the internal and external administration of medical E-commerce cloud operations [16].

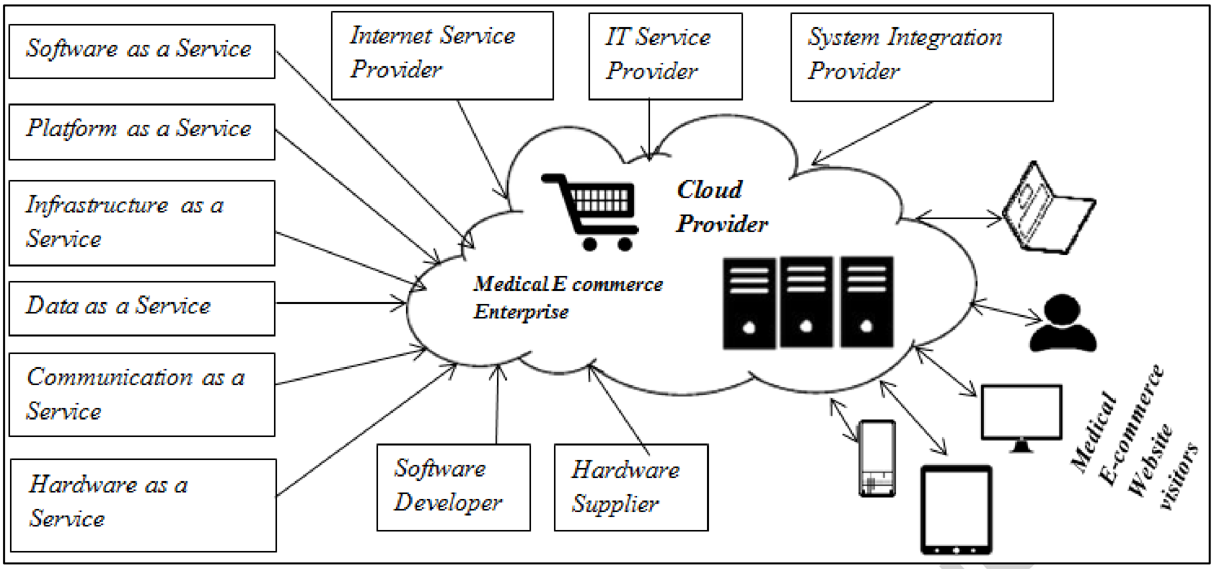


Figure 3– Service Model Architecture of E-commerce in Cloud

A Service Level Agreement (SLA) designs all parts of cloud organization practices and the responsibilities of both service providers and clients, including diverse descriptors in general mentioned as Quality of Service (QoS), which includes availability, throughput, reliability, and security [17]. Medical E-commerce retailer travels on the way to the cloud service provider only based on their QoS.

Impact of shopping cart abandonment in medical E-commerce portal

As per the significant study done by Baymard Institute, 68.81% of shopping carts are relinquished on the web [18] and this leads to the revenue loss, three times more than the online retailer's profit, that is approximately more than $18 billion a year [19]. The top reasons for cart abandonment were complicated web page navigation, product with unexpected cost, better price in other websites, too much time for processing, excessive security issues in payment and unsuitable delivery option. Even though there are many reasons for abandoning the cart which is not directly related to the response time, it is very clear that slow response time is really a major reason. According to Statistics, 20 to 25% of cart abandonment happens if the clients are being made to wait too much time to do the purchasing procedure [20].

Both consumers and patients have highest anticipations for quality health care. The ambitious nature of the medical E-commerce industry demands cost constraint and well-organized delivery of service. Collectively through technology development made the medical E-commerce shopping cart a vital tool for the evolution of business. Abandoning the medical E-commerce shopping cart before a sale is completed, which is the biggest problem that leads to a huge revenue loss for the medical E-commerce retailers. A small revolution in cart abandonment can mean big changes in revenue; if cart completion rate is increased by just 5% from 20% to 25% then it is guaranteed that there will be worthy increase in the revenue.

The rest of the paper is organized as follows: Section 2 briefly reviews the literature. Section 3 enlightens the proposed cloud medical E-commerce analytical model and its hypothesis. Section 4 delivers the steady state results in terms of probability generating function. Section 5 discusses the special situations of the proposed cloud medical E-commerce model. Section 6 presents the simulation results and graphs and Section 7 summarizes the results.

2 Literature review

Queueing models have successfully been used in real life situations like telecommunication systems, traffic systems, call centers, hospitals, computer programs, banks and in many more circumstances. To meet the current world's need, the basic queueing model extends to different perceptions like vacation queueing, correlated queueing, and retrial queueing, queueing with impatience and catastrophic queueing. Balking, Reneging and Jockeying are the three types of Customer impatience [21].

Many researchers' attention towards the Balking and reneging has considerably improved to study the behaviour of impatient customers. Daley [22] is the first researcher in this area of research and to cite a few researchers like Ancker and Gafarian [23], Altman and Yechiali [24], Choudhury and Medhi [25] followed his work and studied the queueing models in different aspects.

The server takes vacation for a period of time after a busy period. After every vacation the server observes the queue, if the system is empty, it stops and waits for a job to come. Or it can extend the vacation until the system is empty. After the vacation period the server resumes the service normally. To quote a few authors, Levy and Yechiali [26], Doshi [27], Ke [28] and Wang et al [29] have studied queues under different vacation policies.

In real life, there are many circumstances for the customers who are in high need of secondary service after a primary service. Madan [30] was the first researcher who introduced the idea of a second optional service and to mention a few, Medhi [31] Wang [32], Jain and Chauhan [33] studied queueing models with an optional service. Monita Baruah has done a substantial contribution in his research work towards the queueing model with Balking [34] [35] and Reneging [36] considering server breakdown, server vacation periods.

Reneging factor is studied in numerous applications but less for medical E-commerce applications. Queueing with customer impatience has exceptional importance for a medical E-commerce world as it has a very adverse consequence on the revenue generation of a medical E-commerce firm. In this research work, $M^{[X]}/G/1$ queueing model is considered and reneging is measured to study an impatient medical E-commerce client. The performances measures derived from the queueing model helps to study the effect of shopping cart abandonment in the medical E-commerce cloud application. As per our knowledge this is the honest work to study the customer impatience during medical E-commerce shopping.

3 Proposed model

The proposed model is designed specifically for the medical E-commerce application which utilizes the comprehensive benefits of cloud computing. Cloud Service Provider (CSP) delivers Infrastructure as a Service (IaaS) for the medical E-commerce application. CSP provides hardware, software, servers, storage and other infrastructure components in support of the medical E-commerce retailers. And it as well helps in maintenance, data backup and resiliency planning. Purchasing the medicines, listing the medicines, processing the orders, receiving the payments and delivering the medicines are the primary job for the medical E-commerce enterprise. Figure 4 shows the internal working model of a medical E-commerce application deployed in cloud.

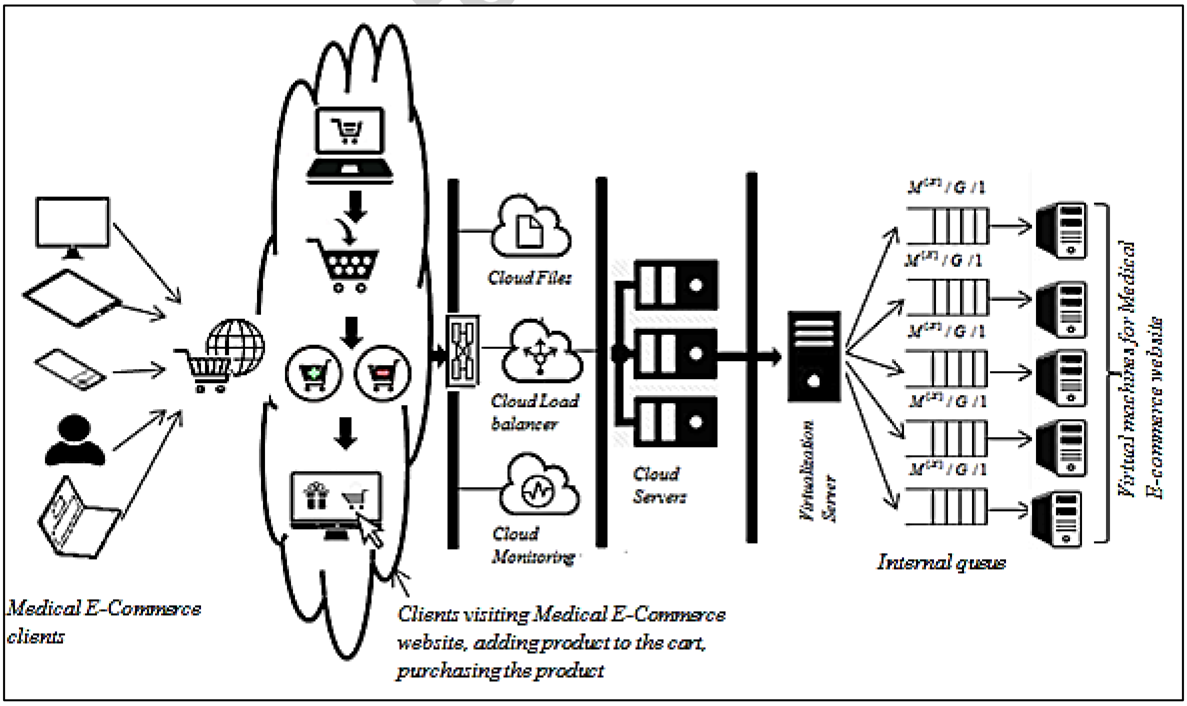


Figure 4 – Proposed framework for a medical E-commerce application deployed in cloud

A conventional online shopping procedure includes different deeds, for instance, clients visits the medical E-commerce website, browsing the site, searching for the medicine which is prescribed, adding the items to the shopping cart, finalizing the items and payment and delivery information is collected. For a static approach, the model overlooks the information of intricate shopping activities and concentrates only on two major services in order to derive the steady state solutions. The first service is adding the items to the medical E-commerce shopping cart, which is essential and the second service is purchasing the medicine, which is optional.

The Cloud Service Provider (CSP) provides IaaS by permitting the medical E-commerce merchants to reserve their suitable virtual machine image of their needed capacity and pay only for whatever resources they consume. These virtual machine images can be in any one of the states: normal state (switched on and functioning), idle state (switched on and not functioning) and switched off state. VMs can go to idle state after completing service for a long period [37]. According to the study, the Idle VMs were not decommissioned and still remain running in the physical host. These idle VMs consume CPU, memory and storage that could be used by other active machines, which leads to performance degradation. If the performance is low, then the clients have to encounter long service times and unintentionally the clients will abandon the cart. This could prompt the cloud service provider to lose its shares of business sector.

Proposed model assumes that each medical E-commerce application is allocated to a distinct virtual machine by the cloud provider and $M^{[X]}/G/1$ queueing system serves as an internal queue to each virtual machine instance from the physical machine. The virtual machine actively serves the request for an ample period of time and it may go to idle state. If the idle VM is not decommissioned from the physical host, it consumes CPU, storage and memory that could be used by other active virtual machines. The ultimate aim of this work is to study the impact of idle VM at the time of providing service to the medical E-commerce application, which may lead to cart abandonment. A stochastic model is proposed with a $M^{[X]}/G/1$ queueing solution by incorporating the reneging factor. This model derives steady state results by means of probability generating functions and has discussed some special situations.

3.1 Hypothesis for the proposed cloud medical E-commerce analytical model

The cloud medical E-commerce model has been well-defined with the following hypothesis:

Hypothesis 1- In this model, our interest is in $M^{[X]}/G/1$ queueing framework. Medical E-commerce client's request arrives in batches of size k to the Virtual Machine. Batch of tasks arrive in a compound Poisson process, and they are given in a one-by-one service in an FCFS fashion.

Hypothesis 2 – Let the first order_probability for the batch of k tasks be $\lambda c_k \left(k = 1,2,3...\right)$ amid a short interval of time $\left(t, t+\Delta t\right)$, where, $\sum_{k=1}^{\infty} c_k = 1$ and $\lambda > 0$, the mean arrival rate of tasks.

Hypothesis 3- Adding the medicines in the medical E-commerce shopping cart is mandatory for all the clients. Next to this, the client can purchase the medicine with probability η or leave the medical E-commerce website with probability $1-\eta$.

Hypothesis 4- The service times of adding the list of medicines to the medical E-commerce shopping cart and purchasing the medicines follow general distribution with distribution function $ES_i\left(n\right)$ and density function $es_i\left(n\right)$.

Hypothesis 5- Let $\mu_{cart}\left(v\right)dv$ be the conditional probability of service completion of adding medicines in the medical E-commerce shopping cart and the equation is

$$\mu_{cart}\left(v\right) = \frac{es_{cart}\left(v\right)}{1-ES_{cart}\left(v\right)} \quad \text{and} \quad es_{cart}\left(n\right) = \mu_{cart}\left(n\right)e^{-\int_0^n \mu(v)dv}$$

Hypothesis 6- Let $\mu_{purchase}\left(v\right)dv$ be the conditional probability of service completion of purchasing medicines from the medical E-commerce shopping cart and the equation is

$$\mu_{purchase}\left(v\right) = \frac{es_{purchase}\left(v\right)}{1-ES_{purchase}\left(v\right)} \quad \text{and} \quad es_{purchase}\left(n\right) = \mu_{purchase}\left(n\right)e^{-\int_0^n \mu(v)dv}$$

Hypothesis 7- The virtual machine allocated for the medical E-commerce application can go to idle state with probability q or be active in the physical host with probability $1-q$.

Hypothesis 8- When the virtual machine is idle, the client may abandon the medical E-commerce shopping cart due to slow response and abandoning the cart follows exponential distribution with parameter φ and the equation is $\varphi e^{-\varphi t}dt, \varphi > 0$

Hypothesis 9- The medical E-commerce VM idle time is also assumed to follow general distribution with distribution function $G(w)$ and density function $g(w)$. Let $\phi(v)dv$ be the conditional probability of the idle period and the equation is $\phi(v)=\frac{g(v)}{1-G(v)}$ and $g(v)=\phi(w)e^{-\int_0^w \phi(w)dv}$.

4 The analytical model for the cloud medical E-commerce application

To solve the proposed cloud based medical E-commerce queueing model, Probability Generating Function (PGF) [18] is derived to find the steady state probabilities of the virtual machine which is allocated for the application.

4.1 Idle state of the virtual machine allocated to the medical E-commerce application

$$idlevm(v,x)=\sum_{j=0}^{\infty}x^j idlevm_j(v) \tag{1}$$

$$idlevm(x)=\sum_{j=0}^{\infty}x^j idlevm_j \tag{2}$$

Steady state equations

$$\frac{d}{dv}idlevm_j(v)+\left(\lambda+\phi(v)+\varphi\right)idlevm_j(v)=\lambda\sum_{k=1}^{j}c_{j-k}idlevm_{j-k}(v)+\varphi idlevm_{j+1}(v),\ j\geq 0 \tag{3}$$

$$\frac{d}{dv}idlevm_0(v)+\left(\lambda+\phi(v)\right)idlevm_0(v)=0 \tag{4}$$

Boundary condition

$$idlevm_j(0)=q(1-\eta)\int_0^{\infty}cart_j(v)\mu_{cart}(v)dv+q\int_0^{\infty}purchase_j(v)\mu_{purchase}(v)dv,\ j\geq 0 \tag{5}$$

Probability Generating Function

$$idlevm(x)=\frac{-Sm\omega\theta\left[1-N^*(n)\right]}{n\left[x-(\psi+\delta+\gamma+\alpha)C^*(m)\right]} \tag{6}$$

4.2 Adding medicines to the medical E-commerce shopping cart

$$cart(v,x)=\sum_{j=0}^{\infty}x^j cart_j(v) \tag{7}$$

$$cart(x)=\sum_{j=0}^{\infty}x^j cart_j \tag{8}$$

Steady state equations

$$\frac{d}{dv}cart_j(v)+(\lambda+\mu_{cart}(v))cart_j(v)=\lambda\sum_{k=1}^{j}c_k cart_{j-k},\ j\geq 0 \tag{9}$$

$$\frac{d}{dv}cart_0(v)+(\lambda+\mu_{cart}(v))cart_0(v)=0 \tag{10}$$

Boundary condition

$$cart_j(0)=(1-q)(1-\eta)\int_0^\infty cart_{j+1}(v)\mu_{cart}(v)dv+(1-q)\int_0^\infty purchase_{j+1}(v)\mu_{purchase}(v)dv$$
$$+\int_0^\infty idlevm_{j+1}(v)\phi(v)dv+\lambda c_{j+1}S,\ j\geq 0 \tag{11}$$

Probability Generating Function

$$cart(x)=\frac{-Sm\left[1-C^*(m)\right]}{m\left[x-(\psi+\delta+\gamma+\alpha)C^*(m)\right]} \tag{12}$$

4.3 Purchasing medicines from the medical E-commerce shopping cart

$$purchase(v,x)=\sum_{j=0}^{\infty}x^j purchase_j(v) \tag{13}$$

$$purchase(x)=\sum_{j=0}^{\infty}x^j purchase_j \tag{14}$$

Steady state equations

$$\frac{d}{dv}purchase_j(v)+(\lambda+\mu_{purchase}(v))purchase_j(v)=\lambda\sum_{k=1}^{j}c_k purchase_{j-k},\ j\geq 0 \tag{15}$$

$$\frac{d}{dv}purchase_0(v)+(\lambda+\mu_{purchase}(v))purchase_0(v)=0 \tag{16}$$

Boundary condition

$$purchase_j(0)=\eta\int_0^\infty cart_{j+1}(v)\mu_{cart}(v)dv,\ j\geq 0 \tag{17}$$

Probability Generating Function

$$purchase(x)=\frac{-Sm\eta C^*(m)\left[1-C^*(m)\right]}{m\left[x-(\psi+\delta+\gamma+\alpha)C^*(m)\right]} \tag{18}$$

4.4 Measures depicting the overall cloud medical E-commerce queueing system

$$Q_s(x)=cart(x)+purchase(x)+idlevm(x)$$

$$Q_s(x)=\frac{S\left\{n\left[C^*(m)-1\right]+\phi C^*(m)\left[R^*(m)-1\right]-(\theta+\omega)\left(m\left[1-N^*(n)\right]\right)\right\}}{m\left[x-(\psi+\delta+\gamma+\alpha)C^*(m)\right]} \tag{20}$$

5 Special cases for the proposed cloud medical E-commerce analytical model

Case 1 : Client is not abandoning the medical E-commerce shopping cart and the virtual machine allocated to the medical E-commerce application is idle

$(\varphi=0, m=n)$

$$Q_s(x)=\frac{S\left\{\left[C^*(m)-1\right]+\eta C^*(m)\left[R^*(m)-1\right]+(\theta+\omega)\left[N^*(m)-1\right]\right\}}{x-\left[(\psi+\delta+\gamma+\alpha)C^*(m)\right]} \tag{21}$$

Case 2: Client is not purchasing the medicine from the medical E-commerce site

$(\eta=0)$

$$Q_s(x)=\frac{S\left\{n\left[C^*(m)-1\right]+mqC^*(m)\left[1-N^*(n)\right]\right\}}{n\left[x-(1-q)C^*(m)-qC^*(m)N^*(n)\right]} \tag{22}$$

Case 3 : Virtual machine allocated to the medical E-commerce application is not idle

$(q=0)$

$$Q_s(x)=\frac{\left[C^*(m)-1\right]+\eta\left[R^*(m)-1\right]}{x-(1-\eta)C^*(m)-\eta R^*(m)} \tag{23}$$

Case 4 : Client is not abandoning the medical E-commerce shopping cart and the virtual machine allocated to the medical E-commerce application is not idle

$(\varphi=0, \eta=0)$

$$Q_s(x)=\frac{S\left\{(1-q)\left[C^*(m)-1\right]+qC^*(m)N^*(m)\right\}}{x-(1-q)C^*(m)-qC^*(m)N^*(m)} \tag{24}$$

Case 5 : Client is not purchasing the medicine and not abandoning the medical E-commerce shopping cart when virtual machine allocated to the medical E-commerce application is not idle

$(\varphi=0, \eta=0, q=0)$

$$Q_s(x)=\frac{\left[C^*(m)-1\right]}{x-C^*(m)} \tag{25}$$

Where

$m = \lambda - \lambda C(x)$

$n = \lambda - \lambda C(x) + \varphi - \varphi/x$

$\psi = (1-q)(1-\eta)$

$\delta = (1-q)\eta R^*(m)$

$\gamma = q(1-\eta)N^*(n)$

$\theta = q(1-\eta)C^*(m)$

$\omega = q\eta C^*(m)R^*(m)$

R^*, N^*, C^* are the Sumudu transforms used in the equations and the Sumudu transform for any function is

$$\mathbb{S}[f(t)] = \int_0^\infty f(ut)e^{-t}dt$$

In $Q_s(1) + P = 1$ by using normalizing condition, the unknown probability P can be determined. L'Hospital's rule [38] is applied twice in equation (20) because $Q_s(1)$ is indeterminate. Little's law [39] is applied to find the performance measures like mean waiting time of medical E-commerce client task in the VM(W), mean number of medical E-commerce clients in the VM(L), mean waiting time of a medical E-commerce client task in the queue(W_q) and the mean number of medical E-commerce clients in the queue(L_q). The utilization factor of the virtual machine allocated to the medical E-commerce application is ρ and it can be calculated by λ/μ .

6 Simulation results and graphs

SHARPE tool [40] is used to simulate the proposed cloud medical E-commerce analytical model. A wide selection of qualities was endorsed for the proposed cloud medical E-commerce model parameter so that the model reflects an extensive range of cloud service provider. The model can deploy up to 8 virtual machines on a single physical machine. $M^{[X]}/G/1$ queueing system is designed as an internal queue to each virtual machine instance from the physical machine. The average arrival rate of a medical E-commerce client request to a single virtual machine is $\lambda > 0$ (each VM organized to handle 500 to 1500 medical E-commerce client request per hour). The mean service time of adding medicines in the medical E-commerce shopping cart is $1/\mu_{cart}$ (from analysis 30 minutes to 45 minutes). The mean service time of purchasing medicines from the medical E-commerce shopping cart is $^{1}\!/_{\mu_{purchase}}$ (from analysis 45 minutes to 1 hour). Idle time of the virtual machine allocated for the medical E-commerce application follows a general distribution with factor φ (for present study1 to 3 seconds). Medical E-commerce shopping cart abandonment rate follows an exponential distribution with parameter $^{1}\!/_{\varphi}$.

Table 1 - Queue performance measures when $q = 0.5, \eta = 0.25, \lambda = 2, \mu_{cart} = 2, \mu_{purchase} = 4$

φ	$Q_s(x)$	ρ	L_q	L	W_q	W
2	0.1032	0.8635	6.1722	6.2655	3.3751	4.3825
5	0.1941	0.7021	5.1732	5.6821	2.5023	3.7207
7	0. 2205	0.7793	4.5056	5.2848	2.2529	2.6426
10	0.3374	0.6626	2.9445	3.6068	1.4723	1.8035
12	0.3978	0.6024	2.7059	3.3081	1.3528	1.6542

Table 2 - Queue performance measures when $q = 0.5, \eta = 0.5, \lambda = 2, \mu_{cart} = 2, \mu_{purchase} = 4$

φ	$Q_s(x)$	ρ	L_q	L	W_q	W
2	0.0674	0.9987	9.8564	12.1321	5.8324	6.2683
5	0.1098	0.9146	8.1248	9.1342	4.1476	4.6235
7	0.1472	0.8528	7.4529	8.3056	3.7265	4.1528
10	0.2754	0.7256	4.1181	4.8433	2.0592	2.4217
12	0.3408	0.6593	3.4417	4.1007	1.7207	2.0505

In Table 1, $\eta = 0.25$ and in Table 2, $\eta = 0.5$. In both tables, $q = 0.5$ and the values of cart abandonment rate are assumed to be different varying values like 2, 5, 7, 10 and 12.

Table 3 - Queue performance measures when $q = 0.6, \eta = 0.25, \lambda = 2, \mu_{cart} = 2, \mu_{purchase} = 4$

φ	$Q_s(x)$	ρ	L_q	L	W_q	W
2	0.0975	1.4387	7.2205	5.9761	3.5639	3.2176
5	0.1028	0.8217	5.5117	5.3564	2.9025	2.7413
7	0.2584	0.7419	4.2527	4.6313	2.1269	2.3158
10	0.5595	0.4408	3.7118	4.4537	1.8559	2.2269
12	0.6207	0.3797	2.9389	3.3795	1.4695	1.6899

Table 4 - Queue performance measures when $q = 0.6, \eta = 0.5, \lambda = 2, \mu_{cart} = 2, \mu_{purchase} = 4$

φ	$Q_s(x)$	ρ	L_q	L	W_q	W
2	0.3779	0.9179	8.8632	9.2165	5.3791	7.1009
5	0.5217	0.8513	7.4681	7.4361	3.8367	5.0265
7	0.4902	0.8099	6.2855	6.4483	3.1429	3.3044
10	0.6101	0.3895	5.5574	6.6085	2.7785	3.2245
12	0.6774	0.3229	4.3324	4.7217	2.1663	2.3607

In Table 3, $\eta = 0.25$ and in Table 4, $\eta = 0.5$. In both tables, $q = 0.6$ and the values of cart abandonment rate are assumed to be different varying values like 2, 5, 7, 10 and 12.

Table 5 - Queue performance measures when $q = 0.75, \eta = 0.25, \lambda = 2, \mu_{cart} = 2, \mu_{purchase} = 4$

φ	$Q_s(x)$	ρ	L_q	L	W_q	W
2	0.1009	0.9521	5.0427	5.5101	5.8741	3.5472
5	0.2765	0.7116	3.1739	4.0162	2.4376	2.0327
7	0.3048	0.6954	2.9817	3.6767	1.4907	1.8382
10	0.4301	0.5704	2.1453	2.7153	1.0728	1.3578
12	0.4913	0.5087	1.9218	2.4307	0.9608	1.2153

Table 6 - Queue performance measures when $q = 0.75, \eta = 0.5, \lambda = 2, \mu_{cart} = 2, \mu_{purchase} = 4$

φ	$Q_s(x)$	ρ	L_q	L	W_q	W
2	0.1013	0.9635	5.8201	7.5309	3.3776	5.7435
5	0.1719	0.8436	4.9711	5.8778	2.8042	3.2511
7	0.2437	0.7564	4.0164	4.7724	2.0081	2.3861
10	0.3804	0.6203	2.3349	2.9549	1.1673	1.4773
12	0.4466	0.5538	2.2848	2.8387	1.1423	1.4194

In Table 1, $\eta = 0.25$ and in Table 2, $\eta = 0.5$. In both tables, $q = 0.75$ and the values of cart abandonment rate are assumed to be different varying values like 2, 5, 7, 10 and 12.

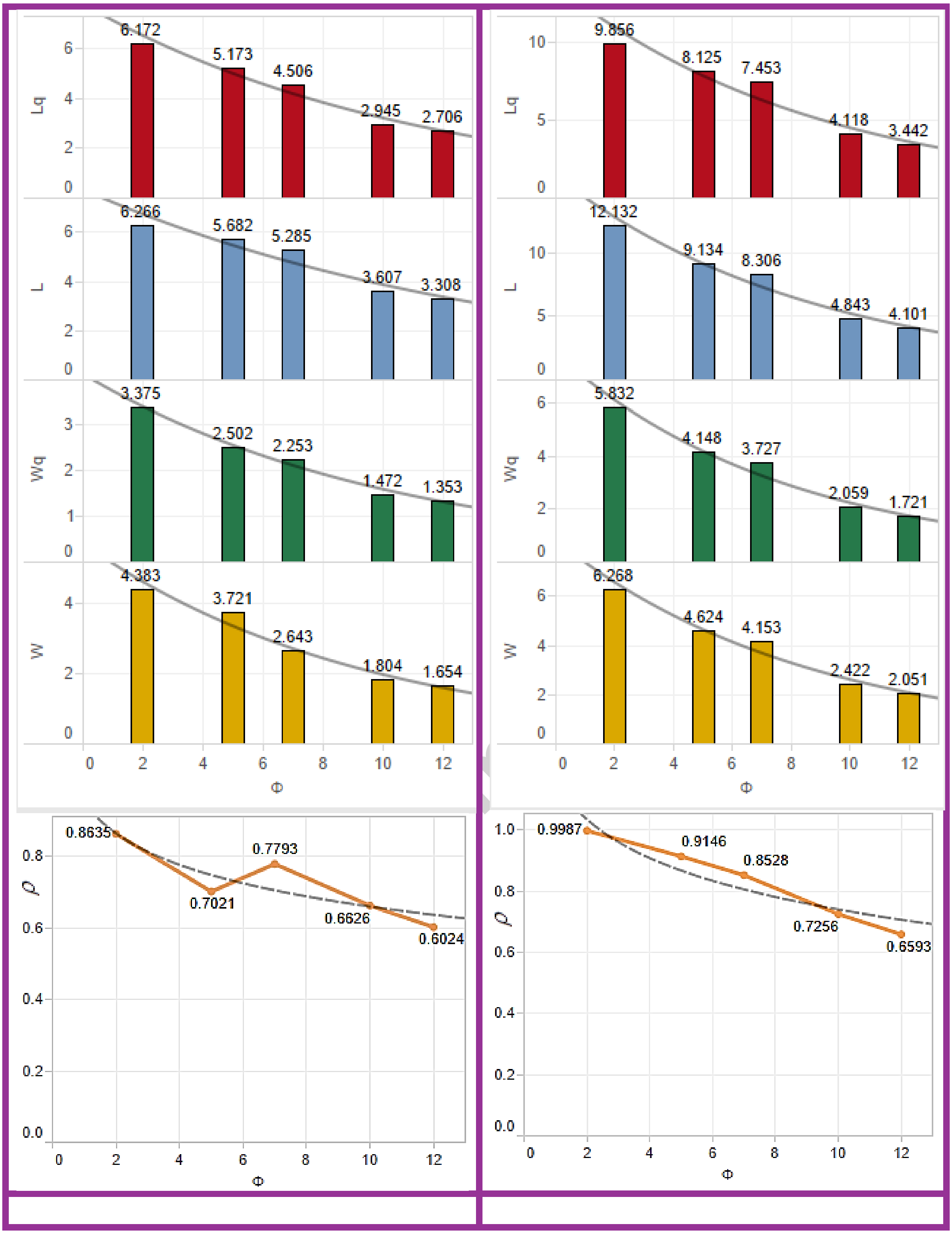
In all the tables, the values of $\lambda, \mu_{cart}, \mu_{purchase}$ are fixed. The tables show the computed values of the utilization factor, mean waiting time of medical E-commerce client task in the VM, mean number of medical E-commerce clients in the VM, mean waiting time of a medical E-commerce client task in the queue and the mean number of medical E-commerce clients in the queue. It is clearly observed that the virtual machine idle time is decreased whereas all the other parameters values are increased based on the different values of the medical E-commerce shopping cart abandonment rate.

Results

From the resultant graphs given in Figure 5-10, it is evident that as the model increases the values of η or q, the virtual machine idle time decreases while the utilization factor, mean queue size and mean waiting time increases for different values of the cart abandonment parameter φ. Hence, we have got the expected results from the proposed cloud medical E-commerce model. The logarithmic curve lines in the graphs clearly depict the impact of medical E-commerce shopping cart abandonment rate with the calculated average number of medical E-commerce clients in the queue, average waiting time of a medical E-commerce client in the queue, average waiting time of a medical E-commerce client in the VM and the average number of a medical E-commerce client clients in the VM.

Figure 5 – Resultant graph for the parameters, $q = 0.5, \eta = 0.25, \lambda = 2, \mu_{cart} = 2, \mu_{purchase} = 4$

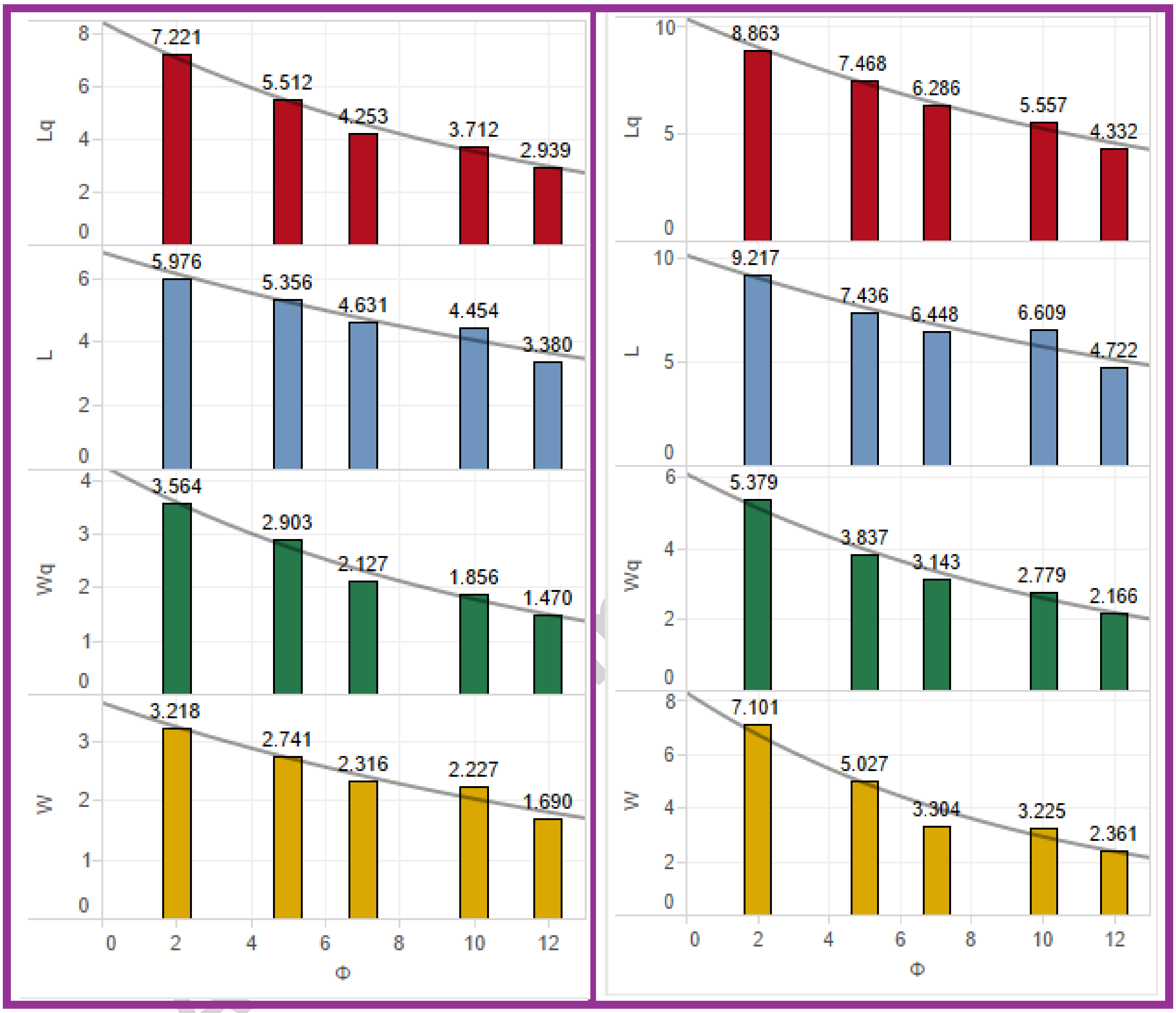
Figure 6 – Resultant graph for the parameters, $q = 0.5, \eta = 0.5, \lambda = 2, \mu_{cart} = 2, \mu_{purchase} = 4$

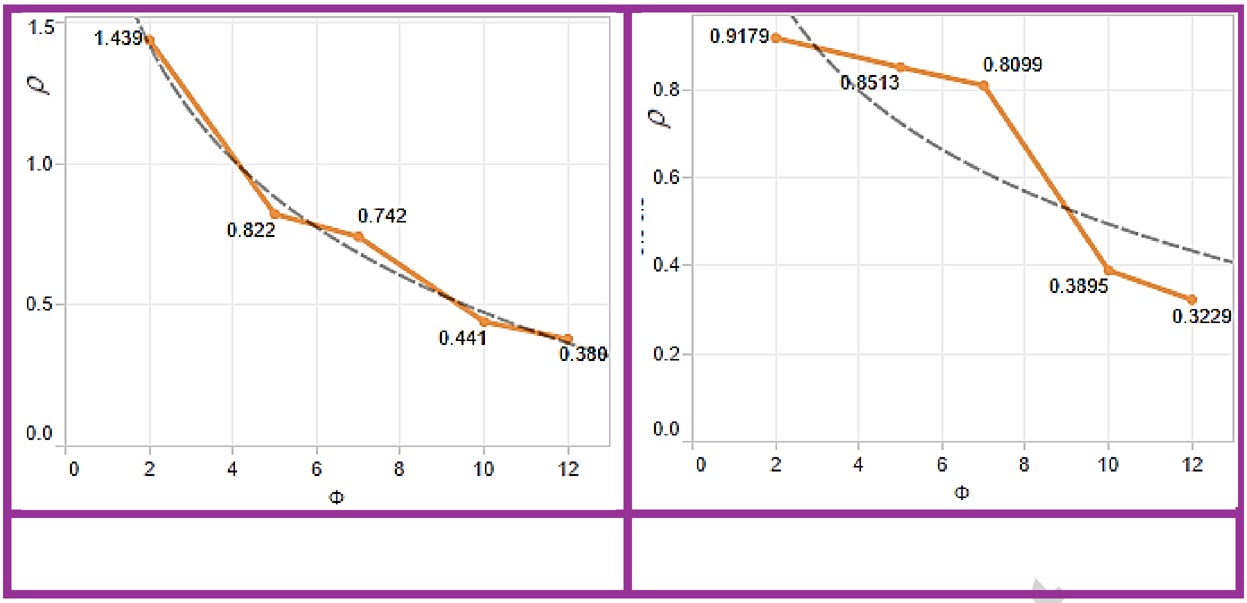


The Figure 5 and 6 shows the virtual machine idle time decreases while the utilization factor, mean queue size and mean waiting time increases for different values of the cart abandonment parameter φ when $q = 0.5$ and the values of $\lambda, \mu_{cart}, \mu_{purchase}$ are fixed.

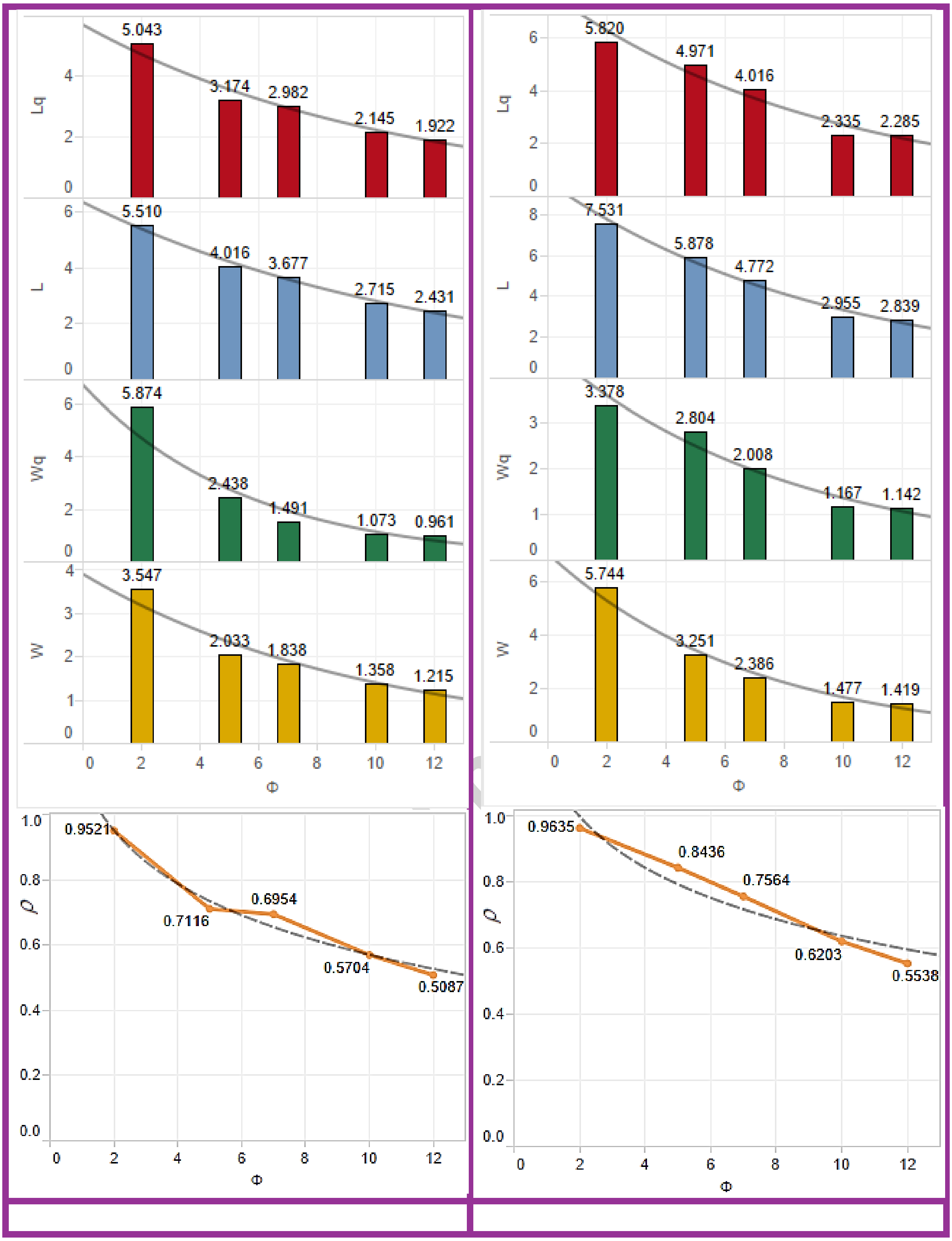
Figure 7 – Resultant graph for the parameters, $q = 0.6, \eta = 0.25, \lambda = 2, \mu_{cart} = 2, \mu_{purchase} = 4$

Figure 8 – Resultant graph for the parameters, $q = 0.6, \eta = 0.5, \lambda = 2, \mu_{cart} = 2, \mu_{purchase} = 4$





The Figure 7 and 8 shows the virtual machine idle time decreases while the utilization factor, mean queue size and mean waiting time increases for different values of the cart abandonment parameter φ when $q = 0.6$ and the values of $\lambda, \mu_{cart}, \mu_{purchase}$ are fixed.



The Figure 9 and 10 shows the virtual machine idle time decreases while the utilization factor, mean queue size and mean waiting time increases for different values of the cart abandonment parameter φ when $q = 0.75$ and the values of $\lambda, \mu_{cart}, \mu_{purchase}$ are fixed.

Figure 9 – Resultant graph for the parameters, $q = 0.75, \eta = 0.25, \lambda = 2, \mu_{cart} = 2, \mu_{purchase} = 4$

Figure 10 – Resultant graph for the parameters, $q = 0.75, \eta = 0.5, \lambda = 2, \mu_{cart} = 2, \mu_{purchase} = 4$

7 Conclusions

Medical E-commerce applications deployed in the cloud saves infrastructure cost, there is the reliability of a steady platform, and it provides numerous benefits and results, creating enormous impact on the economy. Herein, a queueing model was developed to overcome the difficulty faced by a medical E-commerce retailer due to slow response time. This work mainly contributes to the understanding of medical E-commerce customer waiting behaviour by investigating the medical E-commerce shopping cart abandonment behaviour of customers. The focus of our contribution is in providing proof that medical E-commerce retailers can collect information by observing the queue, and update their utility function in response. A detailed analysis was presented, with cart abandonment factor, considering the idle state of the virtual machine allocated to the medical E-commerce application, which has a high impact on the performance of the virtual machine. The numerical results presented will be extremely useful for a medical E-commerce firm facing a customer impatience problem, and will enable execution of diverse strategies to prevent clients from moving to other firms.

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