



Testing The Healing Environment Conditions for Nurses with two Independent Variables: Visibility Enhancement along with Shortening the Walking Distance of the Nurses to Patient - Focused on LogWare stop sequence and space syntax for U-Shape, L- Shape and I-Shape NS-

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ABSTRACT

Purpose: Maximizing human comfort in design of medical environments depends immensely on specialized architects particularly critical care design; the study proposes Evidence-Based Design as an apparent analog to Evidence-Based Medicine. Healthcare facility designs are substantially based on the findings of study in an effort to design environments that augment care by improving patient safety and being therapeutic. On SPSS (Statistical Package for Social Science) t-test is applied to simulate two independent variables of PDR (Pre Design-Research) and POE (Post-Occupancy Evaluation). PDR is conducted on relatively new hospital Hallym University Dongtan Sacred Heart Hospital to analyse visibility from researchers' point of view, here the ICU is arranged in I-Shape. POE is applied on Dongguk University Ilsan Hospital to simulate walking on LogWare where two NS are designed based on L- Shape and Seoul St. Mary's Hospital, The Catholic University of Korea where five NS are functional for ICU Intensive Care Unit, Surgical Intensive Care Unit (SICU), Medical Intensive Care Unit (MICU), Critical Care Unit (CCU), Korean Oriental Medical Care Unit which are mostly arranged in U-Shape, and walking pattern is recognized to be in a zigzag path.

Method: T-Test is applied on two dependent communication variables: walkability and visibility, with confidence interval of 95%. This study systematically analyses the Nurse Station (NS) typo-morphology, and simulates nurse horizontal circulation, by computing round route visits to patient's bed, then estimating minimum round route on LogWare stop sequence software. The visual connectivity is measured on depth map graphs. Hence the aim is to reduce staff stress and fatigue for better patients care by minimizing staff horizontal travel time and to facilitate nurse walk path and support space distribution by increasing effectiveness in delivering care.

Result: Applying visibility graph and isovist field on space syntax on I- Shape, L- Shape and U- Shape ICU (SICU, MICU and CCU) configuration, I-shape facilitated 20% more patients in linear view as they stir to rise from their beds from nurse station compared to U-shape. In conclusion, it was proved that U-Shape supply minimum walking and maximum visibility; and L shape provides just visibility as the nurse is at pivot. I shape provides panoramic view from the Nurse Station but very rigorous walking.

KEYWORD

LogWare Route Stop Sequence, ICU, Surgical Intensive Care Unit (SICU), MICU, Critical Care Unit CCU Nurse Station, Hallym University Medical Center (HUMC), Seoul St. Marry Hospital (SSMU), DonGuk University International Hospital (DUIH), Space Syntax connectivity,

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1. Introduction

This study focuses on nurse ecological design to facilitate the progress of caregivers from Nurse Station of ICU where Evidence-Based Design (EBD) is the conscientious and thoughtful use of existing best evidence, and its significant understanding, to make substantial design decisions for health care. These design decisions are based on sound hypotheses associated with quantifiable outcomes [1].

Innovative research on critical care environments and outcomes is required to answer critical questions [2]. In the area of safety, there is a need for in-depth research on the nurse environment's role.

1.1. Research Backgrounds

There is a vacuum of design related research regarding designs which are connected with reduced error and injury [2]. This paper enhances the visibility and accessibility for all the patient's bed from nurse station.

1.2. Research Objectives

There is a need for multidisciplinary research team to assess data from the STEP-UP (Study To Enhance Prevention by Understanding Practice) [3], where a randomized clinical trial is performed to improve the technique of Evidence-Based Design precautionary services in prototypical Korean ICUs. The goal is Patient Centered Care (PCC) which is an important component of prevention [4].

The two determinants of conceptualizing the nurse's position in

the patient- environment process are firstly is to imagine of the nurse as being in the environment of the patient for care which is generally familiar concept [5]. In this view, nurse and patient are viewing each other from same vantage point into the similar environmental domain [6]. The nurse, together with the patient, patterns the environment to promote healing and comfort. The questions asked here which is the focus of the study, "what can the nurse do to create (pattern) an environment that is more healing?" [7].

1.3. Research Methods and Scopes

To develop a quality assessment of the following steps where followed: (1) prioritizing the ICU as a clinical area to be computed; (2) walking and visibility are selected as the type of determinants; (3) define and design specifications on NS; [8] (4) t-test selected as developed data collection tools; (5) there is a test of data compilation tools and evaluate the authority, reliability, and viability of measures on LogWare stop sequence software (a tool from Supply Chain Management) and Space Syntax [9] (6) then there is a development of scoring and analytical specification on SPSS (Statistical Package for the Social Science); and (7) obtain baseline data of step by step nurse movement [10]. Here authors propose an outline research design for nurse therapy and healing environment [11], and other clinical and health care matters, and in which the research design [12] (1) adapt these information requirements into liable questions[13]; (2) trace, with maximum competence, the best prove with which to respond them (from the NS design clinical assessment from study evidence) [14]; (3) critically review the data for its authenticity (nearness to the truth) and utility (clinical applicability on the hospitals [15]); (4) Finally there is an integration that this appraisal with researchers clinical expertise and apply it in routine on set of selected hospitals; and [16] (5) evaluate the research design and performance [17].

Methodological plans have been achieved with combination of concentric pods with upcoming bedside computer aided software e.g. Space Syntax [18] and Stop Sequence [19].

1.4. Research Flow Diagram

The objective is to reduce the travel time up to 30% and to further drop towards 20% since nurse is walking with supplies at hand and aim to is for fewer unnecessary trips and one way shortest round route design simulation. Second objective is to design walk in a way so more patient bed heads will be seen with each nurse step by step walk. The quest for utmost efficiency in ICU [20] design to facilitate nurse and to reduce the probability of error [21] due to efficiency shortcomings is been investigated in several recent research [22][23], thus suggestion for monitoring ICU, organizing nurse activities, improvement in communication are suggested.

The hospital designs: HUMC, SSMU and DUMC with similar spatial and technical system organization for ICU design is analyzed consisting matrix of I shape, U shape and L shape nurse station configuration for caregiver work path, addressing a minimum amount of travel for caregivers.

2. Literature review

The ecology and health of the caregiver and their sustainability and facilitation is the rationale for several studies [24] [25]. This paper compares the healing environment from a nurse point of view. Nurse fatigue control, falls into the category of human comfort along with nurse burnout in regard to nurse issue as questionnaire suggested here. Thus providing an alternative solution for reducing nurse travel by to provide a defined circulation, i.e. minimized one way route from one point to two points. Similar route was recognized as the most efficient plan: Center for Outcomes Research & Evaluation (CORE).

This study focuses on an intensive care unit of the hospitals nursing stations where three case studies for visibility and walking distance are simulated from the central NS. There are two types of assistance from NS to patient, one is general round type and second is specific. This paper focuses on general round type. The level of illness varies significantly from bed to bed. Every patient need specific medicine and care type including toileting or sleeping assistance; though individual assistance is a separate phenomenon which is occurring simultaneously. A variety of trained nurses are present on NS for such assistance.

Here the focus is "How do different hospital unit layouts affect nurses' walking behavior and distance?" where as the second dimension is affective and instrumental visual communication in primary care Interactions: Predicting the satisfaction of nursing Staff and Patients. Thus the literature from above suggested such parallel tools are been designated to compute nurse satisfaction.

2.1. Ecological Healing Environment

The hypothesis of EBD has been fundamental to nursing's model from the time when Florence Nightingale [26] suggested health and nursing paradigm; there has been key emphasis on healing environment theory [27] in the literature associated with nursing.

A thoughtful philosophy is as a rule influential for care providers when it is supplemented by a perception of intention, precision about their responsibility and those of their colleagues, skilled in supervising with dealings, and a dedication to tender all patients in the ICU in ways that are significant to them [28]. When nurses, combined health professionals and their colleagues own their practice and consciously create environment of healing, their

efforts evidently affect the practitioners, the routine and physical space. Initiating and sustaining a therapeutic relationship with patients is predominant to carting and healing environment.

2.2. Definition of ICU

Caregivers' faces fatigue while serving patients due to excessive walk as Gadbois discussed [19]. To assure patient safety in Korean hospital ICU layout in a patient care center, author considered "care giver safety" [29] as highest priority. The Surgical Intensive Care Unit 9)(SICU) which is a 20-bed, fast-paced (high-acuity, multi-specialty critical care unit) and because of the high pace the SICU has a special task for all the 20 beds to be visible and accessible easily.

3. Precedence Study

The nurse round route was compared with the similar I-Shaped, L-Shaped and U-Shaped ICU, MICU, SICU and CCU configurations. The study for the Nurse round at the adult intensive care units (ICUs), HUMC was conducted as a PRD. T-Test analysis was conducted with two independent variables: PRD and POE of two other hospitals in Korea namely, Seoul St. Marry Hospital (SSMU), DonGuk University International Hospital (DUIH) was compared with POE simulation. On the second stage nurses suggestion was taken with the shortest route calculated on the stop sequence software to reduce nurse walk pattern and calculate healing acceleration process in staff.

3.1. Conceptual Framework

To facilitate nurse visibility and to reduce walking a two prong strategy is designed as a conceptual frame. Three typomorphologies are analyzed to compute the best configuration which helps nurse to heal i.e. ecological and healthy.

The pattern based ranking of the general plan type is similar, for example linear, L-Shape, U- Shape, parallel, or hybrid complex combination as shown in Table.1 where the percentages of the shapes used in each hospital are narrated. Although a considerably compact concentric plan is usually more systematic and efficient.

LogWare estimated walking pattern for all the wards collectively and space syntax [9] illustrates the visibility pattern according to the shape of NS for both PDR and POR t- test analysis.

Table 1. Concept showing the three types of the forms which are analyzed in this research for ICU present in three hospitals.

	HUMC	DUIH	SSMU
L-Shape	50%	100%	25%
U-Shape	25%	-	25%
I-Shape	25%	-	50%

3.2. Case Analysis One

HUMC was inaugurated in the district of Seoul, in 2012 September. This hospital in Dongtan is constructed on a complete site of 21,000 m² the third floor plan is shown in Fig.1. Author continued this study to 2014 to compare the post occupancy evaluation compared with other hospital MICU and SICU which are following similar L- Shape pattern.

A pre-occupancy inauguration session with nurse artificial simulation was conducted at Sacred Heart Hospital, Hallym University Medical Center Dongtan (HUMC) in collaboration with the Korean Institution of Healthcare Architecture.

Since interaction and consultation is a major affair in the ICU,

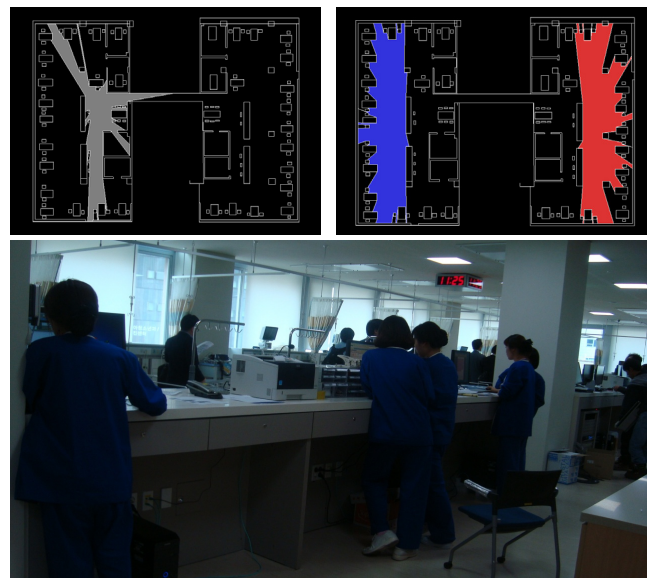


Fig. 1. The mirror image of 20 bedded SICU and MICU blue and red shows the eye view and connectivity from the NS to the patient from counter clockwise: comparison of first and second nurse, comparison of third and sixth nurse vision diagram

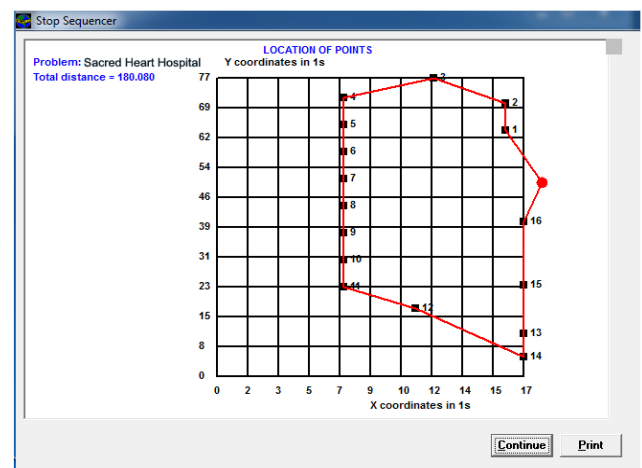


Fig. 2. LogWare simulation of nurse visit to each bed

there is a requirement to design research to determine improved ways to support and improve it.

LogWare is able to simulate the precise pattern to validate the set hypothesis for possible reduced nurse walking without effecting efficiency. Fig.2 is a planned circulation translates finding into interactive tools, such as framework to allow nursing teams to interact with the content, play with the defined path by changing according to the combined willingness, hence trigger critical thinking.

The U – shape ICU design is been simulated on Logware in Fig.2 where 54.8 meter distance is calculated to be the shortest distance which has to be travelled by a set of nurses. Here EBD can be regarded as a natural progression of “healing environment” [30], where nurse walking progress towards patients is aimed to be improved, three month research analysis was conducted by author on three sites, there is a health related quality of life (HRQoL)10),which is a multi-dimensional concept is applied; here on PDR which includes a combination of quantitative analysis and qualitative technique.

In Fig.1 the blue colour coded mirror image of the SICU and MICU is been analysed, in terms of visual connectivity. Here similar pattern was followed to analyse the visibility and walkability of nurse as well as the typology as similar studies shows [31]. Fig.3. The depth map simulation of isovist and visibility for the U-shaped Critical Care Unit. On site PDR simulation of the nurse practicing viewing and walking photo taken by author on 10th September 2012 at 10:30 am.

Because this is a PDR Healthcare trends research which is more interactive and participatory, combination where author’s herself took part of Pre Occupancy Evaluation, for HUIH where she had

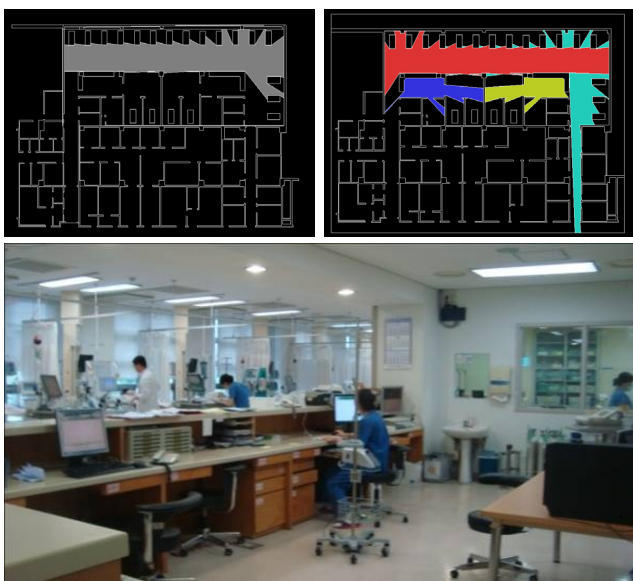


Fig. 3. represents the Nurse Station relationship and the photograph taken by author on eye level along with the space syntax analysis

availed the opportunities to view for the ICU NS and could practice the travel path of nurse on site as shows in Fig.1, such exercise results in EBD innovation design activities results to make better sense of complex trends.

3.3. Case Analysis Two

This case study is based on POE, Dongguk University Hospital inaugurated in June 2005, Ilsan has 800 hospital beds in total. As shown in Fig. 4, the ICU beds are in direct views from NS there are 60 beds in total covering 7.5% of the total area of Entire Hospital. There are 20 beds in Medical Intensive Care Unit (MICU), 20 beds in Surgical Care Unit (SICU) and 20 beds in Neuro Surgical Intensive Care Unit (NSICU 20), 8 beds in Critical Care Unit (CCU) and 12 beds in Korean Oriental Medicine Intensive Care Unit (KOMICU).

The following Fig.4 represents the graph where red round spot represent nurse position as entered in the X and Y coordinates, the square black dots in the graph shows the position of the 1-11th patient bed.

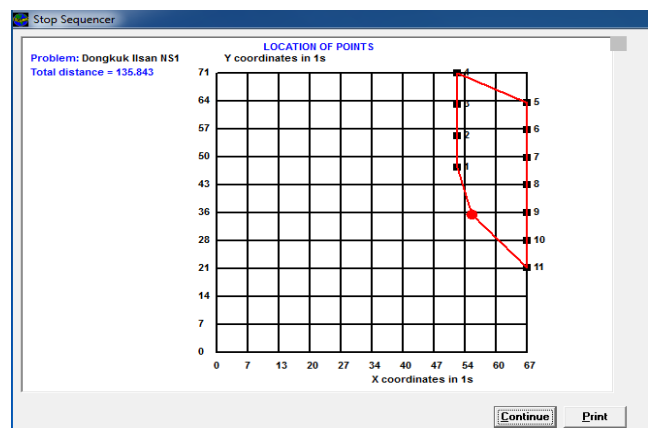


Fig. 4. The layout in terms of walking NS1

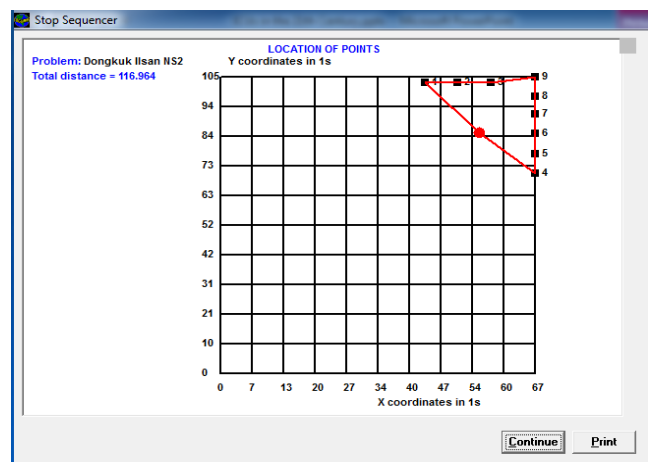


Fig. 5. NS two lay out on Log Ware the graph shows L-Shape formation

The grid is planned on the stop sequence software of Supply Chain Management representing red dot from where nurse origins.

The LogWare simulation provided the minimum distance covered by the nurse from both the station. The photograph in Fig. 4 shows the knee level analysis.

NS 2 patient lay out is shown in Fig. 6 where each patients bed is first marked on X and Y axis on the grid, these data is transformed on stop sequence to get the efficient NS walking route in Fig. 6

It could be inferred that if the nurses are trained in a workshop for the routine round, in a collaborative settings, which may communicate initial round scenarios to propose new healthcare experience.

The Fig. 4 & 5 shows the circulation one way without overlap or reverse movement from nurse station to beds. The Nurse

configuration is in L-shape, as shown in Fig. 6. Two determinants are studied here on t-test; since there are two components, walkability is shown is red and yellow analysis of circulation datum [18], visibility is shown in the photograph from NS, and walking pattern, which are analyzed for the DUIH on LogWare .

3.4. Case Analysis Three

The Catholic University of Korea Seoul St. Mary’s Hospital inaugurated on March 2009 has twelve hundred bed with 60 side view or laterally viewed from NS as shown in Fig. 7., 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.

It was found that the minimum possible round was at SSMU where 5 NS are functional simultaneously where NS1 walks 40 meter; NS 2 walks 30.35 meters, whereas NS 3 walks 65.6 meter, NS4 walks 57.33 meters and NS5 walks 79.48 meters.

“No hidden patient” [32] or “out of sight out of reach” [33] is the most significant motivation for this research, since nurse has a critical role in ICU, her ecology in terms of health ‘first do no harm’ and fatigue reduction is the aim. Therefore the design here in Fig. 6 & 7 is able to facilitate and allow nurse to see as much as possible and walk as less as possible without compromising the efficiency. Thus at planning stage ecological healing environment is incorporated for flexible design, though it is not complete at schematic stage (as seen in case one: HUIH), neither is it finalized after completion of ward (as seen in case two and three: DUIH and SSMU).

The stop sequence [34] shows the U- shape movement which is utmost according to the results. Photograph by author shows the ICU Nurse Station view and the patient bed arrangements in a zigzag or lateral fashion.

The aim is to improve the typology of Nurse Station and morphology of the viewing pattern from Nurse Station to the

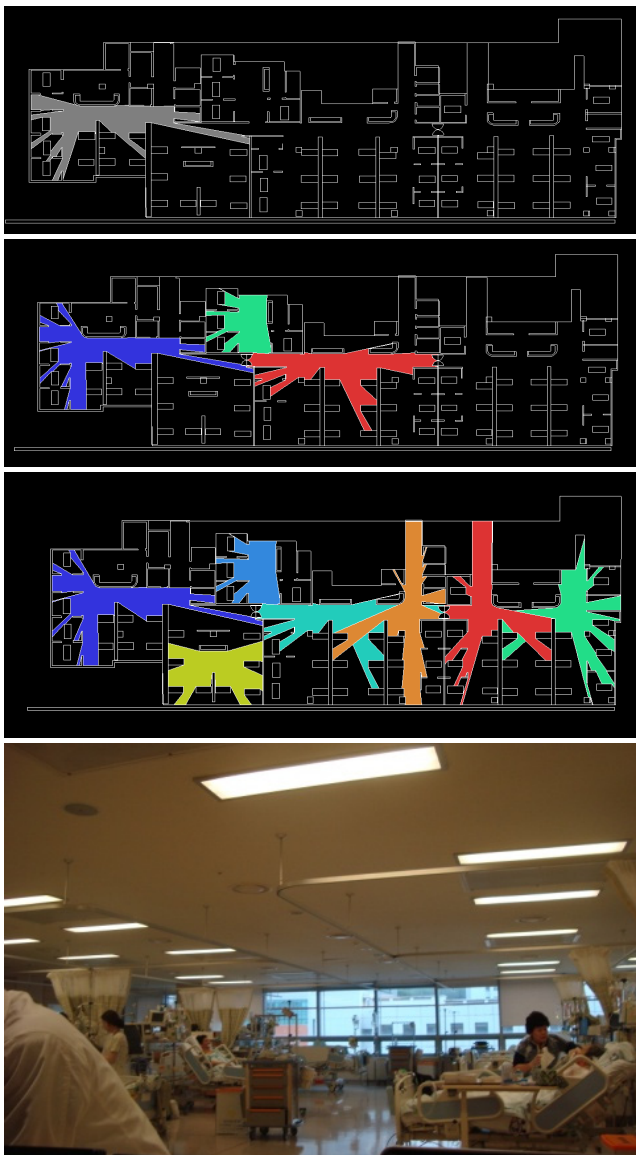


Fig. 6. Analysis of 5 NS at SSMU and Author photograph on 13th June 2014, while filling the questionnaire (photo used by permission)

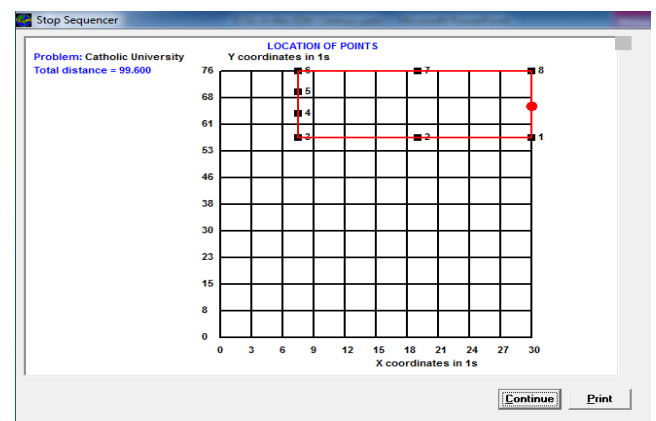


Fig. 7. the graph of first NS of SSMU—U shape configuration

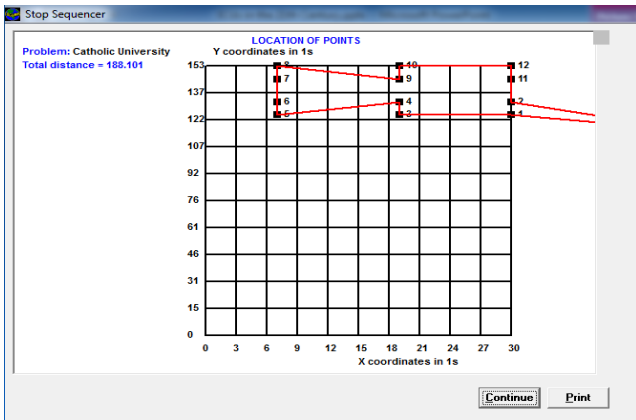


Fig. 8. the graph of fourth NS of SSMU

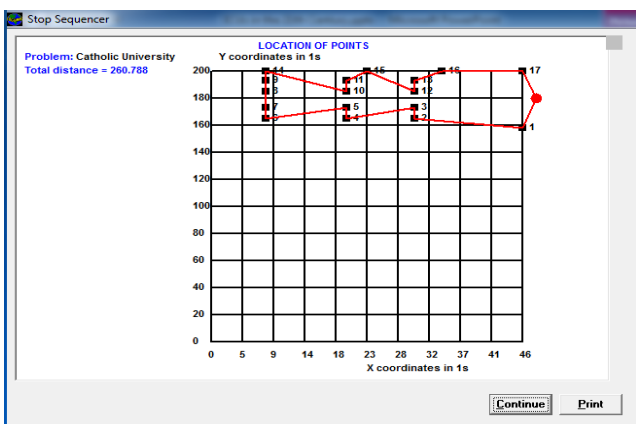


Fig. 9. fifth NS walking in zigzag along with lateral view

patient. The POE suggested that visibility is 20% less than I-Shape and L-shape whereas walking is also relatively higher than previous cases.

4. Synthesis of Cases

A two prong strategy is design as a analytical tools for variance: walkablilty and visibility for arrangement of NS are applied as featured from a group of eight ICUs design in three hospitals located in Korea near Seoul: namely DUIH, SSMU and HUIH. This study analyses the nurse round route to the patient bed, than compute shortest amount of distance for the plan of ICUs on space syntax map. This study aimed to creating the optimal conditions for innovation in healthcare circulation, thus this research focused on team dynamics and mind set than standardize processes and tools. Here is a description the key characteristics of successful circulation path in healthcare innovation is evolved 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.

5. Result

It was proved that U-Shape provides minimum walking and maximum visibility (as shown in Table 2) as nurse is focal point surrounded by patients with two 90o junctions; where as L-shape provides visibility as the nurse is at pivot with one 90o configuration. Lastly, I-shape provides vast vista of a panoramic view from the Nurse Station but on the other hand very rigorous walking route for nurse.

The research team conducted proportional case-study analyses of PDR and POE practices to recognize EBD determinants that are critical to the Nursing process and to generate a conceptual model for the performance towards patients monitoring efficiently. The model depicts the critical elements for understanding and directing nurse practice and underlines the importance of these elements' developing interrelationships. In Fig. 13. the t-value is simulated to

Table 2. synthesis analysis of the set of NS for ICUs of DUIH, SSMC and HUMC.

walking distance in Meters	NS1	NS2	NS3	NS4	NS5	Configuration
HUMC	35	35				I-Shape
DUIH	34	74				L-Shape
SSMC	39.9	30.1	65.5	57.3	79.2	U-Shape

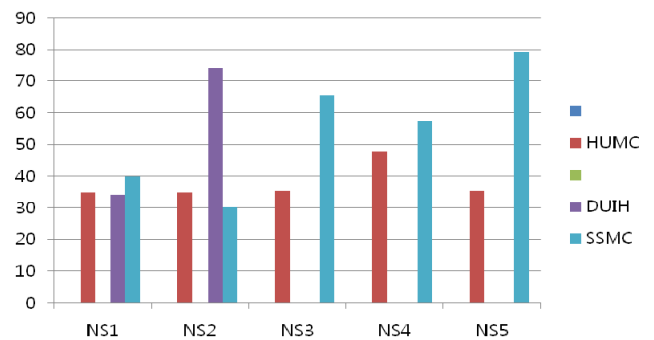


Fig. 10. comparison of the walking in meters of all the NS

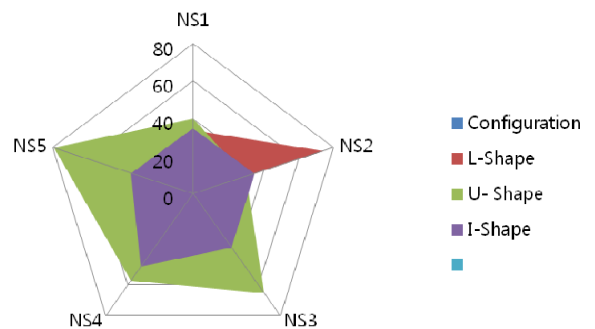


Fig. 11. The walking area of NS

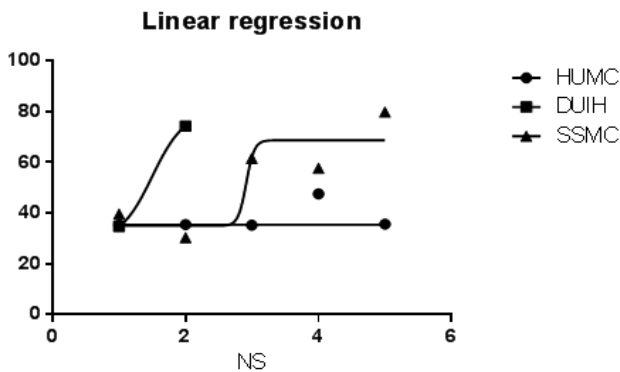


Fig. 12. visibility analysis t-test for PDR and POE

be equal to -8.9724, whereas the degree of freedom is equal to 11 and two-tailed p-value is less than 0.0001. 95% confidence intervals upper level 13.6784 and lower level is -8.1784 visibilities per bed.

Conclusively it was proved that the defined walking route is suitable for enhanced communication and reduction of error therefore falls under EBM and EBD.

Here the limitation is the array of horizontal circulation such as patient (inpatient and outpatient) staff, visitors and materials is out of scope of the study. A complete schematic pattern to bifurcate these multiple layers of overlapping circulation may be practically achieved since it is essential information in ICU design.

6. Conclusions

The subject of the case study was eight ICU from three general hospitals in Korea with ICU that has relatively clear layouts in terms of NS and bed positions. Among them five NS were direct view type i.e. L-Shape or I- Shape and two NS were lateral or side view i.e. U- Shape. A threshold line was formulated to outline the position of each patient according to NS position in ICU EBM. 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.

The zigzag path presents the maximum walking and not comfortable lateral view (not as safe as direct view) presents a long distance for NS5 for SSMC and NS2 for DUIH which has maximum distance of 260 and 243 steps.

NS Design is a method that can let nurse see around beds, thus design thinking is the upcoming management methodology.

Conclusively, LogWare predicted two most advantageous compositions which were concentric around NS: L-Shape or U-Space graded as 5/5 thus walking for nurse reduces and greatest visibility was illustrated. On the contrary I shape and zigzag pattern found at SSMU was recognized as not very efficient arrangement

with 2/5 score, it increases walk and reduces visibility to the last patient in the row. The upcoming research of future work is aimed to be focusing on noise and congestion from patient's point of view.

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