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# EDITORIAL

**Greetings from IAARHIES and the Conference organizing Committee!**

At the very outset, we extend a warm welcome to all our distinguished guests, speakers and the participants who have joined us during 9th & 10th IAARHIES International Conferences in Australia (Melbourne & Sydney).

We are happy to receive the research papers from all part of the world and some of the best papers published in this proceedings. The current edition of the proceedings brings out the various research papers from diverse area of Business, Economics, Management, Engineering and Technology. The IAARHIES conferences are an attempt to provide a platform to the researchers, educators and professionals to present their innovative thoughts and discoveries and to explore future trends and applications in the field of Engineering and Technology. However, this conference will also provide a forum for dissemination of knowledge on both theoretical and applied research on the above said area with an ultimate aim to bridge the gap between these coherent disciplines of knowledge. Our final goal is to make the Conference proceedings useful and guiding factor to audiences involved in research in these areas, as well as to those involved in design, implementation and operation, to achieve their respective goals.

We once again are thankful to all the delegates participating in these two events in Melbourne & Sydney, Australia. We are sure about the contributions to be added by the participating authors to the research community and rapidly growing field of education throughout the globe. We are also thankful to all the International advisory members and reviewers for making this event a successful one.

We are specially thankful to **Mr. Saeed Masoud Alshahrani, Flinders University, Australia** for his gracious presence during IAARHIES 10th International Conference in Sydney, Australia. We wish him all the success in life ahead.

**Sandeep Kumar**
(Chairman, SAR)

**Dr. Hardev Sharma**
(Gen. Secretary, SAR)

# CONTENTS



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# Online Banking Customers Information Security Awareness Model (OBCISAM)

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# Online Banking Customers Information Security Awareness Model (OBCISAM)

**ABSTRACT**
Online Banking has been rapidly developing around the world and has become increasingly important to the profitability of financial institutions as well as adding convenience for their customers to use multiple channels of banking anywhere anytime depending on need and urgency.As the number of customers using online banking increases, online banking systems are becoming more desirable targets for criminals to attack.The unique aspect about security in banking industry is that the security posture of a bank does not depend solely on the advanced security techniques and practices implemented by the bank, it is equally dependent on the awareness of the users using the online banking .But security awareness of online banking customers is an often-overlooked issue.While organizations use advanced security technologies and continuously train their security professionals,little attention is given to increase security awareness in online banking customers which are the weakest link to security.
This paper aims to explainthe need for Information Security Awareness in online bankingcustomers.A model(OBCISAM) is proposed for Information Security Awareness Program for online banking customers.Information Security Awareness Program aims at increasing and maintaining the level of customers' securityawareness.Model starts with the process of analysis of customersand go through process of design, development, implementation, evaluation andends with continuity and improvement of the awareness process.OBCISAMModel alsodescribes how it could be incorporated into website of bankby using developmentlife cycle process.Model also describes the need of ongoing and continually improved awareness program.

**Keywords:Online Banking,Information Security,Customer Awareness**

## 1. INTRODUCTION

Most traditional banks now offer online banking services, which has not only increase the productivity of banks but also gives room for easy transactions by the customers.Online Banking customers can access their accounts from browser and software that runs Internet Banking programs resident on the bank's World Wide Web server.Online Banking has been rapidly developing around the world,becoming one of strategic points for commercial banking development.Online Banking allows customers or users to conduct financial transactions on a secure website operated by their banks.It can be accessed from anywhere and anytime 24 hours a day 7 days a week.Internet banking being customer effective facilitates anytime anywhere banking helps in expansion of customer base and geographical reach. It adds to choice of customers to use multiple channels of banking depending on need and urgency..

The past decade has witnessed a steep increase in the intensity and extent of cybercrimes. The global financial services sector has been hard hit by cyber terrorism, violation of intellectual property rights (IPR), leakage of card data, electronic fund transfer (EFT) fraud, among others. The financial services sector is often targeted due to high recognition of and rewards associated with it. Therefore, banks should keep their information security functions strong by managing IT risks efficiently and diligently and equally important is awareness of customers.[8].

Online banking is one of the most sensitive tasks performed by general internet users.ButSecurity awareness is an often-overlooked factor in an information security program of banks. While banking organizations expand their use of advanced security technology, of coursenecessary to address vulnerabilities such as viruses, denial of service attacks, and prevent unauthorized access and continuously train their security professionals, very little is used to increase the security awareness among the normal users, making them the weakest link which is used by attackers to steal confidential information[3] . However, the involvement of humans in information security is of equal if not greater importance and many examples of security issues such as "Phishing" and Social Engineering exist where any technical solutions can be subverted by misleading the user [6].According to the 2007 Global Security Survey by Deloitte Touche Tohmatsu, "The greatest root cause of external breaches continues to be the human factor." In other words, banks need to continuously educate and engage customers about their online security[14].

Therefore, user's information security awareness is a major component within banking industry that is a goodpractice for security. So banks shouldfocus on making users intrinsic to the security process through education, training, andawareness.

## 2. LITERATURE REVIEW

We propose that, in addition to any advanced security technologies deployed, banks hasto have an information security awareness program for its users. In this paper we present an approach to build a user-oriented security awareness program to increase and maintain a certainlevel of user awareness to the threats and risks associated with online banking and reinforce good security practice. The InformationSecurity Forum (ISF) one of the world's leading independent authorities on information securitydefines information security awareness as: "An ongoing process of learning that is meaningful torecipients, and delivers measurable benefits to the organization from lasting behavioral change"[1]. Information Security challenge mostly affects online banking customers who supply their details during onlinetransactions. . For customer not to be a victim of this information security challenge there must be a proper information security awareness. This information security awareness will serve as a guide for online banking customers. Existing methods of creating information security awareness is not yielding good results. Therefore there is need for our banks to intensify effort on information security awareness creation for their customers so that their existing customers will not be discouraged by attack from attackers and the new customers who are yet to adopt online banking will be encouraged too [7].Security concerns and lack of awareness about online banking and its benefits stands out as being obstacles to the adoption of online banking[10].Author developed an awareness capability model(ISACM) that can be used to identify awareness gaps and associated risks to organizations in relation to specific information security controls[9].In order to measure human awareness, other areas need be measured. The measurement should address three major areas: peoples' behavior, feeling and knowledge. Based on this argument, they have developed a prototype to investigate three major questions: what do they know? How do they feel? And how do they behave? Some users could behave in a way that is against their belief or feeling. For example, a system forces a user to change his password every 30 days. This user has changed his password because he was forced to by the system not because he knows this practice can secure his account. This approach will investigate users' knowledge and match it with their practice[4].

## 3. INFORMATION SECURITY AWARENESS

Information Security Forum defines information security awareness as the degree or extent to which every member of staff understands the importance of information security, the levels of information security appropriate to the organisation, their individual responsibilities, and acts accordingly[4]. From these definitions, organisations focus their information security awareness program on their employees with the intension of protecting confidentiality, integrity and availability of information. Meanwhile, organisations like banks that carry out online transactions need information security awareness for their customers. There is need for them (customers) to know

way and manners in which online transaction works in term of information security threats. Each day that passes without educating your commercial customers and financial institution staff provides cyber-thieves another opportunity to compromise accounts and commit fraud [7].

Security Awareness stimulates and motivates to care about security and to remind them of important security practices, explaining what happens to their computers and valuable information if security fails, this motivates people to take security seriously. The scope of any security awareness campaign is to persuade computer users to listen and act on measures to avoid, deter, detect, and defend against information security threats [13].

So,Information security awareness for online banking costumer is informal training and knowledge acquire to expose customers to adequate information on how to handle information security threats surrounding online transaction in order not to fall victim of attackers. Trainings and awareness campaigns are capable of preventing sophisticated attacks simply by making customers of banks aware of the signs to look for when it comes to fraudulent schemes.

## 4. MODEL FOR CUSTOMER SECURITY AWARENESS IN ONLINE BANKING

Human factor is a crucial issue in the chain of the security and every part of the security chain must be strong because any weakness at any part will make the chain broken as a whole. Users must be aware of system threats and what practice must be adhered in order to keep the system and information protected. Therefore, measuring the awareness of end users from diverse backgrounds (Gender, Age,Religion,Computer knowledge, Authentication Practice and Awareness)is also important point to be considered during customer awareness program.

In this section we propose our general an Online Banking Customers Information Security Awareness Model (OBCISAM)). Figure 4 shows our model which is built around seven core blocks. This model is suggested based on the concept that educating users is best way to increase their awareness about online banking security.Several organizations have launched awareness campaigns to educate the user how to detect attacks like phishing and avoid falling victims to them.Any organization starts its program by learning its own security goals.So in our case the goal is to increase awareness level of online banking customers.So first processanalysis of customers ,based on analysis information program is designed,methods of delivery will be decided, program will be implemented. and reviewed.As the aim of the program is to raise security awareness, it isnecessary to measure this on a regular basis.Ongoing delivery and improvement of the program is also a crucial, which aims to keep the program running with up to date information.In thiswork we have focused on the design and development blocks and we leave details of other blocksfor further work. However, we will give a brief description of the whole model in this section.

### 4.1 Analysis Phase

Analysis of Customers is the first stage in the model that will analyze the various types of online banking customers.The awareness level of customers is influenced by education,age, geographical area,language,knowledge of computer and internet, authentication practice and awareness of customers.So before designing and conducting awareness program for customers,all the above factors should kept in mind.For example education will influence extend knowledge, understanding of humans regardless of their field of study.In the security practice, users between the ages of 30 and 49 have been noticed to be more careful in their security practice[12].The analysis of the customers can be done based on data from forms, submitted by customers (while they opened account)and time to time surveys done by banks and other information security firms .

### 4.2 Design Phase

The design process mainly concerns identifying the required program elements that should be included in the security awareness program Among the program's elements could be security notices and alerts on bank website, Security and privacy policies in simple and easy

to understand language on the website, guidelines, booklets, cartoon movies related to security, awareness training workshops like HDFC bank conducted in year 2014 at various places in india, online forums to enable users to interact and news sections. The banks should also have local awareness campaign by distributing posters and emailing newsletters to alert users to the latest IT security threats and how to prevent themselves to become victim of these threats. The key to the success in awareness is keeping the message relevant , consistent, easily accessible and interactive by utilizing different multimedia elements to keep everyone interested.

### 4.3 Development Phase

The security awareness program development process can be done using a range of web based development tools such as ASP. NET or PHP or Visual Basic.Net.IT professionals of bank should insert cartoon videos, time to time security alerts and newz on the website. They should keep the website up to date including security information and provide information about browser updates and security patches. The decision on development of security programs should be made based on available resources, developers' expertise and information security experts. Security awareness and training materials may be developed in-house, adapted from a professional organization's work, or purchased from a vendor. There are security awareness vendors that provide prepared materials such as computer-based training (CBT), posters, and newsletters.


Figure 1: Model for Online Banking Customer Information Security Awareness(OBCISAM)

### 4.4 Implementation Phase

The implementation process/Delivering Process includes selecting best ways to run and distribute the program: means part of the organization' website, as a local awareness campaign by distributing posters and emailing newsletters, workshops or as a separate website. We suggest in this paper the program that has information security awareness on website integrated with in-person campaigns andworkshops done by bank for customers. We believe this solution will increase the effectiveness of the program and make it more accessible to all customers.

### 4.5 Evaluation Phase

Effectiveness of Information Security Awareness program can checked with evaluation process that measure the users' awareness level after conducting the program.Formal evaluation and feedback mechanisms are critical components of any security awareness, training, and education program. Continuous improvement cannot occur without a good sense of how the existing program is working. In addition, the feedback mechanism must be designed to address objectives initially established for the program. Once the baseline requirements have been solidified, a feedback strategy can be designed and implemented.

### 4.6Improvement and Continuity of Program

Awareness program needs to be continually measured and managed to keep customers up to date with current security threats. To keep users current and their memories refreshed, any awareness program must be ongoing and be an integral part of the very culture of organization.Continuous improvement should always be the theme for security awareness and training initiatives.

## 1. CONCLUSION

Along with this the security polices of the banks have no standard format and policies are inadequate that leads to many security risks. The Security posture of a bank does not depend solely on the safeguards and practices implemented by the bank, it is equally dependent on the awareness of the users using the banking channel and the quality of end-user terminals because the hackers always choose the easiest way to attack.Generally the easiest

seems to be attacking the user or his/her PC, so awareness and usability of users is also equally important to make online banking 100% secure. So 100% security guarantee that is given by banks for users transactions is possible if both banks and users together give flawless security posture to online banking by removing all the given security flaws.

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# A Systematic Assessment of Cleanroom Performance in Hospital's Operating Room

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**ABSTRACT**
A cleanroom is a controlled environment typically used in healthcare facilities, semiconductor manufacturing, and biotechnology research. In general, the performance of cleanroom is assessed through the measurements of several parameters namely, a concentration of airborne particles, air temperature, air humidity, room pressure and air-change rate. These parameters are controlled within specified limits as necessary. In recent years, most hospitals have employed a cleanroom system in operating rooms. It aims to protect patients from surgical-site infection, which is due to airborne particles settle on a wound. To date, no study has reported a systematic procedure in evaluating cleanroom performance. The goal of this study is to present a systematic assessment of cleanroom performance in an ISO Class 7 operating room. The operating room is equipped with a vertically downward airflow system. All the measurements were carried out at a rest condition which agrees with ISO 14644-1 standard. A TSI 9310-02 airborne particle counter was used to measure the different sizes of particles, specifically PM 0.5, PM 1.0, and PM 5.0. An industrial temperature humidity meter, Testo 625, was used for temperature and relative humidity measurements. The data showed that the average particulate matter concentrations (146400 particles/$m^3$ of PM 0.5, 6898 particles/$m^3$ of PM 1, 224 particles/$m^3$ of PM 5), air-change rate (38/hr), supply air velocity (0.43 m/s), air temperature (18.1°C), relative humidity (53.2%) and room pressure differential (> 15.3 Pa) met the specifications of ISO Class 7.

**Keywords:Hospital operating room, cleanroom performance, ISO Class 7, field measurement.**

## 1 INTRODUCTION

A cleanroom is a controlled environment that has a specified level of airborne contamination. For the past decade, operating rooms have employed this technology. There is a total of three main standards for cleanroom classification. They are International Standard Organization (ISO) 14644, Federal Standard (FS) 209, and British Standard (BS) 5295. In Malaysia, the ISO 14644 standard [1] is widely applied in both academic and industrial fields. The attributes of a cleanroom are particle concentration, air temperature, relative humidity, room pressure, and air-change rate. Table 1 shows that there is a total of 9 classes as prescribed in ISO 14644-1. Each class has different allowable limits when it comes to particle concentration

**Table 1:**ISO 14644-1 air cleanliness classification and maximum allowable particle concentration.

| Classification numbers (N) | Maximum concentration limits (particles/$m^3$ of air) for particles equal to and larger than the considered sizes shown below | | | | | |
|---|---|---|---|---|---|---|
| | 0.1µm | 0.2µm | 0.3µm | 0.5µm | 1.0µm | 5.0µm |
| Class 1 | 10 | 2 | | | | |
| Class 2 | 100 | 24 | 10 | 4 | | |
| Class 3 | 1000 | 237 | 102 | 35 | 8 | |
| Class 4 | 10000 | 2370 | 1020 | 352 | 83 | |
| Class 5 | 100000 | 23700 | 10200 | 3520 | 832 | 29 |
| Class 6 | 1000000 | 237000 | 102000 | 35200 | 8320 | 293 |
| Class 7 | | | | 352000 | 83200 | 2930 |
| Class 8 | | | | 3520000 | 832000 | 29300 |
| Class 9 | | | | 35200000 | 8320000 | 293000 |

The relative humidity for an ISO operating room should fall within 45% to 65%. Recently, Liang *et al.* [2] reported that relative humidity (RH) higher than 65% promotes the growth of microbial. They also identified that a high level of RH increases microbial activities. It is necessary for an

operating room to prohibit the presence of the microbial, as it will increase the tendency of patients getting a surgical-site infection. The recommended air temperature at surgical sites should fall within 18ºC to 22ºC. This temperature range will slow down microbial activities and inhibit microbial growth. Murphy [3] also reported that 18ºC is the favourable condition in an operating room. It allows the surgeons and the medical team to work under thermal comfort conditions.

In Malaysia, the differential pressure should staymore than +5 Pa for operating room to control room and more than +8.5 Pa for operating room to corridor[], where a pressure of +25 Pa is practiced in Hong Kong operating rooms []. Based on a study conducted by Mears *et al.[]*, door openings during surgical processes much affect the room pressure drop. Hence, a larger positive pressure is favourable to be practiced in operating rooms. So far, the side effects of large positive pressure still remain unreported.

An ISO 14644 standard recommends the amount of air change rate (ACH) in operating rooms should remain above 20/hr. Recently, Li *et al.* [7] proposed that a high air-change rate managed to lower particle concentration. However, it is a waste of electricity consumption to increase the air-change rate. He further concluded that an ACH of 20/hr is adequate in promoting airborne particle concentration that meets the requirements of cleanroom specification. Hence, a high ACH of more than 45/hr is not recommended in a cleanroom. Wallace *et al.* [8] also claimed that a high ACH increases the electricity usage much. Besides that, Khalil *et al.* [9] discovered that a high ACH will induce turbulent flow and cut the particles removal. Recently, Memarzadeh and Xu [10] found out that ventilation design is more effective than ACH in terms of removing contaminated air. The following equation computes the ACH of a cleanroom in a positive pressure operating room [11].

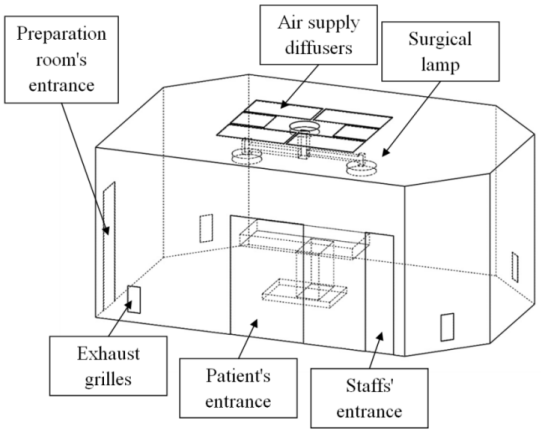
$$\text{Air Change Rate per Hour} = \frac{\text{Total supply air}\left(\frac{m^3}{min}\right)\times 60}{\text{Room volume}\,(m^3)} \qquad (1)$$

This article presents a systematic assessment of cleanroom performance in one of the private hospital operating rooms in Selangor, Malaysia. The goal of this article is todemonstrate the standard method for a cleanroom performance assessment in an ISO Class 7 operating room.

## 2. METHODOLOGY

### 2.1 Description of the operating room

Figure 1 shows the isometric projection view of the real operating room that is regularly used in one of the private hospitals in Selangor, Malaysia. It is categorized as an ISO Class 7 cleanroom with the dimension of 7.5 m L × 6.0 m W × 3.0 m H. The air is delivered through air supply diffuser mounted on the ceiling. The air filtration for this operating room occurs in three stages. The first and second stages filters have a trapping efficiency of 30% and 95%, respectively. The third-stage filter, also known as a high-efficiency particulate air (HEPA) filter is capable of trapping 99.97% of particles with sizes larger than 0.3 μm. [12, 13]. About 10% of the total ceiling area is covered by the air supply diffuser and surgical lamp fixtures. In other words, 90% of the ceiling area is occupied by blank panels. There is total of 3 entrances: patient's entrance, staff's entrance, and preparation room's entrance. The patient's entrance and staff's entrance are directly linked to the corridor. It is the traffic pathway for both patients and staffs. The preparation room's entrance is used for transmitting the surgical tools and instrument.



### 2.2 Measurement procedure

The field measurement of particulate matters, relative humidity, air temperature, room pressure, air change rate, and supply air velocity was carried out in August 2015. In this study, the procedures to assess the cleanroom performance follow the methods set by three standards, namely ISO14644-1 [1], IEST-RP-CC006.2 [14] and NEBB Procedural Standards for Certified Testing of Cleanroom [15]. To ensure steady-state operating conditions, the air conditioning system was working for at least 24 hours before commencing the field measurement. During measurement processes, all doors within the suite were closed to avoid unexpected changes in the airflow. People or traffic movement is prohibited as well. The operating conditions comply with ISO 14644 standards, where the air velocity is 0.45 m/s +/- 20%, air change rate of > 20 per hour, relative humidity of 55% +/- 10%, temperature of 20ºC +/- 2ºC, and room pressure of >5 Pa. Table 1 shows the details of the operating room.

**Table 2:**Details of the operating room

| Description | Operating Room |
|---|---|
| Standard | ISO Class 7 |
| Types of Airflow Supply | Unidirectional & vertically downward |
| Room Size | 13 $m^3$ |
| Staff Entrance | 0.6 m W × 2.1 m H |
| Patient Entrance | 1.3 m W × 2.1 m H |
| Exhaust Grilles | 0.22 m W ×0.46 m H |
| Air-Supply Diffuser | 1.2 m W × 0.6 m L |

### 2.3 Instrumentation set-up

An Alnor EBT 731 micro-manometer was used to measure airflow velocity and pressure differential. There are several advantages of using this manometer instead of other anemometers such as the vane type, hot-wire type, and cup type. By using the manometer, the mean velocity can be measured at a large nominal face area of an air supply diffuser. Moreover, the air-change rate can be measured directly by coupling the manometer with a capture hood. This manometer also managed to measure the pressure difference between two adjacent zones with an error of +/- 3% for both air velocity and pressurization. All doors in the operating room were closed throughout the duration of the measurements.

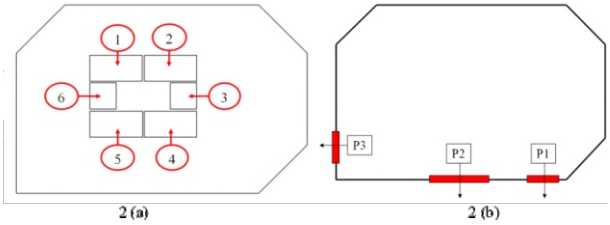



Figure 2: (a) Sampling number of fan filter units (FFU) (b) Plan view for pressure differential measurement locations

A commercially used TSI 9310-02 airborne particle counter quantifies the different particulate matters, namely PM 0.5, PM 1.0, and PM 5.0. Its portable function makes it favourable to be used in this study, where a Testo 625 temperature humidity meter measures the temperature and relative humidity. All the instruments were properly calibrated before the measurement processes were carried out. The measurements were recorded once the readings from the measuring instruments stabled. The 95% upper confidence limit (UCL) as shown in Equation (2) was used to increase the confidence level of the measured particles concentration [1]:

$$95\%\ \mathrm{UCL} = \bar{C} + F_{UCL} \times \sigma_C/\sqrt{N} \qquad (2)$$

where UCL is the upperconfidence limit; $\bar{C}$ is the mean value of particle concentration in particles/$m^3$,$F_{UCL}$ is the factor of UCL, N is the number of samples,and$\sigma_C$ is the standard deviation of particle concentration in particles/$m^3$.

The measurements of airborne particles, temperature, and relative humidity were conducted at 1.1 m above floor level. Because patient's incision exposes to airborne particles at this elevation [14]. The sampling points were coordinated in a lattice arrangement as suggested by IEST standards to get correct sampling data. Figure 3 (a) and (b) shows the arrangement of the sampling points for airborne particle and air relative humidity / temperature, respectively. Each mesh size was fixed not greater than 30 $m^2$. The operating room was divided into 9 sections for measuring airborne particles and 6 sections for both relative humidity and temperature measurements. The

sampling point was placed at the centre of each section and the duration of each sampling was set within 1 minute.

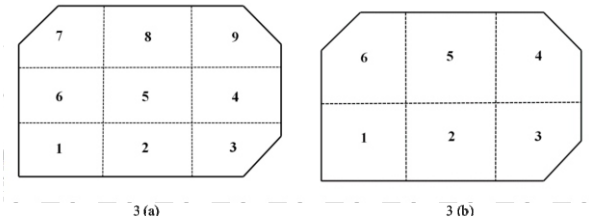



Figure 3: Sampling points arrangement at 1.1 m above floor level for (a) airborne particles, and (b) temperature and relative humidity

**2.4 Data collection procedure**

**2.4.1 Airflow velocity, airflow volume and air-change rate**

During the measurements, the capture hood should fully cover the filter face area. There should be no gap between them in order to prevent air leakage. Two readings were taken at each filter to obtain the average airflow velocity. The airflow volume can be calculated through the average airflow velocity times with filter face area. The air-change rate can also be obtained via Equation (2).

**2.4.2 Room differential pressure**

Differential pressure between the room and adjacent zones were measured with manometer. There are two detection probes for manometer: main probe and secondary probe. The main probe is placed in the room whereas the secondary probe is placed at adjacent zones. The reading is available after allowing the values to stabilize.

**2.4.3 Airborne particles concentration**

A TSI 9310-02 airborne particle counter was used to measure the particle concentrations. Three particle sizes of PM 0.5, PM 1.0 and PM 5.0 were measured simultaneously. The counter's sampling rate was 1 $m^3$/min and the sampling time was set to 1 minute. The counter is placed on the tripod at 1.1 m above floor level. One sample was taken at the centre of each section as shown in Figure 3(a).

**2.4.4 Temperature and relative humidity**

Both temperature and relative humidity were obtained simultaneously. The probe of the temperature humidity meter was placed at the centre of the sampling section as shown in Figure 3 (b). It was placed at a height of 1.1 m above floor level.

## 3 RESULTS

### 3.1 Airflow velocity, airflow volume and air-change rate

The air supply diffuser supplied an average air velocity of 0.43 m/s, producing a nominal air-change rate of 38/hr. The exhaust air is drawn out through return grilles at insignificant different flow rates, placed on corners of walls at floor levels. Table 3 tabulates the airflow data

Table 3: Average air velocity and airflow volume for operating room.

| FFU No. | Velocity (m/s) | | | Airflow Volume ($m^3$/hr) |
|---|---|---|---|---|
| | 1st Attempt | 2nd Attempt | Average | |
| 1 | 0.47 | 0.48 | 0.48 | 1128 |
| 2 | 0.38 | 0.39 | 0.39 | 814 |
| 3 | 0.45 | 0.45 | 0.45 | 601 |
| 4 | 0.36 | 0.36 | 0.36 | 854 |
| 5 | 0.39 | 0.39 | 0.39 | 825 |
| 6 | 0.53 | 0.53 | 0.53 | 708 |
| | Total airflow volume ($m^3$/hr) | | - | 5134 |
| | Average velocity (m/s) | | 0.43 | - |
| | Standard Deviation | | 0.06 | - |
| | Relative Standard Deviation | | 14.99% | - |

*FFU representing fan filter unit*

### 3.2 Room differential pressure test

The operating room has a positive pressure compared to both corridors and preparation room. The tabulated values of the pressure difference are shown in Table 4.

Table 4: Pressure difference to adjacent zones

| Locations | Room Differential Pressure (Pa) | | | Operating Room with Respect to |
|---|---|---|---|---|
| | 1st attempt | 2nd attempt | Average | |
| P1 | +15.20 | +15.40 | +15.30 | Corridor |
| P2 | +20.50 | +20.60 | +20.55 | Corridor |
| P3 | +17.70 | +17.70 | +17.70 | Preparation Room |

### 3.3 Airborne particles concentration of PM 0.5, PM 1.0 and PM 5.0

The average concentration of PM 0.5, PM 1.0 and PM 5.0 are 146400 particles/$m^3$, 6898 particles/$m^3$, and 224 particles/$m^3$, respectively. The standard deviation, standard error, UCL factor, and 95% upper-confident limit are tabulated in Table 5.

Table 5: Standard deviation, standard error, UCL factor, and 95 % upper-confident limit for particle concentration measurement.

| | Particulate matter concentration (particles/$m^3$) | | |
|---|---|---|---|
| | PM 0.5 | PM 1.0 | PM 5.0 |
| Average | 146400 | 6898 | 224 |
| Standard deviation | 32945 | 1956 | 154 |
| Standard error | 16248 | 974 | 77 |
| UCL factor | 1.90 | 1.90 | 1.90 |
| 95% upper confident limit | 167265 | 8136 | 321 |

### 3.4 Temperature and relative humidity measurements

The temperature and relative humidity were maintained at a constant value throughout the operating room. The temperature readings fall at 18.1 ºC +/- 0.1ºC. The relative humidity readings fall at 53.1% +/- 0.1%. Large fluctuations in both temperature and relative humidity are not discovered in the operating room.

## 4. DISCUSSION AND CONCLUSION

ISO 146444-1 standards recommend that the rate of air change (ACH) for an ISO Class 7 operating room should greater than 20/hr for effectively diluting the contaminated air. The main reason that affects the ACH is the ventilation systems [16]. A ventilation system with circulating air usually can deliver 25/hr the least [16] & [17], whilst for the system that introduces fresh air, it can give 15/hr the slightest. Based on the above reports, the air-change rate obtained from the airflow measurement indicates that this operating room meets the requirement specified by ISO 14644 standards, i.e. 38/hr.

The operating room has a positive pressure of at least +15.30 Pa with respect to corridors and the preparation room. This indicates that there is no infiltration of particulate matters from the adjacent zones. Chow *et al.* [5] suggested that a positive-pressure operating room is capable of reducing the risk of patients being infected with surgical-site infection. He further concluded that a negative-pressure operating room is only needed when there is an outbreak of avian influenza or other respiratory epidemics.

The average concentration of PM 0.5, PM 1.0, and PM 5.0 were recorded as 146400 particles/$m^3$, 6898 particles/$m^3$, and 224 particles/$m^3$, respectively. The measured values fall within the allowable concentration limit as proposed in the ISO Class 7 recommendations. Further study could also be conducted to determine the microbial concentration, as it can help in establishing the correlation between microbial counts and PM counts.

The relative humidity and temperature differences within the operating room are insignificant. The fluctuation differences are 0.1% and 0.2ºC, respectively. Based on Figure 4, there was no obvious correlation between relative humidity and temperature. Recently, Kamar *et al.* [13] conducted a study on particulate matters concentration in an operating room. They concluded that both relative humidity and temperature have negligible effects on particles transport. However, Liang *et al.* [2] reported that relative humidity and temperature have significant effects in promoting the growth and activities of microbial.

A systematic procedure for evaluating the cleanroom performance has been conducted in this study. Based on the experimental data, the average particulate matter concentrations (146400 particles/$m^3$ of PM 0.5, 6898 particles/$m^3$ of PM 1, 224 particles/$m^3$ of PM 5), air-change rate (38/hr), supply air velocity (0.43 m/s), air temperature (18.1ºC), relative humidity (53.2%), and room pressure differential (>15.3 Pa) fulfilled the requirements as prescribed in ISO Class 7.

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# STREAMBED HYDRAULIC CONDUCTIVITY - A STATE OF ART

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**ABSTRACT -** The hydraulic properties of a streambed are major control in the hydrologic connection between a stream and an aquifer. Streambed characteristics such asthickness, width, bed material, and vertical hydraulic conductivity ($K_v$) have a great influence on streambed hydraulic properties and water movement. The vertical hydraulic conductivity ($K_v$) of streambed plays an important role in river water and groundwater interaction. Determination of the vertical hydraulic conductivity ($K_v$) of the entire riverbed has significant importance for the study of groundwater recharge. This review attempts to summarize the importance and factors influencing streambed hydraulic conductivity. In this paper a large amount of literature has been explained on methods to determine streambed hydraulic conductivity and the problems associated with these methods. A comprehensive review of the work done on streambed hydraulic conductivity is presented placing special emphasis on their spatial and temporal variations.

**Keywords -** hydraulic properties, vertical hydraulic conductivity, groundwater interaction, spatial and temporal variation..

## 1.. INTRODUCTION

Hydraulic properties of a streambed are major control in the hydrologic connection between a stream and an aquifer [1]. They are key parameters in the calculation of stream flow depletion [2]. Better understandings on the sensitivity of various hydraulic properties are beneficial for model development and application purposes [3]. Streambed characteristics such as vertical hydraulic conductivity, bed material, thickness, width, topography, and the curvature influence the streambed hydraulic properties and thus water movement [4]. The application of flow laws to engineering problems such as design of earth dams, tailing dams, clay liner for waste management practice, and slope subjected to rain water infiltration requires the quantification of hydraulic properties of soil [5].

Modeling of a groundwater system is generally based on solving mathematical equations containing many parameters characterizing the system. In order to have a reliable model, its parameter values should fit their actual ones. Sometimes the parameters can be measured from samples in the field or in a laboratory, or they can be determined by specially designed pumping well tests [6]. Accurate estimation of aquifer properties such as hydraulic conductivity (K), transmissivity (T), and storativity (S) are considered crucial for successful groundwater development and management practices [7].

Hydraulic conductivity (K) is one of the principal and most important soil hydraulic characteristics (parameters) and it is an important factor in water transport in the soil and is used in all equations for groundwater (subsurface water) flow [8].The K-value of a saturated soil ($K_s$) represents its average hydraulic conductivity, which depends mainly on the size, shape, and distribution of the pores. It also depends on the soil temperature and the viscosity and density of the water [7]. In some structure-less soils (sandy soils) the K-value is the same in all directions, but usually the K-values varies with flow direction. Soil layers vertical hydraulic conductivity ($K_v$) is very oftendifferent from horizontal conductivity ($K_h$) because of vertical differences in the structure, texture and porosity [8]. The vertical and horizontal hydraulic conductivities of the streambed play important roles in surface water and groundwater exchanges. Therefore, determination of the streambed anisotropy is of importance in the analysis of stream-aquifer interactions [9].The permeability coefficient of the riverbed is a key factor in the estimation of groundwater recharge from rivers [10].Streambed vertical hydraulic conductivity ($K_v$) also plays an important role in understanding and quantifying the stream-aquifer interactions and stream ecosystems [11]. Higher streambed $K_v$ induces a higher rate of stream depletion due to groundwater withdrawal. Therefore, knowledge of streambed $K_v$ is essential to characterize hydrologic connections between a stream and its adjacent aquifers, and is a necessary parameter in numerical modeling of stream-aquifer interactions [12]. Determination of the streambed vertical hydraulic conductivity ($K_v$) of the entire riverbed has significant importance for the study of groundwater recharge [13]. The major goal in local water resource management is to develop practices that maintain adequate water levels in the streams while allowing withdrawals for agricultural production. The first step is determining the spatial variation in streambed $K_v$ values [14].

The $K_v$value of a soil profile can be highly variable from place to place, and will also vary at different depths (spatial variability). Not only can different soil layers have different hydraulic conductivities but, even within a soil layer, the hydraulic conductivity can vary tremendously [7].The temporal variability of streambed $K_v$ has been studied in detail in the past decades. These studies have shown that temporal pattern in $K_v$ differed from one location to another [15]. Hydraulic conductivity is not generally considered a temporally variable property. However, in the case of inducedstream infiltration temporal variations may be an important consideration [16].

## 2. FACTORS INFLUENCING STREAMBED HYDRAULIC CONDUCTIVITY

Coefficient of permeability (also known as hydraulic conductivity, denoted by 'K') is a highly variable soil property. Previous studies have shown that its coefficient of variation can be as high as 240 %.Bed material size is an important property of streams as it is one of the major factors controlling channel morphology and hydraulics. The rate ofchange in bed material size has important implicationsfor downstream changes in flow resistance and for sediment transport [17]. The two main factors that determine the order of magnitude of the permeability coefficient are: grain size and cleavage (secondary interstices). These two properties can have significant spatial variability, but other influencing factors make the determination of permeability coefficient even more complex are [18].

- Grain shape and orientation
- Quantity and connection of interstices
- Uniformity coefficient
- Water content and saturation conditions before seepage begins
- Properties of the passing liquid (water)
- Hydraulic conditions (hydraulic gradient, Reynolds number etc.)
- Transient phenomena (migration, wash-out and wash-in of grains).

## 3. DETERMINATION OF HYDRAULIC CONDUCTIVITY

Determinations of hydraulic conductivity (K) of soils have done with hydraulic methods or withcorrelation methods. Hydraulic methods can be either laboratory methods or in-situ (or field) methods [7].

### 3.1 Hydraulic Methods

The hydraulic methods are based on imposing certain flow conditions in the soil and applying an appropriate formula based on the Law of Darcy and the boundary conditions of the flow. The K-value is calculated from the formula using the values of hydraulic head and discharge observed under the imposed conditions [19].

#### 3.1.1 Field Methods

The hydraulic in-situ methods can be divided into small-scale and large-scale methods. The small-scale methods are designed for rapid testing at many locations. They impose simple flow conditions, to avoid complexity, so that the measurements can be made relatively quickly and cheaply. The in-situ methods normally represent the K-value of larger soil bodies than the laboratory methods, so that the variability in the results is less, but can often still be considerable [7]. A drawback of the small-scale in-situ methods is that the imposed flow conditions are often not representative of the flow conditions corresponding to the drainage systems to be designed or evaluated.The large-scale in-situ methods are designed to obtain a representative K-value of a large soil body, whereby the problem of variation is eliminated as much as possible. Though these methods are more expensive and time-consuming, but they are more reliable [19].

##### 3.1.1.1 Piezometer Method

This field method can be used for measuring the hydraulic conductivity of layers at relatively great depth or of separate soil layers. Piezometer method is not used in practice very often. This method serves for estimation of impact of soils heterogeneity and also for differentiation of horizontal and vertical components [8]. The piezorneter method is a good method for soil anisotropy investigations. It permits rapid determination of soil layer hydraulic conductivities [20].The streambed vertical hydraulic conductivity values obtained from direct measurement of the streambed with a piezometer is given by:

$$K_v = \frac{Q}{A\,(d_h / d_l)} \qquad (1)$$

Where, Kv = vertical hydraulic conductivity; Q = flow across the portion of streambed covered by the seepage meter; A= cross-sectional area of the seepage meter;

### 3.1.1.2 Slug test

The slug tests include the auger-hole method and the piezometer method, which involve a short term introduction or removal of water via a bored hole into a subsurface interval of sediment, soil, or fractured rock [21]. Ernst, Boast and Kirkham [17] proposed a number of equations for calculation of hydraulic conductivity from auger-hole.They developed two approximate equations for Kfor two different conditions: when the bottom of auger-hole is sufficiently above the impermeable stratum and when the auger-hole cuts across the impermeable stratum. When the bottom of auger-hole is sufficiently above the impermeable stratum,

$$K = \left\{ \frac{4.63\, r^2}{y\,(H + 20r)\left(2 - \frac{y}{H}\right)} \right\} \frac{\nabla y}{\nabla t} \qquad (2)$$

Where, r = the radius of the hole; H = the depth of groundwater from bottom of the auger-hole; y = the difference between the depth of groundwater and the depth of water in the hole; $\frac{\nabla y}{\nabla t}$ = the rate of change of y with respect to time t.

For the condition where the auger-hole cuts across the impermeable stratum, s = 0, hence the equation becomes:

$$K = \left\{ \frac{4.17\, r^2}{y\,(H + 10r)\left(2 - \frac{y}{H}\right)} \right\} \frac{\nabla y}{\nabla t} \qquad (3)$$

One of the problems associated with the auger-hole method is that serious errors might result if proper precautions and steps are not taken during the test.Another problem of this method is the effect of smearing the walls of the hole with the auger which tends to clog the pores and planar voids thereby resulting in wrong estimation of hydraulic conductivity. Also, the auger-hole method does not produce reliable results when the water level is above the soil surface [21].

### 3.1.1.3Field standpipe permeameter test

The field standpipe permeameter test (SP) involves inserting a pipe vertically into the streambed, filling the pipe with river water, measuring the rate of decline of the water level, and then calculating the vertical hydraulic conductivity ($K_v$) using the rate of decline. The tube will be inserted into the streambed sediments, ensuring that the length of the sediment column is approximately 30 cm. River water will be poured carefully into the pipe without destroying the surface structure of the streambed. While the initial water head in the pipe (above the river surface) is recorded, the stopwatch will be started, which records the elapsed time simultaneously. Then, the water head in the pipe will be recorded according to the set time interval. Using the water head records at given time intervals, the values of $K_v$ can be calculated. During each test, the water depth will be measured at each test location to determine its relationship to streambed hydraulic conductivity. The formula used to calculate the vertical hydraulic conductivity $K_v$ is [22]:

$$K_v = \frac{L_v}{t_2 - t_1} \ln(h_1 / h_2) \qquad (4)$$

Where$L_V$ is the length of the measured sediment column, $h_1$ and $h_2$ are the starting and ending water heads at corresponding time $t_1$ and $t_2$.

### 3.1.2 Laboratory Methods

The laboratory methods are applied to core samples of the soil. Although these methods are laborious than the correlation methods, they are still relatively fast and cheap, and they eliminate the uncertainities involved in relating certain soil properties to the K-value. With respect to variability and representativeness, they have similar drawbacks as the correlation methods[7].

### 3.1.2.1 Constant Head Method

The constant head permeameter operation is based on the principles of Darcy's equation of flow through a soil column of uniform cross-sectional area, but in its case, applied to a saturated soil column. It is based on the measurement of the quantity of water that flow under a given hydraulic gradient through a soil sample of known length and cross-sectional area in a given time [19]. The saturated hydraulic conductivity ($K_s$) of the sample is calculated using the mathematical expression:

$$K_s = \frac{V\,L}{A\,t\,\Delta h} \qquad (5)$$

Where V is the volume of water collected through the sample cross-sectional area A in time 't', and Δh is the hydraulic gradient imposed across the length 'L' of the sample [23].

The problem associated with the constant head permeameter method is that the Darcy equation is not valid

for all flow in porous media. Another problem associated with the method is that it does not allow for swelling. In practice, soils with substantial content of clay tend to swell markedly when they absorb water and shrink when dry. Wetness of these soils often causes three dimensional changes in volume while their shrinkage causes opening of cracks which close again when the soil is rewetted [21].

**3.1.2.2 Falling Head method**

The falling head method operates with the principles of Darcy equation as in the constant head method except that in this case, the hydraulic gradient changes with time unlike in the constant head method where the hydraulic gradient is constant. This system is mainly applicable to soils with low hydraulic conductivity where accurate measurement of discharge using a constant head permeameter is difficult [21]. The hydraulic conductivity of the sample is calculated using the mathematical exp

$$K = \frac{a\,L}{A\,(t_2 - t_1)} log_e \frac{h_1}{h_2} \qquad (6)$$

Where a = the cross-sectional area of the standpipe; L =the length of the soil sample; A = cross-sectional area of the soil sample; h = the hydraulic head difference across the sample at time t;$h_1$= the initial hydraulic head; $h_2$= the final hydraulic head; $t_1$= the initial time at $h_1$; $t_2$= the final time at $h_2$.

**3.2 Correlation Method**

The correlation methods for determining K-values in streambed are frequently based on relationships between the K-value and one or more of the following soil properties: texture, pore-size distribution, grain-size distribution, or with the soil mapping unit [7].

**3.2.1Soil texture**

Soil texture refers to the percentage of sand, silt, and clay particles in the soil. Texture or textural class is often used for the correlation of K- values with other hydraulic properties of the soil (e.g. water-holding capacity and drainable pore space) [18].

A generalized table with ranges of K-values for certain soil textures is given in table 1 [7].

Table1. Range of K- values by soil texture [7]

| Texture | K (m/day) |
|---|---|
| Gravelly course sand | 10 - 50 |
| Medium sand | 1 - 5 |
| Sandy loam, fine sand | 1 - 3 |
| Loam, well-structured clay loam and clay | 0.5 - 2 |
| Very fine sandy loam | 0.2 - 0.5 |
| Poorly structured clay loam and clay | 0.002 - 0.2 |
| Dense clay (no cracks, no pores) | < 0.002 |

**3.2.2 Pore-Size Distribution of the Soil**

The pore-size distribution, the regularity of the pores, and their continuity has a great influence on the soil's K-values. Nevertheless, the study and characterization of the porosity aiming at an assessment of the K-values is not sufficiently advanced to be practical on a large scale [7].

**3.2.3Grain-Size distribution**

A relationship between grain-size distribution and hydraulic conductivity has been recognized for nearly 100 years. Methods of predicting hydraulic conductivity from grain-size distribution through quantitative relations have been developed by analogy to pipe flow and flow in capillaries [24]. Grain-size analysis methods provide neither the horizontal ($K_h$) nor vertical ($K_v$) hydraulic conductivities, and they preclude any evaluation of anisotropy or differences in directional hydraulic conductivity [10]. Particle size analysis can give reasonable results for samples of fairly uniform sand with low silt and clay content, provided loss of fines has not occurred. Loss of fines tends to be greater from bulk samples compared with tube samples; K estimated from bulk samples should be treated with caution. It gives very poor estimates in laminated or structured soils or where silt and clay content is significant (relative cost: very low, reliability: very poor to good) [25].

Hydraulic conductivity (K) can be estimated by particle size analysis of the sediment of interest, using empirical equations relating either K to some size property of the sediment. Vukovic and Soro [26] summarized several empirical methods from former studies and presented a general formula:

$$K = \frac{g}{v} C f(n) d_e^2 \qquad (7)$$

Where K = hydraulic conductivity; g = acceleration due to gravity; $v$ = kinematic viscosity; C = sorting coefficient; f (n) = porosity function, and $d_e$ =effective grain diameter. The kinematic viscosity (v) is related to dynamic viscosity (μ) and the fluid (water) density (ρ) as follows:

$$v = \frac{\mu}{\delta} \qquad (8)$$

The values of C, f(n) and $d_e$ are dependent on the different methods used in the grain-size analysis. According to Vukovic and Soro [26], porosity (n) may be derived from the empirical relationship with the coefficient of grain uniformity (U) as follows:

$$n = 0.255\,(1 + 0.83^U) \qquad (9)$$

Where U is the coefficient of grain uniformity and is given by:

$$U = \frac{D_{60}}{D_{10}} \qquad (10)$$

Here, $d_{60}$ and $d_{10}$ in the formula represent the grain diameter in (mm) for which, 60% and 10% of the sample respectively, are finer than these sizes.

Former studies have presented the following formulae which take thegeneral form presented in equation abovebut with varying C, f (n) and $d_e$ values and their domains of applicability [26].

Hazen formula [27] was originally developed for determination of hydraulic conductivity of uniformly graded sand but is also useful for fine sand to gravel range, provided the sediment has a uniformity coefficient less than 5 and effective grain size between 0.1 and 3mm. The formula is given by:

$$K = \frac{g}{v} 6 \times 10^{-4}[1 + 10\,(n + 0.26)] d_{10}^2 \qquad (11)$$

Where K = hydraulic conductivity; g = acceleration due to gravity; $v$ = kinematic viscosity; n = porosity; Hazen formula for predicting the permeability of sand is based only on the $D_{10}$ particle size. Whereas, the Kozeny-Carman formula [27] is based on the entire particle size distribution, the particle shape, and the void ratio. As a consequence, the Hazen formula is less accurate than the Kozeny-Carman formula. The Kozeny-Carman equation is one of the most widely accepted and used derivations of permeability as a function of the characteristics of the soil medium. This equation was originally proposed by Kozeny and was then modified by Carman to become the Kozeny-Carman equation [26]. This equation is not appropriate for either soil with effective size above 3mm or for clayey soil.

$$K = \frac{g}{v} 8.3 \times 10^{-3} \left[\frac{n^3}{(1-n)^2}\right] d_{10}^2 \qquad (12)$$

Breyer formula [28] is often considered most useful for materials with heterogeneous distributions and poorly sorted grains with uniformity coefficient between 1 and 20, and effective grain size between 0.06mm and 0.6mm.This method does not consider porosity and therefore, porosity function takes on value 1.

$$K = \frac{g}{v} \times 6 \times 10^{-4} \log\left[\frac{500}{U}\right] (d_{10})^2 \qquad (13)$$

Slitcher formula [26] is most applicable for grain-size between 0.01mm and 5mm.

$$K = \frac{g}{v} \times 1 \times 10^{-2}\, n^{3.287} (d_{10})^2 \qquad (14)$$

Terzaghi formula [28] is most applicable for large-grain sand and is given by:

$$K = \frac{g}{v} \times C_t \times \frac{(n - 0.13)^2}{(\sqrt[3]{(1-n)})^2} \times (d_{10})^2 \qquad (15)$$

Where, $C_t$ = sorting coefficient and $6.1\times 10^{-3} < C_t < 10.7\times 10^{-3}$.In this study, an average value of Ct is used.

## 4. SPATIAL AND TEMPORAL VARIATION OF HYDRAULIC CONDUCTIVITY

Some studies have revealed that the vertical hydraulic conductivity changes significantly along the river cross section (perpendicular to the river flow) [28]. Along the

river flow (in the downstream direction), even in a small reach (no more than hundreds of meters), the permeability varied remarkably. However, there were no consistent patterns of the variability of $K_v$ at transects across the river, which was influenced by the variation in streambed characteristics [13].

Usually the grain size of streambed sediments declines with the distance downstream due to abrasion and sorting, and selective transport [29] and a downstream gravel–sand transition occurs [30]. Additionally, sediment source of the tributaries plays a significant role in controlling the grain-size pattern change for river bed sediments [31].Generally it is found that as the distance increasing from the river bank towards the center, streambed $K_v$ values are also increasing. These changes in $K_v$values are mainly due to the variation of streambed sediment grain size between the center and sides of the channel. Another important factor influencing $K_v$values is streamwater velocity. In streams, the velocity of water is higher in the middle part as compared to the sides of channel. This leads to the settling of finer particles near the river bank [28].

The streambed$K_v$values of the topsoil are often subject to changes with time, which can be seasonal variations or time trends. This is due to the drying of the topsoil during a dry season or after the introduction of drainage. But in the case of subsoil, the effect of drying, wetting, and other biological processes are also less pronounced. Therefore streambed $K_v$values of subsoil are considered to be less variant [7].Temporal variability in streambed $K_v$ remains relatively unexplored, though there is reason to expect it may occur in response to one or more temporally-variable drivers such as erosion and deposition, temperature, bioturbation, or streambed microbial activity [28].

## 4. CONCLUSION

Hydraulic conductivity is a function of the properties of the fluid as well as the properties of the media. A number of factors may influence the stream bed hydraulic conductivity and therefore, a better knowledge of these factors is helpful to increase the accuracy of measuring streambed hydraulic conductivity ($K_v$).

There is a vast number of laboratory and in situ tests to determine thehydraulic conductivity. Each method has its own advantages, drawbacks and limitations, so different methods should be preferred in different situations.The choice depends on data availability and the budget of a project. Accurate estimation of hydraulic conductivity in the field environment is limited by the lack of precise knowledge of aquifer geometry and hydraulic boundaries.Economic consideration associated with field operations may also be a limiting factor.Alternatively, methods of estimating hydraulic conductivity from empirical formulae based on grain-size distribution characteristics have been developed and are used to overcome these problems.

Streambed $K_v$ is always spatially and temporally variable.Generally, the larger $K_v$ occurs in the midstream, while the smaller occurs close to the bank.Usually the grain size of streambed sediments declines with the distance downstream due to abrasion and sorting, and selective transport. Additionally, sediment sources of the tributaries play a significant role in variability of streambed $K_v$. The change of vertical hydraulic conductivity ($K_v$) before and after a flood season is crucial in understanding the long-term temporal variation of streambed permeability.

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# The application of models to The microRNAs mediated viral oncogenesis.

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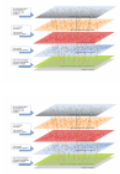
**ABSTRACT** MicroRNAs are a recently discovered class of small noncoding functional RNAs. These molecules mediate post-transcriptional regulation of gene expression in a sequence specific manner. MicroRNAs are now known to be key players in a variety of biological processes and have been shown to be deregulated in a number of cancers. The discovery of viral encoded microRNAs, especially from a family of oncogenic viruses, has attracted immense attention towards the possibility of microRNAs as critical modulators of viral oncogenesis. The host-virus crosstalk mediated by microRNAs, messenger RNAs and proteins, is complex and involves the different cellular regulatory layers. In this commentary, we describe models of microRNA mediated viral oncogenesis

**Introduction**

Interest in the involvement of infectious agents in oncogenic transformation, and more so viruses, has been of historical importance, probably starting with Rous' discovery of filterable particles that could transmit avian sarcoma [1]. This was followed by the discovery of the role of other viruses in oncogenic transformation of eukaryotic cells. Subsequently, attempts were made to understand the molecular mechanisms of viral oncogenesis. A new field of noncoding RNA mediated regulation has emerged following the discovery of microRNAs, which are ~22 nucleotide long noncoding regulatory RNAs found in eukaryotes and viruses, and the unraveling of their critical roles in normal and abnormal biological processes including development, host-virus interaction and neoplasia [2]. These small endogenous noncoding RNAs are derived from introns or intergenic regions in the genome, many of which were previously thought to be 'junk DNA'. They are processed from hairpin forming precursors by a battery of cellular proteins. These small RNAs, in association with a ribonucleoprotein complex termed as the RNA Induced Silencing Complex, or RISC, mediate post-transcriptional regulation of gene expression. They do this by binding to the 3'UTR regions of the transcripts, harboring regions of imperfect complementarity. The biogenesis and action of microRNAs have been extensively reviewed [3,4]. The role played by microRNAs in the defense of mammalian cells against virus infection has also been discussed recently [5-7].

MicroRNAs constitute a hitherto unexplored layer of genetic interactions between the virus and the host. The regulatory impact of microRNAs is huge because a single microRNA can regulate multiple transcripts and multiple microRNAs can regulate a single transcript. This is very similar to transcriptional regulatory networks. Models of microRNA in host-virus cross-talk have been reviewed recently [8,9]. The recent discovery of microRNAs encoded by a number of viruses, including many human oncogenic viruses, has attracted renewed interest in the molecular mechanism of viral oncogenesis. This novel regulatory layer, mediated by microRNAs, has a far-reaching impact on the latency and pathogenesis of viruses, including the mechanism of virus induced cancers. The molecular role of microRNAs in viral oncogenesis may be diverse, ranging from viral encoded microRNAs to virus encoded suppressors of RNA interference. Cancer itself is multifactorial, wherein deregulation at multiple levels culminates in the global regulatory derangement, thereby making molecular oncogenesis an enigma. In this review we discuss, in light of recent reports, the various possible mechanisms and/or models of host-virus interactions culminating in oncogenesis mediated by microRNAs. Figure Figure11 provides a simplistic overview of the role of microRNAs in viral oncogenesis. Challenges in the field and future perspectives are also discussed

Figure 1



Model for host-virus crosstalk in viral oncogenesis. The planes describe the different layers of cellular regulatory organization and the interconnections between different layers marked by thin lines. The arrows on the left side show the mechanisms where (more ...)

Here, we survey host-virus crosstalk culminating in oncogenesis encompassing five major models: (1) viral microRNAs and their effects, (2) viral integration and its effects on host and viral microRNAs, (3) virus induced genetic instabilities, (4) virus mediated suppression of RNA interference, and (5) Virus induced epigenetic changes.

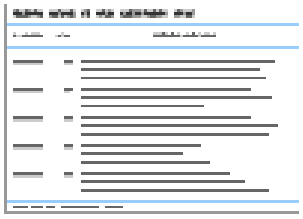
**Virus encoded microRNAs and their cellular targets**

Recent genome-wide screens, enabled by computational approaches and high-throughput validation, have discovered 109 microRNA precursors encoded by viruses. A major chunk of the currently known microRNAs are encoded by the herpes virus family of viruses which include a number of human oncogenic viruses like Herpes Simplex virus, Kaposi Sarcoma Herpes Virus and Epstein Barr virus. The logical question then would be: what are the targets of these virus encoded microRNAs and what are the physiological processes regulated by these microRNAs. A computational analysis of the targets of EBV encoded microRNAs, using a consensus prediction of three commonly used target prediction algorithms, reveals that the transcripts targeted by these microRNAs are over-represented in the genes associated with apoptosis and tumor-suppression [9]. Moreover, a majority of these RNAs are derived from the BART and BHRF cluster of genes, which are classically known to be activated during latent phase of the virus [10]. This finding becomes more relevant in light of recent evidence that suggests that in EBV induced gastric carcinoma, the BART cluster of microRNAs are expressed, while the BHRF cluster is not. Both together suggest an important role for the BART cluster of microRNAs in EBV mediated gastric carcinomas [11] and probably, in other cancers caused by the virus. Recent experimental evidence on the targets of Herpes Simplex Virus, another related Herpes virus, also shows that virus encoded microRNAs target transcripts involved in apoptosis [12]. Similarly another oncogenic virus in avians, Marek's Disease virus (MDV) has been recently shown to encode a microRNA targeting the latency associated transcript and its expression in MDV induced tumors [13,14].

Computational algorithms for prediction of miRNAs' target transcripts have improved drastically over recent years. The current state of the art computational techniques and their application in the prediction of microRNA-targets was reviewed by Maiere and Enright [15]. Efficient computational methods, combined with high-throughput experimental methods, have greatly facilitated the task of miRNA and target identification. The putative functional roles of virus encoded microRNAs are summarized in Table 1. However, the steady increase in the number of microRNAs encoded by viruses does not match with the number of targets experimentally validated, which is a deterrent towards understanding the functional role of these microRNAs. This is primarily because rapid experimental validation of computational predictions is still an unmet challenge.

Table 1

List of virus-encoded microRNAs and their possible functional roles



**Virus integration modulating host microRNAs**

Integration of the viral genome into the host and its effect in tumorigenesis have been active areas of research in oncology. This field has been particularly enriched by studies of gene therapy vectors and the emergence of transposon-mediated mutagenesis as tools to study gene function. Viral integrations can occur non-randomly in the

host genome, with some classes of viruses showing specific insertion patterns. Viral integration is also known to result in short or long range effects on the expression of host genes including genes which code for microRNAs. Recent reports show that oncogenic microRNAs could be up-regulated by viral integration in their vicinity [16,17]. Feitelson *et al*. [18]reported that in Hepatitis B induced viral hepato-carcinogenesis a large number of viral integration events occur near or within fragile sites and/or other cancer-associated host loci which are prone to instability or are critical for tumor development and progression [19]. Similarly, loss of miRNA function can also occur via viral integration because some microRNAs fall within regions disrupted by viral integration. An example for this is hsa-mir-566, a repeat associated microRNA which falls in a retroviral integration site (unpublished results). This throws open a new avenue, whereby stochasticity of viral integration events could differentially modulate the expression of tightly regulated factors, culminating in neoplasia. The effect of viral integration and the consequential modulation of gene expression, including microRNAs and modulators of microRNA expression, have not been explored in detail. Recent analysis of chromosomal susceptibility loci in murine cancers has suggested the association between the locations of mouse miRNAs and known sites of retroviral integration in mouse cancers [20]. Computational analysis of viral integration site libraries for microRNA genes in nearby regions would prove to be useful in understanding viral modulation of microRNA expression and the pathogenesis of viral oncogenesis. Viral transcripts could also possibly modulate host microRNA expression by sequestering microRNAs or the cell's microRNA processing machinery, and tilting the balance of normal cellular regulation, similar to the description of target mimicry in Arabidopsis [21].

**Virus induced genetic instabilities and errors in DNA repair**

Apart from viral integration, genetic instabilities induced by viruses have also been extensively studied. Fragile sites and genomic instabilities, including aneuploidies, have been of particular interest in studying mechanisms of oncogenesis. Recent computational screens for fragile chromosomal breakpoints associated with cancers, including regions of instability induced by papillomaviruses, have shown that many microRNAs including oncogenic microRNAs lie in close proximity to regions of chromosomal rearrangements [19]. Apart from chromosomal rearrangements and instability, virus-mediated suppression of cellular DNA repair, activation of telomerase and telomere maintenance have been well explored in cancers. Examples of viral supressors of the DNA repair mechanism include the E6 protein of Human Papillomavirus which down regulates the methyl guanine methyltransferase (MGMT) and the X protein encoded by Hepatitis B virus, which interacts with UVDDB, a putative DNA repair protein. Viral activation of telomerase has been well studied in the context of KSHV where KSHV viral associated nuclear antigen which binds to Sp1 and transactivates telomerase expression [22]. Widespread mutations in the host genome and their effects on microRNA mediated regulation have not been actively pursued though accounts of mutational effects on microRNAs and target regions in the 3'UTR have emerged very recently [23].

**Virus encoded suppressors of RNAi**

RNA interference has emerged as a mechanism of antiviral defense in many plants and insects. Viruses have overcome this by encoding for proteins that can particularly suppress the RNAi mechanism by multiple methods ranging from binding to dsRNA, to binding and disrupting functions of key proteins involved in microRNAs processing [24-26]. Such global suppressions of host microRNA expression have been recently shown in HIV infection studies [27]. Recently Haasnoot *et al*. [28] have shown that Ebola Virus VP35 protein is a suppressor of RNAi, akin to the function of Tat in HIV infection. This means that suppressors of RNAi are a conserved feature in many pathogenic viruses. Many of these mechanisms culminate in deregulation of microRNAs biogenesis. Such global derangement of microRNA biogenesis has been recently shown to be oncogenic [29]. Direct evidence for virus encoded suppressors of RNAi resulting in a global derangement of microRNA biogenesis resulting in abnormal microRNAs

mediated regulation of key tumor suppressors and cell cycle checkpoint genes remains to be established. It would also be interesting to explore how viral microRNAs modulate the cellular RNAi mechanism to regulate viral and/cellular targets.

**Virus induced epigenetic changes in the host**

Epigenetic changes have recently been shown to be critical in modulating the spatial and temporal expression profiles of microRNAs. Viruses, especially those involved in oncogenesis have been extensively investigated for their potential to modulate host epigenetic changes, including DNA methylation, histone modification and chromatin remodeling. Flanagan has exhaustively reviewed the different models of host epigenetic regulation by oncogenic viruses [30]. The possibility of viral proteins to modulate microRNA expression through epigenetic mechanisms has not been thoroughly studied. Recent evidence has substantiated an epigenetic role for viral microRNA in the transcriptional silencing of HIV [31]. Further understanding of how viral microRNAs modulate epigenetic regulation would open up potential new arenas for therapy.

**Virus infection modulating microRNA expression and host signaling**

Viral infections have been shown to modulate host gene expression in multiple ways. One major pathway used by host cells in viral defense is the Toll-like receptor (TLR) pathway. Viruses have the potential to activate Toll-like receptors. TLR-pathways can trigger a cascade of downstream effectors, some leading to the activation of transcriptional modulators such as NF kappa B which can in turn regulate the expression of oncogenic microRNAs [32]. It remains to be seen whether this type of virus-initiated circuitry contributes substantively to the effects of chronic viral infections which can result in cancers.

Separately, recent evidence suggests that HIV-1 infection can significantly remodel the host cell's microRNA profile [33]. Specifically, HIV-1 appears to down regulates a number of antiviral microRNA genes and to up regulates of a small number of microRNAs, including the miR-17-92 cluster of microRNAs previously known to be involved in oncogenesis [27]. The exact role of these microRNAs in viral pathogenesis and/latency is not known. There is a possibility that the functional role of the microRNAs would be different in different cell-types due to transcript diversity between cell types.

The way forward- understanding microRNA role in viral pathogenesis: a systems biology approach to host-virus interaction

The current understanding of the role of microRNAs in host-virus crosstalk or viral oncogenesis is far from complete. There is a need to co-ordinate efforts from multiple experimental labs to build a holistic view of host-virus interactions. This would include prediction and validation of genome-scale protein-protein and microRNA -target interactions, along with temporal analysis of gene expression which could be integrated onto a bioinformatics platform to understand the dynamics and intricacies of host-virus crosstalks. Recently, a number of databases of biological pathways and protein interactions including host-pathogen interactions as in the case of HIV have been developed by Reactome [34]. Similarly, there have been consistent efforts to collect gene expression and proteomic datasets in central repositories [35]. Availability of high-throughput expression and proteomics coupled to high performance operating platforms could allow one to integrate questions and answers in a systems biology manner. This collective approach could greatly aid in understanding host-virus interactions in an inclusive way.

**Authors' contributions**

VJ and VS conceived the topic. Both authors discussed the data and formulated the models .VS wrote the manuscript. Both authors read and approved the final manuscript.

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# Culture, Teaching & Content – The trifecta that leads to fewer women in Engineering

Mr Robert Snelling

Engineers Without Borders Australia

It is well understood that gender diversity in the workforce brings many benefits including increased innovation and diversity of engineering knowledge. Whilst other professions, such as law, have managed to reach near gender parity of graduates entering the workforce, engineering has been left behind. Within Australia, women constitute just 14.2% of engineering course acceptances and only 10.7% of the wider engineering workforce. Forming part of a wider series of` initiatives on diversity in STEM (science, technology, engineering, mathematics), this paper represents findings from an investigation into the current state of gender diversity within the Australian engineering profession. The report foundthat there were three key life-stages where a women's decision to enter or leave the engineering pipeline was highly susceptible to change: school, university and the workforce. Across all three life-stages, the themes of culture, teaching and content were prominent and consistent. In school, gendered academic stereotypes, unengaging teaching methods and decontextualized content all influencelowering school science enrolments and stagnant university course uptakes by women. At university, negative student cohort experiences, mismatches of teaching and learning styles and curriculum content that is not socially grounded predict few women entering the profession upon graduation.In the workforce, an unaccommodating masculine culture, a lack of mentor support and discrimination in content and career advancement opportunities dissuade further career continuation once entering the profession. This investigation suggests various future research topics based on these findings including exploring the connections between female teachers and increased engineering university enrolments as well as investigating university curriculum changes and researching mentor arrangements to mitigate negative cultural experiences. Overall, addressing low gender diversity requires a holistic approach that considers all three key issues(culture, teaching, content) at all three life-stages (school, university, professional workforce).

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# Modeling a Software Development Process in a Small Software Firm using SP2MN: a case study

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**ABSTRACT:** Nowadays, software Process Modeling is becoming a higher priority in software development industry. Software process modeling delivers many benefits for a software firm and its development process in several aspects, principally in, improving the project management, reusing the knowledge acquired about software development among development teams, comparingsoftware work products across projects on a concrete basis, and makingeasier and less error prone the evolution of the software process itself.Several software process modeling formalisms have been introduced lately, however, they have failed to gain the attention of the industry.Modeling a software process using the existing modeling formalisms is not an easy effort for software teams especially in small software firms. One of the noticeable reasons is the complexity of their modelling notations. This paper presents SP2MN, a simple and graphical-based software process modeling formalism. We show how this modeling formalism is applied in a small size Malaysian software company to formalize and model their software process. The purpose is to prove the simplicity of SP2MN, it's capability to enhance the understanding and communication among the software process users, and to study its acceptability and adoptability by the software development team.

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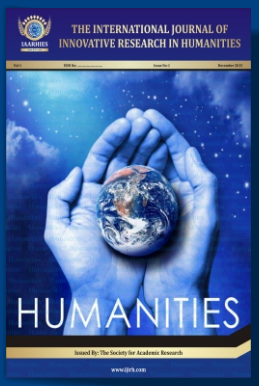


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