

Radio Frequency Identification (RFID) Adoption in Healthcare Linen Management: A Case Study at Medilaund

Siva Kumar Ramasamy¹, Shahizan Hassan²

¹Medilaund Sdn Bhd, Kawasan Perusahaan Teluk Panglima Garang, Kuala Langat, Selangor

²Othman Yeop Abdullah Graduate School of Business, Universiti Utara Malaysia, Sintok, Kedah

Corresponding author: arsivaa15@gmail.com

Abstract

The Malaysian healthcare industry is experiencing a steady growth, rapidly expanding to meet the needs of society. Expectedly, this development led to a high demand for healthcare linen. With increasing competition, healthcare linen and laundry services (LLS) provider companies need to efficiently cope with the impending demand and business issues / challenges. Presently, Medilaund, a pioneer in linen and laundry industry in Malaysia is struggling with healthcare linen management which gives a strong impact on its total inventory management. The company's Linen Manager, Mrs. Hasnidahwati is looking for an immediate solution to increase efficiency in healthcare linen management in order to meet the customers' demand. Thus, a comprehensive study is essential and need to be carried out systematically in order to identify the possible solution(s). The company should take various factors into account, including technological advancements. Radio Frequency Identification (RFID) technology is a fast growing technology that is able to produce major changes in healthcare linen management. The primary purpose of this paper is to demonstrate the ways to increase efficiency in healthcare linen management by adopting RFID technology. A case study was initiated at Medilaund (M) Sdn Bhd. The case study was carried out by assessing the key processes in healthcare linen management, interviewing key personnel and reviewing selected secondary data. In addition, an observation of data obtained from the laundry site visits was also conducted to evaluate the business issues / challenges and suggest mitigation plan to increase efficiency in healthcare linen management in order to meet performance indicators and exceeding customer satisfaction.

Keywords

RFID, Healthcare linen management, Linen and laundry services, Inventory discrepancies, Linen loss.

Case Objectives

The case took place in Medilaund (M) Sdn Bhd, one of the largest linen and laundry companies in Malaysia. Medilaund is specialised in healthcare linen and laundry services since its inception in 1994. The company provides solutions that cover end-to-end linen and laundry services in assisting their customers to concentrate on the patient care and medical activities.

After discussing this case, readers will be able to:

- i) illustrate the main activities in healthcare linen management
- ii) outline the performance indicators in healthcare linen management
- iii) evaluate the business issues / challenges in healthcare linen management
- iv) identify a mitigation plan to increase efficiency in healthcare linen management

Introduction

Linen and Laundry Services (LLS) is one of the five services which are privatised and they are obligated for duty under the privatisation of hospital support services in 1997. The service demand has increased gradually for the past 19 years from 2,956 tons of clean linen in 1997 to 72,500 tons in 2016 and the fee paid by the government for the services at 122 hospitals in 1997 has increased from RM11.5 million to RM270 million for 144 hospitals in 2016 (Kementerian Kesihatan Malaysia, 2016). In addition to this, patient's expectations towards healthcare service, especially in linen and laundry service has also increased. Indeed, patients expect daily linen changes. In areas like Intensive Care Units (ICU), linen has to be changed even more frequently. An adequate supply of clean linen that is delivered on time is undeniably essential for the comfort and safety of the patient. It also helps in physician satisfaction since it can prevent delay in operation theatre (OT), ICU procedures and also in the Central Sterile Services Department (CSSD) operations. It is believed that shortage of linen leaves patients dissatisfied. Sometimes, even surgeries get cancelled due to shortage of OT linen (Bloom, 2015).

Currently, Medilaund is facing a severe linen shortage problem in the Linen Department which needs immediate and permanent solution. Medilaund took various actions to overcome the shortage problem, such as strengthening its standard operating procedure (SOP), increasing stock audit, conducting training to create awareness on linen handling, and purchasing new linen regularly for addition in its linen circulation. However, all of the measures taken in overcoming the issue seem temporary and the measures were unable to solve the linen shortfall completely.

Mrs. Hasnidahwati was entrusted by the top management of Medialund to resolve the business issues. Mrs. Hasnidahwati has been given an authority to assign external consultant to thoroughly analyse the problem and take a holistic action plan to resolve this issue. She is also expected to transform the company's inventory management to be effective and competitive within one year time frame.

Background on the Company, Industry and Competitors

Company Background

Medilaund (M) Sdn Bhd, (Medilaund) is a subsidiary of *Radicare (M) Sdn Bhd* incorporated in year 1997. It is today one of the largest linen and laundry companies in Malaysia. Medilaund is a specialised healthcare linen and laundry services provider company that is regarded as a leading pioneer in the linen and laundry industry since its inception in 1994. Medilaund provides solutions that cover end-to-end linen and laundry services in assisting the medical practitioners to optimize the use of their linen while giving them freedom to devote their full commitment on the core function which on the patient care and medical activities (Radicare, 2017).

Medilaund's technologically advanced central laundry facility implements an innovative linen processing system that meets the highest industry standards. Medilaund has capability, knowledge, skills and experience to serve more than 14,000 beds in 38 government hospitals and 7 medical institutions in four states (Selangor, Pahang, Kelantan and Terengganu) and federal territory of Kuala Lumpur and Putrajaya. Medilaund also provides laundry services for 11 private hospitals in Negeri Sembilan, Selangor and Pahang (Radicare, 2017).

Presently, Medilaund has three centralized laundry plant strategically located at Teluk Panglima Garang, Selangor and Gebeng, Pahang. Medilaund's 1st plant was constructed in 2000 and started their operation in 2001. The 2nd laundry plant was constructed in 2006 and commissioned in 2007, with a combined load of up to 70 tonnes per day. Since Malaysian healthcare industry is experiencing steady growth which led to the high demand for healthcare linen, Medilaund decided to build 3rd laundry plant in Gebeng, Pahang to meet demand from east-coast customers with additional 15 tonnes washing capacity per day. Overall, the company has capacity to manage 18 million kg of linen annually.

The laundries were regulated by the Ministry of Health and adhered to several legislations and specific requirements including the related environmental aspects. In addition, Medilaund has laundry expertise from Germany and Denmark to provide technical resources and maintenance supports. Besides that, Australia and New Zealand Standard on Laundry Practice (AS/ANZ 4146:2000), Textile Rental Services Association of America (TRSA) and Fabric Care Research Association (FCRA) are amongst the standards adopted by Medilaund (Radicare, 2017). End users are assured that the level of services provided will exceed their expectations. Besides that, services are benchmarked against the services standards set by the leading Asia Pacific countries.

Medilaund has more than 140 linen items ranging from bed linen, staff linen, patient linen, operation theatre linen and miscellaneous linen. Basically, Medilaund provides linen rental to government hospitals and other government medical institution based on the technical requirements as per stipulated in Technical Standards and Performance Indicators (TRPI). The company also provides linen rental to a few private hospitals based on their requirements. For other private hospitals, Medilaund only provides laundry services since the linen belongs to them (customer own goods).

Key Laundry Processes

Figure 1 shows Medilaund’s key laundry processes. At first, soiled linen were collected from various user areas (hospitals) and transferred to a centralised laundry plant (Medilaund) via dedicated lorry and routes. At point of receiving, soiled linen were segregated and transferred into soiled linen bags. Later, the soiled linen bags is transferred and unloaded into washing machines such as Continuous Batch Tunnel Washer (CBTW) and washer extractors. The washing process will begin after adequate water and chemicals are injected into washing machines. Upon completion of washing process, the clean linens were transferred to Clean Zone for drying and finishing process such as ironing and folding. While at Clean Zone, clean linens were gone through visual inspection and quality control activities to ensure the clean linens were meet user’s requirements and expectation. Then, clean linens were packed and placed into trolleys and deliver back to users. Refer to **Appendix A** for the comprehensive pictorial laundry process flow.

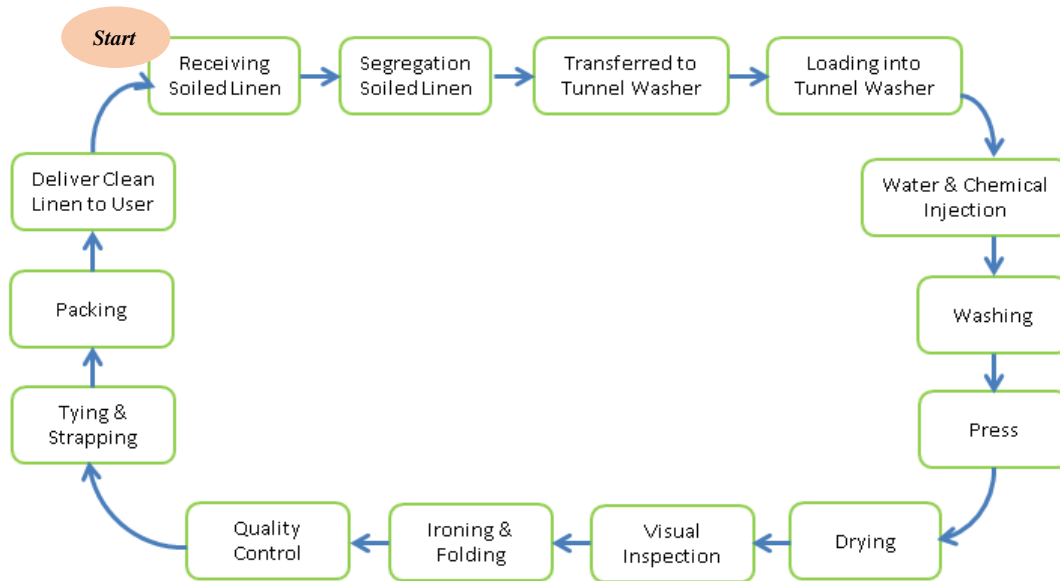


Figure 1:
Medilaund’s Key Laundry Processes

Healthcare Linen Rental Industry

The healthcare linen rental industry is attractive to private equity and strategic buyers. It is more practical and cost effective for hospitals, nursing homes, physician’s practices, and surgery centres to let companies who specialize in laundry processing provide the service. Industry statistics show that more hospital and health care facility administrators are outsourcing linen and laundry services. Ultimately, they find that on-premise laundries are not cost effective to operate. As a result, these administrators are also suggesting an environmentally safe decision by using reusable linens instead of disposable products.

The trend of outsourcing linen ownership, laundering and management have increased over the last twenty years as hospitals strive to control costs and avoid the large capital expenditures associated with laundry equipment. As hospitals seek to increase profitability, they often identify the physical laundry space for use for revenue producing services. Additionally, hospitals recognize that processing linen is not a core competency. According to Modern Healthcare magazine, laundry services are now the number one most outsourced service in healthcare facilities. Concurrent with the trend toward outsourcing, the growth of clinics and surgical centres has increased the need for outsourced linen services, as those entities cannot process their own linens efficiently, cost effectively or to necessary standards.

As part of its end-to-end approach, the industry provides a comprehensive healthcare linen management service to their customers. Besides linen rental, the main activities in healthcare linen management service are devoted to the delivery of good clean linen and collection of soiled linen to and from ward or user location in accordance to the pre-determine schedules, frequencies and routes. Good quality linen refers to hygienically clean and meeting standard (size, type, material and colour) as set by the Ministry of Health. In addition, new linen needs to be purchased constantly to replace condemned linen, losses and increased in demand to ensure adequacy in the hospitals. Tools and equipment such as laundry bags, trolleys and holders for the purpose of collection and delivery activities need to be adequately available.

Furthermore, healthcare linen management is also responsible for the maintenance and management of related stores to ensure that they are clean, well ventilated, have adequate stacking racks and has a proper inventory system. Periodic audit was conducted to ensure the issues are under control. In addition, stock check activities is carried out monthly by Linen Department to verify and evaluate the current inventory situation.

Moreover, the industry also provides on-site survey / scoping studies, consultation and advices the customer on the type and quantity of clean linen required by the customer. User training on linen and laundry is also provided to educate hospitals staffs and end users on linen abuse, linen loss, the danger of soiled linen, cross infection, lint, laundry wastes and proper handling of related laundry tools and equipment also has been provided as part of healthcare linen rental services. Refer to **Appendix B** for the summary of healthcare linen and laundry service options.

The Competitors

Medilaund has four competitors; namely Edgenta Mediserve Sdn Bhd, Pantai Medivest (M) Sdn Bhd, One Medicare Sdn Bhd and Sedafiat Sdn Bhd. They are another concession companies for hospital support service under Ministry of Health (MOH).

Edgenta Mediserve Sdn Bhd (*formerly known as Faber Medi-Serve Sdn Bhd*), is a Wellness Support Services company, whose hospital support and facility management services are widely acknowledged to be industrial benchmark-setters in Malaysia. Edgenta Mediserve, a member of the UEM Group of Companies, is a pioneer and one of the largest linen and laundry service providers in Malaysia, serving more than 100 hospitals and over 300 healthcare institutions in Malaysia and around the world. In Malaysia, Edgenta Mediserve covered northern region of peninsular Malaysia namely Perlis, Kedah, Penang and Perak. As one of the largest Linen and Laundry Service (LLS) providers in Malaysia, UEM Edgenta offers end-to-end linen and laundry

services including laundry, processing, quality testing, delivery and procurement (Mediserve, 2017). The strength of Edgenta Mediserve's LLS operations stems from several factors; the company's technical expertise coupled with LLS management experience equipped with modern facilities and equipment, plus a network of laundry plants nationwide, all of which allow them to provide efficient linen and laundry services for clients.

Pantai Medivest Sdn Bhd, (Medivest) was first set up as a hospital support services provider to government hospitals and healthcare centres in southern region of Peninsular Malaysia inclusive Negeri Sembilan, Malacca and Johor. Today, Medivest is one of the key players in providing healthcare solutions to the healthcare industry in Malaysia. Medivest has grown from strength to strength since embarking on the effort to provide healthcare support services from 1996 (Pantai Medivest, 2017).

One Medicare Sdn. Bhd. is a special vehicle purpose company that has been awarded the Hospital Support Services for all of Sarawak, effective 1st April 2015. It has built a partnership between Edgenta Mediserve Sdn. Bhd. (formerly known as Faber Mediserve Sdn. Bhd., which has been providing the Hospital Support Services for the past 15 years in Sarawak) and Metrocare Sdn. Bhd., which is a Sarawak-based company. One Medicare Sdn. Bhd. is committed to ensure conformity in all their services by adhering to every aspect of contractual and legal requirements as its baseline of Quality Performance Standard. The company serves all 22 hospitals in Sarawak (One Medicare, 2017).

Sedafiat Sdn. Bhd. is another concession company that has been awarded the Hospital Support Services for all of Sabah, incorporated in year 2011. The company serve for all 21 hospitals in Sabah. As a new comer in the healthcare linen industry, this company is committed to provide excellent linen and laundry services to their customers (Sedafiat, 2017).

Business Issues / Challenges

Bad linen service is one of the most frequently heard complaints in a hospital. Attention to patients' personal needs and comforts are as important as the physician's medication and therefore adequate supply of clean linen becomes imperative. There are several challenges has been raised in healthcare linen management. However, inventory discrepancies and linen loss are among the main critical business challenges faced by Medilaund which have strong implications on healthcare linen management.

Inventory Discrepancies

Generally, inventory control is the processes employed to maximize a company's use of inventory. In other word, discrepancies in inventory stock management refer to situations in which actual warehouse inventory or in-store **inventory differs from the records** of those inventories. When the expectation based on records for inventory doesn't match the actual counts in inventory, there is a discrepancy. Shrinkage, poor record keeping, incorrect location, human error, and faulty inventory management software are among the five common causes of inventory discrepancies have been identified for companies across all industry (Koumanakos, 2008). By discovering these issues helps to move the business in a more profitable direction and eliminate anything that may have been attributing to stock loss or incorrect counts. Thus, the

goal of inventory control is to generate the maximum profit from the least amount of inventory investment without intruding upon customer satisfaction levels.

In the case of Medilaund, it was found that inventory shrinkage is the one the main sources of inventory discrepancies. Basically, **inventory shrinkage** is the term used to describe the loss of inventory. The term **shrinkage** is also used by manufacturers when referring to the loss of raw materials during a production process.

According Mrs. Hasnidahwati, Linen Manager:

Whether caused by accidental loss or intentional theft, the result of inventory shrinkage is the same. We can lose linens to theft in number of ways. Actually, we have many linen stores either in laundry plant or at user area at hospitals premise. Other people might have chances to access the linens stores. The chances are so great especially during peak hours and night time. The most type of linens which were lost is baby napkin, baby wrappers, bath towel and staff's attire. Noticed that some irresponsible hospital staffs and patients may be walking out with it...

Mrs. Hasnidahwati also believed that inventory shrinkage depletes the business' potential income, and thus, potential profit. The company which has to replace the linens were lost frequently to ensure that the particular linens are adequate in the linen cycle.

Poor record keeping is another root cause for inventory discrepancy. The staffs at linen department and linen distribution department must be vigilant about recording all transactions affecting inventory. It was noticed that standard operating procedure (SOP) are available at point use indicating that the steps to follow in the event of receiving new linen or clean linen either from vendors or laundry plant. Unfortunately, the employees did not follow the SOP all the time.

According to Mr. Rudy, Linen Distribution Manager:

Linen items as they enter and exit the storage facility should be recorded and monitored. Currently at Medilaund, every time receiving new linens from vendor or clean from laundry facilities, the person in-charge should verify the data such as type of linens and quantity to avoid any discrepancies. Unfortunately, sometimes this verification process was not done efficiently. Other than that, staffs easily can access to linen store since there is no proper control. They can take whatever linen items as they want to, without any record...

The above situation caused inventory discrepancies which lead to overall inventory management. Furthermore, for Medilaund, incorrect location of linen caused linen tracking become more complicated since the company has more than 140 types of linens which can be categorized based on size, colour, type and materials.

According to Mr. Rudy:

Linen tracking manually is very labour-intensive, because keeping detailed records requires that different types of linen items must be separated, counted, recorded on paper and then later entered into a computer. In some situation, misplacement of

linen items by staff also caused linen tracking more difficult. Moreover, the company has linen store in every hospital. Basically, manpower is used to do stock count whenever is necessary and there is high possibility for human error. In this situation, it is very difficult to have an accurate data on real time inventory levels...

Thus, inventory discrepancies caused Medilaund cannot accurately plan for linen management and face potential delay in day-to-day operations due to inaccurate inventory. Moreover, human errors also another factor of inventory discrepancies which lead to demand forecasting becomes inaccurate. Mistakes happen in even the best-run company. The employees are so careless in counting and key in data into system.

According Mrs. Hasnidahwati:

Medilaund will do demand forecasting by estimating the quantity of linen that hospital will order based on daily, monthly, quarterly or yearly linen usage data. Based on this demand forecasting data, Linen Department will do necessary arrangements to purchase new linen in order to ensure adequacy of linen in the user area. Since human factors caused demand forecasting error, it will affect decision making in purchasing new linen...

From the business point of view, the error in demand forecasting may lead to either shortages in linens purchased or linens were overbought or even wrong linen items were purchased (Aksoy *et al.*, 2012). Basically, it will give a strong impact on company's image profit and loss (P & L). Most of the time, Medilaund bear additional cost for alternative measures to overcome the linen shortage issues. In some other cases, Medilaund had been charged some kind of penalties in dollar and cents as per stipulated in deduction formula by MOH.

Faulty inventory management software is one of the causes for inventory discrepancies for company all over industry. However, in Medilaund, there is no specific inventory management software was available. The company have Central Management Information System (CMIS) which has been used to capture overall demand and supply of linen and quality of linen supplied to their respective customers.

Linen Loss

Linen loss is another business challenges in healthcare linen management. It is widespread and expensive. Linen loss refers to the disposal or disappearance of linen item before it has reached the end of its useful life. Linen loss is one of the biggest problems faced by laundry services management. According to the results of AmericanLaundryNews.com **Wire** survey, roughly 9% of respondents say linen loss is their main problem, and 45.5% say it is "one of our biggest issues." Approximately 39% say linen loss is "no worse than any other issue." This loss is "an issue only on rare occasions" for the remaining 6.1% of respondents. No one believes that linen loss is "no problem at all" (Beggs, 2007).

Meanwhile, the survey also used to identify the sources of linen loss. It was found that four possibilities linen loss are improper disposal, deliberate theft, abuse or improper use and inadvertent theft. The survey indicated that 62.5% is most often due to improper disposal (throwing linen away before the laundry can attempt to clean them). Deliberate theft (taking

items for personal use or resale – 56.3%), abuse/improper use (53.1%) and inadvertent theft (belief that items can be taken after a hospital stay or hotel visit – 46.9%) are other key causes (Beggs, 2007).

Medilaund is also facing the similar challenges stated above. However, based on data reviewed, it was found that abuse / improper use is one of the main possibilities of linen loss. Basically, hospital staffs misused healthcare linen as floor mat, table cloth; cover the medical equipment, cotton rag, and so on. Inevitably, some linen gets stolen, especially napkins and hand towels, but this is a relatively small issue compared to situations where towels are used to clean bathrooms, napkins being used to clean cutlery or soiled bed linen being stuffed into duvet covers that are then dragged along corridors and over yards.

Meanwhile, improper disposal of healthcare linen was another possibility of linen loss. Evidently, this has caused problems to Medilaund in managing linen efficiently. Based internal linen loss analysis which carried out by Linen Department, found that hospital staffs, particularly nurses, throw soiled linen into trash, biohazard bag or alginate bag. Even though user training has been conducted to create awareness among nurses but improper disposal issues still happen all the time.

According to Mrs. Hasnidahwati:

Mostly lost occurs due to hospital staffs (I'm mean nurses but not all) throwing soiled linens in a trash or red biohazard bag or alginate bag. They are not being deliberately wasteful; rather, they were trained to do things as safely and quickly as possible. They thought the red bag as the quickest, safest route to dealing with soiled linen, even though linens heavily soiled with bodily fluids can still be processed to hygienically clean standards...

Another significant source of linen loss happens when it is taken by people, both hospital staffs and patients. It was noticed that a significant number of staffs are taking blue colour staff attire for their personal use. In addition to this, it is also found that doctors are accustomed to take the doctor's coat and keep it in their room. Basically, they knew that doctor's coat is one of the linen rental items which needs to be stored in a designated place. Due to this, the doctor's coat was missing from circulation and this leads to linen loss. Other than that, patients are also taking linen items such maternity linen, bath towel, baby napkin and baby wrappers as personal belongings. In some cases, they bring back the linens with them when being transferred or discharged.

All those issues discussed above have caused the inefficient distribution of linen to customers, demand forecasting was not accurate, and purchase of new linen delayed and quantity of linen in circulation were reduced which led to the shortfall in linen supply. The shortfall refers to difference in quantity of linen requested by customer and quantity of linen supplied by services provider. The greater value of shortfall is able to cause significant implications on healthcare linen management.

Figure 2 shows Medilaund’s linen shortfall data from year 2009 to year 2016. It is noticed that the linen shortfall percentage is between 0.9% and 8%. When the linen shortfall percentage is converted into ringgit, the amount can be totalled to RM1.17 million to RM9.8 million annually.

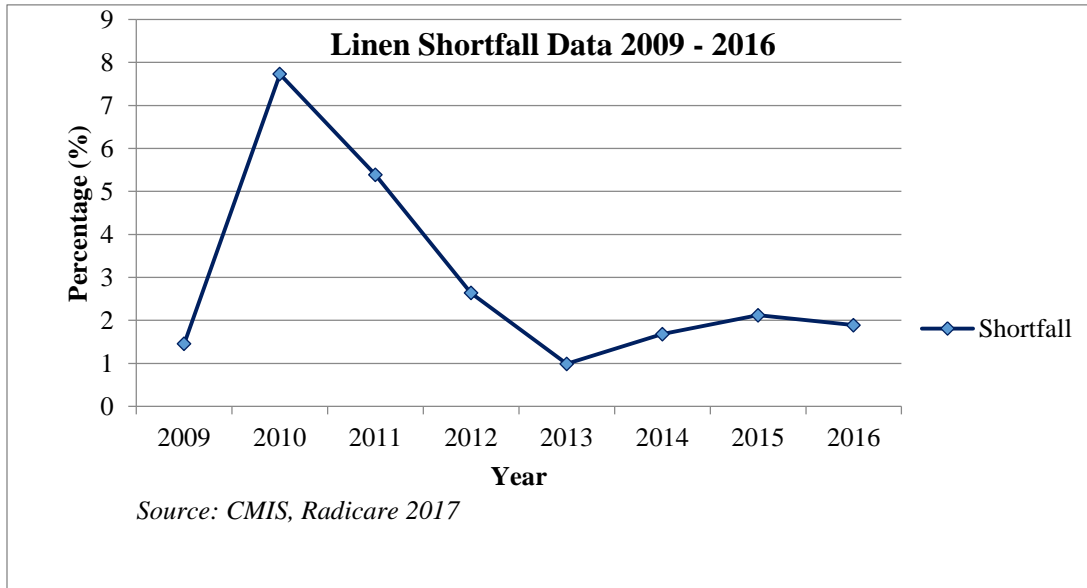


Figure 2:

Linen Shortfall Data 2009 - 2016

Most of the time, Medilaund takes an immediate action in order to reduce linen shortfall since linen shortfall does not only affect Medilaund’s profit, but it also affects the overall hospital’s supply chain.

According to Mrs. Hasnidahwati:

New linens were injected into circulation as an immediate action in order to reduce linen shortfall. We understand the consequence of linen shortfall. It also incurred some additional operational cost...

Mrs. Hasnidahwati realised that Medilaund needs an immediate preventive measure to overcome the above issues / challenges effectively and efficiently. Therefore, the company should consider various factors including technology advancements to increase efficiency in healthcare linen management in order to meet customers’ requirements.

Case Analysis

Based on the business issues / challenges highlighted above, it can be concluded that Medilaund is facing a serious inventory management problem. The estimated lost due to these issues /

challenges is between RM1.17 million to RM9.8 million annually. If the inventory problem is managed efficiently, the stated amount can be utilized by the company for other relevant purposes. In addition, it is also able to add to the company profit. The lost actually does not include other cost incurred such as manpower cost, new linen purchased cost and etcetera. Other than that, Medialund is also facing a problem in meeting the performance indicators set by MOH.

Performance Indicators

Performance indicators were established by MOH since the privatisation of healthcare support services in 1997 in order to monitor overall performance of concession companies. Based on that performance indicators data, MOH is able to measure efficiency of the concession companies in all non-core support services including linen and laundry services. Thus, as one of the concession companies, Medilaund has to put endless efforts to continually improve efficiency in healthcare linen management. The performance indicators for linen and laundry services are as follow:

- a) *Adequate Linen Supply (95%)*
Adequate linen supply is sufficient quantity of clean linen which, need to supply as per ordered by customer.
- b) *Acceptable Linen Supply (98%)*
Acceptable linen supply is quality of linen supplied to customer in accordance to Quality Guideline.
- c) *Timely Collection and Delivery (100%)*
Timely collection and delivery refer to mutually agreed time schedule between services provider and customer on which the soiled linen should collect from user area and delivery of clean linen to user area.

Corrective Measures

Medilaund had taken some corrective measures to rectify the linen discrepancy and linen loss issues. The details are as follow:

- a) Established standard operating procedure on linen management
- b) Conducted periodic internal audit to identify any abuse / misuse of linen at user area
- c) Carried out regular manual stock count at all branch store to know quantity of linen in the circulation
- d) Conducted user training to respective hospital staffs to create awareness on handling of healthcare linen

Fishbone Diagram

Figure 3 presents fishbone diagram that identifies the possible causes for linen discrepancy and linen loss faced by Medialund. It clearly showed that man (human errors, improper linen handling, linen abuse, theft and less awareness) and machine (there is no proper linen tracking system) are the possible causes for linen discrepancy and linen loss problem. It was noticed that the corrective measures has been taken by Medilaund was unable to solve the problems and now the company is looking at technological advancement as a permanent solutions.

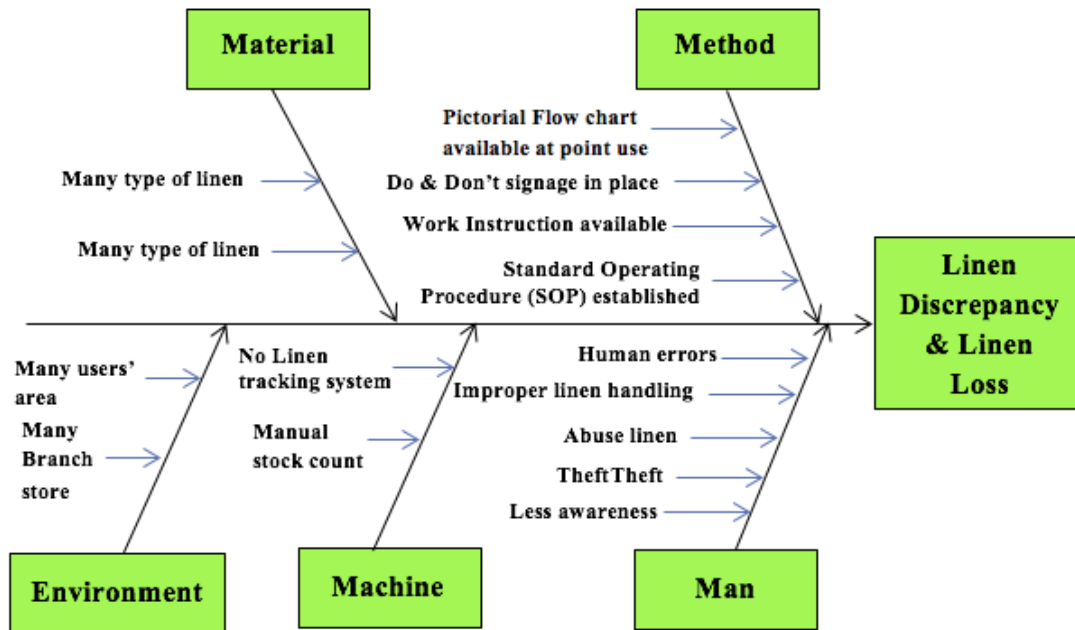


Figure 3:
Fishbone Diagram

Solutions / Recommendations

Technology has become a vital and integral part of every business plan. It has a bigger impact on inventory control in terms of efficiency, ease of accessing information and accuracy which affects the organization performance (Muhammad Masum *et al.*, 2013). Therefore, modern inventory systems should be implemented since it forms a platform for ease of evaluating risk in which the organization invest a lot of money in purchasing inventory. When it comes to managing inventory, organization needs to maintain enough stock without investing in more than they require. Inventory management systems track the quantity if each item a company maintains triggering an order of additional stock when the quantities fall below a predetermined amount. There are two well-known technologies which are broadly used in inventory management namely Radio frequency Identification (RFID) and Barcode.

Radio Frequency Identification

The adoption of RFID is a long term preventive measures to increase efficiency in healthcare linen management by eliminating inventory discrepancies and linen loss problems (Visich *et al.*, 2009). RFID is a well-known identification technology helping to automate and computerize data capturing (Muhammad Masum *et al.*, 2013). It is capable of using radio waves to automatically identify people or objects. An RFID system uses distinct components to capture object information. This technology has a scanning antenna that scans for radio waves. There is a transceiver to interpret data, a reader to transmit and receive radio frequencies, and a transponder (RFID tag) that is attached to the object that is being identified. RFID is a term used for technologies utilizing radio waves for identifying individual items automatically. The most

common way is storing a serial number identifying a product and related information on a microchip attached to an antenna. RFID is used very similar to barcode. It is designed to track items in the supply chain without requiring a line of sight.

Barcode

According to Russell (2003), “a barcode is a graphic representation of data (alpha, numeric, or both) that is machine-readable. Barcode are a way of encoding numbers and letters by using a combination of bars and spaces of varying widths. Both the lines and spaces are read. They may be thought of as another way of writing, because they replace key data entry as a method of gathering data. In business, correct usage of barcode can reduce inefficiencies and improve a company’s productivity, thereby growing its bottom line. Simply put, barcode are a fast, easy, and accurate way of entering data.”

“Barcode come in many varieties. Most of the barcode are familiar with those seen in grocery or retail stores, but there are many others that are used in various industries,” he added. Barcode technology can be translated into three primary functions: tracking, inventory management, and validation. Whether you use one function or a combination of functions, the benefits in cost savings, improved productivity, and quality can be substantial.

Comparison of RFID and Barcode

RFID is not necessarily better than barcode. The two are different technologies and have different applications, which sometimes overlap. In many circumstances, RFID offers advantages over traditional barcode. The big difference between the two is that barcode are line-of-sight technology. That is, a scanner has to “see” the barcode to read it, which means people usually have to orient the barcode toward a scanner for it to be read.

One advantage of RFID is that the technology doesn’t require line of sight. RFID tags can be read as long as they are within range of a reader. Barcode have other shortcomings as well. If a label is ripped or soiled or has fallen off, there is no way to scan the item, and standard barcode identify only the manufacturer and product, not the unique item. The **Table 1** shows direct comparison of the two technologies.

Table 1:
Comparison of RFID and Barcode

Items	RFID	Barcode
Read rate	High throughput. Multiple (>100) tags can be read simultaneously.	Very low throughput. Tags can only be read manually, one at a time.

Line of sight	Not required. Items can be oriented in any direction, as long as it is in the read range, and direct line of sight is never required.	Definitely required. Scanner must physically see each item directly to scan, and items must be oriented in a very specific manner.
Human capital	Virtually none. Once up and running, the system is completely automated.	Large requirements. Labourers must scan each tag.
Read/write capability	More than just reading. Ability to read, write, modify, and update.	Read only. Ability to read items and nothing else.
Durability	High. Much better protected, and can even be internally attached, so it can be read in very harsh environments.	Low. Easily damaged or removed; cannot be read if dirty or greasy.
Security	High. Difficult to replicate. Data can be encrypted, password protected, or includes a “kill” feature to remove data permanently, so information stored is much more secure.	Low. Much easier to reproduce or counterfeit.
Event triggering	Capable. Can be used to trigger certain events (like door openings, alarms, etc.).	Not capable. Cannot be used to trigger events.

Benefits of RFID

Based on the above comparison between RFID and barcode, RFID seem better option for Medilaund in order to mitigate linen discrepancy and linen loss problem. The following is the way that how adoption of RFID technology can assist Medilaund to overcome their business challenges effectively to increase efficiency in healthcare linen management.

a) Provide visibility into inventory quickly and easily

Companies without visibility into their inventory cannot accurately plan for events, conduct efficient operations, or prevent lost and stolen items. If linen is stolen, and the company does not conduct daily inventory counts, they may face potential delays in day-to-day operations due to inaccurate inventory. RFID tags sewn into each linen item help the company take inventory faster, more efficiently, and daily. RFID readers placed in each storage room take a continuous inventory to help accurately indicate where linens are lost or stolen. Linen items, as they enter and exit the storage facility, can be recorded and monitored.

Besides that, access to linen store can control and avoid the staffs from taking the linen items without any record. It can easily eliminate the transaction errors. Linen tracking become more convenience with RFID technology (Zare Mehrjerdi, 2011). The RFID linen tracking solutions are able to help healthcare linen management to manage human errors in data entry and stock count process to have accurate data on real time inventory levels. It can reduce inventory discrepancies (Visich *et al.*, 2009).

b) Eliminate Linen Loss

The RFID technology is also able to help Medilaund to monitor when its linens are soiled and shipped to an offsite laundry facility, as well as when they return, thereby identifying when any inventory ends up missing. For instance, Mr. C Hotel Beverly Hills is using the RFID-based Linen tracker system to track when its linens are sent to, and then returned from, an off-site laundry facility, and thereby determine if any items are not returned. According to Sam Jagger, “Mr. C Hotel's general manager, by using the technology, the hotel has reduced the rate of missing items from 20 to 30 per cent of all stock to only about 3 per cent” (Swedberg, 2013). Based on this instance, the same RFID-based linen tracker system can be adopted in healthcare linen management.

Conclusion

In conclusion, the demand of linen and laundry services is gradually increasing and patient's expectation towards the availability and the effectiveness of the services has also increased. Healthcare linen management has to play an important role to ensure an adequate, clean and constant supply of linen for hospital usage without any failure. This is one of the business challenges and it must be carried out effectively and efficiently. The company should take various factors into account, including technological advancements since the dependency on human being is no longer relevant and competitive in this industry. Thus, adoption of RFID technology will be able to help the company to overcome business challenges in healthcare linen management. Even though the barcode system is another technological advancement which is widely practiced in the area of inventory management, RFID is still better than barcode. The company should develop a clear deployment strategy from defining the business case and forming a cross-functional team to developing training programs to achieve benefits from RFID in healthcare linen management.

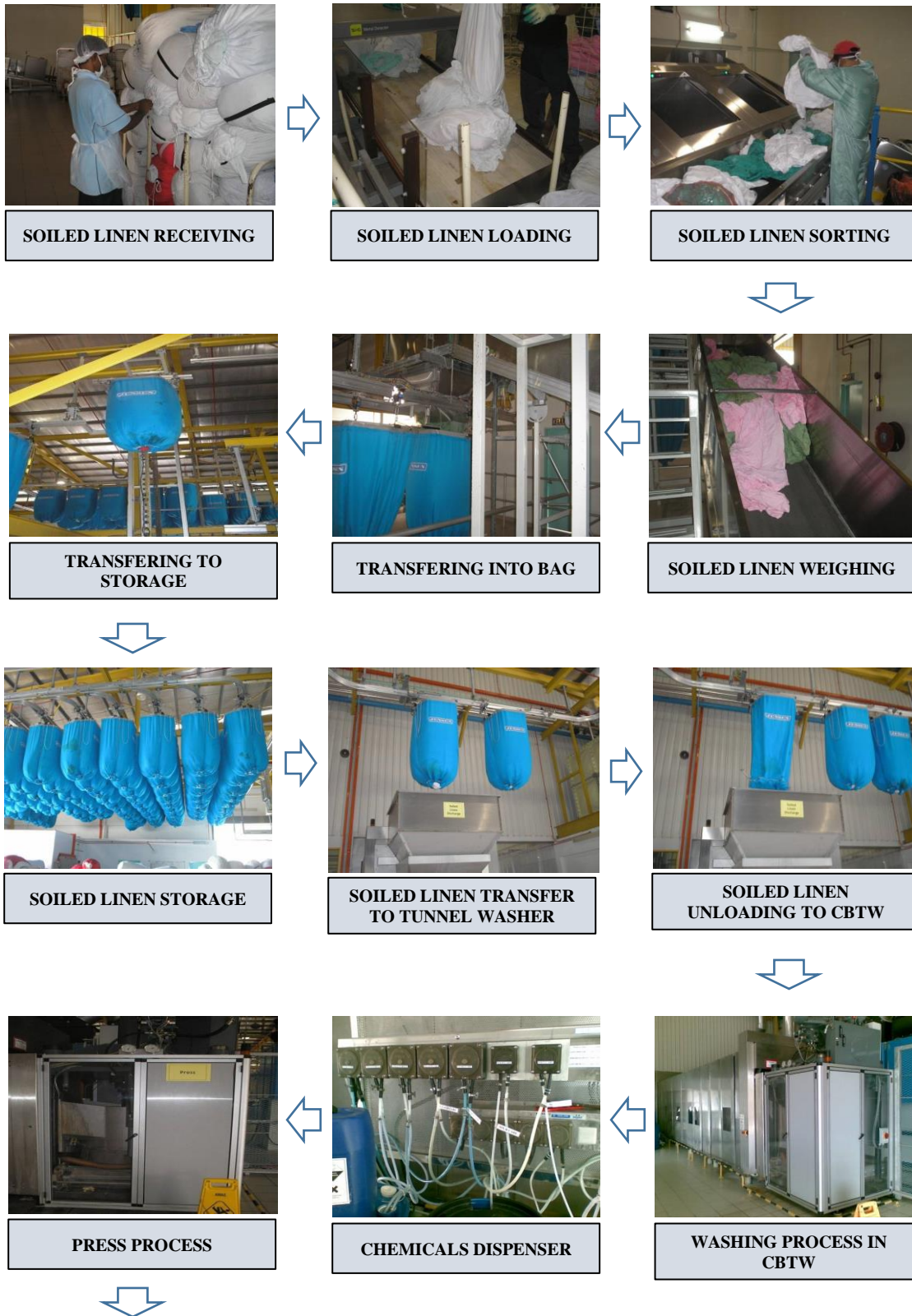
References

- Muhammad Masum, A.K., Bhuiyan, F., & Azad, M.A.K. (2013). Impact of radio frequency identification (RFID) technology on supply chain efficiency: An extensive study. *Global Journal of Researches in Engineering Civil and Structural Engineering*, 13(4), 9 – 14.
- Aksoy, A., Ozturk, N., & Sucky, E. (2012). A decision support system for demand forecasting in the clothing industry. *International Journal of Clothing Science and Technology*, 24(4), 221 – 236.

- Beggs, B.(2007). Survey: 50% of polled say linen loss one of their biggest issues. American Laundry News. Retrieved from <https://americanlaundrynews.com/articles/survey-50-polled-say-linen-loss-one-their-biggest-issues>
- Swedberg, C. (2013). Linen loss drops by 90% at Los Angeles luxury hotel. *RFID Journal*. Retrieved from <http://www.rfidjournal.com/articles/view?10953>
- Koumanakos, P. D. (2008). The effect of inventory management on firm performance. *International Journal of Productivity and Performance Management*, 57(5), 355 – 369.
- Mediserve, E. (2017). Company description. Retrieved from https://www.emis.com/php/company-profile/MY/Edgenta_Mediserve_Sdn_Bhd_en_2381206.html
- Bloom, J. (2015). Surgery cancelled at Helen Joseph because of linen. Retrieved from <http://www.timeslive.co.za/local/2015/07/28/Surgery-cancelled-at-Helen-Joseph-because-of-linen>
- Visich, K. J., Li, S., Khumawala, M.B. & Reyes, M.P. (2008). Empirical evidence of RFID impacts on supply chain performance. *International Journal of Operations & Production Management*, 29(12), 1290-1315.
- Kementerian Kesihatan Malaysia, (2016). KKM health fact 2016. Retrieved from <http://www.moh.gov.my/images/gallery/publications/KKM%20HEALTH%20FACTS%202016.pdf>
- Pantai Medivest, (2017). Company profile. Retrieved from <http://www.medivest.com.my/>
- One Medicare (2017). Corporate information. Retrieved from http://www.one-medicare.com/c_about_02.php
- Radicare (2017). Medilaund (M) Sdn Bhd. Retrieved from <http://www.radicare.com.my/medilaund.html>
- Russell F. Lewis, (2003). *Implementation guide for the use of barcode technology in healthcare* (1st ed.). Healthcare Information and Management Systems Society.
- Sedafiat (2017). Corporate info. Retrieved from http://sedafiat.com.my/v2/index.php/About_Us
- Zare Mehrjerdi, Y. (2011). Radio frequency identification: the big role player in health care management. *Journal of Health Organization and Management*, 25(5), 490-505.

Appendices

Appendix A: Pictorial Laundry Process Flow





Appendix B: Healthcare Linen and Laundry Service Options

Linen Rental Service	<ul style="list-style-type: none">• Provides linen rental to contracted hospitals and medical institutions. There are more than 140 types of linen ranging from bed linen, staff linen, patient linen, operation theatre linen and miscellaneous linen• Provides specialized equipment (weighing scales, trolleys and linen bags) and consumables supplies (gloves, face mask and alginate bags)
Laundry Service	<ul style="list-style-type: none">• Service devoted to soiled linen collection, washing, ironing and folding, quality control, packing and delivering clean linen to user
Customer Owned Goods Service	<ul style="list-style-type: none">• Linen owned by the hospital• Service devoted to soiled linen collection, washing, ironing and folding, quality control, packing and delivering clean linen to user
Other Service	<ul style="list-style-type: none">• Conduct on-site survey /scoping studies, consultation and advice the customer on the type and quantity of clean linen required for use by the customer