Value Chain Strategies of Linen Logistics Management: The Case of a University Hospital Planning a Triple Expansion (Thailand)

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***Abstract*— *This study observed one case hospital, a tertiary care teaching hospital (1670 beds). The research purposed to investigate the value chain strategies to cope with the current linen shortage while exploring extra approaches and technology for its upcoming expansion, which will triple its current size. Data was collected via in-depth interviews, observations, documentation, experiment and developed checklists, in which the data obtained was managed by the content analysis method. Factors regarding successes and failures as well as the root causes and resolutions of the problems associated with this operation were identified. Obviously, the case hospital adopted two key practices: one was leasing a tunnel washer, and another was hiring the third-party logistics company to deliver clean linen. However, new practices lost the hospital budget around 50 million Baht, thus it was not suited to this early-stage of expansion. Effective value chain strategies were suggested such as using only in-house laundry personnel to operate linen services, obtaining the motorized carts for the delivery, using the designed routes, and leasing only important machines of the tunnel washing system. The findings indicate the need for restructuring policy planning and establishing purposes to generate a true value to users during this preparation for massive enlargement*.

***Keywords*— Linen logistics management, value chain strategy, Thailand's university hospital, hospital expansion, and linen shortage.**

1. INTRODUCTION

The aim of hospital laundry management is to provide an adequate amount of clean linen at the set standards for cleanliness and timeliness [1]. The term linen is used for items made of cloth, including blankets, bed sheets, blue sheets, patients' garments, gowns and towels [2]. Unlike in other industries, healthcare linens are frequently contaminated with blood, excreta or secretions that are infectious [3]. Poorly cleaned cloth can act as a vehicle for transferring pathogens to other patients or hospital employees [4]. Coming into contact with such linen can extend the patient's stay or make surgery necessary in extreme cases [5]. Consequently, in order to protect workers and patients from exposure to potentially infectious linen during collection, the handling and sorting of soiled linen of paramount concern [6]. National Infection Control (IC) Guidelines well as hospital policies must be strictly followed.

Hospital logistics concerns the movement of material, information, goods, and services (including financial flows) across legally separated organizational units [7]. Goods including key medical resources such as medicine and medical supplies, and others such as linen. Linen logistics management may have responsibilities for purchasing, receiving, inventory management, and transportation [8]. Therefore, it is important to examine the functions of linen logistics management to improve services and cut costs. Supply chain management has a wider scope than logistics in that integrated the collaboration among logistics functions or organisation in the supply chain [9, 10].

Upon reviewing the extant literature on linen/textile management in healthcare, it turned out that the salient discussions have focused on: (i) controlling the spread of infections/antimicrobial textiles [11, 12], (ii) user satisfaction [13], (iii) linen cost [14], and (iv) the development of smart healthcare textile and hygiene products [15]. Shortages of linen in public hospitals is common place. This is a significant issue, but it has received scant attention. Many hospitals have discovered linen costs consume approximately 2% of their total expenses [14]. In Barbados, 14% of cancellations and delays in surgical procedures are caused by the unavailability of linen [16]. Several reasons of these shortages were discovered, including lack of procurement transparency, limited budget allocations for linen, theft of linen by hospital staff and patients, broken/insufficient machines (washers, dryers and ironers), staff shortages, poor linen segregation, dramatically increased patient population/hospital expansion, poorly designed linen delivery and in-house/outsource decisions [17-21]. Shortages not only lower the satisfaction of patients and relatives and undermine healthcare service [22], but they are also a source of stress experienced by hospital staff [17].

Considering the value chain theory, central operations, i.e., linen cleaning procedures which are the research focus, were affected by both other primary activities (such as inbound and outbound logistics) and supporting activities (such as procurement, human resource management, technology development, and infrastructure) [23].

Previous studies by Bandoophanit et al. [20, 21, 24] revealed that the infrastructure factor, which covers management (policy), finance, legal and planning,

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continues to be more significant in terms of hospital resource and waste management in the highly hierarchical organizations. **The possibility of increasingly drastic shortages has emerged, particularly when hospitals expand with poor logistics plans and designs. Furthermore, it appears that the level of this impact is driven by hospital size or the complexity of their services or both.** The new area of logistic theory, namely Reverse Exchange (RE), will ground this study in its focus on the exchange of linen between the laundry and users. In the service industries, RE provides insights into the exchange of single-use products between specific stakeholders, e.g., the customer, distributor and manufacturer. Therefore, these exchanges have clear movement and healthy repetitions [25]. In hospitals, RE is used to examine product exchanges (those which are used as part of a service process for a given period of time, i.e., a product is 'on loan to someone for a specific purpose,' but it will have to be exchanged within a given period of time or when it is no longer needed) [20]. There is a dearth of research studies which have focused on laundry services and their continual exchanges as value chain operations.

For service improvements and cost reductions, public hospitals have relied on outsourcing, clustering and maximizing the use of advanced technologies [8, 26]. Traditionally, management has been reluctant to empower laundry workers and listen to their demands in terms of change [27]. However, many changes have involved the ergonomic and health and safety aspects of their jobs. Accordingly, these workers should be involved in all stages of change, as involving people at all levels helps organizations deal as effectively as possible with the implementation of changes [28]. Linen management is either the responsibility of the laundry department (in house) or outsourced to external providers. On one hand, outsourcing allows hospitals to get around human resource limitations [29]; on the other hand, outsourcing can sometimes lead to the perception of lower quality standards with increased risks of infection and contamination [30]. Whatever the choice, the three significant factors "performance," "finances," and "human resources" should be considered. The approximate appropriate number of laundry personnel per hospital beds is 7 workers for 75 beds, 12 for 100–175 beds and 15 for 200–300 beds [18, 31]. These proportion work well only for those hospitals with good-quality equipment allowing one staff member to manage 60-75 kg of linen. In terms of the space required for laundry operations, Singh et al. [18] recommended a space of 5800 square feet for a teaching hospital with 500–600 beds.

The Internet of Things (IoT), one of the most advanced current technological theories, can support change establishment for the current and future medical technology platforms. IoT connects patients with doctors 24/7 via video conferencing, small radio-frequency identification (RFID) sensor nodes, smart mobiles and database cloud computing [32, 33]. In a smart linen and uniform management system, every item is uniquely identified by an RFID tag, and the system is able to record the current location and status of each item [34]. The simulation software ARENA can manage large-scale linen operations and can keep track of highly sensitive changes, e.g., it will raise a red flag when linens go missing after being checked out by staff [35]. Service robots can be used for linen transportation, but they require deliberate, detailed travel paths and proper building infrastructure (automatic doors, elevators and so on) and a station [36]. The processing of large quantities of linen is normally achieved via a 'continuous batch tunnel washer (CBTW)' [2]. This old technology is comprised of several washing units and functions. For instance, every 50-100 kg of linen is loaded into a pre-wash, then passed through the wash, rinse and dry processes. In order to transport both dirty and clean linens effectively, hospitals may consider investing in: (i) modified golf carts, (ii) heavy-duty utility carts or (iii) motorized carts (a scooter connected to a cart) [24]. Previous study exposed that only using two scooters or motorized carts (costs 40,000-50,000 Baht each) can deliver all clean linen for a 200-bed hospital within 1 hour. Clearly, no matter how highly developed the technology/method a hospital has, transparency in administration, as well as window dressing, can be seen as the main driver or a barrier to success [37-39]. Therefore, some authors have noticed this topic when exploring change establishment.

While some studies have examined the shortcomings of linen management, a limited number of studies have investigated this chronic issue emerging during periods of dramatic bed expansion. This study explores the question: '**How has the laundry tackled the preliminary planning for a hospital's triple expansion?**' and is grounded in the integrated theories of the value chain, the RE, Change Management, 4 M and Healthcare Laundry Management.

2. MATERIALS AND METHODS

In a complex organization such as a university hospital, conducting field research in case organization is an effective method for investigating operations [40]. The key research tools used in the field for data collection were in-depth interviews, focus groups, observations, documentation, developed checklist and experiments [41-43]. The case hospital, Hospital "A," was selected purposively since it represented an information-rich case related to the phenomenon of interest [44]. The first phase of this study was already carried out during the period January-March 2018 and compared the linen operations of "A" with two other large-sized hospitals [21]. Linen shortages were evident at all three case hospitals and affected mostly by factors related to infrastructure. Policy of the Ministry of Public Health (MOPH) suggested having 4-6 sets (or called par) of linen: one in use, one ready for use, one being processed, one in transit and two for weekends. However, three case hospitals had only 1-3 sets.

The second phase of research conducted during the period April 2018 to July 2019 **investigated the hospital's strategies and operations while coping with dramatic change**. Hospital "A" plans *to become the*

largest hospital in Thailand and ASEAN via a 5,000- bed capacity. The laundry management processes at Hospital "A," especially the linen exchanges, were observed, along with other important aspects, such as the delivery routes, personnel perceptions, and failure identifications associated with this operation. All personnel working in the laundry department were interviewed at least one time, while the heads were discussed nearly everyday. Furthermore, their working processes were observed and recorded. Ultimately, data were gathered for statistical, root cause and problem resolution analyses. This large volume of data was reviewed and managed via the "content analysis" method [45] in order to identify solutions as well as re-design the exchange or delivery routes. The backbone of the investigation was the value chain theory, along with RE [23, 46, 47]. The detailed analyses employed **'The 4-M Checklist'** for contributing factors from man, machines, methods and materials [48]. In this study, 4 M refers to: (i) **M-M**an - the number of personnel and their workloads, (ii) **M-M**achines - volume of machines/tools/equipment and their capacities, (iii) **M-M**aterials - sufficiency of linen (4-6 par/set) and (iv) **M-M**ethod – strategies or policies, as well as linen management procedures. The identification of operations was based upon the principal logistic requirements: sufficiency of linen (par/set), speed, cost, quality of service and flexibility [49]. At the end of this research, the findings were discussed with the Head of Laundry Department to increase the validity and reliability of the study. Since the research involves a hospital, an ethical application was submitted and approved prior to research being conducted. In particular, the Khon Kaen University Ethics Committee for Human Research (KKUEC) granted an ethics exemption. The approved number was 0514.1.27/4049. In addition, the research was approved by the Head of the Laundry Department of Hospital "A".

3. RESULTS

Using data collected from the various data collection tools, the following profile (section 3.1) was constructed of hospital site laundry logistics based on the linen logistics management and the Value Chain theory. Later, it presented the laundry service (section 3.2) and the detailed analyses employed 'The 4-M Checklist' (sections 3.3-3.5).

3.1 Hospital Background

To fully understand hospital linen operations and how they respond to change, an observational analysis was carried out in a case hospital – Hospital "A" (see Table 1). Hospital "A" is a tertiary care university hospital and is to the main teaching hospital for the Faculty of Medicine. It is located in Thailand and governed by the Ministry of Public Health (MOPH). Hence, it has a centralized administration, and the Director has the highest authority. "A" serves over 700,000 out-patients and 50,000 in-patients each year. Currently, the hospital has 1,670 beds. The Dean of the Faculty of Medicine announced the 5,000-bed project on March 14, 2018 as a solution to increasing demand. The first phase of this project, to be completed within 2.5 – 3 years, is to increase the beds to 3,500 within a budget of 14,000 million Baht. This phase will be followed by a second phase to bring the total number of beds to 5,000 beds with an additional 10,500 million Baht. This megaproject will result in a 39-story building with one-stop service for all patients. The laundry has been preliminary upgraded for the change. The hospital has been awarded the highest level on the Hospital Accreditation (HA) scale (level 3) and is now moving to the international level, called Continuous Quality Improvement (CQI). CQI is a strategy for improving the quality of service throughout the hospital, including in all supporting operations (laundry) [50]. Therefore, good-quality linen management is to be expected.

Table 1. Overview of Case Hospital.

Background	Hospital "A"
1. Number of beds	1,670 beds
2. Type	University Hospital, Tertiary Care
3. HA level	HA3, now moving to CQI
4. In-patient volume	792 persons/day or 50,000 in-patients each year
5. Out-patient volume	700,000 out-patients each year

3.2 Laundry Service

The laundry is located at the back of the hospital. It is administered by the Head of the Laundry Department, who reports to the Administration Department, which then reports to the Hospital Director (see Table 2). The department had 68 personnel (one head, six permanent workers and 61 temporary workers). The hospital purchases new linen items for 15-18 million Baht per year, and the budget was deemed sufficient for the current number of patients and staff. Key linen users were the ICU ward, followed by the surgery wards and operation theatres. Approximately 9,000 – 10,000 kg/day of dirty linen was managed on a daily basis by seven large washers (450-650 pounds) and four small washers (50-125 pounds).

Figure 1 presents the linen flow as well as a floor plan. Dirty linen was transported in the early morning. Linen was washed, dried, ironed, folded and packed according to user requisitions before distribution by cart. Once washed only flat linen, such as bed sheets, was sent to the ironer.

The observations taken over the course of the study found that almost half of the machines were not functioning because they were beyond their useful lives of 10-30 years. Previously, before April 2018, most wards had sent their housemaids to collect clean linen from the laundry since there was insufficient laundry personnel and the maids could handle the additional duties. Delivery by cart took approximately 5-15 minutes

to go between 340 – 730 meters. Therefore, a cart took 10-30 minutes per round trip. In early of 2018, the hospital aimed to establish logistics services to support the delivery of various supplies such as medicine, medical supplies and linen.

Table 2. Overview of Laundry Service

Background	Hospital "A"
1. In-house staff	1 Head and 67 workers
2. Outsourced staff	7 logistics workers (e.g., 6,650 deliveries, 1-31 May 2018 for 460,000 Baht)
3. Change Plan	Hospital expansion to 5,000 bed capacity
4. Linen purchases	15-18 million Baht per year
5. Volume of linen used	9,000 – 10,000 kg/day (Not included the heart centre)
6. *Sets of linen*	Average 3 sets of linen per patient per day
7. Laundry management	In-house
8. Washers/Dryers/ Ironers	30-50% of the machines were not functioning for more than 6-8 months
9. Users	78 large departments (key users: ICU, followed by surgery wards and operation theatres)
10. New machine installation	Leasing of tunnel washer with folding lid (12-batch) for 60 months at a cost of 74.9 million Baht.

The work was outsourced to a third-party logistics company starting in May 2018, and the service included 7 workers devoted to transporting clean linen only. The contract stipulated that the company had to make 6,650 rounds per month, i.e., twice a day at 08.30 and 15.00. In July 2019, the hospital began building a basement for a new CBTW. Ever since the laundry has limited space, three washers were removed for this purpose. Currently, the laundry experiences linen shortage mainly due to: (i) a broken machine, and (ii) machine removal. Hospital "A" expected to be able to provide sufficient linen in 6 months after the CBTW installation.

In short, to tackle the hospital expansion, the laundry has come up with two strategies: (i) redesigning the delivery services by outsourcing delivery to a third party at a cost of approximately 460,000 Baht/month or 5,520,000 Baht/year, and (ii) leasing the CBTW, which can manage 10 tons of linen a day (CBTW costs 74.9 Million Baht of leasing/5 years).

3.3 Man-Personnel

The number of in-house laundry personnel at "A" is 67. Each person generally works for 20-22 days/month, meaning that there are 48 persons working daily. During urgent periods, such as times of increasing demand from patients or a broken machine, the staff has to work overtime (OT) for a maximum of 4 hours per day (at the rate of 200 Baht) in order to provide sufficient clean linen. Their responsibility level is relatively high for 1,670 beds at a teaching hospital. A total of 15-20 of the male staff rotates through working with dirty linen since many of the activities related to dirty linen, such as loading-unloading dirty linen from the washers, involve heavy lifting. The dirty linen comes in from the wards (4-6 staff from 7.00-8.00 am). Then all dirty linen is sent through the cleaning process from 8.00-19.00: washing shaking it and loading it into dryers (about 10 staff).

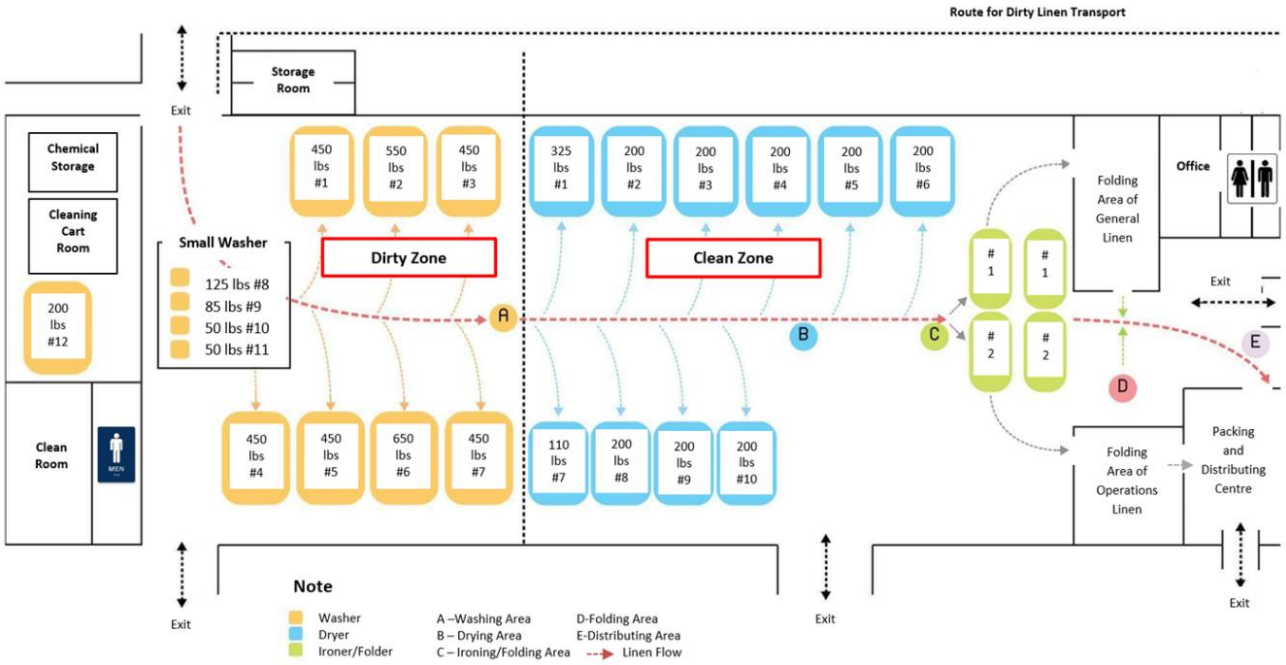

Fig. 1 Floor plan of laundry department.

The 28 female workers deal with ironing (4-8 persons), folding and bundling (in bundles of 5-10 pieces of linen) (14-15 persons), packing linen into carts according to the requisitions (4-5 persons) and delivering the linen by cart and storing it in the users' cupboards (at least 6 persons a day). This system was adopted until April 2018. According to Singh et al. [19], a hospital should have 15 staff for 200–300 beds and a good-quality machine. Therefore, "A" should have at least 84-125 persons assigned to the laundry (i.e. 200/1670*15), indicating that 17-58 more staff should be recruited to support these tasks.

As mentioned earlier, as of May 2018, the hospital has had 7 logistics personnel to transport clean linen. In fact, less than half of the clean linen was transported by them, with the rest of the linen still being delivered by the female laundry staff. The logistics personnel often transported linen with a normal cart, but they used a modified golf cart (belonging to their company) once a day to transport linen to the farthest building. The observations uncovered that each of them worked 2 hours a day for a 14-hour (7*2hours) total contribution per day. This total is less than that of 2 in-house persons (2*8 hours = 16 hours). According to the interviews with laundry staff, the logistics company pays their workers 400 Baht a day, while the in-house workers receive a minimum wage of 325-350 Baht for working 8 hours a day for the hospital. Therefore, if the hospital paid the logistics workers the same in-house rate, their labour costs would only amount to 81.25-87.5 Baht/ person/day (325/8*2hours) or 612.5 Baht/7 persons/day, i.e., 12,551 - 13,475 Baht/7 persons/month. The hospital could then review recruiting more in-house staff with these savings of up to 447,449 Baht/ month (460,000-12,551) or 5.37 million Baht/year. Hence, the outsourcing should be eliminated. The hospital should revert to the previous system whereby the maids from the wards helped distributing clean linen. Would more personnel even be needed?

3.4 Methods and Materials

According the Labour Protection Act [51]: "A boss shall be prohibited from ordering an employee to lift, tote, carry with both hands, carry suspended from the ends of a pole across the shoulder, carry on the head, drag or push a heavy object in excess of the weights prescribed in ministerial regulations (25 kg for woman and 50 kg for man)." Since the male staff have to push dirty-linen carts weighing more than 100-200 kg/round, and the female staff have to carry clean-linen carts weighing 100 kg/round (1 person), or 200-400 kg/round (2 people), the hospital's practices do not follow the Labour Protection Act (1998) (see Figure 2). To solve this problem, the hospital should spend the annual budget for outsourcing delivery of 5.52 million Baht on developing a logistics system while considering the following strategies.

Fig. 2 General cart.

3.5 Machine

The laundry department had 6 large washing machines, 4 small washing machines, 10 large dryers and 2 ironers. Most of the machines were older than 10-15 years old, and some were as much as 25-30 years old. Washers often broke down due to the following causes. One was poor waste segregation. Unsorted metal object such as forceps, scissors, syringes and blades blocked the washers' motors frequently. Another was programming errors, for example, overloading the machines and working them more than 12 hours a day. The waiting time for the washers to be fixed ranged from 3 months to more than 6 months, in some cases, repairs took over a year (such as for an ironer). However, the urgent need for an ironer resulted in the Director's approval for repairs being completed within a day. However, there must be better coordination with linen users in terms of improving object segregation in line with the guidelines issued by the World Health Organization [3, 52]:

These tools should be sorted at sources such as clinics and wards to be further sterilized, or disposed of, and not cause such risks in the laundry operations. Also, linen should be sorted from sources mainly into (i) infected linen and (ii) general linen, because they use different cleaning procedures, failure to do so carries risk but also extends the time taken for the laundry cycle.

In preparing for coming hospital expansion, it was announced on 22nd February 2018 that a tunnel washer with folding lid (12 batches) would be leased at a cost of 74.9 million Baht for a 60-month contract. According to the published contract, this first process of machine installation was undertaken during 18 January – 17 July 2019 (6 months). However, the company delayed the work until the second week of July 2019. Purchasing a machine instead of leasing it means maintaining it, and maintenance costs grow as the machine gets older [53]. Consequently, the hospital's decision to lease a tunnel washer could be appropriate.

Head of the Laundry Department revealed the strong intention of both hers and Hospital Director's in obtaining the tunnel washer. This was because currently the hospital outsourced the laundry service for the heart centre to manage a ton of dirty linen per day. The cost was 9 Baht per kilogram, which equals to 9000 Baht per

day (1000 kg*9 Baht), or 3.285 million Baht per year (9000 Baht * 365 days). If this one ton of linen was managed by the Laundry Department, so the total volume can reach 10-11 tons a day. And if we used the standard cost of 9 Baht per kilogram of cleaning service, linen management cost per day should meet 32.85 million Baht per year (10,000 kg on linen/day * 9 Baht * 365 days). Because of this, the washer that costs 74 million Baht would have 2.25 years of payback period of an investment. Generally, the government equipment has 3-5 years to break-even the amount of money invested. The Head confirmed that the payback period would be shorter than 2.25 years owing to the increasing volume of patients that generate greater use of linen.

In the implementation of a tunnel washer, Hospital "A" removed three washers to make sufficient space for installation. The personnel interviewed about the removal of the three washers stated that they were in good condition, while other washers in the laundry were malfunctioning. The criterion for this selection was unclear. However, these factors and the subsequent effects should be taken into account. A tunnel washer generally requires a small number of personnel to load dirty linen (1-2 persons) and fold linen (about 2 persons). (Note that this machine can wash and dry linen automatically.) Whereas, the rest of the activities, including delivering dirty and clean linen as well as packing the linen, requires the same amount of staff if using the existing delivery system. Hence, this strategy effectively minimises the number of personnel from 28-35 persons to 4 persons. "A" should devise a fair plan for personnel selection and lay-offs in advance to reduce or prevent any future damage.

4. RECOMMENDED STRATEGIES

From the above findings, several strategies were searched, tested, and then recommended as follows.

1st Strategy – Use In-house Personnel

Replacing the third-party logistics company with more in-house personnel. Hospital "A" itself needs to hire more 1-2 male workers for delivering clean linen that can work equal to 7 logistics personnel.

2nd Strategy- Use Motorized Carts

Bandoophanit [24] states that two motorized carts can deliver clean linen in a 200-bed hospital within 1 hour (each cart having one driver) (see Figures 2 and 3). The cost of connecting motors to the current carts is only 40,000-50,000 Baht per cart, and each motor has a useful life of more than 5 years. Hospital "A" could start by having two motorized carts transport all the clean linen within a day or have more motorized carts to make deliveries at the same time as usual (at 08.30 and 15.00). The practice can be supported by other university faculties: (i) the Mechanical Engineering Faculty, who could make the motorized carts and come up with effective delivery routes, and (ii) the Business School, which could figure out the most cost-effective delivery system and calculate the payback period of a motorized cart.

Fig. 3 Motorized cart.

3rd Strategy – Use a Modified Golf Cart

Currently, the third-party logistics company has one modified golf cart (see Figure 4) that can help transport clean linen to the farthest building (has to cross the road) one time a day since it has to transport other hospital supplies as well. Based on the interviews with laundry staff, a new cart costs 600,000 Baht, and can carry up to 500 kg of linen per round. However, a used cart is much cheaper, which could suit the hospitals, desire for a trial. Consequently, "A" should consider purchasing its own golf cart for the first stage of the hospital's enlargement with some of the 5.52 million Baht of budget.

Fig. 4 A modified golf car.

4th Strategy-Redesign the Delivery Routes

The hospital could redesign the delivery routes if it decides to transport the clean linen via the current carts (Figure 2). The outcomes of redesigning routes are found in Table 3 and Figure 5. Eight relevant factors were taken into consideration in this development: (i) the volume of linen used by particular users, (ii) trends in patient use, (iii) user's location, (vi) distance, (v) speed of delivery, (vi) time the linen is stored in the user's cupboard, (vii) the number of laundry personnel, and (viii) the number of carts.

Thirteen routes of clean linen delivery were developed for this purpose, such as route 1, which transports linen to two wards (2A, 3B) and runs for half a kilometre,

taking 24.46 minutes per round. Each cart has a capacity of 100-150 kg, meaning that they should be carried by two people instead of following the current practice of assigning one person per cart. Therefore, 26 persons are needed for delivery and could finish this task within just 16-40 minutes. The total linen transport time is 5 hours and 52 minutes. However, it acknowledges a laundry personnel shortage. Therefore, "A" should consider the previous strategy of having the maids from the wards support this activity. Note that there are three routes located in two other buildings, therefore, they are not presented in Figure 5.

Table 3: Redesign the Delivery Routes of Linen.

No	Wards	Linen (Kg)	Distance	Delivery Time (Min)
Old Building (Wards A,B, C, D and E) [Year 2018-2019]				
1	2A, 3B	135-150	510	24.46
2	2B, 2C, NICU, 2D, IMC2D	130-145	510	28.62
3	3A, 3E	140-150	520	18.96
4	3C, 3D	140-155	440	16.46
5	4A, 4B	120-140	440	23.46
6	4C, 4D	130-150	440	19.46
7	5C, 5E	125-145	440	22.46
8	5B, 5E	115-130	520	27.46
9	5A, 6A	105-125	500	29.46
10	6B, 6E	85-120	520	28.46
CPB Building				
11	2F, 3F	115-140	850	37.90
Central Building				
12	AE1, AE3, AE4, Burn Unit	130-150	705	35.77
13	AE, Psycho, S&E, CVT, CCU	120-140	700	39.45
Total				**352.38**

5th Strategy-Lease Only Tunnel Washer

To save the hospital money, "A" could elect to purchase/lease just the tunnel washer without the ironer, which would cost approximately 30 million Baht and include a full service package, since the two current industrial ironers are functioning well. This strategy could save up to 44.9 million Baht, which could be spent on other important areas such as medicine and medical supplies or fixing all broken machines to reach full operational capability. On an average, the volume of linen was 3 sets which was less than the standard (4-6 sets). Therefore, having one more set is reasonable idea to minimise shortage.

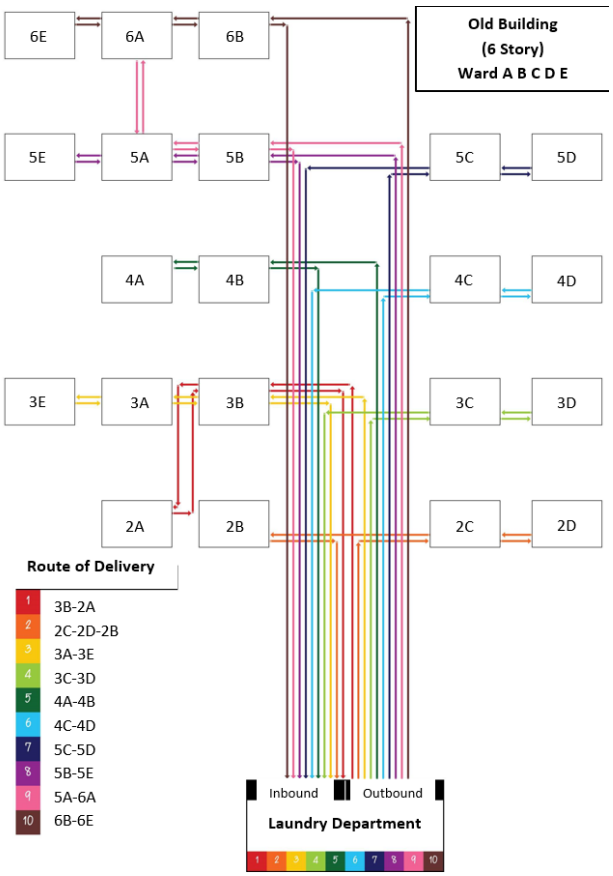

Fig. 5 Redesign of Linen Delivery Routes #1-#10.

5. CONCLUSIONS

The aim of linen management is 'to provide a regular and timely supply of clean linen to the satisfaction of patients and staff,' as mentioned earlier. This study principally applied the value chain theory, in combination with R/E, linen logistics management and 4 M to investigate the hospital's strategies for coping with the early stages of a drastic expansion. The study indicates that the greatest changes were mainly generated by the Hospital Director, who made their decisions based upon the information provided by the Head of the Laundry Department (see Figure 6). Such decisions resulted in smooth or disruptive linen operations and exchanges which impacted users, both patients and hospital personnel. Accordingly, effectively implemented linen strategies should start with the Head of the Laundry Department.

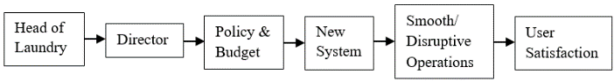

Fig. 6 Processes of change generation and implementation.

Given a large amount of money "A" allocated to (i) leasing a tunnel washer (74.9 million Baht over 5 years), and (ii) contracting with the third-party logistics company to deliver clean linen (5.52 million Baht, every 1 year). This study asserts that "A" can increase its cost savings by up to 50 million Baht and still can meet the greatest working capacity, future capacity, and the satisfaction of both user and current employees. The recommended strategies are: (i) use only in-house laundry personnel to operate linen services (both cleaning and delivering), (ii) purchase or lease a tunnel washer for 30 million Baht, plus and use the two current industrial ironers instead of leasing a high-technology tunnel washer. Linen delivery routes should be redesigned (see Table 3 and Figure 5) and supported by the motorized carts (40,000-50,000 Baht per cart) and/or modified golf carts (500,000-600,000 Baht per cart). This new technology requires a budget of approximately 1 million Baht, which is equivalent to hiring the third party logistics company for 2 months (460,000*2months). The suggested two motorized carts and one golf cart can be utilized extensively for at least 5 years and will provide faster transport for a greater volume of clean linen while occupying only 3-5 persons. Therefore, the rest of the staff will have sufficient time for their main duties. While addressing change, poor planning resulted in a serious shortage of linen because: (i) three large washers were removed to provide sufficient space for the tunnel washer's installation, while (ii) only 2-3 of the remaining 7 large washing machines were operating. Another concern is how the change (personnel selection and lay-offs) has affected morale. Hence, the above-mentioned strategies focus on what in-house operations to follow.

This study confirms the beneficial applications of the value chain theory in investigating the organizational change in terms of how policies should be created rationally and how they impact the hospital budget, linen operations, and all users. All laundry personnel should be involved in all stages of change in order to increase morale and the effectiveness of implementation [28]. The findings indicate the need for restructuring policy planning and establishing purposes to generate a true value to users during this preparation for massive enlargement.

ACKNOWLEDGMENT

The author would like to thank Hospital "A", the personnel in the Laundry Department, as well as students graduated in 2018 and lecturers in management sciences, Khon Kaen University for the support.

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