University of Applied Sciences Hamburg

Faculty of Life Sciences

Bachelor Thesis:
Market analysis of the Sysmex RET/PLT-F channel

Submitted by: Payam, Moftakhari Azad

[redacted]

Degree: Bachelor Biomedical Engineering

Semester: 11, SoSe 2022

Submission: Hamburg, 30. June 2022

Supervisors:

Prof. Dr. Petra Margaritoff (University of Applied Sciences Hamburg)

Dr. Pieter Steenhuis (Sysmex Europe SE)

This thesis was supported by:

Sysmex Europe SE

University of Applied Sciences Hamburg

Table of contents

1. Introduction

This chapter will provide an introduction into Sysmex as a company as well as some of the basic concepts that will be researched as a part of this market analysis.

1.1 Market analysis

As a part of this thesis, the RET (reticulocyte) licences for the Sysmex XN and XN-L haematology analysers and PLT-F (platelet-fluorescence) licences for the XN haematology analysers will be analysed in terms of sales over five years from 2017 to 2021 for three selected regions in EMEA. The methodology and criteria for selecting the three regions will be discussion in '2. Methodology and materials'.

1.2 Sysmex Europe Société Européenne

The Sysmex Corporation is headquartered in Kobe, Japan, with the Sysmex Europe Société Européenne (SE) being a subsidiary of the Sysmex Corporation and working closely together with it. The Sysmex Europe SE provided the necessary information and tools for this bachelor thesis, as well as a supervisor. The Sysmex Europe SE, in Norderstedt, broadly oversees and looks after the entire Europe, the Middle East and Africa (EMEA) region (see figure 1) [1].

Figure 1: EMEA region [2]

This means that it supports other Sysmex affiliates as well as Sysmex distributors in the EMEA region when it comes to marketing, service, or regulatory issues. Furthermore, training courses are offered at the Sysmex Europe SE for the entire EMEA region in the Sysmex Academy [1]. The focus of the Sysmex Corporation is the development of in vitro diagnostic methods, especially for haematology. While the analysers are mainly manufactured in Japan, the Sysmex Europe SE takes care of the local

requirements for the EMEA region [1].

As a part of this thesis, a market analysis of Sysmex haematology analysers and two of their measurement channels will be conducted in the EMEA market. Simply put, the RET channel offers clinical insights about reticulocytes and the PLT-F channel offers clinical insights about platelets. A Sysmex measurement channel is equipped with a specialised measurement method and parameter outputs.

1.3 Sysmex XN and XN-L analysers

In order to explain the research of this paper, the history of Sysmex analysers and the current licence system will have to be explained. Historically, the RET channel was always included when ordering the previous generation haematology analyser called XT-2000 (see figure 2) [3].

Figure 2: XT-2000 [Sysmex Digital Asset Management]

With the market introduction of the XN-Series (see figure 2) that changed. XN analysers come in multiple configurations. All the XN analysers are considered 5-part differential analysers, meaning they can differentiate white blood cells into lymphocytes, monocytes, neutrophils, eosinophils, and basophils. In comparison, 3-part differential analysers offer a separation of white blood cells into lymphocytes, monocytes, and granulocytes, with the granulocytes summarising neutrophils, eosinophils, and basophils counts [4].

The XN-Series consists of two different analyser modules, XN-10 and XN-20. The XN-10 module is the basic model which can be upgraded with optional measurement channels through a licence model. The XN-20 module is equipped with a RET and PLT-F channel by default [5].

Figure 3: XN-2000 [Sysmex Digital Asset Management]

The XN-10 (on the right of figure 3) and the XN-20 (on the left of figure 3) can also be combined in different configurations. In this set-up the XN-2000, one RET, and one PLT-F licence would be included in the XN-20 and an optional addition for the XN-10.

The XN-L analysers (see figure 4) are an alternative to the high-end XN models. They are targeted at lower volume labs and allow for an optional addition of the RET channel [6].

Figure 4: XN-L Series [Sysmex Digital Asset Management]

Historically, the measurement of reticulocytes was already possible with Sysmex devices as of 1988 with the RT-1000. However, the market has still not fully adopted the RET channel, which will be seen in '3. Results and market distribution of RET and PLT-F'. The same is true for PLT-F, which allows for a measurement of immature platelet fragments. This channel was only recently introduced in 2011.

1.4 Sysmex RET channel

The Sysmex RET channel is capable of separating reticulocytes from mature red blood cells (RBCs). Reticulocytes are precursor cells of RBCs, which develop in the bone marrow. As can be seen in figure 5, reticulocytes still show leftovers of the nucleus [7].

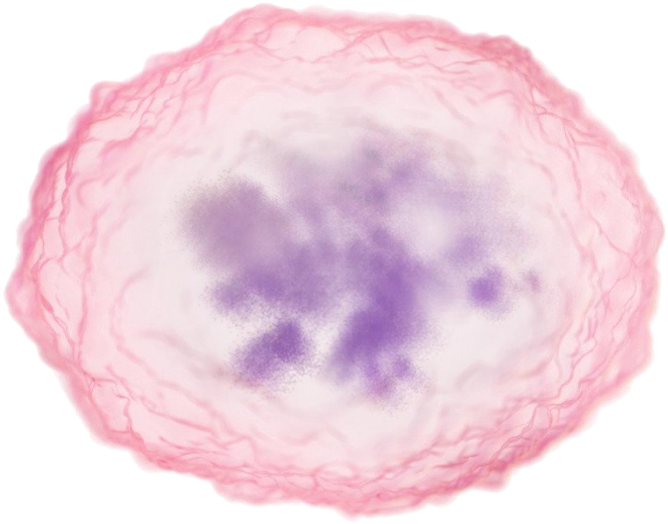

Figure 5: Reticulocyte [Sysmex Digital Asset Management]

Over time the nucleus of a healthy reticulocyte should disappear. Meaning in contrast, a fully matured RBC (see figure 6) has no nucleus. This characteristic will be used to separate the different cells from each other.

Figure 6: Red blood cell [Sysmex Digital Asset Management]

The RET channel offers a separation of reticulocytes into three categories [7]. It does so by using a measurement principle called fluorescence flow cytometry (FFC). FFC provides information about the cell size, structure, and cell interior. The aspirated blood sample flows through a narrow pipe and is marked with a marker which binds to nucleic acids. Then it is illuminated by a semiconductor laser beam, thus breaking the light into three different signals. The three signals being the forward-

scattered light (FSC), side-scattered light (SSC) and side-fluorescence light (SFL) [8].
FSC provides information about the cell volume, SSC about the cell structure and SFL about the amount of nucleic acids in a cell.
The following figure 7 displays a scattergram of the RET channel. On the x-axis, the SFL is being displayed from low to high and on the y-axis, the FSC is being displayed from low to high.

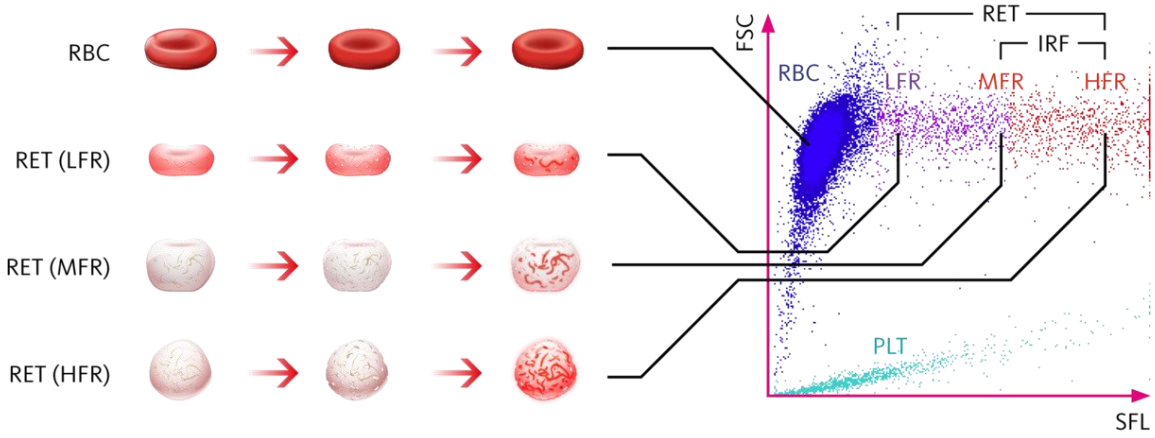

Figure 7: RET channel scattergram [Sysmex Digital Asset Management]

By analysing the cell regarding their cell volume and amount of nucleic acids present in the cell, the scattergram can separate the blood sample into RBC, low fluorescence reticulocytes (LFR), medium fluorescence reticulocytes (MFR) and high fluorescence reticulocytes (HFR). The clinical value this separation provides will be discussed in '1.5.1 Clinical use of the Sysmex RET channel'.

The other adopted measurement method for reticulocyte counts is the staining of reticulocytes with new methylene blue followed by manual counting in a counting chamber. This method is the current reference method for providing a reticulocyte count. However, in literature the reliability of this method has been discussed: 'due to its variability, it is rather a semiquantitative method. Automated reticulocyte counting based on flow cytometry has provided more objective and exact measure of reticulocytes' [9].

1.5 Uses of the Sysmex RET channel

The chapter introduces the core use cases provided by the RET channel, such as greater clinical insights and improved workflow. These use cases will be analysed in '4. Analysis and discussion of the market distribution' to determine possible medical drivers.

1.5.1 Clinical use of the Sysmex RET channel

As previously discussed, reticulocytes are the nucleated precursor cells of red blood cells. Thus, measuring reticulocytes and immature reticulocyte fractions can be an indicator of erythropoiesis functionality. In combination both can offer multiple insights when it comes to clinical diagnosis [10].

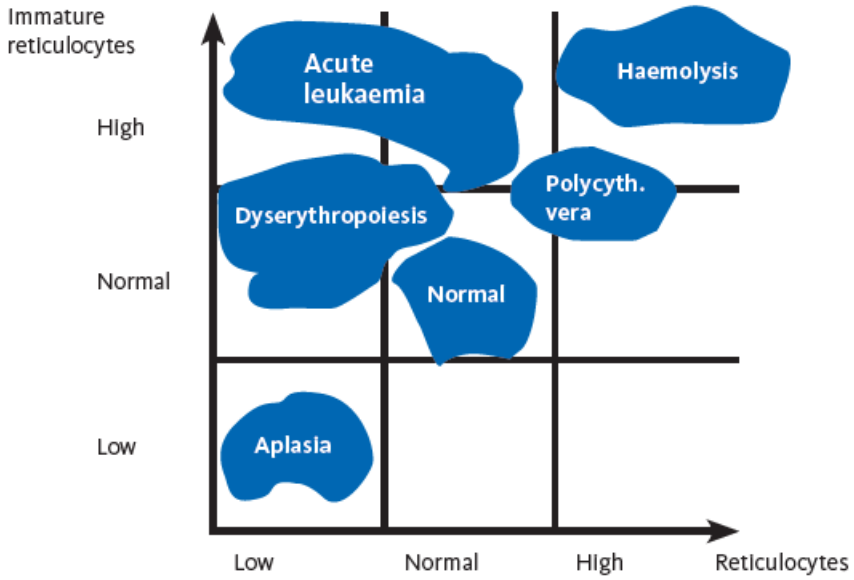

Figure 8: Reticulocytes clinical uses [Sysmex Digital Asset Management]

Figure 8 shows that different levels of immature reticulocytes and reticulocytes can be an indication for various pathologies. To name an example, high reticulocyte and immature reticulocyte counts could indicate haemolysis. Haemolysis is defined through the lysis of red blood cells followed by the release of plasma into the cell's surroundings.

Furthermore, the RET channel offers advanced clinical parameters. These parameters aim to offer further insights compared to a standard complete blood count measurement. The specific use cases of certain parameters provided by the RET channel will be discussed in '4.1 Analysis RET on XN devices'.

1.5.2 Workflow and measurement improvements with the RET channel

The RET channel can provide workflow improvements for the user. It does so by combining the capabilities of the XN analyser with a work area manager, called *Extended* IPU. As the XN analysers offer multiple measurement channels, the *Extended* IPU can make use of those channels automatically if needed. For example, a rule set could trigger a RET channel measurement if a certain parameter is measured below or above a certain threshold. There are pre-set rule sets based on papers, such as the 'Smear microscopy revision' [11]. However, users are free to create their own rule set.

1.6 Sysmex PLT-F channel

The PLT-F channel is focused on analysing platelets and immature platelets. As the name suggests it uses the fluorescence method to measure cell counts. Traditionally analysers used the direct current (DC) sheath flow detection method exclusively for the measurement of platelets. Even current generation XN devices measure the platelet count with said sheath flow method. As mentioned previously, XN-Series analysers allow for the optional usage of the PLT-F channel. The DC sheath flow detection method will be shortly explained in order to outline the differences in the PLT-F channel.

The DC sheath flow method uses aspirated blood which will be diluted before passing through an aperture, as can be seen in figure 9 [12].

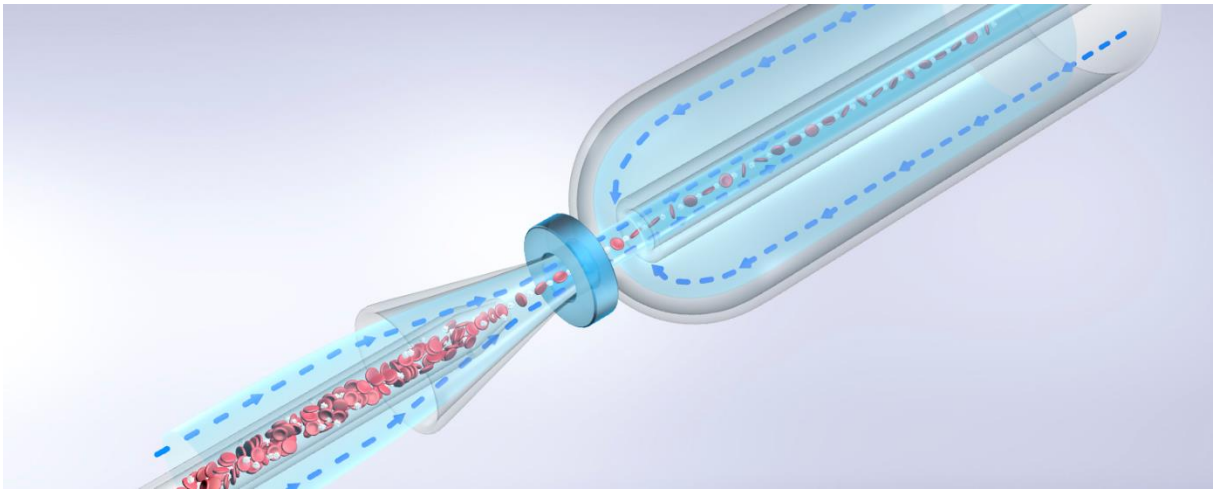

Figure 9: Sheath flow and aperture [Sysmex Digital Asset Management]

The direct current passing through the aperture will be influenced based on how large the cell passing through the aperture is, since bigger cells replace a high volume of the diluent. This means a larger cell will come with a higher resistance. The information will be analysed based on the induced resistance peaks of cells passing through the aperture, as can be seen in figure 10 [12].

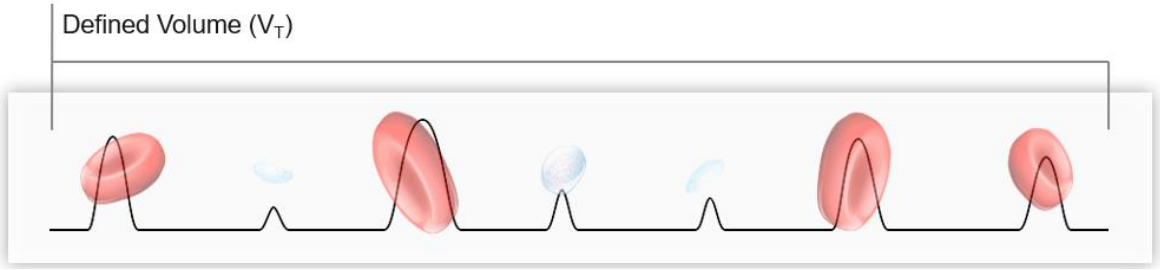

Figure 10: DC detection method [Sysmex Digital Asset Management]

Then the measured data will be visualised on a histogram based on the cell's volume and the frequency they were measured at, see figure 11.

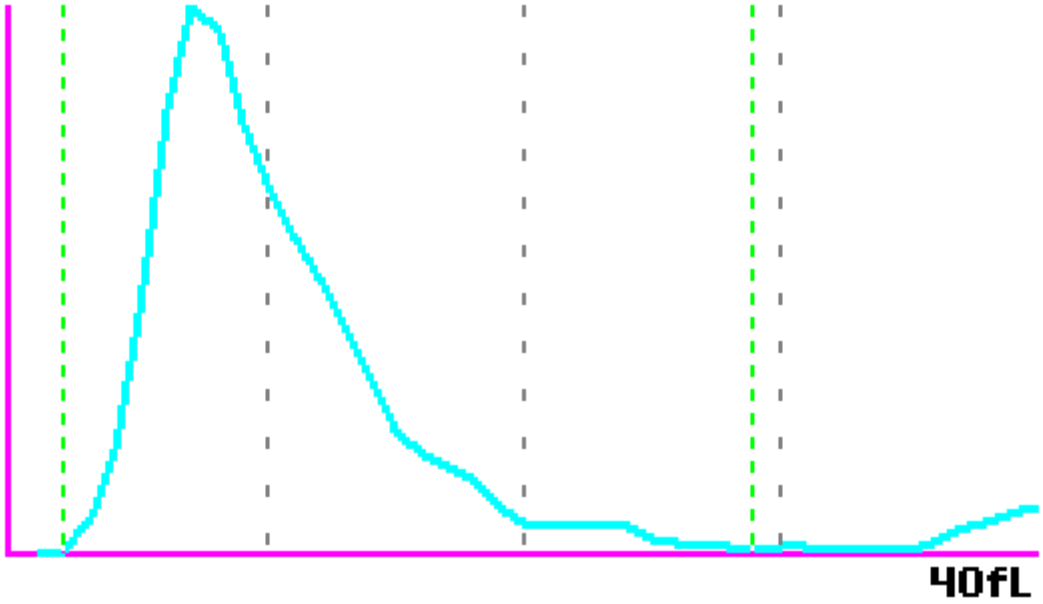

Figure 11: PLT histogram [Sysmex Digital Asset Management]

The PLT-F channel can be compared to the impedance method, as both methods aim to measure PLTs accurately. However, the mechanisms differ in the way they measure PLT, as well as the additional information that the PLT-F channel can provide [13].

Similar to the RET channel, the Sysmex PLT-F channel also uses FFC to measure three signals. The scattergram uses SFL and FSC to display the cell populations [13].

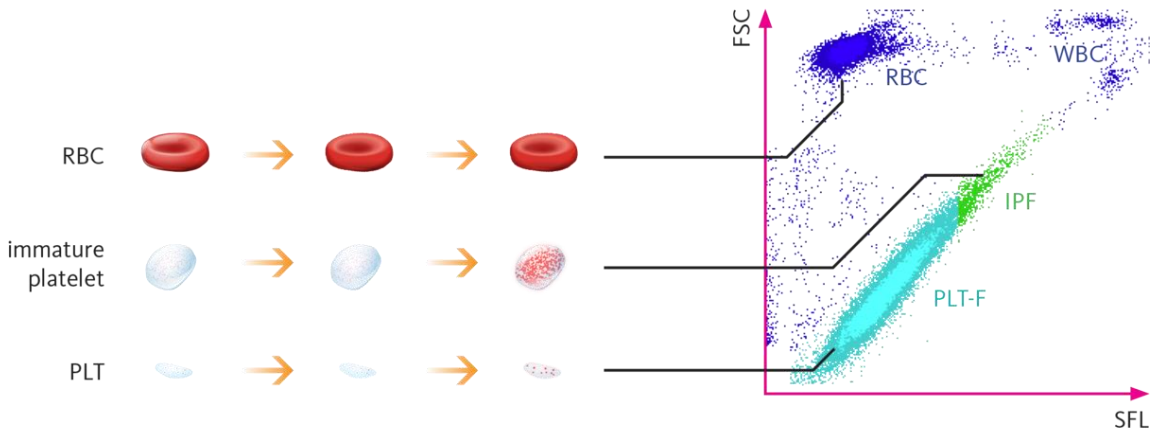

Figure 12: Scattergram of the PLT-F channel [Sysmex Digital Asset Management]

As can be seen in figure 12, the PLT-F scattergram's x-axis shows the SFL from low to high and the y-axis shows the FSC from low to high. Using these two signals, the channel can differentiate between RBC, immature platelets (IPF), platelets (PLT) and white blood cells (WBC).

1.6.1 Clinical use of the Sysmex PLT-F channel

The PLT-F offers greater clinical insights over previous PLT measurement methods. One example is the detection of thrombocytopenia. A disorder defined through an abnormally low amount of PLTs in the peripheral blood. However, the DC sheath flow detection method is also capable of detecting simple thrombocytopenia. The biggest difference lies in the immature platelet fraction (IPF) that can be detected using the PLT-F channel. These reticulated platelets result in the bone marrow through thrombopoiesis. An increased IPF in the presence of thrombocytopenia indicates a functioning bone marrow that tries to compensate for the low platelet numbers in the peripheral blood. Further, this information implies that the thrombocytopenia is caused due to consumption of the platelets in the blood, e.g. due to internal bleeding or platelet destruction. A specific example would be immune thrombocytopenic purpura (ITP), this autoimmune haematological disorder results in an accelerated platelet destruction leading to a loss of peripheral blood platelets. On the other hand, a low IPF value in presence of thrombocytopenia indicates a malfunction of the bone marrow, e.g. due to replacement of the normal haematopoietic stem cells due to uncontrolled growth of one or more cell lines, e.g. in case of leukaemia, lymphoma or myeloma cells. The ability to check for IPF in the peripheral blood allows clinicians to reduce the number of bone marrow examinations, as an increased IPF value will indicate an active bone marrow, making a bone marrow puncture superfluous [14].

1.6.2 Workflow and measurement improvements with the PLT-F channel

Compared to only providing a PLT count, this measurement method offers additional parameters. However, the PLT-F measurement method uses a fluorescence dye in order to statin the cells and is connected to higher reagent costs. Further, always measuring with the PLT-F channel could thus provide excessive information.

The XN analyser provides a solution to this in combination with the *Extended* IPU middleware. In case the XN detects that a sample is showing interferences or abnormalities after an initial measurement, the measurement can be repeated or additional measurement modes, like PLT-F, can be added to provide additional information. This method is called ‘Rerun & Reflex’. It is beneficial to platelets, example given, a blood sample can suffer from in-vitro interferences, such as platelet clumps, which result in lower PLTs counts than expected [13].

In this case PLTs could be falsely counted as RBCs. With the help of the *Extended* IPU a reflex would be triggered, and the PLT-F would be able to measure the sample more accurately or to confirm a possible flag.

Another measurement method to look at it is the reference method for platelet counting, the microscope chamber count. While this is the current reference method, a study states that ‘this

method exhibits a number of important limitations with high interoperator imprecision in the order of 10% to 25%'. [15]

The implications in using this reference method for key influencers in a laboratory or hospital will be outlined in '4.3 Analysis of PLT-F on XN analysers'.

2. Methodology and materials

This chapter will go into detail about the methods and materials used to conduct the market analysis of the Sysmex RET/PLT-F channel.

2.1 Determining the purpose of the market analysis

The Sysmex RET and PLT-F channels are optional licences for XN analysers. The Sysmex Europe SE has not conducted any market analysis to see the distribution of channel sales relative to device sales in EMEA. Thus, there was an interest to learn more about the EMEA market, which the Sysmex Europe SE is responsible for.

2.2 Understanding the state of the market

For this part of the market analysis, SAP (Systems, Applications, and Products in Data Processing) software tools called 'Service Cube' and 'Sales Cube' were used to extract the data from various countries, see '2.5 Sales and Service Cube' [16].

Once the data about various countries was collected, three areas were selected based on the following criteria. First, an area that sells RET and PLT-F licences above the EMEA average. Second, an area that sells RET and PLT-F licences broadly aligned with the EMEA average. And lastly, an area that underperforms in RET and PLT-F licences sales compared to the EMEA average.

Areas with different levels of sales were collected, so that an analysis would point out different KPIs that lead to strong sales for these two advanced measurement channels.

2.3 Analysing the state of the market

Once the three areas have been selected, the state of the market will be analysed by calculating relative sales. This was calculated as:

$$Relative\ sales = \frac{Licence\ sales}{Total\ XN\ sales}$$

This was done for RET licence sales built into XN device and RET licence sales built into XN-L and PLT-F licences for the EMEA area and the three selected areas. The three selected areas will then be compared from 2017 to 2021. If noticeable, trends, peaks and all-time lows will be pointed out.

This data was presented to the Sysmex representatives of the selected areas.

First, this will ensure that the gathered data is correct.

Second, it will be used as an opportunity to learn more about economic and medical drivers, as well as economic and medical roadblocks. The mentioned economic and medical drivers, as well as economic and medical roadblocks will be compared to two selected key performance indicators

(KPIs), the gross domestic product (GDP) per capita, as well as the expenditure on health care per capita.

Additionally, questions about specific marketing incentives and tools were evaluated to see if there is an alignment of certain marketing measures and high sales.

In this process one relevant competitor posing a threat to one of the selected markets will be discussed.

Thus, the interview encompassed questions about

1. Plausibility of the collected data
2. Reasons for peaks and floors for RET licence sales
3. Reasons for peaks and floors for PLT-F licence sales
4. Influences on trends in the collected data
5. Marketing incentives for the RET and PLT-F channels

2.4 Formulating a conclusion

In a traditional market analysis, a conclusion in the form of a strategy will be formulated and put into place in order to grow the market share. However, since this is a document meant for external publication, the final part of the market analysis will summarise the findings of the research and discuss the analysed data.

2.5 SAP Sales and Service Cube

The Service Cube was used to structure a table that provides data about XN device sales yearly from 2017 to 2021 sorted by legal entity. With a legal entity being an affiliate or a distributor of Sysmex. To give an example, figure 13 shows the final data extraction of the total XN and XN-L analysers sales in Germany yearly from 2017 to 2021.

Legalentity Short	SDG					
Active Systems		**Year**				
Instrument Series	**Instrument Model**	**2017**	**2018**	**2019**	**2020**	**2021**
XN Ergebnis		**1182**	**1455**	**1673**	**2106**	**2325**
XN-L	XN-330			5	12	23
	XN-350	91	113	132	152	177
	XN-450	10	14	18	34	41
	XN-550	123	166	215	310	366
XN-L Ergebnis		**224**	**293**	**370**	**508**	**607**

Figure 13: Service Cube [Sysmex internal application]

The Sales Cube has provided tables with data, for one, about RET licences sales sorted by countries and PLT-F licence sales sorted by country. Furthermore, the RET licence sales were divided even further into RET licence sales activated on XN devices and RET licence sales built into XN-L devices. Both tools are Sysmex-internal.

3. Results and market distribution of RET and PLT-F

This chapter will display the collected data in the selected markets of Turkey, Germany, and the Nordics (Denmark, Norway, Sweden). Turkey was selected as a country with low RET and PLT-F sales, Germany as a average performer, and the Nordic countries as an area with high sales.

It is important to mention that the representatives in the Nordic countries pointed out flawed data. Thus, the following data was provided by a Sysmex Nordics affiliate instead of being extracted from the Sales and Service Cube.

Additionally, the Sysmex Turkey representative mentioned that the XN-L sales in Turkey include sales towards Iran. While this might cause falsely high sales, the conclusions drawn in '4. Analysis and discussion of the market distribution' still apply, as the sales are still low compared to the other two selected markets.

3.1 RET on XN analysers

The following data has been collected for total sales of XN in all EMEA, the Nordics, Germany, and Turkey over five calendar years, spanning from 2017 to 2021. The selection was based on relative licence sales compared to analyser sales. Generally, the three selected countries had low, medium, and high sales compared to the average in EMEA. The analysis of the markets will follow in '4. Analysis of the market distribution'.

Table 1 depicts the total XN device sales in all EMEA, the Nordics, Germany, and Turkey.

Table 1: Total XN device sales

Year	2017	2018	2019	2020	2021	Sum
Total XN device sales in EMEA	3637	4538	5207	6116	6700	**26198**
Total XN device sales in the Nordics	28	37	27	59	13	**164**
Total XN device sales in Turkey	256	375	350	435	385	**1801**
Total XN device sales in Germany	1182	1455	1673	2106	2325	**8741**

Additionally, the following data has been collected for total RET licence sales in all EMEA, the Nordics, Germany, and Turkey (see table 2).

Table 2: Total XN RET licence sales

Year	2017	2018	2019	2020	2021	Sum
Total XN RET licence sales in EMEA	775	820	944	841	803	**4183**
Total XN RET licence sales in the Nordics	0	2	7	21	5	**35**
Total XN RET licence sales in Turkey	11	8	31	24	10	**84**
Total XN RET licence sales in Germany	190	107	151	344	197	**989**

This means the following relative numbers ($\frac{Total\ RET\ licence\ sales}{Total\ XN\ sales}$) can be attributed to all EMEA, the Nordics, Germany, and Turkey (see table 3).

Table 3: Relative RET to XN sales

Year	2017	2018	2019	2020	2021	Sum
Relative XN RET in EMEA	21,31%	18,07%	18,13%	13,75%	11,99%	**15,97%**
Relative XN RET in the Nordics	0,00%	5,41%	25,93%	35,59%	38,46%	**21,34%**
Relative XN RET in Turkey	4,30%	2,13%	8,86%	5,52%	2,60%	**4,66%**
Relative XN RET in Germany	16,07%	7,35%	9,03%	16,33%	8,47%	**11,31%**

3.2 RET on XN-L analysers

The following data has been collected for total sales of XN-L in all EMEA, the Nordics, Germany, and Turkey over five year, spanning from 2017 to 2021 (see table 4).

Table 4: Total XN-L device sales

Year	2017	2018	2019	2020	2021	Sum
Total XN-L device sales in EMEA	792	1085	1422	1875	2329	**7503**
Total XN-L device sales in the Nordics	23	11	10	4	2	**50**
Total XN-L device sales in Turkey	58	94	122	169	148	**591**
Total XN-L device sales in Germany	224	293	370	508	607	**2002**

Additionally, the following data has been collected for total RET licence sales in all EMEA, the Nordics, Germany, and Turkey (see table 5).

Table 5: Total XN-L RET licence sales

Year	2017	2018	2019	2020	2021	Sum
Total XN-L RET licence sales in EMEA	281	279	316	428	397	**1.701**
Total XN-L RET licence sales in the Nordics	0	4	0	0	0	**4**
Total XN-L RET licence sales in Turkey	5	0	6	4	1	**16**
Total XN-L RET licence sales in Germany	37	30	58	79	99	**303**

This means the following relative numbers ($\frac{Total\ RET\ licence\ sales}{Total\ XN-L\ sales}$) can be attributed to all EMEA, the Nordics, Germany, and Turkey (see table 6).

Table 6: Relative RET to XN-L sales

Year	2017	2018	2019	2020	2021	Sum
Relative XN-L RET in EMEA	35,48%	25,71%	22,22%	22,83%	17,05%	**22,67%**
Relative XN-L RET in the Nordics	0,00%	36,36%	0,00%	0,00%	0,00%	**8,00%**
Relative XN-L RET in Turkey	8,62%	0,00%	4,92%	2,37%	0,68%	**2,71%**
Relative XN-L RET in Germany	16,52%	10,24%	15,68%	15,55%	16,31%	**15,13%**

3.3 PLT-F on XN analysers

The following data has been collected for total sales of XN devices in all EMEA, the Nordics, Germany, and Turkey over five years, spanning from 2017 to 2021 (See table 7).

Table 7: Total XN device sales

Year	2017	2018	2019	2020	2021	Sum
Total XN device sales in EMEA	3637	4538	5207	6116	6700	**26198**
Total XN device sales in the Nordics	28	37	27	59	13	**164**
Total XN device sales in Turkey	256	375	350	435	385	**1801**
Total XN device sales in Germany	1182	1455	1673	2106	2325	**8741**

Additionally, the following data has been collected for total PLT-F licence sales in all EMEA, the Nordics, Germany, and Turkey (see table 8).

Table 8: Total PLT-F licence sales

Year	2017	2018	2019	2020	2021	Sum
Total PLT-F licence sales in EMEA	337	330	319	363	341	**1.690**
Total PLT-F licence sales in the Nordics	0	13	6	28	2	**49**
Total PLT-F licence sales in Turkey	1	5	4	2	4	**16**
Total PLT-F licence sales in Germany	43	26	41	70	51	**231**

This means the following relative numbers ($\frac{Total\ PLT-F\ licence\ sales}{Total\ XN\ sales}$) can be attributed to all EMEA, the Nordics, Germany, and Turkey (see table 9).

Table 9: Relative PLT-F to XN sales

Year	2017	2018	2019	2020	2021	Sum
Relative PLT-F in EMEA	9,27%	7,27%	6,13%	5,94%	5,09%	**6,45%**
Relative PLT-F in the Nordics	0,00%	35,14%	22,22%	47,46%	15,38%	**29,88%**
Relative PLT-F in Turkey	0,39%	1,33%	1,14%	0,46%	1,04%	**0,89%**
Relative PLT-F in Germany	3,64%	1,79%	2,45%	3,32%	2,19%	**2,64%**

4. Analysis and discussion of the market distribution

The collected data will be compared and analysed based on economic and medical drivers, as well as economic and medical roadblocks. Additionally, the three selected areas were contacted to confirm influences on sales.

When comparing the three areas economically, a graspable metric is the GDP (gross domestic product) per capita. For the Nordic countries, Denmark, Norway, and Sweden must be considered. As of 2019, Denmark has a GDP per capita of $59,795, Norway of $77,975 and Sweden of $51,242. The average for the Nordic countries is thus $63,004.

Ranking second, Germany has a GDP per capita of $46,564 as of 2019.

Lastly, Turkey has a GDP per capita of $8,957 as of 2019 [17].

To determine the general state of an area's health care system an KPI (Key Performance Indicator) called 'health care expenditure per capita' will be compared.

Extracting the KPI for 2019, Germany ranked first among the three selected areas with $6,518 per capita spent on health care expenditure.

The Nordic countries ranked second in 2019. Norway spent $6,744 per capita. Sweden spent $5,551 per capita. And Denmark spent $5,477 per capita. The average for the Nordic countries is thus $5,924.

Lastly, Turkey ranked the lowest among the selected areas with a health care expenditure per capita of $1,266 [18].

This data only provides absolute numbers, so table 10 has been created to give an overview of the relative amount of GDP a region capita for health expenditures per capita.

Table 10: Relative health care expenditure per capita

Area	GDP per capita (in $)	Health expenditure per capita (in $)	Relative health care expenditure per capita
Nordic countries	63004	5924	9,40%
Denmark	59795	5477	9,16%
Norway	77975	6744	8,65%
Sweden	51242	5551	10,83%
Germany	46564	6518	14,00%
Turkey	8957	1266	14,13%

Table 10 reveals that Turkey has the highest relative health care expenditure per capita among the three selected areas with 14,13%, but the lowest absolute expenditure. It is followed by Germany with 14,00%. The lowest ranking region are the Nordic countries with 9,40%.

4.1 Analysis of RET on XN analysers

When comparing the collected data in the Nordics, Germany and Turkey, the following ranking can be observed.

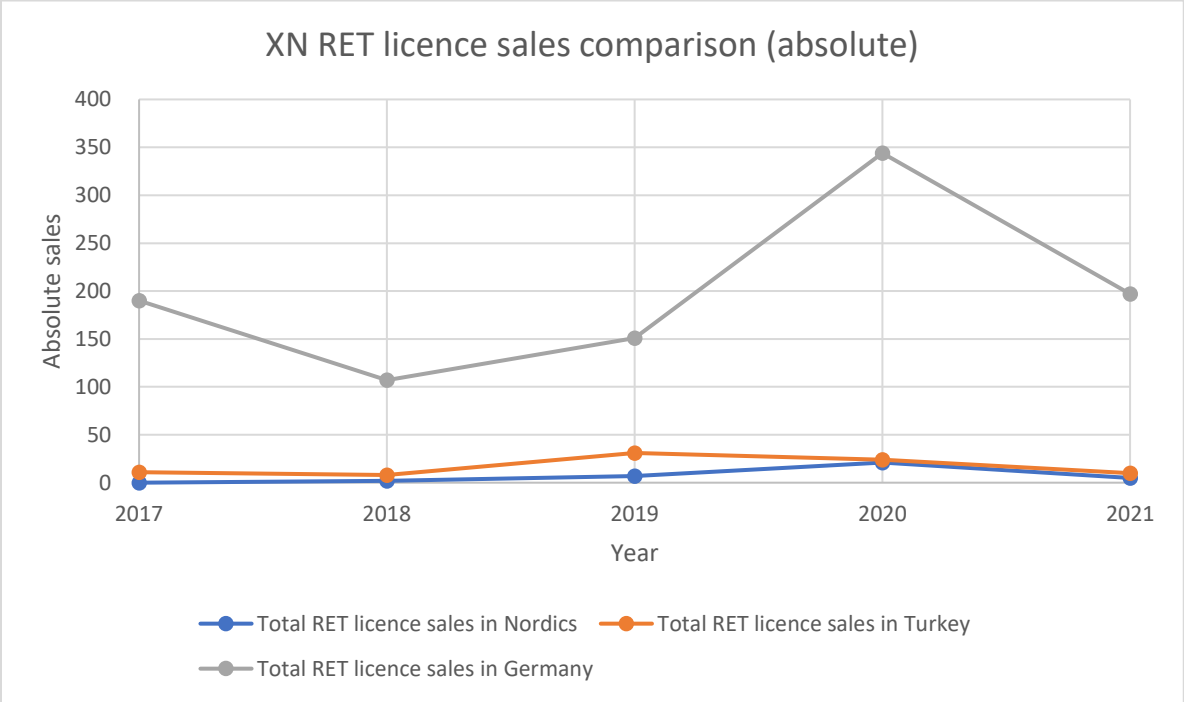

Figure 14: XN RET licence sales comparison (absolute)

As can be seen in figure 14, in absolute numbers (y-axis) over five years (x-axis), Germany is outselling the Nordics, and Turkey.

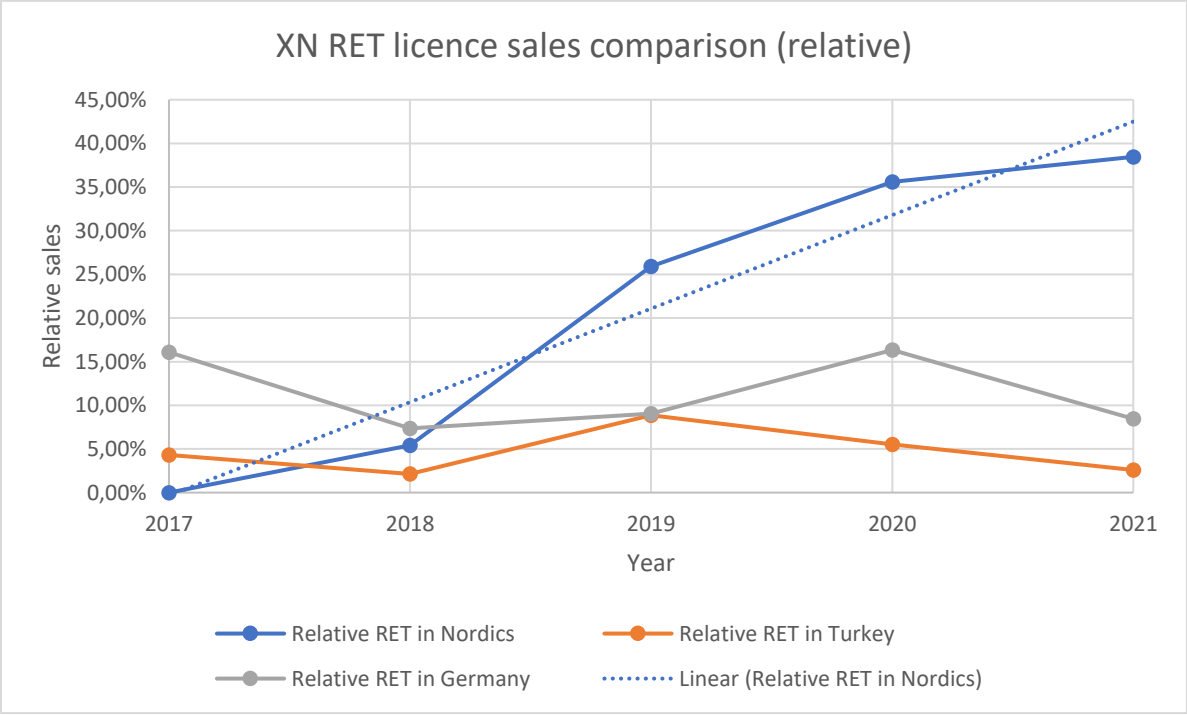

Figure 15: XN RET licence sales comparison (relative)

However, when comparing the relative numbers (see figure 15), the Nordics start out as the country with the lowest relative sales. However, the Nordics show a strong upwards trend with relative sales, starting with 0% relative sales in 2017 and reaching more than 35% in 2021. Germany is ranking below the Nordics with around 11,31% relative sales averaged over five years. The lowest among them is Turkey with relative sales around 4,66% averaged over five years.

4.1.1 Nordics

When looking at the three Nordic countries (see table 11) separately, it becomes evident that the Nordics are selling a high amount of RET licence relative to their XN device sales. The relative sales come down to approximately 21,34% averaged over five years.

Table 11: Nordics XN and XN RET sales

Year	2017	2018	2019	2020	2021	Sum
Total XN RET sales in Nordics	0	2	7	21	5	**35**
Total XN RET sales in Denmark	0	0	0	5	4	**9**
Total XN RET sales in Norway	0	0	2	7	0	**9**
Total XN RET sales in Sweden	0	2	5	9	1	**17**
Total XN sales in Nordics	28	37	27	59	13	**164**
Total XN sales in Denmark	15	11	10	16	6	**58**
Total XN sales in Norway	8	15	2	25	5	**55**
Total XN sales in Sweden	5	11	15	18	2	**51**

In an interview the Sysmex representative of Norway mentioned that the RET channel is in high demand, since the reticulocyte measurement is a mandatory test in all laboratories.
This alone enables Norway to sell Sysmex XN devices to hospitals and laboratories with the inclusion of a RET channel.
Generally, the Nordic countries have the highest GDP per capita when looking at the areas that are

being compared for this study. This in exchange, as confirmed by the representative from Norway, means that there is a 'high focus on quality'.

4.1.2 Germany

In Germany, the reticulocyte measurement is no mandatory test as it is in Norway. However, the German affiliates confirmed that Sysmex Deutschland GmbH (SDG) is actively marketing the RET channel through multiple means to keep the sales as high as possible.

SDG publishes a magazine titled 'xtra' twice a year [19]. This magazine is featuring Sysmex customers, preferable key opinion leaders, which educate other customers about using various Sysmex technologies, including RET. This marketing tool allows SDG to advertise possible clinical values to the market. To name a few key opinion leaders in Germany, Professor Dr Mathias Zimmermann [20] and Prof. Dr Roland Schaefer [21] are featured on multiple interviews, webinars, and articles for Sysmex's RET channel.

SDG also features a 'clinical benefits' section on their website [22].

Additionally, SDG offers training, but also follow-up training at the customer's site on a wide variety of topics, including RET. They further promote the training process by offering a variety of courses on the online portal 'Sysmex Academy Online' [23].

Another key incentive specific to Germany, is the Medical Science Team. This team focuses their efforts on educating their customers about clinical use cases of Sysmex devices and customer relationships. The aforementioned key opinion leader webinars are being coordinated by SDG's Medical Science Team.

Furthermore, to optimise work processes for Sysmex customers, SDG provides laboratory advice from experienced consultants [24].

Another specific use case is the anaemia management that the RET channel provides [25]. For example, the advanced clinical parameter called RET-H*e*. RET-H*e* helps with diagnosing and monitoring anaemia caused by iron deficiencies. It is the fastest method for detecting iron level changes. Identifying iron deficiencies and alterations in erythropoiesis using conventional haematological tests such as HGB (haemoglobin), MCV (mean corpuscular volume), MCH (mean corpuscular haemoglobin) or measuring hypochromic RBCs is only possible with larger delays, because RBCs have a lifespan of 120 days.

Reticulocytes are the precursors of RBCs and flow from the bone marrow into the bloodstream, where they mature up to four days. The measurement of reticulocytes haemoglobin content can thus indicate shifts in iron status earlier than traditional RBC parameters can.

Another advanced clinical parameter, Delta-H*e*, is being provided by subtracting RBC haemoglobin content (RBC-H*e*) from reticulocytes haemoglobin content (RET-He), as can be seen in a RET channel scattergram (see figure 16). This parameter can be used to monitor iron therapies after an anaemia

has been detected. Since RET-He provides information about the early stages of erythropoiesis an improvement, through medication, can later be measured with RBC-H*e*. The Delta-H*e* values above the normal range are an indication of improvements in erythropoiesis and vice versa [26].

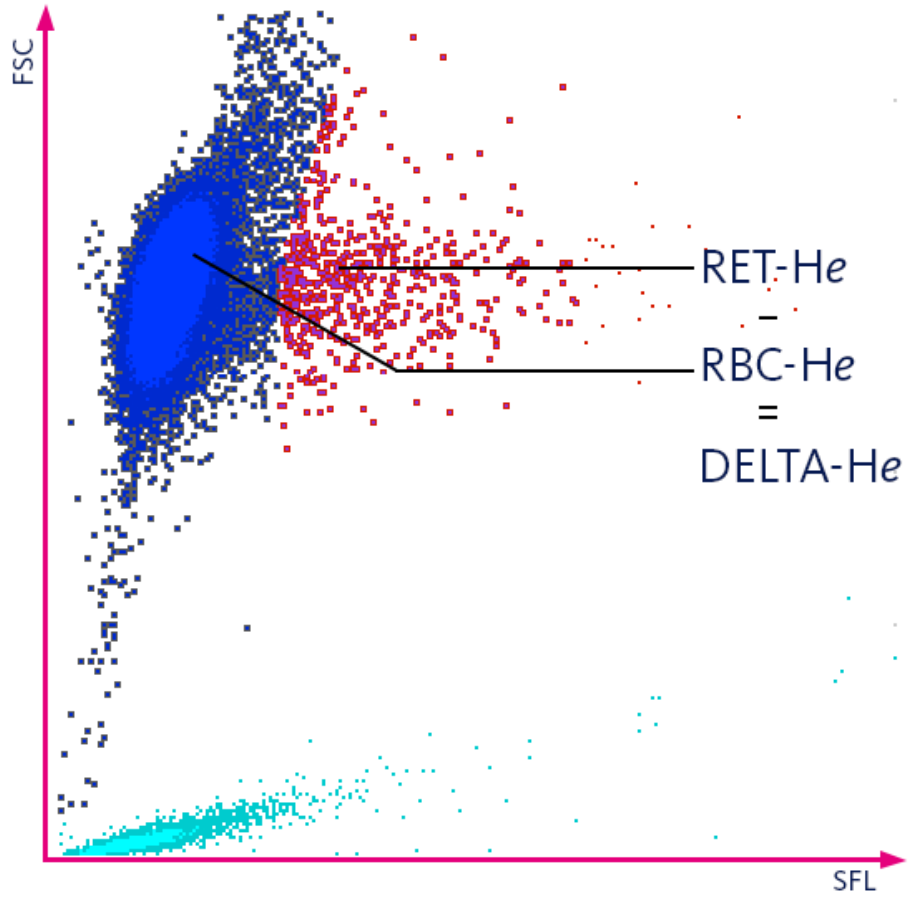

Figure 16: Delta-He [Sysmex Digital Asset Management]

Another aspect that is heavily being marketed in Germany is the workflow improvement provided by RET channel, see '1.5.2 Workflow and measurement improvements with the RET channel'. Building on this, a specific workflow improvement application called CBC-O (complete blood count-optical) is popular in Germany and aims to minimise the manual work for the user. It achieves this by comparing the standard CBC measurement to a rule set based on the paper 'Smear microscopy revision' [11]. If certain parameters are out of the normal area, a reflex measurement using the RET channel is automatically triggered providing further clinical insights to the user.

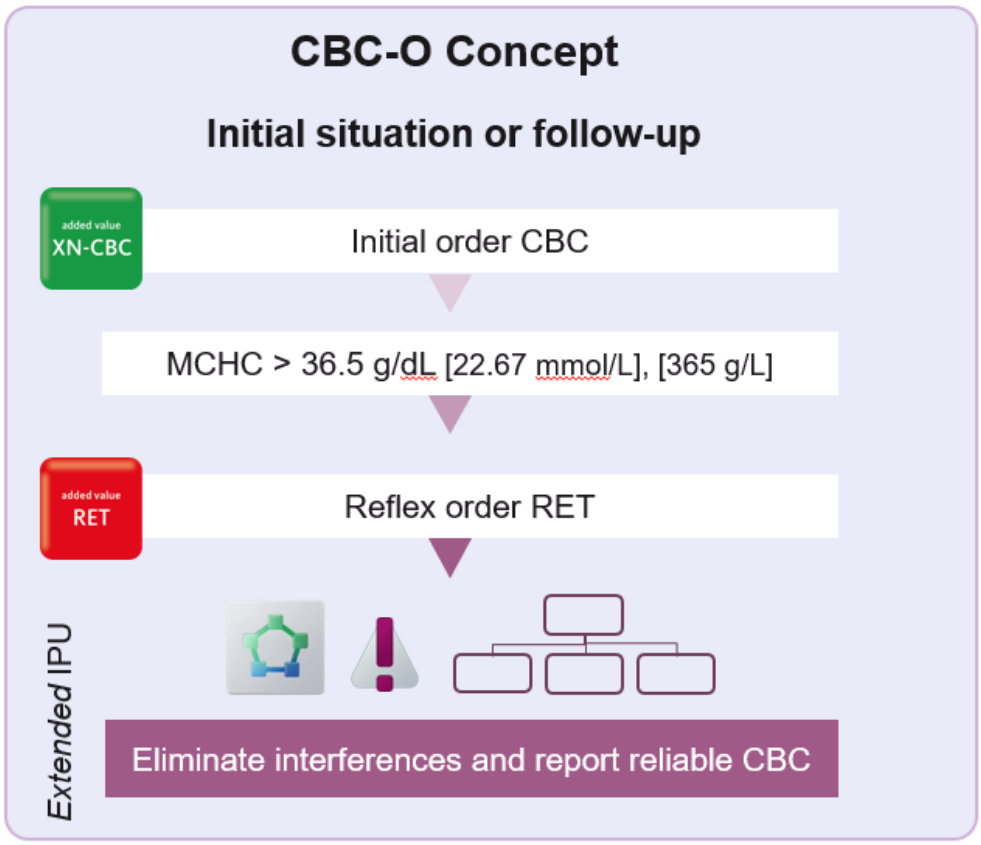

Figure 17: CBC-O [Sysmex Digital Asset Management]

An example can be seen in figure 17. Here the initial CBC measurement resulted in a mean corpuscular haemoglobin concentration (MCHC) bigger than 36.5 g/dl. MCHC, which is an indicator of the ratio total red blood cells and haemoglobin, can be more accurately measured through the RET channel, since the MCHC is being calculated as:

$$MCHC\ \left(\frac{g}{dL}\right) = \frac{Haemoglobin\ (\frac{g}{dL})}{Haematocrit\ (\%) \cdot 100}$$

4.1.3 Turkey

As can be seen by the collected data, RET licence sales in Turkey are low compared to the EMEA average.

One of the key differences between the Nordic countries and Turkey becomes evident when looking at Norway. In an interview the Norwegian representative mentioned that the Norwegian market is 100% funded through a public healthcare system. This is in stark contrast to the Turkish health care market, where around 27% in health care financing comes through private expenditure [27].

This in combination with the suffering economy, as can be seen in the hyper-inflation of the Turkish lira, and GDP per capita of $8,081 in 2021, means that the market is more susceptible to competitors in the budget market segment. A prominent upcoming competitor is the Chinese manufacturer

called Mindray. Mindray was founded in 1991 [28], a rather new company compared to Sysmex which was founded in 1968 [29]. While Sysmex is still the market leading in haematology, in economically weaker countries such as Turkey Mindray has been gaining market share and is ranking second in haematology, according to the Sysmex Turkey representative.

Especially in tender processes where the lowest bid that fulfils the conditions is selected, the competition leads to Sysmex Turkey being forced to offer refurbished X-Class devices (the XN-Class predecessor) to larger hospitals when competing with Mindray's competitor devices, the BC-6000 series. This device series can also provide the optional inclusion of a reticulocyte measurement channel [30].

To compete with Mindray's aggressive pricing strategy, the RET channel is even deactivated on XN devices and will be used as a standard 5-part CBC channel according to the Sysmex Turkey representative. This can be done in order to save on reagent costs, as RET channel reagents are more expensive than CBC reagents due to the fluorescence stain that is necessary for the reticulocyte measurement technology.

4.1.4 Discussion of RET on XN devices

Taking the relative health expenditure per capita KPI into account, Turkey and Germany should have performed with relatively high sales in RET sales per XN device sales.

Yet Turkey performed the worst among the selected countries. It is evident that Turkey is limited through economic influences. So even though the government is spending a high percentage of the country's GDP on health care, due to the small absolute budget it seems to go towards the minimum requirement, at least when looking at haematology. This creates a bottleneck for Turkey and throttles RET licence sales.

Here the Turkish Sysmex representative confirmed that CBCs are still the gold standard in Turkey, even in oncology wards the doctors conduct simple 3-part differentials.

Germany spends more than the Nordic countries on health care. Yet the focus does not seem to be on advanced clinical insights. The sales of RET compared to XN devices in Germany are average when looking at EMEA as a whole. There is no trend deviation to be found and due to long tender cycles it is difficult to point out an upwards trend in relative sales.

One example is the rather large sales spike in 2020, here the German Sysmex representative states that two large laboratory groups, the Sonic Healthcare Germany and the Synlab Group, were turned into Sysmex customers through a tender process.

Germany is marketing the RET channel actively towards the user. To expand on the idea of the CBC-O concept, which partially relies on the RET channel, a feature like CBC-O is actively targeted towards all influencers in a laboratory. Key influencers are the lab supervisor, the clinician, and the lab technician.

For the lab supervisor the benefit is a reduced turnaround time, and a reduction in manual labour, thus encompassing a reduction in costs through staff. Staff costs are not only reduced by letting the analysers handle more of the diagnostic process, but also through the fact that machines are not being taxed, whereas staff hours must be taxed.
The clinician benefits through a fast response to interferences and a reliable report that they can use to diagnose the patients.
The lab technician also benefits through a faster turnaround time, enabling them to focus on more vital tasks.
Lastly, the Nordic countries spend a relatively low amount of their GDP on health care with an average of 9,4%. However, they have the largest GDP per capita. Compared to Germany their GDP per is about 135% larger. And compared to Turkey it is about 700% larger. So, while the comparison to Turkey can easily be reduced to economic influences, a comparison to Germany will prove more interesting.

With XN analysers being higher end flagship analysers, which offer high levels of clinical insights and automation, the benefits for countries with reimbursement programs for automatic reticulocyte count measurements and higher standards of health care is clear. This can be seen in the fact that the Nordic countries and Germany offer reimbursement for clinics while Turkey is not offering any reimbursement [34].
In this regard Turkey is facing further difficulties with inflation in the double digits since 2020, exerting pressure on the country's economy [35]. Furthermore, a stricter budget helps competitors, such as Mindray, which aggressively target budget market segments. Turkey is an example which depicts how factors outside of medical drivers, such as economic and political influences can affect the healthcare standards.
On the opposite end, the Nordic countries show a high adoption rate of the RET channel. In comparison to Turkey the economic situation is more stable, and the healthcare system is more advanced with programs such as the aforementioned reimbursement for reticulocyte measurements. Additionally, the Nordic countries are known to be early adopters for new Sysmex products. This supports that there is an interest in research parameters [36], which the RET channel offers.

Lastly, The Nordic countries prove that a wide adoption through a mandatory test will increase sales. An upward trend could be observed for channel sales and it looks like the channel is being rapidly adopted.
For Germany, a mandatory test instead of a reimbursement could push the sales to a similar level as the Nordics. Especially given that the budget for health care expenditure is present. This in combination with the fact that around 10% of Germans are facing anaemia could make the test mandatory in the future [37].

Turkey is still focussed on equipping the hospitals and laboratories with standard measurement devices providing a 5-part CBC. Once this level has been broadly achieved, further marketing for the RET channel should be considered.

4.2 Analysis of RET on XN-L analysers

XN-L analysers are a compromise between automation, value, size, and clinical insight. They can provide a 5-part differential analysis with lower throughput and come without automation. This chapter will outline some of their use cases next to analyse the acquired data.

As can be seen in figure 18, when looking at absolute numbers (y-axis) Germany outsells the Nordics and Turkey. Additionally, an upwards can be observed from 2018 onwards.

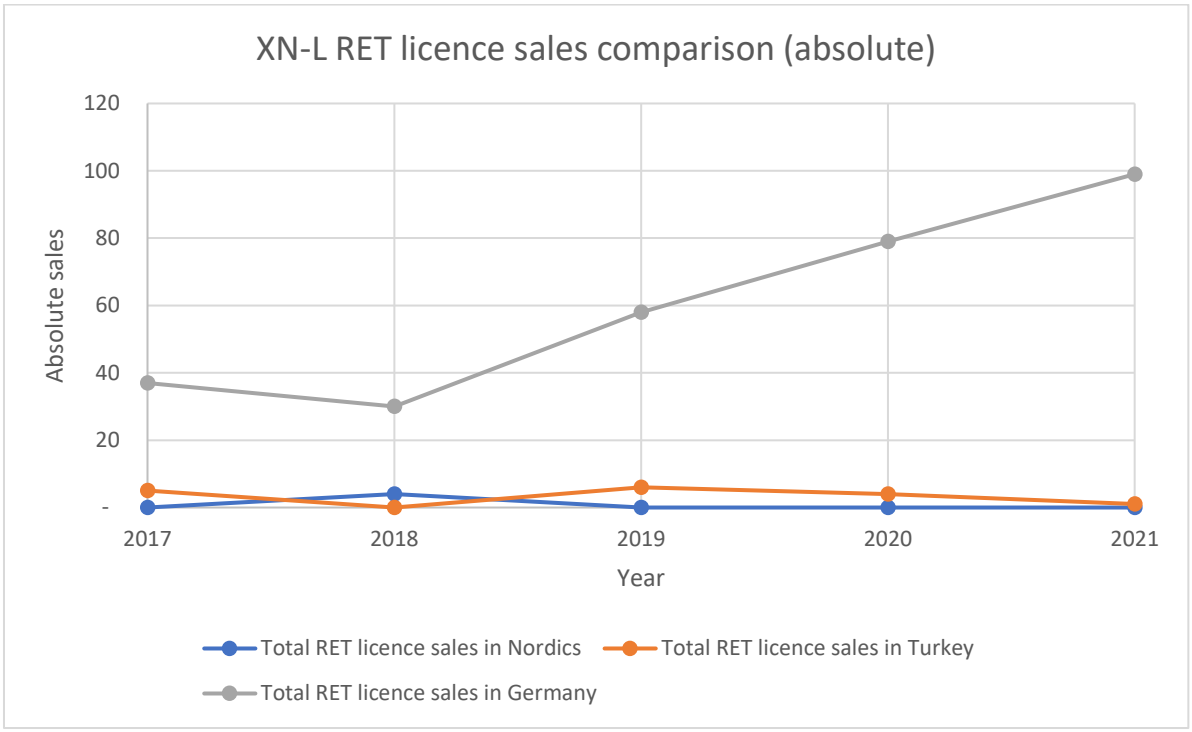

Figure 18: XN-L RET licence sales comparison (absolute)

The comparison to the relative numbers (see figure 19) shows a constant level of RET sales relative to the XN-L analyser sales. In the Nordics a strong sales spike of around 35% relative sales could be observed in 2018 with a rapid drop-off back to 0% in 2019. Relative sales in the Nordics continued to stay at 0% in the following years. Turkey consistently sells under 10% from 2017 to 2021. With 2018 being the all-time-low at 0 RET sales in absolute numbers.

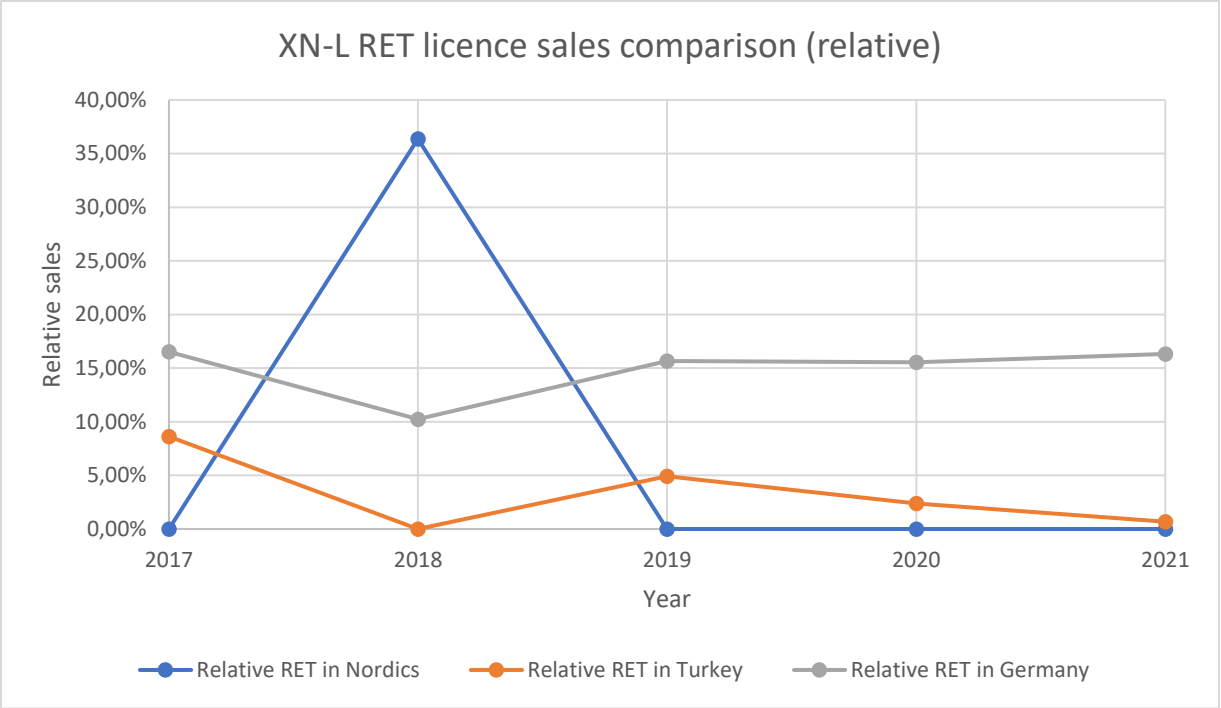

Figure 19: XN-L RET licence sales comparison (relative)

4.2.1 Nordics

When looking at table 12, it becomes clear that all the Nordic countries do not buy a lot of XN-L devices. The only sales that were achieved in 2018 likely were the result of a tender process.

Table 12: Nordics XN-L and RET licence sales

Year	2017	2018	2019	2020	2021	Sum
Total XN-L RET sales in Nordics	0	4	0	0	0	**4**
Total XN-L RET sales in Denmark	0	3	0	0	0	**3**
Total XN-L RET sales in Norway	0	0	0	0	0	**0**
Total XN-L RET sales in Sweden	0	1	0	0	0	**1**
Total XN-L sales in Nordics	23	11	10	4	2	**50**
Total XN-L sales in Denmark	1	3	3	4	2	**13**
Total XN-L sales in Norway	1	3	7	0	0	**11**
Total XN-L sales in Sweden	21	5	0	0	0	**26**

As was established in '4.2.1 Analysis of RET on XN-L analysers in the Nordics', the Nordic countries care about high-quality. And large amounts of XN flagship devices are equipped with RET channels

compared to the EMEA average. Thus, the laboratories and hospitals are already equipped with fully functional automated 5-part differential set-ups and apparently can do without the XN-L analysers.

4.2.2 Germany

Contrary to the Nordic countries, in an interview the German affiliate stated that XN-L devices are usually used as back-up devices in laboratories or hospitals. This means they could be placed next to an automated haematology system like the XN-9100. The XN-9100 comes with a minimum of two XN-10 analysers and is usually equipped with a RET and PLT-F channel [31].
In case of an emergency measurement being necessary, the entire automation line would not have to be interrupted. The back-up device could be used instead.

4.2.3 Turkey

Turkey performs the worst among the selected areas with sales from 2017 to 2021 averaging around 2,71%. Turkey again must compete with Mindray especially in this market segment, as XN-L analysers are the cheapest option for 5-part differential analysers in the current product line-up.
Mindray's competitor device in this category is the BC-700 series. On the product website the marketing is aimed towards budget segments, with a focus being on accuracy, automation and cost-effectiveness [32].
Again, Turkey has to offer the XN-L devices without the inclusion of the RET channel, in order to compete in with Mindray's tender offers.

4.2.4 Discussion of RET on XN-L devices

The XN-L RET licence sales mark the only category where the Nordic countries are not achieving the highest relative sales. Germany reached 15,13% relative sales over the observed five-year period while the Nordic countries reached 8,00% relative sales.
In the Nordic countries the customers prefer not to use the optional RET licence for their XN-L device. While the licence is not the expensive part, the reagent costs for the RET channel and the upkeep costs of the additional measurement channel are too high for some laboratories to justify the upgrade.

4.3 Analysis of PLT-F on XN analysers

The PLT-F channel is an interesting case since it is not widely adopted. Even in the Nordic countries, this channel does not provide any parameters needed for mandatory blood tests. This means if hospitals or laboratories include it, it is purely for the advanced clinical insights and workflow improvements it provides.

As can be seen in figure 20, when looking at absolute numbers (y-axis) Germany constantly outsells the Nordic countries and Turkey in absolute numbers. Turkey consistently sells less than ten PLT-F

licences every year with no upward or downward trend. Germany has been increasing its sales from 2018, resulting in a peak in 2020. A similar trend can be observed in the Nordics. However, the peak in 2020 is followed by a sharp drop-off in sales from 2020 to 2021.

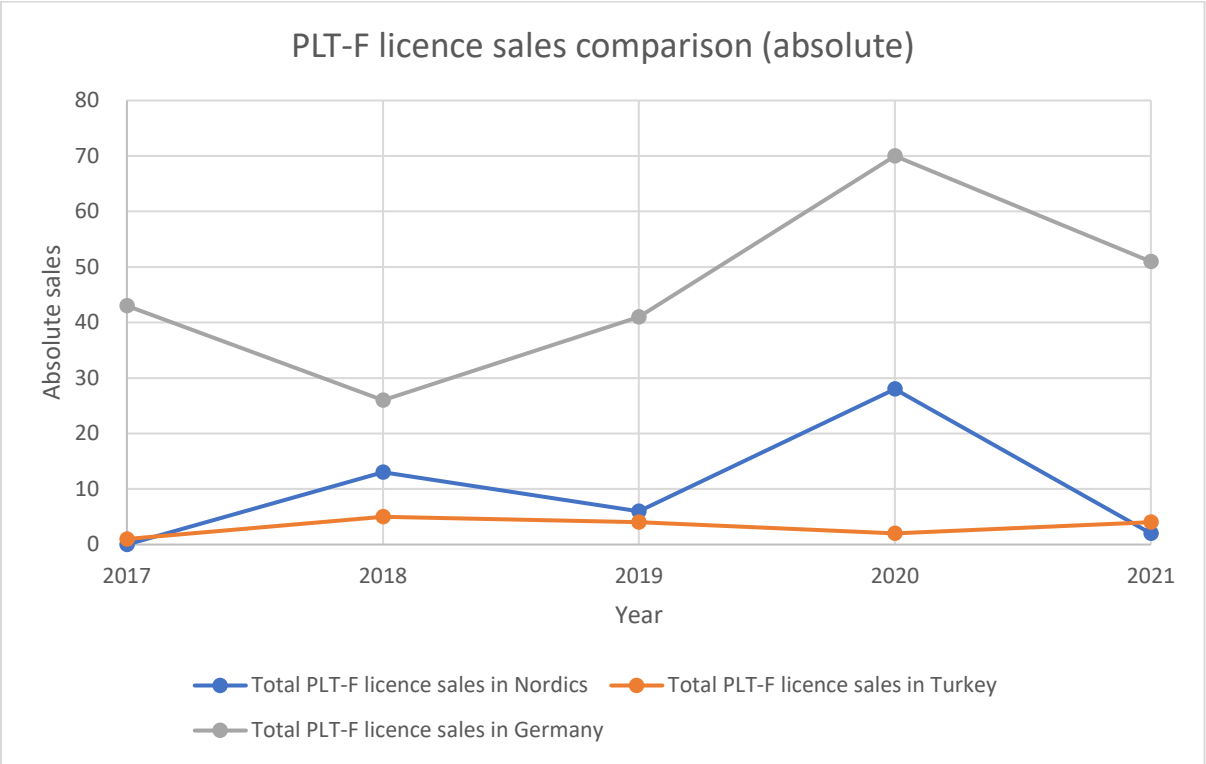

Figure 20: PLT-F licence sales comparison (absolute)

The comparison to the relative numbers (see figure 21) shows a constant low-level of PLT-F licence sales relative to the XN analyser sales for Germany and Turkey. The Nordic countries have their highest selling year in relative number in 2020. The drop-off in sales for the Nordics 2021 can also be observed in relative numbers. Turkey consistently sells under 2% from 2017 to 2021. Germany constantly stayed below 4% relative sales.

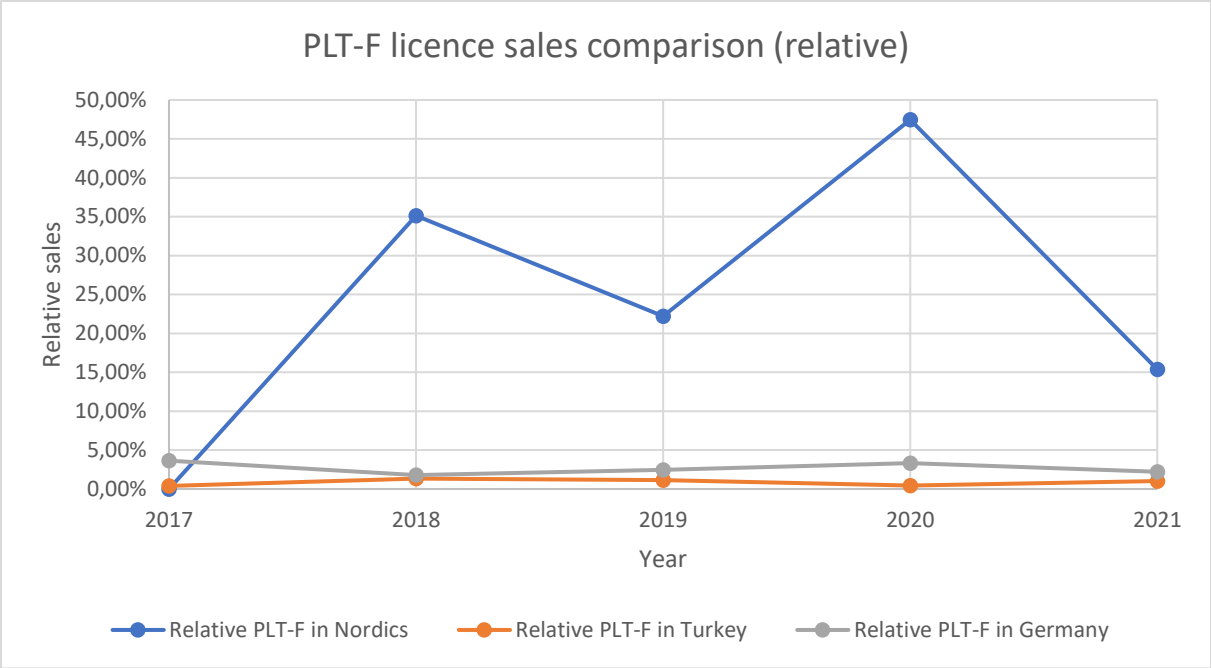

Figure 21: PLT-F licence sales comparison (relative)

4.3.1 Nordics

Table 13 depicts the data for PLT-F licence sales in relation to XN sales in the Nordic countries. All of the three Nordic countries achieved similar amounts of relative sales.

Table 13: Nordics XN and PLT-F licence sales

Year	2017	2018	2019	2020	2021	Sum
Total PLT-F sales in Nordics	0	13	6	28	2	**49**
Total PLT-F sales in Denmark	0	4	1	11	0	**16**
Total PLT-F sales in Norway	0	5	1	9	1	**16**
Total PLT-F sales in Sweden	0	4	4	8	1	**17**
Total XN sales in Nordics	28	37	27	59	13	**164**
Total XN sales in Denmark	15	11	10	16	6	**58**
Total XN sales in Norway	8	15	2	25	5	**55**
Total XN sales in Sweden	5	11	15	18	2	**51**

In the Nordic countries, PLT-F is being marketed as a specialised tool that provides further clinical insights by providing advanced clinical parameters, such as IPF#, the absolute immature platelet count, and IPF%, the ratio of immature platelets to mature platelets [33].

A specific use case is the diagnosis and monitoring of immune thrombocytopenia, a disease that is defined by uncontrolled bleeding and impaired platelet clotting. Here the total platelet count a standard CBC provides does not give all the necessary information needed to monitor or predict a response to the treatment of ITP. This is because both decreased platelet production and rapid platelet breakdown induce thrombocytopenia in ITP. Another metric, the absolute count of immature platelets can provide information regarding a treatment response. This includes the analysis of production and consumption of PLTs to determine the danger of uncontrolled bleeding [14].

4.3.2 Germany

Germany, as stated in the interview with the representative of SDG, has issues with selling PLT-F licences. Contrary to the RET channel, which includes a health insurance reimbursement through the automatic measurement of reticulocyte counts, the PLT-F channel does not provide any parameters which qualify for a reimbursement. Additionally, there are no key opinion leaders pushing for adoption of PLT-F channels across laboratories in Germany.

All the efforts that could be determined are internal marketing measures through SDG. Again, this includes the 'Medical Sciences Team'. Their efforts go towards hosting webinars, featuring key opinion leaders, as well as supporting the release of publications describing the use of Sysmex parameters.

4.3.3 Turkey

As previously mentioned, the private medical sector in Turkey is prevalent with 27% in health care financing coming through private expenditure. The Sysmex Turkey representative states that most of the PLT-F licences sales went towards private lab groups and the remainder went towards university hospitals. However, even with the support of the private sector PLT-F licence sales are consistently below five licences per year.

The use cases for private lab groups and university hospitals lies in advanced clinical parameters as well as research parameters. Research parameters must be verified by the customers, as there is no guarantee through in-depth research papers that the parameter can be used for diagnostics. Additionally, they need a clearance from the analyser manufacturers.

Again, the representative for Sysmex Turkey stressed the country's economic state and said that those must be considered to properly evaluate the sales that have been achieved.

4.3.4 Discussion of PLT-F on XN devices

As established in '1. Introduction', the PLT-F channel provides some of the latest and most experimental parameters Sysmex currently has to offer. Keeping this mind, it is a fitting showcase to see at what stage the health care system of a selected market is.

From 2017 to 2021, the Nordic countries have an average of 29,88% relative sales. Compared to the

EMEA average of 6,45%, this is a stark outlier in EMEA, and Sysmex Europe SE generally considers the Nordic countries as early adopters for their latest technology. The Nordic countries are in a stage where clinical insight, quality, workflow improvements, and research are being prioritised as the health care standard is high which can be seen in the health care expenditure per capita KPI.
Germany can be considered average for the RET channel sales, but for the PLT-F channel Germany reached around 2,64% relative sales. While PLTs measurements are being reimbursed [38], the additional parameters provided through a PLT-F measurement, like IPF, are not being reimbursed. This in combination with the standard *Extended* IPU rule set that triggers PLT-F measurement only after a standard CBC measurement, causes the laboratory or hospital to lose money through reagent costs and a missing reimbursement. Furthermore, the fact that hospitals in Germany are struggling economically, as well as a decline in hospital numbers due to consolidation of the health care system, means that measurements without reimbursement are difficult to justify even with the additional clinical insight they might provide [38].
While Germany still reached around 3% relative sales, Turkey reached around 0,89% relative sales over the five-year period. As this channel is newer and more experimental than the RET channel, it has not yet been adopted in Turkey. According to the Sysmex Turkey representative, there are corporations with Sysmex Europe SE to educate customers about PLT-F through symposiums, magazines, and papers. However, the focus seems to be on other market segments.
This supports the statement that the absolute health care expenditure of Turkey creates a bottleneck in this area and limits Turkey to the technologies such as standard CBC measurements.

Sources

1. Sysmex SE. About Sysmex Europe SE; 2022.
   Link: https://www.sysmex-europe.com/company/about-us.html (accessed on 14.05.2022)
2. ActuHub. EMEA map; 2022.
   Link: https://img1.wsimg.com/isteam/ip/7126bf48-0e7b-4bb6-84cc-b3e9de399bf8/EMEA-report.png (accessed on 20.06.2022)
3. Sysmex SE. Sysmex XT-2000; 2022.
   Link: https://www.sysmex.se/products/products-detail/xt-2000i.html (accessed on 20.05.2022)
4. Sysmex SE. Sysmex XN-Series; 2022.
   Link: https://www.sysmex.se/products/diagnostics/xn-series.html (accessed on 20.05.2022)
5. Sysmex SE. Sysmex XN-2000; 2022.
   Link: https://www.sysmex.se/products/products-detail/xn-2000.html (accessed on 20.05.2022)
6. Sysmex SE. XN-L Series; 2022.
   Link: https://www.sysmex-europe.com/products/diagnostic/haematology/xn-l-series.html (accessed on 20.05.2022)
7. Sysmex SE. RET channel; 2022.
   Link: https://www.sysmex-europe.com/academy/clinic-laboratory/analyser-channels/ret-channel.html (accessed on 21.05.2022)
8. Sysmex SE. Fluorescence flow cytometry; 2022.
   Link: https://www.sysmex-europe.com/academy/knowledge-centre/technologies/fluorescence-flow-cytometry.html (accessed on 21.05.2022)
9. Turowski D et al. (2000): Peripheral blood reticulocytes and their reference range values for percentage, absolute count, and immature fraction in children, measured with flow cytometry. Folia Histochem Cytobiol. 2000;38(1):31-6.
10. Sysmex SE. The importance of reticulocyte detection; 2022.
    Link: https://www.sysmex-europe.com/academy/library/documents/detail/seed-the-importance-of-reticulocyte-detection.html (accessed on 21.05.2022)
11. Genevieve F et al. (2014): Smear microscopy revision: propositions by the GFHC. Feuillets de Biologie VOL LVI N° 317.
12. Sysmex SE. DC sheath flow detection method; 2022.
    Link: https://www.sysmex-europe.com/academy/knowledge-centre/technologies/dc-sheath-flow-detection-method.html (accessed on 21.05.2022)

13. Sysmex SE. PLT-F channel; 2022.
Link: https://www.sysmex-europe.com/academy/knowledge-centre/technologies/plt-f-channel.html (accessed on 21.05.2022)
14. Sysmex SE. The importance of thrombocytopenia and its causes; 2022.
Link: https://www.sysmex-europe.com/academy/library/documents/detail/the-importance-of-thrombocytopenia-and-its-causes.html (accessed on 21.05.2022)
15. Harrison P et al. (2004): Platelet counting. Methods Mol Biol . 2004;272:29-46.
16. SAP North America. About SAP; 2022.
Link: https://www.sap.com/about.html (accessed on 21.05.2022)
17. Knoema. GDP per capita ranking 2019; 2020.
Link: https://knoema.de/sijweyg/world-gdp-per-capita-ranking-2019-data-and-charts (accessed on 22.05.2022)
18. Statista Research Department. Health spending per capita by country 2019; 2022.
Link: https://www.statista.com/statistics/236541/per-capita-health-expenditure-by-country/ (accessed on 22.05.2022)
19. Sysmex Deutschland GmbH. German Xtra customer magazine; 2022.
Link: https://www.sysmex.de/akademie/wissenszentrum/literatur/xtra-unser-kundenmagazin.html (accessed on 22.05.2022)
20. Sysmex SE. Professor Dr Mathias Zimmermann on tracing iron deficiency; 2019.
Link: https://www.sysmex-europe.com/academy/knowledge-centre/expert-voices/haematology/tracing-iron-deficiency-part-1.html (accessed on 22.05.2022)
21. Sysmex SE. Prof. Dr Roland Schaefer on parameters that will become very valuable tracing iron deficieny; 2019.
Link: https://www.sysmex-europe.com/academy/knowledge-centre/expert-interviews/haematology/tracing-iron-deficiency-part-2.html (accessed on 22.05.2022)
22. Sysmex Deutschland GmbH. Clinical insights; 2022.
Link: https://www.sysmex.de/produkte/diagnostik/haematologie/xn-serie/klinischer-nutzen.html (accessed on 22.05.2022)
23. Sysmex SE. Sysmex Academy Online
Link: https://www.sysmex.de/akademie/kursangebot/online-kurse.html (accessed on 22.05.2022)
24. Sysmex Deutschland GmbH. Laboratory consulting; 2022.
Link: https://www.sysmex.de/produkte/laborautomation/laborberatung.html (accessed on 22.05.2022)
25. Sysmex Deutschland GmbH. Anaemia management; 2022.
Link: https://www.sysmex.de/akademie/wissenszentrum/haematologie/management-von-anaemien.html (accessed on 22.05.2022)
26. Sysmex SE. Reticulocyte haemoglobin equivalent; 2022.
Link: https://www.sysmex-europe.com/academy/knowledge-centre/sysmex-parameters/reticulocyte-haemoglobin-equivalent-ret-he.html (accessed on 22.05.2022)
27. Prof. Mustafa Özmen. Overview of the Healthcare System in Turkey; 2008.
Link: https://healthmanagement.org/c/imaging/issuearticle/overview-of-the-healthcare-system-in-turkey (accessed on 22.05.2022)
28. Mindray. Mindray corporate profile; 2022.
Link: https://craft.co/mindray-medical-international (accessed on 22.05.2022)
29. Sysmex Corporation. Sysmex corporate profile; 2022.
Link:

https://web.archive.org/web/20150119214307/http:/www.sysmex.co.jp/en/sysmex/profile/index.html (accessed on 22.05.2022)
30. Mindray. BC-6800Plus; 2022.
Link: https://www.mindray.com/en/products/laboratory-diagnostics/hematology/5-part-differential-analyzers/bc-6800-plus (accessed on 22.05.2022)
31. Sysmex Deutschland GmbH. XN-9100; 2022.
Link: https://www.sysmex.de/produkte/details/xn-9100.html (accessed on 22.05.2022)
32. Mindray. BC-700 Series; 2022.
Link: https://www.mindray.com/en/products/laboratory-diagnostics/hematology/5-part-differential-analyzers/bc-700-series (accessed on 22.05.2022)
33. Sysmex SE. Immature platelet fraction; 2022.
Link: https://www.sysmex-europe.com/academy/knowledge-centre/sysmex-parameters/immature-platelet-fraction-ipf.html (accessed on 22.05.2022)
34. Teramed. GOÄ-Ziffern: Reticulocyte measurement reimbursement; 2022.
Link: https://www.teramed.de/goae/go%C3%A4-abschnitt-m-laboratoriumsuntersuchungen/3552-%E2%80%93-retikulozytenzahl-r7124/ (accessed on 22.05.2022)
35. Triami Media BV. Turkey CPI; 2021.
Link: https://www.inflation.eu/en/inflation-rates/turkey/historic-inflation/cpi-inflation-turkey-2021.aspx (accessed on 22.05.2022)
36. Sysmex SE. Advanced clinical parameters; 2022.
Link: https://www.sysmex-europe.com/academy/knowledge-centre/sysmex-parameters.html (accessed on 22.05.2022)
37. Institut für Qualität und Wirtschaftlichkeit im Gesundheitswesen. Anaemia incidence; 2021.
Link: https://gesund.bund.de/blutarmut-anaemie-quellen (accessed on 22.05.2022)
38. kbv. Thrombocyte measurement reimbursement; 2022.
Link: https://www.kbv.de/tools/ebm/html/32037_2901915093949732019520.html (accessed on 22.05.2022)