DEVICE MONITORING SYSTEM IN MEDICAL FIELD

AUTHOR/S: Verne Kurri

Abstract

The topic of this thesis was creating a new device monitoring system for Mehiläinen Oy.Mehiläinen Oy is a Finnish healthcare company. Mehiläinen Oy is one of the biggest healthcare companies in Finland, operating in over 540 locations in Finland and employing over 22 300 people.

The purpose of this project was to create a new device monitoring system for Mehiläinen Oy, as the previous system was outdated. The old device monitoring system also lacked in information that is required by law, and was complicated to use. There was a need for a new device monitoring system, that had all the information about the machines that are used by Mehiläinen Kielotie are found in one place.The new device monitoring system fixes these problem by adding the missing sections, and making it more user friendly. The new device monitoring system also adds data that makes other processes easier, such as maintenance information.

This thesis has also some theory on process improvement and Lean, that is used by Mehiläinen and on this project. The device monitoring system was done in Excel, as the previous one, because it's quite suitable for the job and Mehiläinen already had a license for it. The new version has instructions to use the system, and its easier to use.

Now that device monitoring system has the new changes, its faster and clearer than previous version.Mehiläinen Kielotie has started using the new device monitoring system that is being used now. The new device monitoring system will also be used as a base for their device acquisition for their new medical center in Vantaa.

Keywords
Device monitoring system, Excel

CONTENTS

1   INTRODUCTION

Process improvement is important. If processes are never improved they will become inefficient over time and create extra costs and defects. Processes that are inefficient are bad for the employer too, as they are often overburdening or unnecessarily complex.

This thesis is about creating a device monitoring system for medical equipment in Excel, that is easy to use and easy to learn for Mehiläinen Oy's Kielotie medical center staff. According to (Valvira guidance on device monitoring system, 2016) a device monitoring system is a register of all the medical equipment in a medical center, and also all medical applications used in a computer. It is used in equipment management, and is a useful tool when deciding purchasing.

Along with this information it also has additional info such as history of fault events and user manuals of the equipment. A Device monitoring system is also required by Finnish law.

A well made Device monitoring system will save company time and money. It will help the company to decide when to replace equipment, and save time when looking for info about the current equipment. It will also reduce waste.

1.1 About Mehiläinen Oy

Figure 2: Logo of Mehiläinen (Mehiläinen website)

Mehiläinen Oy is one of the biggest private healthcare companies in Finland. Mehiläinen has over 540 locations in Finland and employs over 22 300. They provide private healthcare services along with public social care services.(Mehiläinen website, Mehiläinen as a company) Mehiläinen is owned by capital found CVC capital partners, LocalTapiola group, pension companies Ilmarinen and Varma, Pharmacy Pension Fund, Valion Eläkekassa Pension Fund, State Pension Fund of Finland, private persons and investors. (Mehiläinen website, Mehiläinen management)

Mehiläinen was founded in 1909,as one location in Helsinki. Later Mehiläinen expanded to Töölö, and after the second world war it expanded to locations outside Helsinki, first as maternity hospital, then to medical centers. (Mehiläinen website, 110-year celebration blog)

In 2020 Mehiläinen had approximately one million customer visits. 500 000 Finnish customers had occupational health care occupation agreements. 246 000 had agreement through public healthcare, and the rest were in old people houses and social service houses (psyciatrian, children care etc.). (Mehiläinen website, Mehiläinen as a company)

Based on this, it's quite important to have a comprehensive and good device monitoring system. It is also quite important to have a device monitoring system that does not change between locations. Device purchasing costs account for a large portion of expenses yearly. The year 2021 is projected to be a big year to Mehiläinen in terms of investments, and thus having an efficient device monitoring system is crucial.

1.2 Lean

The goal of Lean is reducing waste to zero. The best results in Lean come when everyone from management to nurses follow Lean philosophy. Acording to Williams, these are continuous learning and everyday improvement. (Williams,2012, 11)

When removing waste from a process using Lean, it must be identified first. Value stream map can be used for this.

"A value stream map is a graphical repsentation of how all the steps in any process line up to produce a product or service, as well as the flow of information that triggers the process into action." (Williams,2012, 72)

```
2 minutes ─┐  ┌──────────────────┐
           └──│   Appointment    │
              └──────────────────┘
                      │ Δ 12 Days
                      ▼
4 minutes ─┐  ┌──────────────────┐
           └──│ Arrival & check-in│
              └──────────────────┘
                      │ Δ 17.3 minutes
                      ▼
3 minutes ─┐  ┌──────────────────┐
           └──│ History & physical│
              └──────────────────┘
                      │ Δ 15 minutes
                      ▼
10 minutes ─┐ ┌──────────────────┐
            └─│    Treatment     │
              └──────────────────┘
                      │ Δ 9 minutes
                      ▼
2 minutes ─┐  ┌──────────────────┐
           └──│    Discharge     │
              └──────────────────┘
                      │
                      ▼
              ┌──────────────────┐
              │     Depart       │
              └──────────────────┘
```
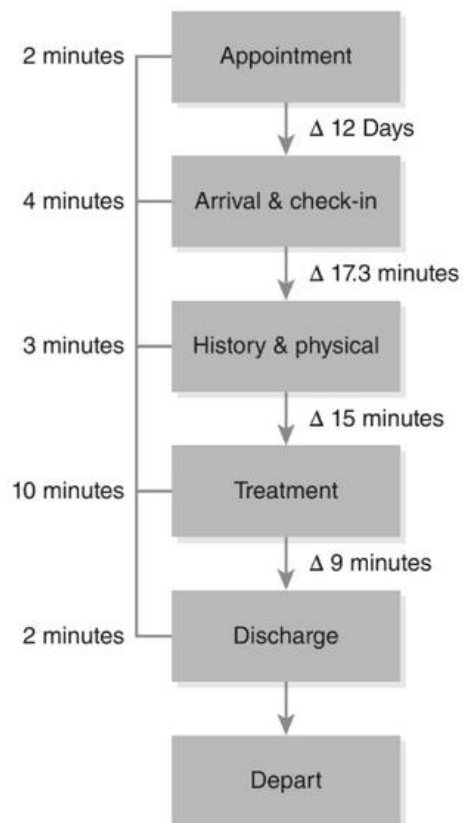
Figure 3: An example of a value stream map in medical center (Thomas K. Ross 2021, 149)

After drawing up a value stream map, the processes can then be divided into two sections:

Value added processes: These are for example, the treatment of patient.

Non-value adding processes: Some are necessary for example because of a law or regulations, but not profitable, but some are unnecessary, such as waiting times. The latter is called waste.

1.3 The seven wastes

In Lean the waste is divided into seven sections:

1. Transportation
   "Sharing work (moving it between repsentives) is often a clue that people are overburdened;"
   (Karyn Rose, 2019, 106)

2. Inventory
   "Large build up of emails or files waiting to be worked on can be evaluated to 'see' if work has been received unevenly;"
   (Karyn Rose, 2019, 106)

3. Motion
   "Switching back and forth between screens and tasks may mean that people are overburdened;"
   (Karyn Rose, 2019, 106)

4. Waiting
   "The overburden of customers waiting in queue (physical or virtual) can signal that there's an unevenness in how work is coming in;"
   (Karyn Rose, 2019, 106)

5. Overprocessing
   "The need to over-audit a process because of numerous errors can signal that there's an unevenness in how work is coming in;"
   (Karyn Rose, 2019, 106)

6. Overproduction

"Working ahead can be evaluated to determine if people are 'making too much too soon' because they have extra time on their hands due to unevenness;"

(Karyn Rose, 2019, 107)

7. Defect

"Missing or incomplete information"

Drew A. Locher, (2008, 17)

The new device monitoring system reduces many of these wastes. For example when every data required is in one place and not spread across the data base, it requires motion. It also reduces motion, since all the data is at one location, and defects if the data found is up to date and accurate. All employees who need this information find it on one place.

One of the most popular tools to remove waste is PDCA. "The Plan-Do-Check-Act (PDCA)--cycle is a technique for the continuous observing of processes, indefying their flaws or shortcomings or identifying potential improvements". (Thomas K. Ross 2021, 303)
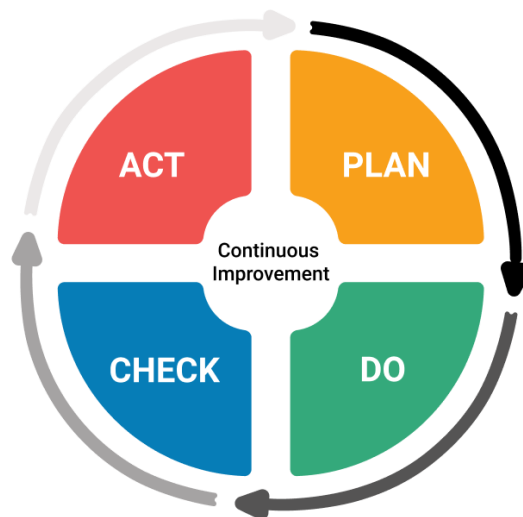
1.4   PDCA-cycle

Figure 3: The PDCA cycle (www.kanbanize.com)

Plan: "Indefying spefically what you want to change."(Williams, 2012,121)

Do: "Carry out the plan in a trial or test enviroment, on a small scale."(Williams, 2012,121)

Check: "Examine the results of your trial. Verify that you've improved the process."(Williams, 2012,121)

Act: "Implement the changes you've verified on a broader scale."(Williams, 2012,121)

This was also used in this project, as the device register is first used in Kielotie medical center, and then possibly expanded, if the results are positive. It is also important to keep improving the process, and not just leaving it after improving it once.

After deciding what changes to implement a future-state value stream map can be drawn, that "shows the process after implemented changes" (Williams, 2012, 177). This can help decide if implementing the change is a good idea.

1.5 Mehiläinen and Lean

"Although the term Lean was originally associated with manufacturing and production processes. Lean covers the total enterprise including – - healthcare and government – have applied Lean." (Williams, 2012, 12)

Mehiläinen have alot of measurement tools for their processes. They monitor for example:material costs (all costs which come from purchased care suppliers), and staff costs (employees) compared to medical center turnover, efficiency of the staff overall (how many customers/ researches per hour), how many hours per day per person is customer work. Mehiläinen also asks for feedback in many different channels, from customers and employees in order to improve their services and processes. These measurement tools are important, when deciding what to focus on and what to improve next, and to see what is working well and what needs more work.

2 GOAL AND METHOD

2.1 Goal

The goal of this thesis was to create a user friendly device monitoring system that is easy and simple to use and easy to maintain, that follows the regulations. A device monitoring system must include all the medical equipment used in the medical center, including medical programs. The device register was to be made in Finnish, as everyone using it would be speaking it. All the devices listed in the system must have the following info according to law:

1.Basic info such as manufacturer, supplier, purchase year, warranty, location, serial number, and what type of device it is

2.It must include maintenance info such as: How often the device must be maintained and who is responsible for it.

3.How often the device must be calibrated

4.It must include log of dangerous incidents or close calls, such as device malfunctions

Mehiläinen also wanted the following info to be added as well:

1.The estimated length of payback period and how much is left
This is important information for people responsible for purchasing new devices and has potential to reduce time needed for purchasing, and thus reduce waste. When all the information required, to decide what devices need replacing , are in one place the process becomes much more simpler and faster, which follows Lean philosophy.

2.Purchase price

Along with the payback period, the purchase price is also important, when deciding what needs replacing.

3. Instructions on how to use the sheet

This was done because people using the system might not be the best with computers, and it saves time, by reducing time it takes to use the system for a person not familiar with Excel. It also reduces~~es~~ risks as a person not familiar with Excel might do mistakes that affect the whole system. However, the instructions were also done so, that it does not slow down the use for those that are more familiar with Excel.

2.2 Method

The device register was done in Excel. It was chosen because the company already owns a license for Microsoft Office, and it is familiar to most people. The data for the system was to be given from the company. Also the data from the previous device monitoring system will be used to save time. Maintenance reports will be saved in their own device folder (for example: blood pressure meter) named with their serial number and the year of last maintenance, for example 01548384 2019. On the first page there are instructions on how to use the worktable, the second one is the register itself and third one is dangerous incident log, with instructions how to report dangerous incidents. There is also a link to the maintenance report folder on the register sheet.

2.3 Starting point

LAITE	VALMISTAJA	TYYPPI	LAITE-/SARJANRO	SIJAINTI HUONE	HUOLTO	KALIBROINTI	ED. K/H	SEUR. K/H	K/H:N SUORITTAJA	TOIMITTAJA	HANKITTU
LAITEREKISTERI / KIELOTIE											
VASTAANOTTO							10.01.2021	Sanna T.			
Gyn-Uä Toshiba	Tosfin Oy	Nemio SSA-550A	P5603928	38	tarv	tarv	2007	tarv	Tosfin Oy	Tosfin Oy	2005
Gyn-Uä Volyson S6	GE Healthcare	BT14	290280SU7	29	tarv	tarv	2015	tarv	GE Healthcare	GE Healthcare	2015
Gyn-Uä Volyson S6	GE Healthcare	BT14	290281SU5	35	tarv	tarv	2015	tarv	GE Healthcare	GE Healthcare	2015
Gyn-Uä Volyson S6	GE Healthcare	BT14	271595SU1	36	tarv	tarv	2014	tarv	Ge Healthcare	GE Healthcare	2014
Kardiolog.UÄ Vivid S6	GE Healthcare	H45041FT	7731VS6	100	tarv	tarv	2014	tarv	GE Healthcare	GE Healthcare	2014
Kard/urol uä	GE Healthcare	Logiq P9	LP9351765	38	tarv	tarv	2020	tarv	GE Healthcare	GE Healthcare	2020
Korvamikroskooppi Kaps	Karl Kaps	SOM22	1746	19	tarv	tarv	2010	tarv	Otoplug Oy	Sairtec oy	1995
Korvamikroskooppi Kaps	Karl Kaps	SOM22	1907	20	tarv	tarv	2007	tarv	Otoplug Oy	Sairtec oy	1995
Korvatutkimusyksikkö	Heinemann	Modula Europa	MOD15-228	21	tarv	tarv	2015	tarv	Otoplug Oy	Otoplug Oy	2015
Toimenpidemiksroskooppi tutkimusyksikköön kiinnitettävä 3-port.	Kaps Led	SOM22	24103	21	tarv	tarv	2015	tarv	Otoplug Oy	Otoplug Oy	2015
Nenäoptiikka 30 ast. 3,0mm, pituus 15cm		7197200330	994487	21	tarv	tarv	2015	tarv	Otoplug Oy	Otoplug Oy	2015
Korvamikroskooppi Kaps	Karl Kaps	SOM22	20112	31	tarv	tarv	00.03.2015	tarv	Otoplug Oy	Sairtec oy	2011

Figure 4: Screenshot of the old device register

As you can see from the figure above, the Device monitoring system Mehiläinen was using was very simple, and it lacked a lot of info and was very confusing to read.

Basic information such as the room where the equipment was located ~~in~~ was missing, and there were holes between some of the rows in Excel. It also lacked such important info as fault event history, and warranty. The device monitoring system also lacked proper log of dangerous incidents. Also a lot of the information was all over the place, for example payback period was in a separate file that was hard to find.

3 BENEFITS OF DEVICE MONITORING SYSTEM

3.1 Beneftis of device monitoring system

Acording to Valvira "A device monitoring system in medical field is a system consisting of every medical device in a medical center.-- It also must include medical applications". (Valvira guidance on device monitoring systems, 2016) A device monitoring system has many benefits, if done correctly, for example, it makes maintaining the equipment easier. Mehiläinen has device maintenance contracts with many companies and the device monitoring system makes it easier to see which is the responsible company and their contract person. A device monitoring system also makes it easy to follow that every equipment is calibrated as often as is required.

 A device monitoring system also helps purchasing when deciding which devices need replacement,as it has a lot of useful information such as maintenance history and payback period.

These benefits mean, that if device monitoring system is done correctly, it can reduce waste and increase process efficiency.

4   THE DEVICE MONITORING SYSTEM

4.1   The instructions page

Figure 5: Screenshot of the instructions page

As you can see from the figure above, the instruction page has instructions on how to use the worktable. It has instructions on how to add a new maintenance report folder, how to use the filter option,and how to add new data to the sheet. This was made so that it would be as little time consuming to learn how to use the device monitoring system as possible. This ultimately reduceses waste as people will spend less time learning complicated device monitoring systems and looking for information in other locations, and instead quickly fill out the additional information. The risk of complicated device monitoring system is that it would take time to learn, and would not be used as often, thus reducing its benefits.

The filter option also is not very useful if every device has different data, such as serial number, in this case a better feature to use is the Excel search function

4.2 The device monitoring sheet

1	LAITEREKISTERI / KIELOTIE				Vuosi:
2	**Laite** ▾	**Toimittaja** ▾	**Tyyppi** ▾	**Tuote/sarjanumero**	**Hankittu**
3	Kard/urol uä	Tosfin Oy	Logiq P9	LP9351765	2020
4	Gyn-Uä Volyson S6	GE Healthcare	BT14	45943590	2017
5	Gyn-Uä Toshiba	GE Healthcare	BT14	54699431	2016

Figure 6: Screenshot of the device monitoring sheet

As you can see from the figure above, the device register has three filters to make browsing it more simple. Filters in Excel allow the user to show only specific data on the sheet. For example if you choose blood pressure meter on the device filter, it will only show the blood preasure me-ters, and hide everything else. However, filters in excel can make finding information from the system more complicated too. For example if you choose to hide blood pressure meters on the first filter, and the only look at devices whose supplier is GE Healthcare it might get confusing even for more experienced Excel users, because you have to remove the filter selection at the order the filters were selected in. The more filters there are the more confusing it may become.

There are also a formulas and color coded cells in the worktable. The first formula used is =(NOW) which gives the current time and date as a result. It also updates everytime a change is done to the worksheet. Second formula is =(YEAR)(H1). The year part of the formula takes the current year out of the selected cell, which in this case is the first formula, the second part is the location of the first formula on the worksheet. The first two formulas are located on the first row of the sheet.

There is also a third formula on the sheet, this time directly on the table. The third formula is =(E3+G3)-F1 which combines the the purchasing year and expected years how long it takes for the equipment to reach break even point with its profits. The combination of these two numbers is reduced by the current year that is displayed at the location of formula two. The dollar signs around the location of the current year make copying the formula to every column easier, as it makes it so that the location of the the current year stays,when estimated break even point in years and purchasing year changes when the devices changes.

4.3   Maintenance report folder
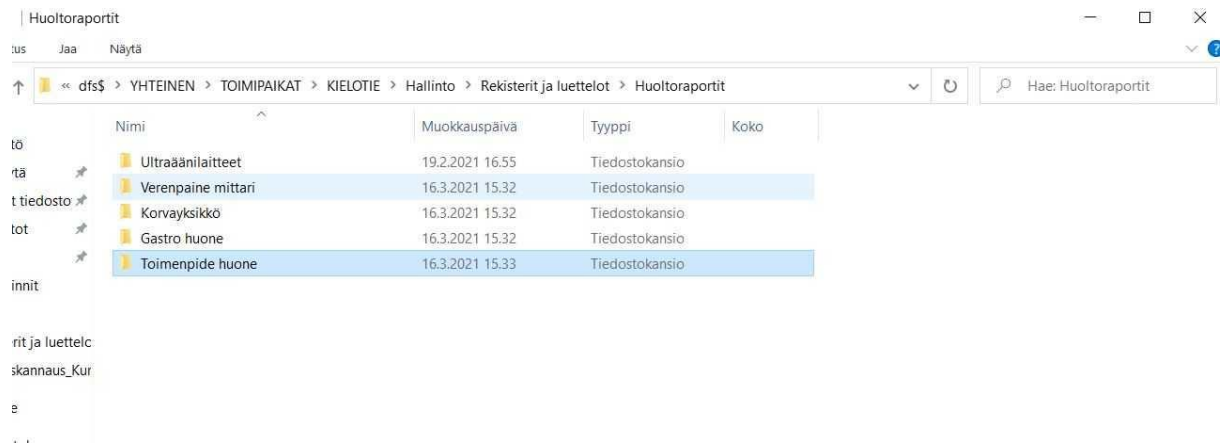
Figure 7: Screenshot of the new folders for the maintenance reports

As you can see from the figure above a new folder location was created for the maintenance reports. The new folder location location was meant to be as easy and simple to browse as possible.

The folders were named after the device type, such as blood pressure meters. In some specific cases the folders were named after the room they were in, for example in gastroscopy room. In these rooms the equipment is totally unique compared to others, so there will not be any overlapping. Overall this should save time from searching around for maintenance reports all over the data base.

4.4 Dangerous incident log

1							
2	**LAKI SANOO NÄIN**						
3	**Terveydenhuollon laitteen tai tarvikkeen aiheuttamasta vaaratilanteesta on aina tehtävä ilmoitus Fimealle niin pian kuin mahdollista:**						
4							
5	**Vakavasta vaaratilanteesta 10 vuorokauden kuluessa siitä, kun käyttäjä tai valmistaja on ensimmäisen kerran saanut tiedon tapahtumasta.**						
6	**Läheltä piti –tapauksesta 30 vuorokauden kuluessa.**						
7							
8	Täytä seuraavat tiedot						
9							
10							
11	**Laite**	**Sarjanumero**	**Tapahtuma päivämäärä**	**Haittatapahtuma**	**Ilmoitus päivämäärä**	**Korjaavat toimenpiteet**	**Vastuuhenkilö**
12							
13							
14							
15							

Figure 8: Screenshot dangerous incident log

As seen in the figure above, the dangerous incident log mentions the actions required by law in case of dangerous incident or a close call. The incident log also has fill out boxes for the required information. By putting the required actions on the sheet, it will save time and ensure that the law is followed when dangerous incidents happen.

5 CONCLUSION & RESULTS

Lean is a useful tool for every company, not just the manufacturing companies it is usually perceived with. When Lean is applied correctly it will reduce waste and make processes work better.

Device monitoring systems are mandatory for medical field companies, but they have some benefits too. A good device monitoring system can improve non-value added activities and reduce waste despite being a non-value added activity.

Mehiläinen Oy is changing their device monitoring system, because the laws have changed.The old device monitoring system was also lacking important information.The new device monitoring system has all the information required by law, but also other information that makes other activities faster. The information locations were also made more simpler, so upkeeping the system takes less time, leaving more time for value activies.

Mehiläinen Kielotie has applied the new device monitoring system, that is being used now. The new device monitoring system will also be used as a base for their device acquisition for their new medical center in Vantaa.

6   REFERENCES

Drew A. Locher, (2008) Value Stream Mapping for Lean Development: A How-To Guide for Streamlining time to market, Taylor & Francis group

Thomas K. Ross (2021) Applying Lean Six Sigma in Health Care: A practical guide to performance improvement, Jones & Barlett learning

Karyn Rose, (2019) How to Coach for Creativity and Service Excellence: A Lean Coaching Workbook Taylor & Francis group

Williams, S. (2012). Lean For Dummies, 2nd Edition.Hoboken: John Wiley & Sons, Inc.

https://www.valvira.fi/-/terveydenhuollon-laitteiden-ja-tarvikkeiden-seurantajarjestelma-kuntoon-kattavasti (In Finnish)Retrieved 12.4.2021

https://finlex.fi/fi/laki/alkup/2010/20100629#Pidp447482640 (In Finnish)Retrieved 12.4.2021

https://www.mehilainen.fi/en/company-informationRetrieved 12.4.2021

https://www.mehilainen.fi/en/company-information/mehilainen-as-a-company Retrieved 12.4.2021

https://www.mehilainen.fi/mehilaisen-blogi/mehilaisen-toimitusjohtajan-tervehdys-110-vuotis-juhlapaivana (In Finnish) Retrieved 15.4.2021

https://www.mehilainen.fi/laatukenno (In Finnish) Retrieved 12.4.2021

https://www.mehilainen.fi/en/company-information/mehilainen-managementRetrieved 12.4.2021

PDCA cycle picture from: www.kanbanize.com/Lean-management/improvement/what-is-pdca-cycle retrieved 15.4.2021

Mehiläinen logo from: www.mehilainen.fi/yritysinfo Retrieved 15.4.2021