AUGMENTING WALKABILITY, VISIBILITY AND ARRANGEMENT FOR KOREAN ICU
Nurse Station ANOVA application: Enhancing walking by Log Ware, Visibility by Depth map and Arrangement by Pattern Recognition

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Abstract—Clinical teams are facing increasing demands to perform more consistently and efficiently in delivering improved health outcomes. Hospital management team in Korea face difficulties in complex routine task for nurse, which result in workforce burnout, fatigue, foot and hip ailments from the necessary walking during a single shift on corridors as questionnaire suggested. Three analysis of variance as walkability, visibility and arrangement are applied as programmed attributes from a set of seven Korean adult intensive care units (ICUs), namely SNUH, SSMU, SCC, DUIH, KUMC, PNUH, YUHS. These ICUs are accepted as the best-performing prototypes by the Korean Institute of Healthcare Architecture as Acute Care Medicine. This study systematically analyses the Nurse Station (NS) visit to the patient bed, than calculates minimum round route on the ICUs depth map plan; with aid of the connectivity on supply chain simulation analytical tool ‘route stop’ of LogWare. It was found that the maximum walk was calculated for the singular NS at KUMC where primary NS walks 542.005 feet zigzag path and secondary NS walks 214.814 feet linear path. Conclusively, ANOVA predicted three optimum arrangements which were concentric around NS: L-Shape, U- Space or O- Shape scored 5/5 thus walking for nurse reduces and utmost visibility was illustrated. On the contrary I shape and zigzag pattern was recognized as not very efficient arrangement with 2/5 score, due to an increase in walking and reduction in visibility to the last patient in the row.

Index Terms—Analysis of Variance, EBD, Space Syntax connectivity, NS, Korean ICU, LogWare route Stop Sequence, Seoul National University Hospital (SNUH), Seoul St. Marry Hospital (SSMU), Samsung Cancer Center (SCC), DonGuk University International Hospital (DUIH), Konkuk University Medical Center (KUMC), Pusan National University Hospital (PNUH), Yonsei University Health System (YUHS).

I. INTRODUCTION

The ‘Evidence Based Design’ theory for recent decades have drawn significant attention in healthcare architecture. Despite major challenging accomplishment that healthcare designers have so far achieved, the desired outcome has by and large not yet been entirely achieved. ‘Evidence Based Design’, or EBD [1] is a spontaneous view based on architect’s own practice, moreover it is automatic progression of the ideology of ‘healing environment’. EBD is the diligent, categorical and thoughtful use of up-to-date suitable suggestion from study and performance in formulating significant outcomes, along with a well-advised nursing staff.

Though this updated area of research approach in healthcare settlings is in its early area in Korea [2].

A. Research Question:
How could Optimum Path be extracted, for nurse in ICU?

B. Hypothesis
The organizational arrangement of nurse station can effect, walking pattern along with viewing patterns of patients

C. Analysis of Variance
The variables of analyses is used to determine the relationship between three variables for ICU Plan Type, these are the walking pattern, the viewing pattern and the arrangement pattern, this was done on pattern recognition software. Evaluating EBD’s adoptability into Korean ICU [3] which is a special medical culture and environment, and application of these ideas in a surgical manner for betterment of ICU patient for a safer and efficient stay, these patients are like each other, they tend to like each other.

Since, “Perfection is correlated to competence whereas mistakes are correlated to incompetence” [4] thus Standardization along with the other evidence based design factors, patient and staff comfort is usually utmost priorities. While the old doctrine says “first, do no harm” [5] here it is valid for the nurse’s practice, this applies to healthcare design. The routine route and walking has been hectic for staff. Fatigue control or nurse tiredness or burnout might be greater issues in regards to nurse satisfaction [6], here ‘standardization’ is catered to since it depends on design.
Because few cognitive psychologists have classified, tangible atmosphere has a substantial influence on quality of care and individual executions. ‘Standardization’ has been accepted as a significant strategy in personnel feature design by Reason [7]. Standardized walking and visibility has a potential to improve patient safety to an utmost level [8] & [9] doctors and staff can use these healthcare settings intuitively and efficiently, as a result great amount of reduction in human errors can be calculated. Similar standardization could be applied to these ICU in hospital.

On the other hand EBD can be regarded as a natural progression of ‘healing Environment’ [10] as further more research evidence has become accumulated and available. EBD focuses on measurable outcomes in designing a healing environment. Although the current concept of “healing Environment” emphasizes on reducing patients and staff stress, EBD has been proven to have a positive impact not only on patient outcomes but also on quality and safety, staff satisfaction, operational efficiency and even financial performance. If the nomenclature of “healing environment” becomes a cliché found for every healthcare project, EBD can rejuvenate the meaning of “healing environment” with more clear guides that will allow us to continue our quest towards better design.

In the recent research design we applied EBD theory as far as we could. However it was difficult to implement into real project because it is rather a new concept in Korea.

The main reason is that, in Korea, there is little existing research on EBD, or even POE (post occupancy evaluation) of existing hospitals which is the most basic material for EBD research. Though we as researcher planned to design based on resources and available research. Moreover evaluating the research based on the adoptability into Karachi’s unique culture and medical environment.

Methodology including questionnaire, interview of staff and patients in typical Korean ICU setting. This study is based on the Jeff Hardy [11] proposal that: a view of patient is essential i.e. “no hidden patient” and “out of sight out of reach” strategic elements [12] which serves to manage staff stresses for critically ill in ICU [13 - 19].

II. LITERATURE SURVEY

Standardized bed and movement pattern plan might be augmented along with patient satisfaction to an utmost extent [20]; staff is facilitated to use the healthcare ICU system with greater intuitiveness and effectiveness, thus minimizing human errors. Following are few standardization analysis tools which are applied to these hospitals.

An elaborate system of pattern recognition is found in machine learning technique as recognized by Hanson III, C. William, and Bryan E. Marshall [21] [22] while studying human activity recognition. Kim, Eun Young [23] master’s thesis research is an effort towards, Health-related quality of life (HRQoL) which is a multi-dimensional concept, where a POE including a combination of quantitative analysis as well as qualitative techniques. Here POEs will involve measuring healthcare staff and patient’s placement VS. Nurse route, which is been evaluated; this is achieved through variety of survey.

A. Background of NS form evolution

An optimization of nurse movement is essential for organizational productivity in clinical setting. Major determinant of mobility is spatial layout as reported for NHS report by Dowdeswell [24]. However further research is conducted for correlating nurse movement with types of hospital layout on space syntax by Heo, Y. Choudhary [25]. Hence commutating effectively with patients as well as staff is an ever more networked concern today. The ICU is the most critical place which should be standardized for patient safety demanding rigorous standards in its care providing procedure and equipment as emphasized by Rashid, M. [26]. Many hospitals aim to adopting a more ‘universal movement pattern’ concept, because it has more operational efficiency in scheduling compared to conventional haphazard or linear for specific type of round e.g. as discussed by Gadbois, C., Bourgeois, P., Goeh-Akue-Gad, M. M., Guillaume, J., & Urbain, M. A. [27] and [28].

Space Syntax historical evolutionary version of earlier NS position is shown in figure 1, 2 & 3.

Fig. 1. Compact Cross Shape 1950s and Double-Loaded 1900s

Changing policies and the freedom with potential economical air-conditioning in the fifties reflected in Holy Cross Hospital in Los Angeles. Here the single corridor plan is compared with the cross design which demonstrated in figure 2 shows a circular which is considered far more efficient unit. As compared to the “double corridor” plan support nursing area where two corridors are placed between the core which contains spaces both related to nursing and unrelated (elevator space) and thus is less compact.

Fig. 2. Compact Circular plan and compact square plan 1950’s
A compact circular unit as shown in figure 2 Valley Presbyterian Hospital in Van Nuys, California (1956) was developed. Nursing support space as central core and arrayed 34 beds arranged around the core. Where minimal distance was possible, for both the range of distance and average distance from the work cores to patient bed; hence communication was competent and well-organized. An alternative solution for reducing nurse travel is to provide redundant circulation, i.e. more than singular route from point to point [29]. This was recognized by the Yale evaluations as the most efficient plan designed to date: Center for Outcomes Research & Evaluation (CORE)¹

![Diagram of nursing unit growth](image)

**Fig. 3. 1940’s race track and 1970’s compact triangle**

Nursing Unit were added adjacent to one another, this practice was common earlier, with individual elevator cores, this resulted in creating disorienting circulation patterns for the visitor and staff searching for the right bank of elevators. Much of the work [30] of recent years has been focused on clearing up this confusion of circulation [31] caused by ill-thought-out patterns of nursing unit growth. Though today design analysis is no longer merely form based rather it is a method of thinking of management methodologies.

### B. ICU Plan type

The pattern based ranking of the general plan type is similar, for example linear, L-Shape, U-Shape, parallel, or hybrid complex combination. Although a considerably compact concentric plan is usually more systematic and efficient [32]; though exterior shape is less an indicator than the internal Nurse Station core organization and layout [33]. Currently very methodological plans have been achieved with combination of concentric pods, and with upcoming bedside computer aided software e.g. Space Syntax and Stop Sequence.

Healthcare trends research for this article has groomed to be more interactive and participatory, often combined with author’s insight research and innovation design activities to make better sense of complex trends.

### C. Nurse Circulation in ICU

There is an array of horizontal circulation such as patient (Inpatient and outpatient), staff, visitors and materials. A complete schematic pattern to bifurcate these multiple layers of overlapping circulation may be practically achieved since it is essential in ICU in Korea where the distance is not very high. However in this research, overlapping of several set of nursing and separation of public activity and private activity circulation is not the major issues to resolve.

Here we were able to simulate initial insights of validation and enrichment of basic form pattern in a further robust manner along with share set of hypothesis and assumption that it is possible to reduce nurse walking without effecting efficiency. Thus this planned circulation translates trends and finding into interactive innovation tools, such as framework posters or trends cards, allows nurse teams to interact with the content, play with the defined path by manipulating when needed, hence trigger critical thinking.

### D. Perimeter working circulation versus internal core²

Mirroring created a commonality of physiology that underscores staff shared humanity. The other determinant for circulation operational is the core and corridor (or axial length along which the Nurse walks) and interior work core (The Nurse Station). The meaning of the communication in ICU is the response patient elicit. The responsibility in communication rests upon staff. V.C: Visual constructed refers to seeing reality in ICU as never seen before, or seeing things differently than they were seen before.

Here the future hospital was a project that mapped the future health landscape onto the historic timeline of hospitals as shown in figure 1, 2 & 3.

### E. Socially Responsible Design is Dynamic Design

At construction of the flexible stage design begins, at Visual Remembrance which refers to seeing images or things as seen before, in the same way they were seen earlier [34], [35]. Our research focuses on the following objectives.

This research is based on

1. Information provided by Nurse
2. An explicitly understandable shared value system
3. It is the product of design review and participatory
4. It incorporates systematic and periodic space syntax review
5. It incorporates periodic evaluation of the visibility design ICU ward

### F. Dynamic Design is Synergenial Design³

The implied dynamic approach goal of socially responsible design is integrated in what Earl Swensson Associates has called “Synergenial Design”³, established on synergism and geniality, the three determinants termed here are the main

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¹Yale School of Medicine 333 Cedar Street, New Haven, CT 06510; http://medicine.yale.edu/core/


concept. Thus this research focuses on these determinants to facilitate Nurse by reducing walking and enhancing visibility.

Caregivers’ faces fatigue while serving patients due to excessive walk Gadbois, [27]. To assure patient safety in Korean hospital ICU layout in a patient care center, author considered “care giver safety” [36] as highest priority.

Standardization of route for the movement of nurse is discussed by and predicting the shortest route without overlaps or reverse movement on depth map model can ease the staff. Specifying the beds assigned to a specific nurse during her shift Vreeland, [37], here the entire ICU topology is not responsible for the nurse, but few assigned beds are her domain. Movement patterns were captured by Space Syntax software. Route stop ‘standardization’ is catered to by means of application on the architecture layout and map. The study finds walking route on LogWare.

III. METHODS

Surprisingly, there is little evidence that such approaches as LogWare: stop sequence are applied on ICU design for nurse walking, though an accurate study by P. Wonbae [2] as a Korean ICU design specialist analysed the bed gross factor and compared to the area of Medical intensive care unit, Surgical Intensive Care unit, Neuroscience Intensive Care unit, Coronary Intensive Care unit, Neonatal Intensive Care unit compared with US standards.

A three month quasi experiment was conducted, on site by the authors after survey. The nurse round route was studied for the patients visit at the adult intensive care units (ICUs), in Korea namely Seoul National University Hospital (SNUH), Seoul St. Marry Hospital (SSMU), Samsung Cancer Center (SCC), DonGuk University International Hospital (DUIH), Konkuk University Medical Center (KUMC), Pusan National University Hospital (PNUH), Yonsei University Health System (YUHS). On the second state nurses were suggested with the shortest route calculated on the stop sequence software to reduce nurse walk pattern and calculate healing acceleration process in staff. The study was approved by the Korean institute of Healthcare Architecture and hospital”s Public Relations Committee for Medical and Healthcare Research Ethics and the privacy ombudsman for the research at these hospitals Data Service for facilitating the data collection.

A. Universal Bed positions and clockwise movement

The first step is automation for scalability and adoptability as suggested by Reiling, J. [9] for ‘universal nurse movement’ and ‘same handed’ design movement in ICU when compared to conventional un-planned orientation movement. This reduces ‘wrong-patient choice’ and allows quick and efficient response in an emergency or stressful situation, with less chance of error moreover it also facilitate immediate accessibility towards information due to close proximity to the patients Relling, J. [4]. In this project, most ICU nurses were designed in ‘planned movement’ mode, with ‘same- handed orientation walking. This was done to minimize fatigue, have just culture along with learning culture, blame free environment and recognizing human fallibility Reiling, J., Hughes, R. G., & Murphy, M. R. [8]. This also encourages physician teamwork, since the medical staffs are well informed, there is a shared value and belief about safety within the ICU organization.

IV. CASE STUDY

A. Case One

Dongguk University Hospital opened in June 2005, Ilsan has 800 hospital beds in total of 996393.65 square foot total floor area Kim, J. H [38]. As shown in figure 4, the ICU beds are in direct views from NS there are 60 beds in total covering 7.5% of the total area. Medical intensive care unit comprises of 20 beds, and 20 bed in both Surgical intensive care unit combined with Neuro science intensive care unit, 8 in coronary intensive care unit and 12 in oriental medicine intensive care unit. The area covered per bed is 367.992 square foot. Figure 5 & 6 represent the two nurse station relationship, and the photo taken by author on eye level along with the space syntax analysis of eye level, Choi, Y. J [39]. The logWare simulation provided the minimum distance covered by the nurse from both the station. The photograph in the last row shows the knee level analysis and photo.

Fig. 4. Grid formation pattern by author

The grid represents the position of the bed in ICU, every 10 feet the grid is marked thus the distance walked by NS could also be calculated.

Figure 7 & 8 stop sequencer input of coordinates for X and Y axis patient 1 bed lies on the X coordinate of 43.4 and Y coordinate of 102.5 which is also true for patient 2 and patient 3 Y-Axis. Patient 2 and patient 3 X-Axis is 50.5 and 57.5 respectively though x axis remain constant from patient 4 to patient 9 because it is on same line. Whereas Y axis varies slightly: 70.5, 77.5, 84.5, 91.5, 97.5 and 104.5.
The visual axis is shown in figure 17 where NS 1 and NS 2 are demarcated and the patient beds are numbered according to the NS accessibility. Figure 6 shows the L shape pattern visibility analysis by blue arrows marking towards all the patients, which was rated 5/5 most efficient by nurses in the questionnaire.

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**Fig. 5.** The possible stop sequence pattern on LogWare

**Fig. 6.** The efficient layout in terms of viewing NS2

**Fig. 7.** Space Syntax analysis and LogWare sequences.

**Fig. 8.** Representation of the second determinants of walk ability simulated on stop sequence software
NS 1 patient lay out is shown in figure one where each patient’s bed is first marked on X and Y axis on the grid in figure 8, then these data is transformed on stop sequence to get the efficient NS walking route.

The first determinant for ANOVA is view, thus the following figure shows the view from NS 1.

The dark blue corridor is shown in following figure 8. with yellow triangle representing, corridor, photo taken by author.

All the three determinants are studied here and ANOVA collects the statistical model to analyze all three particular variable component attributing to varying sources, e.g. here there are three components, walkability, view ability and form pattern, which are analyzed for the first case study.

The stop sequence shows the L shape movement which is utmost according to the ANOVA results. Photos by author shows the ICU Nurse Station view and the patient bed arrangements.

B. Case Two

New Yonsei Severance Hospital was functional from 2005 comprising of a total of thousand beds with almost 7.5 % dedicated to ICU, they are laid out in a direct view from nurse station, MICU combined with SICU has 45 beds in total, which are divided into three units, then there are 15 beds Neonatal intensive care unit and further 15 more beds in Neuroscience intensive care unit. While the area per bed is 460.53 square foot Rivera-Romero [40]. This layout consist of four nurse station according to the comfort level of Nurse as discussed by Lee, E. H., & Ahn, S. H. [41] here organization is linear rather than zigzag as compared to SSMH shown in figure 13. The six layer analysis, analyzes culture of continuous improvement, moreover the synthesis of the syntax multiple layer of information can be complex, therefore there is a collaborative, interactive and multi-step approach. Here the LogWare analysis presents a unique way which could be compared to other innovative disciplines. Thus there is a complex inter-dependent findings of scalability and adoptability which are two key principles guide this space syntax synthesis and articulate of insight- to be interactive and to be visual.
Fig. 13. 2nd Floor ICU DUMC Analysis on space syntax
The distance travelled by one or a pair of nurse is 157 feet, and the shortest route is defined that if Nurse will supply the services in a managed form (supply Chain Management), then she could intelligently serve all the patients accordingly. In the sequence of above mentioned in figure 15.

These simulations were carried out for the all the four Nurse Stations and flowing figure could be the possible outcome. All four nurse station are demarcated in the following figure 22.
Fig. 18. Analysis of YUHS ICU on space syntax and stop sequence software
The five NS are highlighted by the colour code. The first image in the row shows the depth map analysis of horizontal circulation. Then the axial map shows the visual connectivity.

The figure 19 & 20 in third, fourth and fifth row shows the zigzag circulation on depth map flanked by the LogWare point to point movement. The Spaghetti diagram shows the connectivity for walking.
First column first row of figure 20 represents knee level and eye level analysis of the Pusan hospital ICU, here there are three NS, for which stop sequence walking is calculated to be 143.163 feet for first NS. Whereas second NS walks 136.775 feet. The third NS walks 138.107 feet. Thus making it a linear pattern which is calculated to be not very efficient in terms of walking as well as viewing.

Therefore this arrangement earned 3/5 for arrangement and 4/5 in walking as well as viewing.

This form of arrangement is linear which is found in Pusan Hospital design. It is semi concentric as the three stop sequence graph shown in above figure 20 where nurse station is represented by a red dot which was operate both in clock wise as well as anticlockwise. Here it is important to note that this walking pattern is not limited to singular nurse but a group or a pair of nurse can operate on this route after coordination.
C. Case Three

The Catholic University of Korea Seoul St. Mary’s Hospital inaugurated on March 2009 has twelve hundred bed with 60 side view laterally viewed from NS as shown in figure 17, here ICU area covers approximately 5% of the entire hospital area. CCU comprises on 18 beds, where as SICU consists of 22 beds, there are 20 beds in MICU, whereas area is 341.092 square foot per bed as shown in figure 17. This ICU consist of the maximum number of NS which is 5, first two are arranged in linear fashion where as rest three are zigzag, circulation as this problem was solved by management of nurse problem solving behavior by Tucker, A. L., & Edmondson, A. C.[42]. In figure 19 there is a study of understanding patient’s experiences and staff needs, demands ways to capture their visibility environment and walking context and path conditions Mark, B. A., & Hagenmueller, A. C.[43]. The automated LogWare shortest route graphs includes pace, rhythm and flow line, which is threshold of nurse route activities and behavior as well as specified contextual qualities of multi sensorial experience. As Carayon, P., & Gürses, A. P. [44] researched the possibilities to reduce work load in Nurse.

D. Case Four

PNUH is located in Yangsan, here ICU comprises of 43 linear arrangement beds which covers 5.5 percent on the floor area. First ICU consists of 12 beds, second ICU 9 and third ICU 9 and 4th ICU has 12 beds respectively. The area covered per bed is 487.4 square foot. Figure 18 is a visual representation which reveals knee level visibility diagram as well as eye level visibility diagram on syntax. Here the experimental design combines several disciplines to create a total system solution which harness. product, interaction, user interface, environment and multi analytical design. Here there is a use of a proprietary experience design model- where healthcare experience from expectation and memory has given special weight. Each bed is defined by X coordinate and Y coordinate, hence patient one is defined by 54 as X coordinate and Y coordinate. 53 as X coordinate and 21.5 as Y coordinate are representing Patient two. Patient three is defined at 53 X coordinate and 13.5 Y coordinate.

Patient four is located at 53 X coordinate and 5.5 Y coordinate. On the other hand Patient 5 is defined by 60 X coordinate and 5.5 as Y coordinate. Patient 6 is represented by 60 X coordinate and 13.5 Y coordinate. Patient 7 is located at 62 X coordinate and 21.5 Y coordinate. Patient 8 is defined by 62 X coordinate 28 Y coordinate. 62 X coordinate and 34.5 Y coordinate is defines Patient 9. Patient 10 is represented by 62 and 43.5 and Patient 11 is located at 62 and 51. Patient 12 also lies on same X coordinate of 62 though Y coordinate is located at 58. This description is for first nurse station. Since it is a linear arrangement therefore X is constant from 6th patient to 12th patient.

Nurses could be trained in a workshop for the routine round, in a collaborative with multi-disciplinary 2D story board, animated flash demos and three dimensional renderings, which are used to communicate initial round scenarios to propose new healthcare experience. This way innovation

E. Case Five

Samsung Cancer Center (SCC) has a total of 700 bed hospital, whereas in ICU there is 40 bed arranged in liner fashion, SICU comprises of 14 beds, MICU consists of 26 bed. The area per bed is 465.90 square foot.
Fig. 24. SCC Nurse Isovist Analysis and Connectivity
KUMC follows a zigzag pattern, which increases the walking distance and makes the vision difficult.

As the walking and viewing pattern shown in above figure 25, from both knee as well as eye level: 1/5 is the average grading for 3 variables.
Fig. 26. SNUH Depth Map Analysis and Stop Sequence Plan
**G. Case Seven**

SNUH is located in Bundang has total number of 389 in the entire building of hospital. Where ICU comprises of 29 beds with total percentage 7.4 and all are arranged in linear fashion. NICU and NSICU sum is 15 beds. OICU has 14 beds, here the area per bed is 441.16 square feet.

**A. ANOVA: Results**

The results of a ANOVA statistical test performed at 05:28 on 4-OCT-2014

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The probability of this result, assuming the null hypothesis, is 0.000

Group A: Dongduck University Hospital: Number of items= 3
Mean = 5.00
95% confidence interval for Mean: 4.236 thru 5.764
Standard Deviation = 0.00
Hi = 5.00 Low = 5.00
Median = 5.00
Average Absolute Deviation from Median = 0.00

Group B: Catholic University of Korea Seoul St. Mary’s Hospital: Number of items= 3
Mean = 2.67
95% confidence interval for Mean: 1.902 thru 3.431
Standard Deviation = 1.15
Hi = 4.00 Low = 2.00
Median = 2.00
Average Absolute Deviation from Median = 0.667

Group C: New Yonsei Severance Hospital: Number of items= 3
Mean = 3.00
95% confidence interval for Mean: 2.236 thru 3.764
Standard Deviation = 1.00
Hi = 4.00 Low = 2.00
Median = 3.00
Average Absolute Deviation from Median = 0.667

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**F. Case Six**

KUMC Kankuk University Hospital with 889045 square feet as floor area was inaugurated in 2005. The entire hospital complex consists 870 beds. Here ICU has total of 63 beds, which is approximately 7.2 percent of the total number of beds. Here SICU has 30 beds MICU has 27 beds and 6 beds in CCU all are arranged in linear manner. The area per bed is 320.648 square feet.

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![Fig. 28. Author’s photo of exterior in April 2014](image)
ANOVA

One-way completely randomized

Table I
ANOVA calculation

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| X_{ave} | 3.619 |

V. DISCUSSION

NS Design is no longer merely about form rather it is a method of thinking that can let nurse see around corners, thus design thinking is the upcoming management methodology. The zigzag hyperline of the minimum walking in a lateral view presents a long distance of 542.005 feet at KUH where single bed comprises of 320.648 square feet area for single ICU design.

Tripartite analytical tools for variance: walkability, visibility and arrangement are applied as featured from a group of seven ICUs located in Korea near Seoul: namely SNUH, SSMU, SCC, DUIH), KUMC, PNUH, YUHS. This study analyses the NS calls to the patient bed, than compute lowest amount of round route on the ICUs space syntax map. It was found that the minimum possible round was at SSMU where 5 NS are functional simultaneously where NS1 walks 131.225 feet; NS2 walks 99.6 feet, whereas NS 3 walks 215.211feet, NS4 walks 188.101 and NS5 walks 260.788 feet. Maximum walk was calculated for the singular NS at KUMC where primary NS walks 542.005 feet zigzag path and secondary NS walks 214.814 feet linear path. Conclusively, ANOVA predicted three most advantageous composition which were concentric around NS: L-Shape, U- Space or O-Shape graded as 5/5 thus walking for nurse reduces and greatest visibility was illustrated. On the contrary I shape and zigzag pattern was recognized as not very efficient arrangement with 2/5 score, it increases walk and reduces visibility to the last patient in the row.
A. Recommendation

Healthcare designers are working utmost to improve the human experience in healthcare; they also intuitively realized that an innate ability to socio-cultural changes from nurse perspective, and secondly to translate this understanding into tangible value propositions. The new modern nurse society need emerged and reshaped NS for better healthcare. Usually the source of information is the formal guidelines for example Lundstrom, T., Pugliese, G., Bartley, J., Cox, J., & Guither, C. [45] and Haq [46] application of space syntax on healthcare architectural organizational.

The theory of Ulrich [47] of rich interior for staff and patients need is recommended to be further explored specially by application of Logware software in the field of healthcare and facilitation nurse movement.

B. Limitation

Due to the research structure, age was out of the scope of this research; here nurse walk was significantly lower value in terms of mobility. Though this is the case of non-emergency and non surgery period, thus routine tasks are calculated on depth map analysis which was chosen due to the availability of experimental structures.

Table II

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VI. Future Work

Since this methodology has potential to be repeated for other ICU or ward type, therefore author plans to re-use this specific method on ICU at Agha Khan Hospital and Civil Hospital Karachi.

VII. Conclusion

This study focused on creating the optimal conditions for innovation in healthcare circulation, this research focused on team dynamics and mindset than standardize processes and tools. Here we describe the key characteristics of successful circulation path in healthcare innovation mindset and introduced the approaches and set of methods and tools to minimize walking and maximize visibility as an innovation research, design and consulting. Korean ICU are case studies as illustration. The main findings of this study are summarized in figure 2. All decisive factor to differentiate between zigzag walk, linear plan and concentric beds around the centralized nurse station.

The subject of the case study was seven general hospitals in Korea with ICU that have relatively clear layouts in terms of NS and bed positions. Among them five were direct view type and two were lateral or side view, a threshold line was formulated to outline the position of each patient according to NS position in ICU evidence. This mapping course of action was completed qualitatively and this work extends the geometric theory of patient output to LogWare stop sequence distributed parameter systems.
Conclusively we proved that the defined walking route is suitable for enhanced communication and reduction of error therefore the pattern recognition is used to classify the movement pattern at micro level; same technique of machine learning is applied at macro level: floor Plan.

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