Case 2: Hilti

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Introduction

1. Define outliers
2. Problematic customers
3. Problematic tool types
4. Limitations

1. Data analysis

1. Outliers Analysis Method

   Identifying Outliers Using Normal Distribution

- **Assumption:** Customer and tools repair frequency follow a normal distribution.
- **Objective:** Set a 90% confidence level to identify outliers.
- **Steps:**
  - 1.Calculate Mean and Standard Deviation: Compute the average (mean) and spread (standard deviation) of the data.
  - 2. Define Confidence Interval: Determine the range within which 90% of the data lies based on the properties of the normal distribution.
  - 3. Identify Outliers: Any data points falling outside this range are considered outliers.

For each month, we calculate SD, upper and lower bound for the set of customers' overall RRF1% (from results line), and any RRF1 sample higher or lower than the boundaries will be regarded as an outlier sample.

Similarly for tools, we evaluate the tools' RRF1% per each month to find the outliers by calculating SD, upper and lowerbound for the dataset.
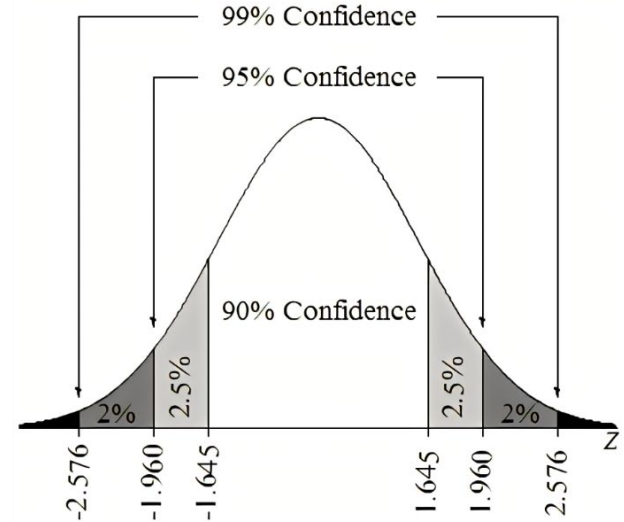
1. Data analysis

2. Customer Outliers results

Taking January as an example. Filtering only 'Results' to look at each customer in overall, we have 1177 lines with RRF1% values.

The SD for those is 34,38. Under 90% confidence interval, the upper and lower bounds are -49,7% and 63,5% respectively.

Then we marked all customer that have their RRF1% as an outlier to the dataset, making it easier to locate the pain points in later analysis

Month	1	2	3	4	5	6	7	8	9	10	11	12
Count RRF1 >0	1 177,00	976,00	999,00	708,00	630,00	980,00	923,00	1 122,00	594,00	1 017,00	956,00	537,00
mean	7,10	5,60	4,98	4,43	3,72	6,67	6,89	6,82	3,17	5,82	6,04	4,40
std	34,37647	34,20692	34,32157	31,95147	34,80112	33,51789	33,13518	33,57146	27,27277	34,08478	34,10342	34,02348
x + n* sigma	63,48024	61,69881	61,26363	56,83413	60,79876	61,63821	61,22815	61,87537	47,89659	61,71582	61,97019	60,19908
x - n*sigma	-49,2746	-50,4999	-51,3111	-47,9667	-53,3489	-48,3005	-47,4552	-48,239	-41,5581	-50,0823	-49,889	-51,3979

1. Data analysis

2. Tools Outliers results

Filter only tools, we have 4053 rows.(ignore the duplicates of tools for now)

Taking January as an example: The SD for tools is 33.82. With 90% confidence level, the upper and lower bounds are -48.36% and 62.57%, this is our confidence intervals. Tools in January with rate over 62.57% should be outliers. Same steps for the remaining months.

We marked all outlying tools in red, for further analysis.

Tool Type	(n) Cal. Month Nr. (Ref. Cal. Month)	1	2	3	4	5	6	7	8	9	10	11	12
DD 150-U	%											100.00	
VC 10M-22	%										50.00		
SR 30	%							100.00					
DD 250	%										100.00		
DD 250-CA	%										100.00		
WFE 450-E	%						100.00						
DCH 150-SL	%	50.00											
SD 5000-A22	%							100.00					
DSH 600-X	%			50.00				100.00					
SCW 22-A	%						50.00						
DSH 600-X	%	100.00											
DSH-P	%	100.00											
SF 6H-A22	%			100.00									
TE 50-AVR	%	20.00					20.00						
DSH 600-X	%										100.00	100.00	
SR 6-A22	%			100.00									
DSH 600-22	%										100.00		
TE 500-AVR	%			100.00									
SF 4-A22	%										50.00		
TE 4-A22	%											50.00	
TE 56	%	100.00											
TE 80-ATC/AVR	%											33.33	
NPR 032 PE-A22	%										100.00		
AG 115-7S	%							50.00	33.33				
TE 700-AVR	%							100.00					
SF 6H-A22	%							100.00					
GX 90-WF	%		50.00										
SFH 22-A	%	50.00											
PM 30-MG	%			100.00									
SF 6-A22	%		100.00										
NPR PA	%			50.00									
NPR PR M	%			50.00									
SF 6-A22	%			100.00	50.00								
AG 6D-22-150	%			100.00									
AG 125-19SE	%							100.00					
SR 30	%								50.00				
VC 40-UM	%									50.00			
TE 6-A22	%					50.00							
PR 30-HVSG A12	%										100.00		
DD 350-CA	%												100.00
GX 90-WF	%		66.67		25.00	100.00		33.33					
AG 125-19SE	%										50.00		

	1	2	3	4	5	6	7	8	9	10	11	12
Mean	7.10	5.60	4.98	4.43	3.72	6.67	6.89	6.82	3.17	5.82	6.04	4.40
SD	33.82	34.37	34.56	31.93	34.70	33.24	32.99	33.27	27.26	33.37	33.79	32.78
L	-48.36	-50.77	-51.70	-47.93	-53.19	-47.84	-47.22	-47.74	-41.54	-48.91	-49.37	-49.36
U	62.57	61.97	61.65	56.80	60.64	61.17	60.99	61.38	47.88	60.54	61.45	58.16

2. Problematic customers

1. Overall analysis of customers
2. Monthly analysis
3. Problematic customers
   - Customers that have required repair at least 6 times within a month of previous repair
   - Customers that have significant outliers
   - Customers with the most outliers
   - Customers with the most 100% RRF1 values

2.1 Overall analysis of customers

Distribution of customers

The majority of customers have no problems with their tools. Still, 30 companies required repair at least 10 times within a month of the previous time.
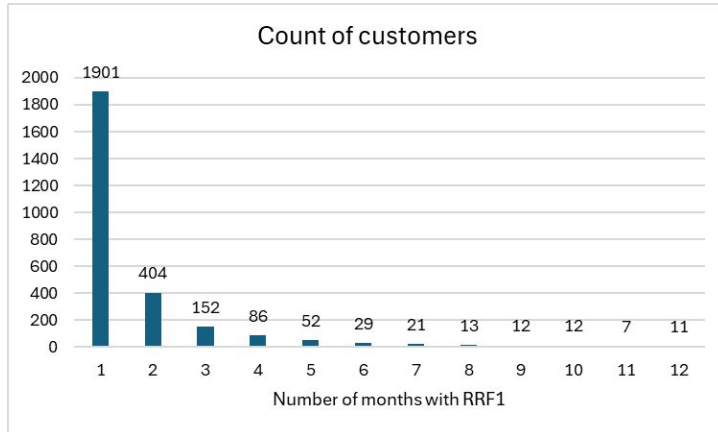
Development of %RRF1

The trend is downward, which means that the number of returns per month has decreased in a big picture, in other words, we can assume the quality of TSC has improved during the year.

Count of customers

Count of customers that has %RRF1 > 0

2.2 Monthly analysis of outliers

The average number of outliers per month is ~97 or 4%. However, the amount is not stable throughout the year. With more information on e.g. the reasons for the returns, there could be some addressable issues to be found, especially in the first two months of the year, where the number of returns is notably high in January and low in February.

Number of outliers

Outliers as % of all customers
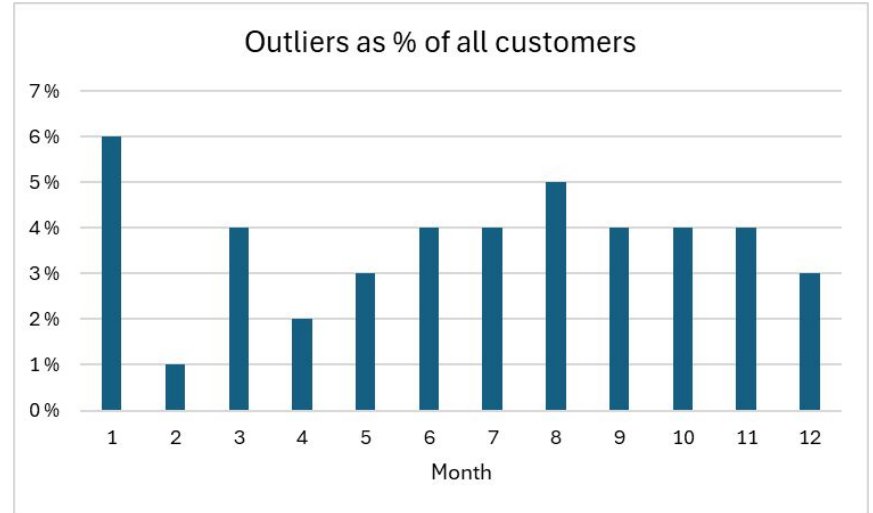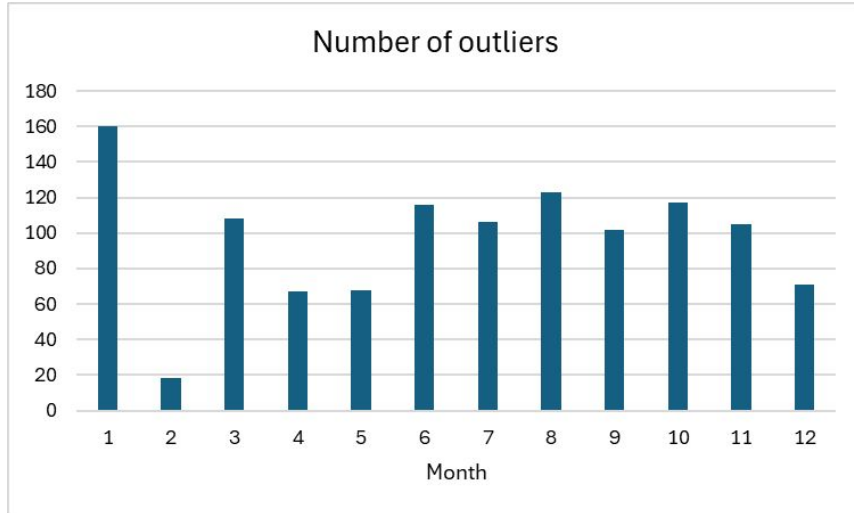
2.3 Problematic customers: required repair 6-12 times

List of customers that appear to have continuous problems with their tools. These customers have required repair within a month of the previous one 6-12 times during the year.

Problematic customers with 6-12 returns within a month during the year				
ALIGN JV	DEMON DRILLERS LIMITED	J COFFEY PLANT LIMITED	NORTHERN GROUNDCARE LIMITED	STEPHENSON LIMITED
ALLOY FABWELD LIMITED	Diamantboring & Diamantskæring ApS	Jysk Diamantskæring A/S	OFF SITE SOLUTIONS (RT) LIMITED	STRABAG AG - UK BRANCH
ARDMORE STRUCTURES LIMITED	ETEX REMAGIN	K P H DECONSTRUCTION LTD	ONE STOP HIRE LIMITED	SUNBELT RENTALS LIMITED
ASPEN MASKINUTHYRNING AB	EXPLORE 2050 MANUFACTURING LIMITED	KILNBRIDGE CONSTRUCTION	OULUN BETONIPORAUS OY	SWIFT GROUP LTD
B&T PLANT HIRE LIMITED	FLC Tunnel Group North I/S	KIRUNA WAGON AB	P. Olesen og Sønner A/S	TARDEC LÄNSI OY
Balfour Beatty VINCI JV for HS2	FLOORSPAN CONTRACTS LTD	KNIGHT BUILD LIMITED	POHJOLAN PURKUTYÖ OY	THE HIREMAN (LONDON) LTD
BARRETTS OF ASPLEY LTD	GAP GROUP LIMITED	LAWMANS (UK) LIMITED	POWDERHALL BRONZE LIMITED	TIFFEN GAS LIMITED
BEAVER TOOL HIRE (CHICHESTER)	GARMET LIMITED	LDD CONSTRUCTION LTD	PURKUPIHA ASBESTITYÖT PORI OY	TIGER TRAILERS LTD
BLADEROOM GROUP LIMITED	GEMINI HIRE AND SALES LIMITED	LH Hockerup A/S	RAKENNUS JA LAATOITUS A. MERE OY	TIMANTTIPORAUS TEHO OY
BOXPAL LTD	GLOBAL MASKINCENTER	LIEBHERR SUNDERLAND WORKS LTD	REDHOUSE FENCING LTD	Titan Nedbrydning A/S
BRADGATE CONTAINERS LTD	GM WALLTRACKING (BANBRIDGE)	LUJABETONI OY	RENTA OY OULU	TOROS DE OBRA AB
BYLOR JV REPAIRS	HAC Plant Hire Ltd	LUMON SUOMI OY	ROBINSONS SCOTLAND LTD	TRACK ATTACK - ANTHONY
CAREY LONDON LIMITED	HEGARTY DEMOLITION LTD	M D FENCING CONTRACTORS LTD	Skanska Rental AB	TRAVIS PERKINS (REPAIR ACCOUNT)
CHEP UK LIMITED	Hilti Complete Systems UAB	MAARAKENNUS & PURKUTYÖ VEHANEN OY	SMITH & SONS FENCING LTD	TURUN TIMANTTITYÖ OY
Cimbria A/S	Hilti Eesti Oü	MAXENERGY LIMITED	SMITHS EQUIPMENT HIRE LTD	TYLLIS OY AB
CRAMO AB	Hilti Services Limited SIA	ML DEMO AB	SNA-RAKENNUS OY	UTS ENGINEERING LIMITED
CRANFORD CONCRETE	HILTI SERVICES LIMITED SIA	MORGAN MARINE LTD	SO-PURKU OY	V&P VENTECH LTD
CUCHULAIN CONSTRUCTION LIMITED	HLL Hyreslandslaget Sverige AB	MPG ENTREPRENAD AB	SPECIALIST CUTTING SERVICES LIMIT	VLADVIT OY
Dan-Pal A/S	HOCHTIEF-MURPHY JOINT VENTURE LPT2	MUNIAK SVERIGE AB	SPEEDY ASSET SERVICES LIMITED	VS-RAKENNUSTYÖT OY
Daniel & Sebastian Byggentreprenad	HSS HIRE SERVICE GROUP LIMITED T/A	NCC DANMARK A/S	SRS SANERING RIVNING SERVICE AB	WATSONS OF PRUDHOE LTD
DAVID M THOMSON HAULAGE LTD	J C BAMFORD EXCAVATORS LTD	NIKSOL TMI	STATOM PLANT LIMITED	WILLIE WILKIN

# 2.3 Problematic customers: customers with outliers

While 105 customers have requested a repair 6-12 times since the previous time, there are up to 25 customers who have monthly outliers. For example, BOXPAL LTD has required repairs 7 times, and 5 of these are outliers.

Customer	Average %RR	Number of outlie	Number of months when repairs were required
NORTHERN GROUNDCARE LIMITED	37,18	1	12
GM WALLTRACKING (BANBRIDGE)	47,12	4	11
POWDERHALL BRONZE LIMITED	37,47	2	11
REDHOUSE FENCING LTD	46,92	3	10
TIFFEN GAS LIMITED	41,31	2	10
FLOORSPAN CONTRACTS LTD	58,15	3	9
Dan-Pal A/S	54,07	2	9
GARMET LIMITED	50,35	2	9
CUCHULAIN CONSTRUCTION LIMITED	49,44	2	9
SMITH & SONS FENCING LTD	52,98	2	8
V&P VENTECH LTD	44,17	1	8
UTS ENGINEERING LIMITED	41,42	2	8
BOXPAL LTD	70,55	5	7
DAVID M THOMSON HAULAGE LTD	54,76	2	7
CRANFORD CONCRETE	50,87	2	7
BRADGATE CONTAINERS LTD	37,26	1	7
POHJOLAN PURKUTYÖ OY	35,03	1	7
Daniel & Sebastian Byggentreprenad	34,55	1	7
MPG ENTREPRENAD AB	33,81	1	7
WILLIE WILKIN	75,00	4	6
VS-RAKENNUSTYÖT OY	58,33	2	6
NIKSOL TMI	55,00	1	6
TRACK ATTACK - ANTHONY	53,89	2	6
TYLLIS OY AB	51,39	2	6
BARRETTS OF ASPLEY LTD	42,13	2	6

2.3 Problematic customers: Greatest amount of outliers

Our suggestion is to focus on these four customers with the largest amount outliers. The standard deviation of each of them is relatively small, indicating that these customers have constant problems with their tools.

There is one customer, BOXPAL LTD, who has even five monthly outliers during the year. The standard deviation as well as the CV are quite small, which means its RRF1 values are often below the target. GM WALL TRACKING, in turn, has a large CV value indicating high variability - the outliers are not that common.


Customers with greatest amount of outliers
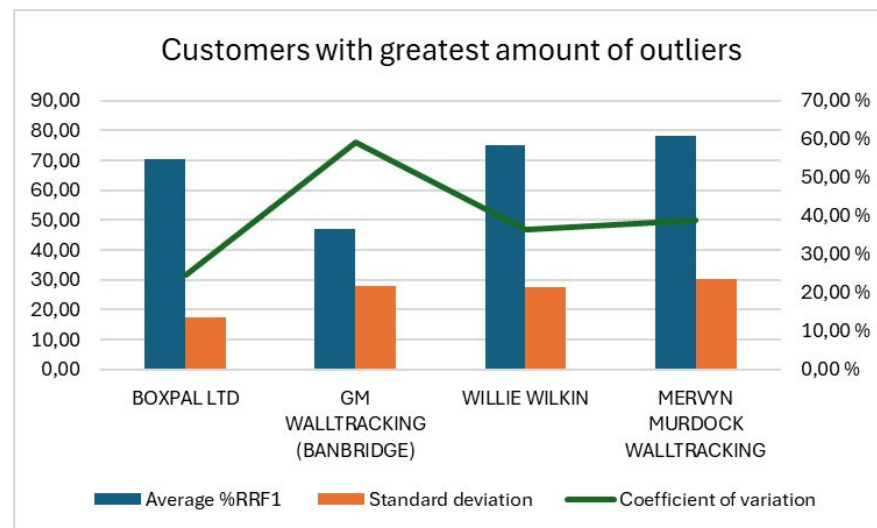
Customer	Month 1	2	3	4	5	6	7	8	9	10	11	12	Average %RRF1	Amount of outliers
BOXPAL LTD	83,33	68,75	64,71	66,67	43,75	66,67	100,00						70,55	5
GM WALLTRACKING (BANBRIDGE)	62,50		71,43	18,18	12,50	50,00	66,67	62,50	22,22	25,00	100,00	27,27	47,12	4
WILLIE WILKIN		100,00				100,00	50,00	50,00	50,00			100,00	75,00	4
MERVYN MURDOCK WALLTRACKING				100,00				100,00	50,00		40,00	100,00	78,00	4

2.3 Problematic customers: Customers with a 100% RRF1 value for at least three months

Companies like ADM PLUMBING CONTRACTORS LTD, EASTERN DOORS LTD T/AS EASTERN, NEIL JOHNSTONE JOINER as well as STEPHEN ROBINSON FENCING T/AS have only 100 %RRF1 values, which indicates significant problems with these customers.
WILLIE WILKIN, on the other hand, has "only" half of the %RRF1 values similar to 100.

Customers with a 100% RRF1 value for at least three months

Customers with a 100% RRF1 value for at least three months
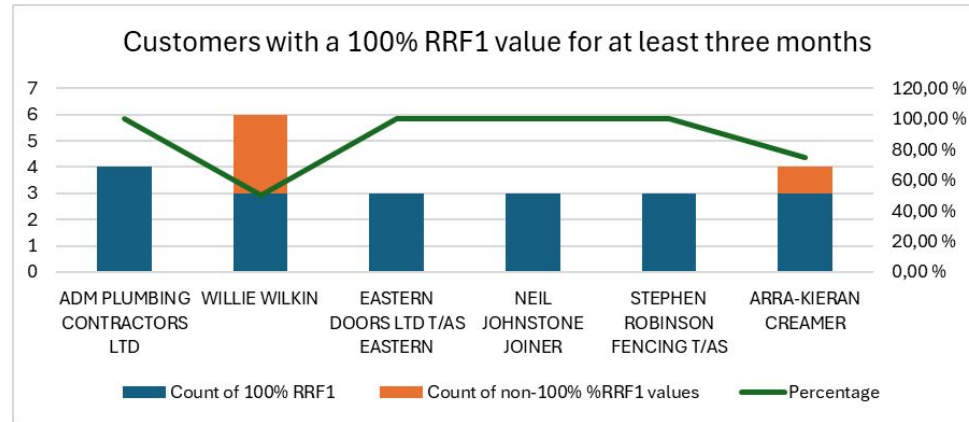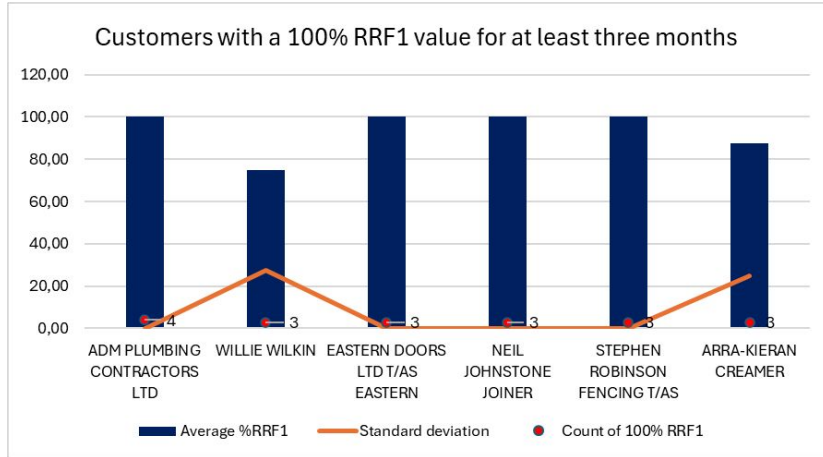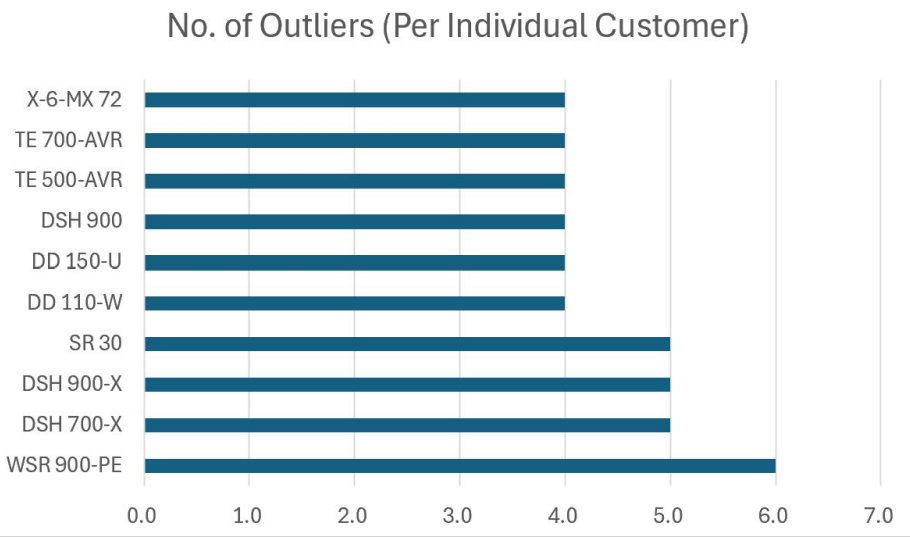
3. Problematic Tools

1. Problematic tools
    - Tools that have required repair at least 4-6 times per individual customer
    - Tools with the most outliers (individual)
    - Tools with the most outliers (overall aggregate)
    - Tools with the most 100% RRF1 values (overall aggregate & individual)

3.1 Problematic Tools: Required Repair 4-6 Times Per Individual Customer

While there are a lot of tools that needed repair consecutively (2-3 months), it is more important to identify the overall number of repairs within the year.

The total number of repairs over the entire year gives a broader perspective on the maintenance workload and the overall health of the equipment.

No. of Outliers (Per Individual Customer)

Tool Type	(n) Cal. Month Nr. (Ref. Cal. Month)	1	2	3	4	5	6	7	8	9	10	11	12
WSR 900-PE	%	83.33	68.75	64.71	66.67	43.75	66.67	100.00					
DSH 700-X	%			100.00			66.67	100.00	100.00		50.00		100.00
DSH 900-X	%	100.00	50.00	100.00			100.00				100.00		100.00
DD 110-W	%						100.00				100.00	100.00	100.00
X-6-MX 72	%				50.00		100.00		100.00		100.00	100.00	
DSH 900	%	100.00			100.00	66.67	100.00						

3.2 Problematic Tools: Tools with Most Outliers (Individual)

WSR 900-PE:

- It has the highest number of outliers.
- The repair percentages for this tool type vary across months, ranging from 43.75% to 100%.
- It shows a spike in repair percentage in Month 7, where all the tools of this type required repair.
- Overall, this tool type exhibits fluctuations in repair needs, indicating potential variability in performance.

Tool Type	(n) Cal. Month Nr. (Ref. Cal. Month)	1	2	3	4	5	6	7	8	9	10	11	12
WSR 900-PE	%	83.33	68.75	64.71	66.67	43.75	66.67	100.00					
DSH 700-X	%			100.00			66.67	100.00	100.00		50.00		100.00
DSH 900-X	%	100.00	50.00	100.00			100.00				100.00		100.00
DD 110-W	%						100.00				100.00	100.00	100.00
X-6-MX 72	%				50.00		100.00		100.00		100.00	100.00	
DSH 900	%	100.00			100.00	66.67	100.00						

There are tools with consistently high repair percentages, suggesting potential reliability issues.

These insights can be used for targeted maintenance planning, reliability assessments, and overall equipment management strategies.

3.3 Problematic Tools: Greatest Amount of Outliers (Overall)

Our suggestion is to focus on the following **33 tools** with the largest amount of outlier RRFs out of the **274 unique tool types**.

There is one tool, **AG 123-19SE**, which has **137 outliers** during the year followed by **SID 4-A22** with **102 outliers**.
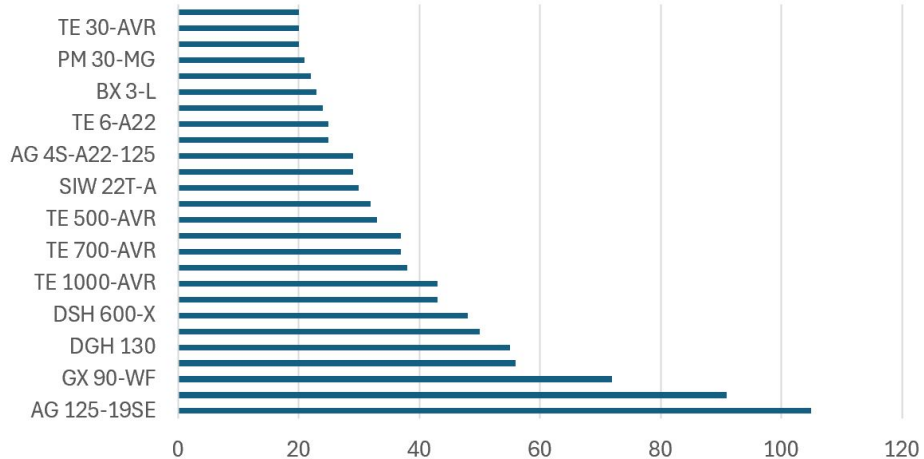

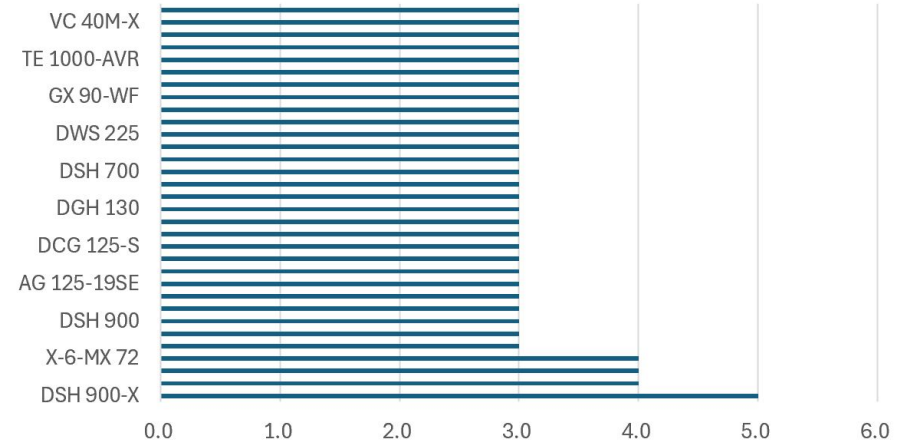No. of Outliers Per Tool (for tools with more than 20 outliers)
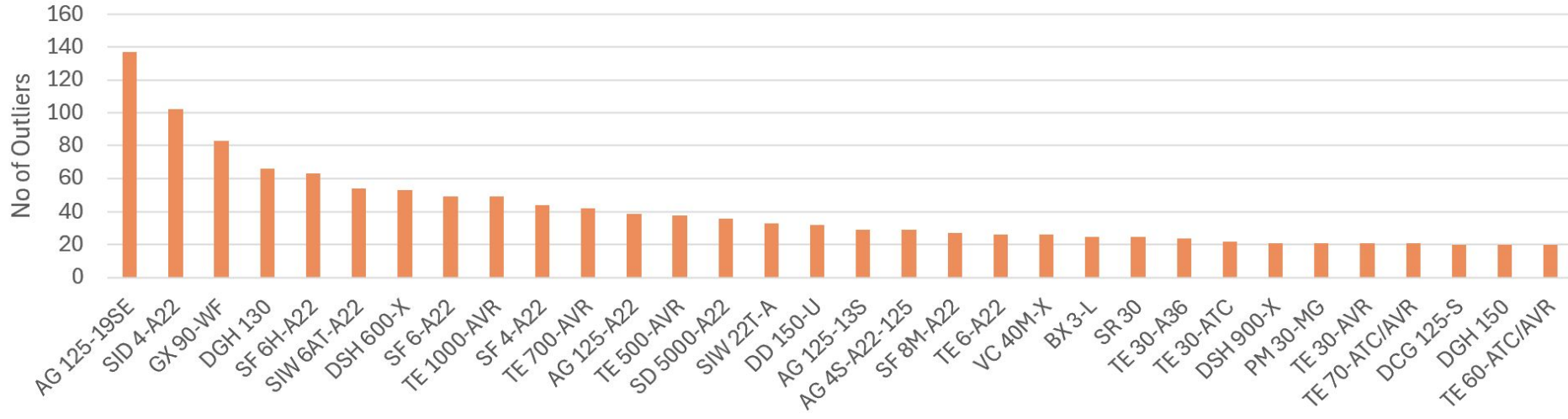
3.4 Problematic Tools: Most 100% RRF (Overall & Indv.)

No. of RRFs = 100 (Overall Aggregate Per Tool)

Sorted: Most - More than 20

No. of RRFs = 100 (Per Individual Customer)

Sorted: Most - More than 3

Limitations

- **Assumption of Normality:** The method assumes that the data follows a normal distribution. In reality, data may not always exhibit perfect normality, especially if the sample size is small or if there are underlying factors influencing the distribution.

- **Assumptions of overall Hilti RRF1%:** the overall results row is the overall RRF1 % CY for the whole Hilti and can be used as the average to benchmark all our calculations.

- **Sensitive to Extreme Values**: Outliers can significantly impact the mean and standard deviation, especially in smaller datasets. This sensitivity can result in misinterpretation of the normal distribution and the confidence interval.

- **May Miss Non-Normal Outliers:** If the data does not follow a normal distribution, using a normality assumption and confidence intervals may lead to missing outliers that fall outside the defined range.

References

[Homepage - Hilti Suomi](#)

[Hilti - Maintenance and calibrations](#)