

Formative Evaluation of Data Management Tools on Data Quality and Usability

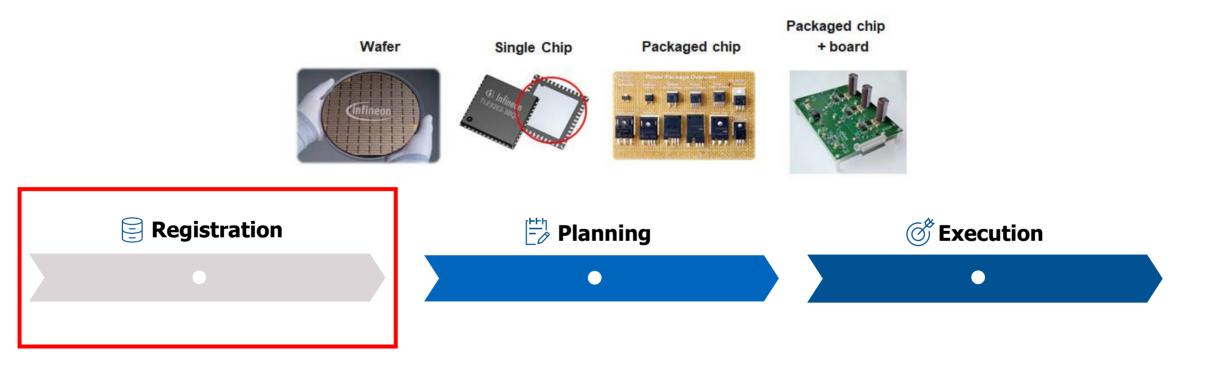
Supervisors: Dr.-Ing. Stefan Röhrl, M.Sc. Bastian Busch (Infineon Technologies AG)



Bachelor's Thesis

25 October, 2024

Better tool to manage test samples

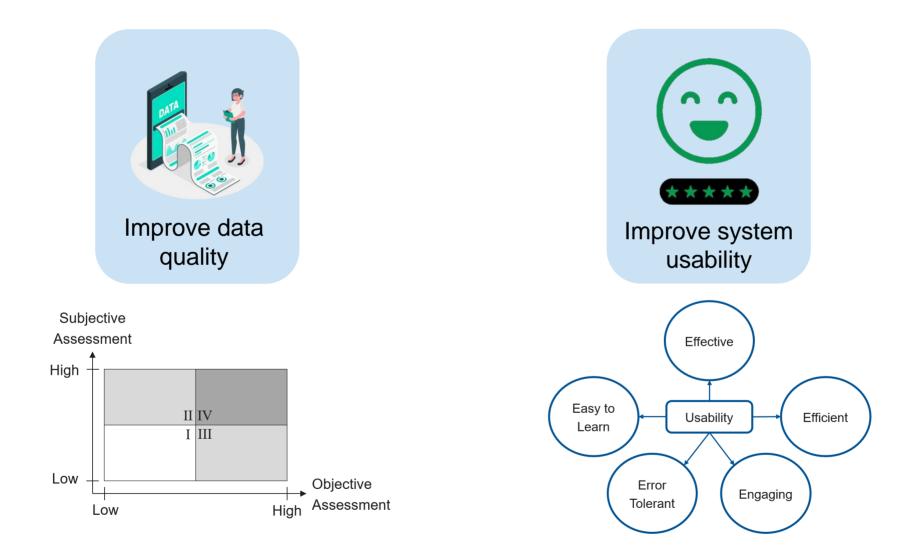


Background – Problem Statement

Shelf	Location Detail	Lot Number	Wafer Number	Technology	Responsible	Scrap Date
4	5	TU889614.03	1,2,3	HSTF1200	Max Turan	Dezember 24
4	5	TU223344	#3-#20	CIT110305	Franz Giebel	Dezember 25
4	4	TU911312	1,4,7,10,13,16,19	CIT120310	Kloppenburg	Dezember 30
4	4	QU778812.04	1,2,3	C9LMG	Kloppenburg	Dezember 30
4	4	QU778812.01	22,23,24,25	C9LMG_GG	Kloppenburg	Dezember 30
		PL887026	4	CARD 7	I.Kranz	Dezember 25
		P99667 UWU	1,2,3	INNOVAT TUM	Fromme	Dezember 25
4	3	GP0210201	13, 15, 17,18	Ρ90ΤΡΑ	Rebstock	Oktober 40
		GP2269622	9, 10	Р90ТРА	Rebstock	Oktober 40
4	3	HF151005.00	7	MOSFET - 10V	L.Balz	Dezember 25
4	3	HF888000.02	2	MOSFET - 10V	L.Balz	Dezember 25
4	3	PO118005.09	3	MOSFET - 10V	L.Balz	Dezember 25
		6ABB87HQZ2	4,5,6	CPTZ	H.Schaffer	
4	3	HF212007	18	CPTZ		Jan-25
1	5	QU106700	1,3,5,6,23,24	PMOS99R (GaN)	L.Deckert	Dec-25

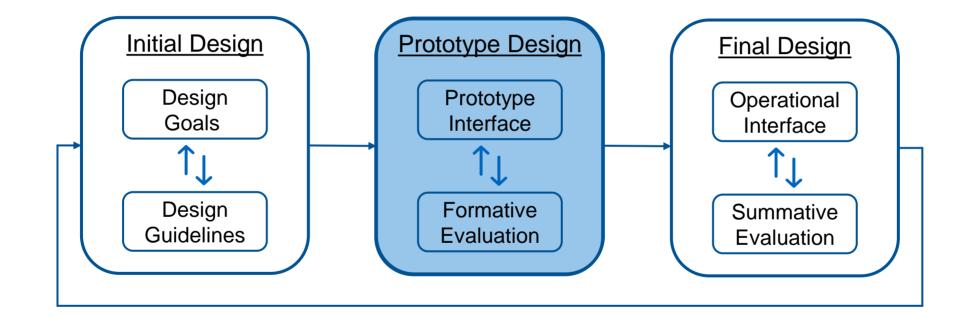
Background – Problem Statement

Shelf	Location Detail	Lot Number	Wafer Number	Technology	Responsible	Scrap Date
4	5	TU889614.03	1,2,3	HSTE1200	Max Turan	Dezember 24
4	5	TU223344	#3-#20 🖛	Inconsistent	Franz Giebel	Dezember 25
4	4	TU911312	1,4,7,10,13,16,19	data	Kloppenburg	Dezember 30
4	4	QU778812.04	1,2,3	C9LMG	Kloppenburg	Dezember 30
4	4	QU778812.01	22,23,24,25	C9LMG_GG	Kloppenburg	Dezember 30
		PL887026		CARD 7	I.Kranz	Dezember 25
		129966		INNOVAT TUM	Fromme	Dezember 25
4	3	GP0210201	ata, 13, 17, 18	Р90ТРА	Rebstock	Oktober 40
		GP2269622	9, 10	Р90ТРА	Rebstock	Oktober 40
4	3	HF151005.00	7	MOSFET - 10V	L.Balz	Dezember 25
4	3	HF888000.02	2	MOSFET - 10V	L.Balz	Dezember 25
4	3	PO118005.09	3	MOSFET - 10V		Dezember 25
		6ABB87HQZ2	4,5,6	CPTZ	Incomplete	
4	3	HF212007	18	CPTZ	data	Jan-25
1	5	QU106700	1,3,5,6,23,24	PMOS99R (GaN)	L.Deckert	Dec-25



Motivation-Background-Goal-Method-Implementation-Evaluation-Conclusion





Method – Evaluating Data Quality & Usability



Data Quality

- Accuracy
- Completeness
- Consistency

Usability

	Strongly			
I found the information provided by the	disagree			
tool to be accurate.				
	1	2	3	
	Strongly			
I found the available data fields to be	disagree			
complete.				
	1	2	3	
	Strongly			
I found the data in the tool to be	disagree			
consistent.				
	1	2	3	

Subjective Assessment

Strongly agree 5

Strongly agree

5 Strongly agree

5

	Strongly				Strongly
	disagree				agree
I was satisfied with this tool overall.					
	1	2	3	4	5
		2	3	4	-
	Strongly				Strongly
I found this tool unnecessarily complex.	disagree				agree
Fround this toot anneodobarry comptox.					
	1	2	3	4	5
	Strongly				Strongly
	disagree				agree
I found it easy to fill in the data.					
	1	2	3	4	5
		2	5	4	~
I think that I would need the support of a	Strongly				Strongly
technical person to be able to use this	disagree				agree
tool.					
1001.	1	2	3	4	5
	Strongly				Strongly
I had a clear understanding of where	disagree				agree
each data needs to be entered.					
	1	2	3	4	5
	Strongly	2	3	4	Strongly
I found it as such a surplementary data a surplement					
I found it easy to understand the correct	disagree			1	agree
format for entering the data.					
	1	2	3	4	5
	Strongly				Strongly
I received support from the tool for	disagree				agree
entering the data.					
	1	2	3	4	5
		4	0	4	0

Objective Assessment

$$CA_{i} = \frac{\sum_{j=1}^{a} acc\left(r_{j}, D\left(r_{j}\right)\right)}{|a|}$$

$$CC_i = 1 - \frac{Y}{X}$$

$$CCS_i = 1 - \frac{Y}{X}$$

$$\sum_{i=1}^{n} CW_i \times CA_i \quad ; \quad \sum_{i=1}^{n} CW_i \times CC_i \quad ; \quad \sum_{i=1}^{n} CW_i \times CCS_i$$

Record time taken, mouse clicks and keystrokes

		»	=	Sample Type T	Lot Number T	Wafer Number T	Technology T	Status T			• New sample
	243 samples		1	Wafer	TU180333	3	CIT001	In Storage		Select a sample	
Status:	Select	~	2	Wafer	TU180333	4	CIT001	In Storage	Details		- î
Status.	Jelect	•	3	Wafer	TU180333	5	CIT001	In Storage	Sample Type: *		~
Туре:	Select	~	4	Wafer	TU180333	6	CIT001	In Storage			
Responsible:	-	~	5	Wafer	TU180333	7	CIT001	In Storage	Lot Number: *		
Responsible.		·	6	Wafer	TU180333	8	CIT001	In Storage		No project	~
Creator:	-	\sim	7	Wafer	TU180333	9	CIT001	In Storage			
Technology:	-	~	8	Wafer	TU285748	1	CIT002	In Storage	Status: *		
i cennology.			9	Wafer	TU285748	2	CIT002	In Storage	Responsible: *		
Lot Num:			10	Wafer	TU285748	3	CIT002	In Storage		Select a sample to edit	~
Basic Type:	Select	~	11	Wafer	TU285748	4	CIT002	In Storage	Use Case: *	Monitoring	~
			12	Wafer	TU285748	5	CIT002	In Storage			
Wafer Num:			13	Wafer	TU285748	6	CIT002	In Storage	Scrap Date Actual:		
SpaRQ Project:	Select	~	14	Wafer	TU285748	7	CIT002	In Storage	Location		
			15	Wafer	TU285748	8	CIT002	In Storage			
Scrap Timeframe:			16	Wafer	TU285748	9	CIT002	In Storage			
			17	Wafer	TU285748	10	CIT002	In Storage			
▼ Reset Filter			1 to 100	of 243 records			<	1 2 3 >	Save Changes 🗎		

Implementation – Prototype Development

NEXTREL							1	🕒 Hian Zing Voon 🕒
		« Create new	sample					 New sample
	243 samples	Sample Type: *	Select	~			Select a sample	
Status:	Select	Sample Status: *	Select	~				î
Туре:	Select	Lot Number: *	Enter your lot number		Validate Lot			
Responsible:		Wafer Number: *						
Creator:		Technology:	Select	~			No project	
Technology:		Project:	No project	~				
Lot Num:		Responsible: *	Select	~			Hian Zing Voon Select a sample to edit	
Wafer Num:		Creator: *	Select	~			Qualification	
Project:	Select	Use case: *	Select	~				
Scrap Timeframe:		Shelf:	Select	~				
		Location Detail:	Select	~			1	
Y Reset Filter		🖺 Save sample				Cancel		

Motivation – Background – Goal – Method – Implementation – Evaluation – Conclusion Hian Zing Voon: Formative Evaluation of Data Management Tools on Data Quality and Usability

Slide 9

Implementation – Generated Data

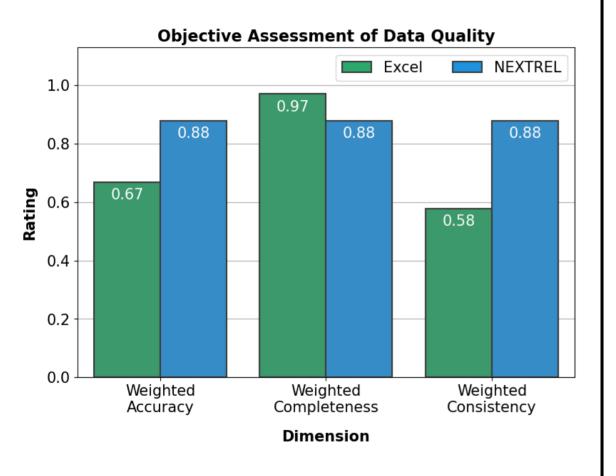
ЪШ

<i>CW</i> ₁ = 0.05	$\begin{array}{c} CW_2 \\ = 0.05 \end{array}$	$CW_3 = 0.25$	$ CW_4 \\ = 0.20 $	$\frac{CW_5}{= 0.15}$	$ CW_6 = 0.20 $	$\frac{CW_7}{= 0.10}$
Shelf	Location Detail	Lot Number	Wafer Number	Technology	Responsible	Scrap Date
4	5	TU180333	3	CIT001	Linus Thorun	2029-12-01 00:00:00
4	5	TU180334	4	CIT001	Linus Thorun	2029-12-01 00:00:00
4	5	TU180335	5	CIT001	Linus Thorun	2029-12-01 00:00:00
4	5	TU180336	6	CIT001	Linus Thorun	2029-12-01 00:00:00
4	5	TU180337	7	CIT001	Linus Thorun	2029-12-01 00:00:00
4	5	TU180338	8	CIT001	Linus Thorun	2029-12-01 00:00:00
4	5	TU180339	9	CIT001	Linus Thorun	2029-12-01 00:00:00
-	-	-	1	KEY_8	-	2027-12-01 00:00:00
w2	3	QU664520	23	PPTX2	Max Turan	2027-12-01 00:00:00
w2	3	QU664522	9	РРТХЗ	Max Turan	2027-12-01 00:00:00
w2	3	QU664530	22	PPTX4	Max Turan	2027-12-01 00:00:00
w2	3	QU664550	15	PPTX5	Max Turan	2027-12-01 00:00:00
w2	3	QU664555	9	PPTX6	Max Turan	2027-12-01 00:00:00
3	2	HF888000.02	2	-	Leon Balz	2026-05-01 00:00:00
w2	2	GP226922.03	15	P90TPA	Hans Rebstock	-

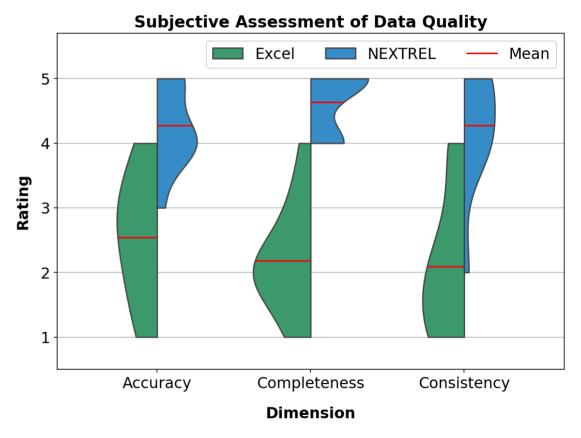
Evaluation – Data Quality

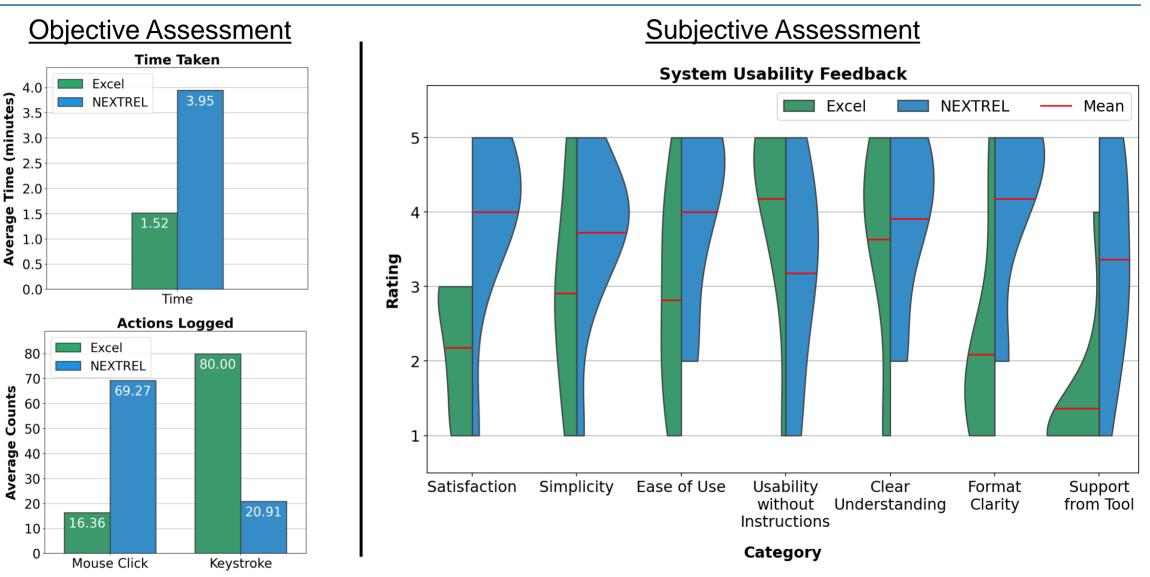


Objective Assessment



Subjective Assessment





Motivation – Background – Goal – Method – Implementation – Evaluation – Conclusion Hian Zing Voon: Formative Evaluation of Data Management Tools on Data Quality and Usability

Slide 12



- Improved data quality and usability
- NEXTREL requires longer time and training for new users
- Standardized templates improve data quality

Thank you for your attention

Accuracy

- Syntactic accuracy
- Semantic accuracy

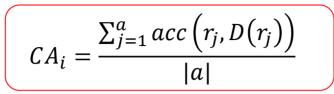
Name	Address	Postal Code	City	Delivery Date	
Alice	Arcisstraße 21	80333	Müncen	01.09.2024	
Bob	Boltzmannstraße 15	10623	Garching bei München	15.09.2024	
Charlie	Am Campeon 1-15	85579	Neubiberg	30.09.2024	

 $Acc(t) = \frac{\sum_{i=1}^{t} acc(r_i, D(r_i))}{|t|},$ String errors $acc(r_i, D(r_i)) = \begin{cases} 1, & \text{if } r_i \in D(r_i), \\ 1 - NED(r_i, D(r_i)) & \text{otherwise.} \end{cases}$

Numerical errors
$$acc(r_i, D(r_i)) = \begin{cases} 1, & \text{if } r_i \in D(r_i), \\ 1 - \frac{|r_i - D(r_i)|}{Max(r_i, D(r_i))} & \text{otherwise.} \end{cases}$$

Backup – Data Quality (Accuracy)

Technology	
HSTF1200	Ν
CIT110305	F
CIT120310	κ
C9LMG	Κ
C9LMG_GG	к
CARD 7	1.
INNOVAT TUM	F
P90TPA	F
P90TPA	F
MOSFET - 10V	L
MOSFET - 10V	L
MOSFET - 10V	L
CPTZ	ŀ
CPTZ	
PMOS99R (GaN)	L



INNOVATIV_TUM

NED = Normalized Edit Distance (0,1)

Levenshtein Distance between "INNOVAT TUM" and "INNOVATIV_TUM" = 3

$$NED = \frac{3}{13}$$
$$acc = 1 - \frac{3}{13} = 0.77$$

Technology	,							
HSTF1200	1	Ν						1 4 7
CIT110305	1	F	С	A_{toc}	hnol	nav	=	14.7
CIT120310	1	К		150	πποι	Ugy		15
C9LMG	1	К	C	4			_	0 98
C9LMG_GG	1	К	U1	¹ teci	hnol	оду	_	0.98
CARD 7	1	I.						
INNOVAT TUN	1	0.77	7					
P90TPA	1	R						
P90TPA	1	F						
MOSFET - 10V	1	L						
MOSFET - 10V	1	L						
MOSFET - 10V	1	L						
CPTZ	1	F						
CPTZ	1							
PMOS99R (Gal	N)	1						

Completeness

- Schema completeness
- Column completeness
- Population completeness

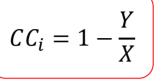
Person ID	Name	Gender	Birth Date	Email
1	Danny	Male	01.01.1990	danny90@gmail.com
2	Emily	Female	10.02.1993	NULL
3	Frank	Male	15.03.1995	NULL
4	Gabrielle	Female	20.05.1992	NULL

$$Completeness \ rating = 1 - \left(\frac{Number \ of \ incomplete \ items}{Total \ number \ of \ items}\right).$$

$$CC_i = 1 - \frac{Y}{X}$$

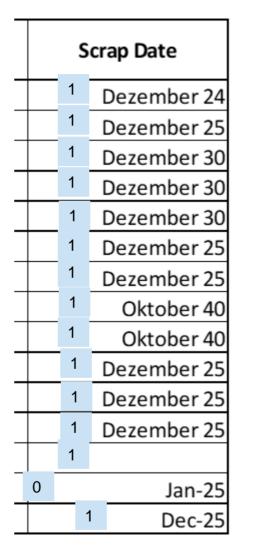
Backup – Data Quality (Completeness)

Scrap Date Dezember 24 Dezember 25 Dezember 30 Dezember 30 Dezember 30 Dezember 25 Dezember 25 Oktober 40 Oktober 40 Dezember 25 Dezember 25 Dezember 25 Jan-25 Dec-25



Oct-24

Cell completeness for this particular cell = 0



$$CC_{Scrap Date} = 1 - \frac{1}{15}$$
$$CC_{Scrap Date} = \frac{14}{15}$$

Backup – Data Quality (Consistency)

Consistency

- Integrity constraint
 - intrarelation constraint
 - interrelation constraint
- Between 2 related data elements

Format

Employee ID	Name	Age	Start Year	Position
100	Harry	22	2024	Reliabilty Engineer
101	lvy	25	2023	Sales Representative
102	Jack	15	2022	IT Specialist

Table 2.3.: Example of an Employee relation

Promotion ID	Employee ID	Promotion Year	New Position
321	100	2022	Senior Reliability Engineer
322	101	2026	Sales Manager
323	102	in 5 years	Senior IT Specialist

Table 2.4.: Example of a Promotion relation for employees in Table 2.3

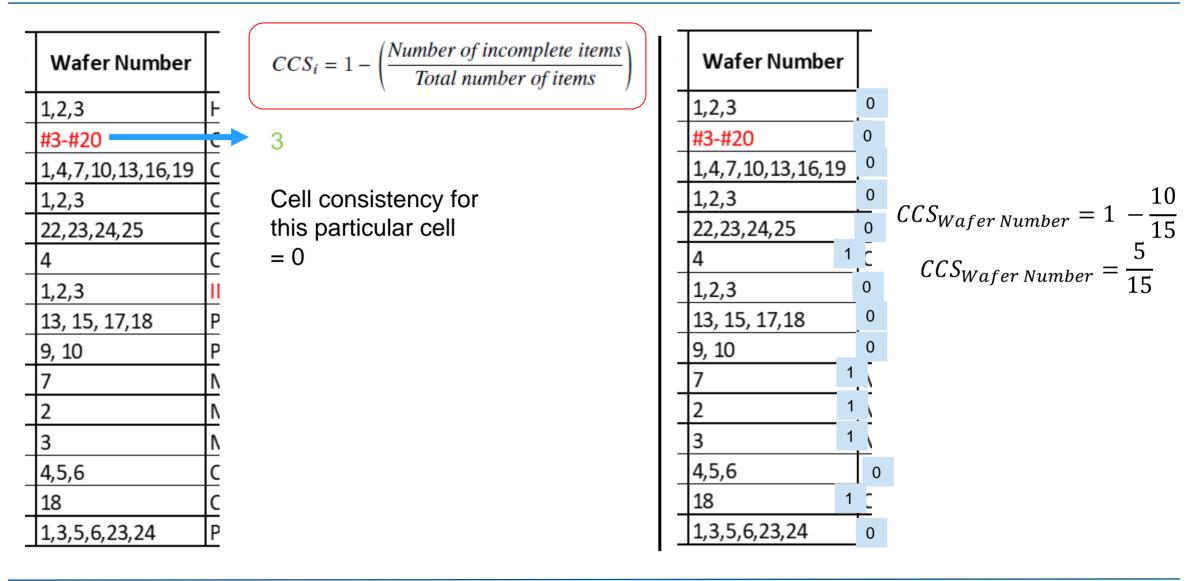
Consistency rating = 1 -

Number of inconsistent units

Total number of consistency checks performed

 $CCS_i = 1 - \left(\frac{Number \ of \ incomplete \ items}{Total \ number \ of \ items}\right)$

Backup – Data Quality (Consistency)



Backup – Implementation

NEXTREL		1	_	-	-	-	-	-	-	_	_		💄 Hian Zing Voon 🕞
Create new sample								New sample					
	243 samples	Ň	Sample Type: *	Wafer			×	•				Select a sample	
Status:	Select	~	Sample Status: *	In St									i
Туре:	Select	~	Lot Number: *	TUE	Edit Waf	er Select	ions	Selectabl	o Dongo			Wafer	
Responsible:		~	Wafer Number: *		Jelec			Selectabl					
	-		Technology:	Sele	1	2	3	4	5			I No project	
Creator:	-	~	Project:	No	6	7	8	9	10				
Technology:	-	~	Responsible: *	Sele	11	12	13	14	15			In Storage Hian Zing Voon	
Lot Num:			Creator: *	Sele	21	22	18 23	24	20			Select a sample to edit Qualification	
Wafer Num:			Use case: *	Sele			20	21				Select a date	
Project:	Select	~	Shelf:	Sele	Ok				Cancel			Select a date	
Scrap Timeframe:			Location Detail:									1	
▼ Reset Filter				Select.			~						
			🖺 Save sample								Cancel		

Motivation – Background – Goal – Method – Implementation – Evaluation – Conclusion - Backup Hian Zing Voon: Formative Evaluation of Data Management Tools on Data Quality and Usability

Slide 21

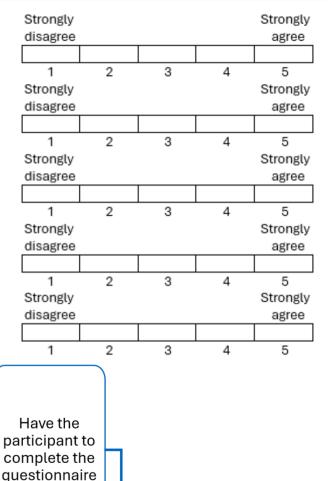
Backup – Implementation

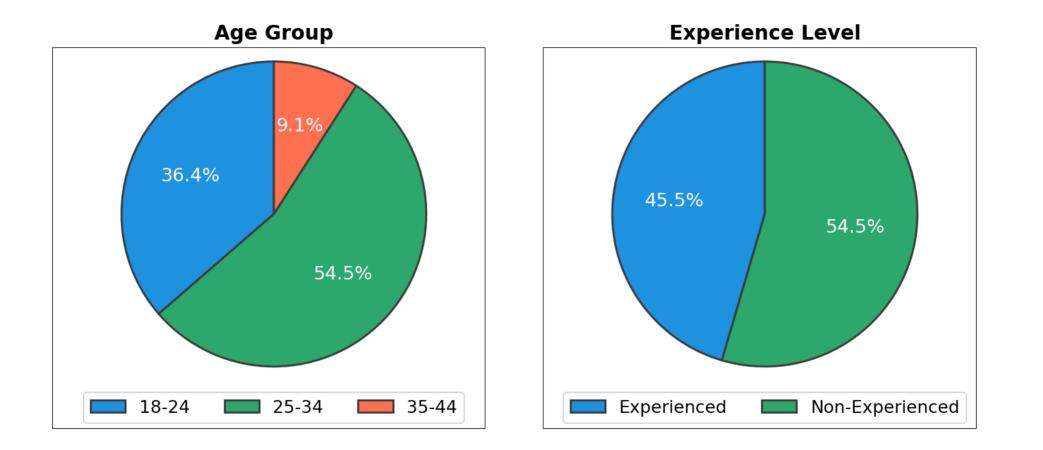
NEXTREL							💵 Hian Zing Voon 🕒
		« Create ne	w sample				New sample
	243 samples	Sample Type: *	Wafer	ж ~		Select a sample	
Status:	Select	Sample Status: *	In Storage	ж ~			i
Туре:	Select	Lot Number: *	TU385354		Validate Lot	Wafer	
Responsible:	-	Wafer Number: *	1-25				
Creator:	-	Technology:	Select	~		No project	
Technology:	-	Project:	No project	~		- In Storage	
Lot Num:		Responsible: *	Hian Zing Voon	ж 🗸		Hian Zing Voon	
Wafer Num:		Creator: *	Hian Zing Voon	* ~		Select a sample to edit Qualification	
Project:	Select	Use case: *	Monitoring	× ~		Select a date Select a date	
Scrap Timeframe:		Shelf:	Select	~			
		Location Detail:	Select	~			
▼ Reset Filter					Const		
		🖺 Save sample			Cancel		

Backup – Questionnaire and Study Workflow

- 1. I was satisfied with this tool overall.
- 2. I found this tool unnecessarily complex.
- 3. I found it easy to fill in the data.
- I think that I would need the support of a technical person to be able to use this tool.
- I had a clear understanding of where each data needs to be entered.

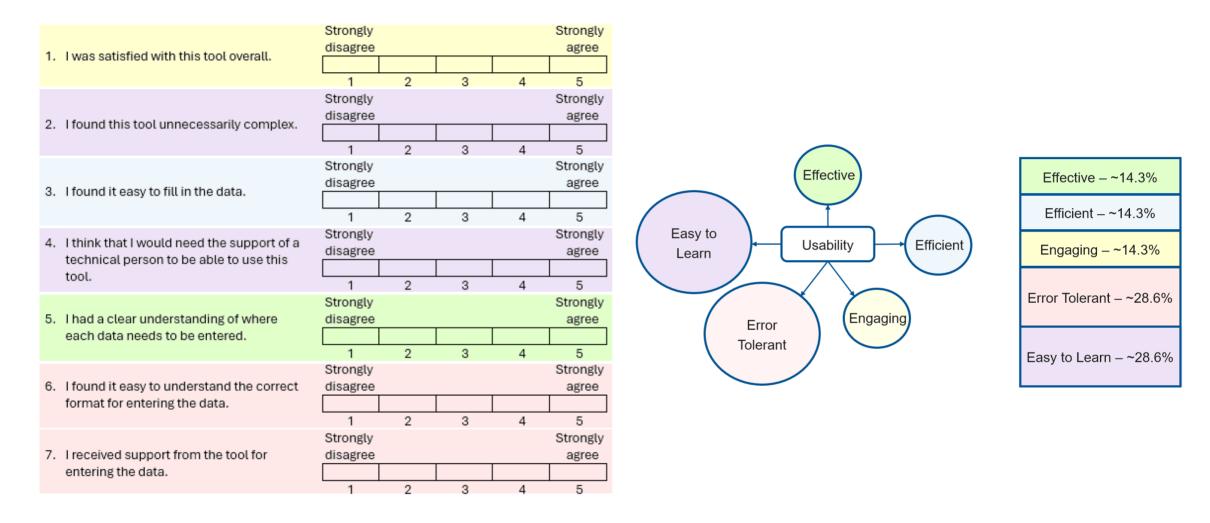
Strongly Strongly disagree agree 6. I found it easy to understand the correct format for entering the data. 1 2 3 Δ 5 Strongly Strongly disagree agree 7. I received support from the tool for entering the data. 1 2 3 4 5 Strongly Strongly disagree agree 8. I found the information provided by the tool to be accurate. 2 3 5 1 4 Strongly Strongly disagree agree 9. I found the available data fields to be complete. 1 2 3 4 5 Strongly Strongly disagree agree 10. I found the data in the tool to be consistent. 2 3 5 1 4 Enauire Ask the participant's participant to Show the raw fill in data Provide a background Demonstrate data that brief and using Tool A how Tool A is needs to be introduction familiaritv (record time. used in daily entered (via with the "Test log clicks to the topic life pictures) Sample" and workflow keystrokes) Repeat using Tool B





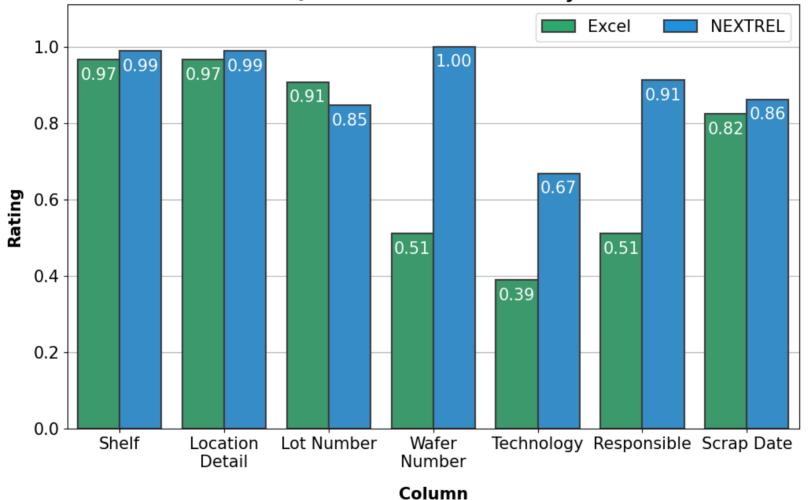
Backup – Subjective Assessment of Usability





Backup – Objective Assessment of Data Quality



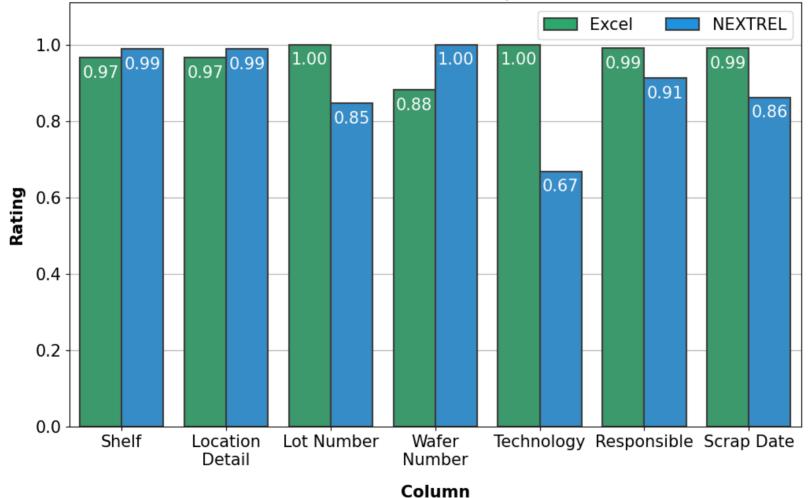


Quantitative Data Accuracy

Slide 26

Backup – Objective Assessment of Data Quality





Quantitative Data Completeness

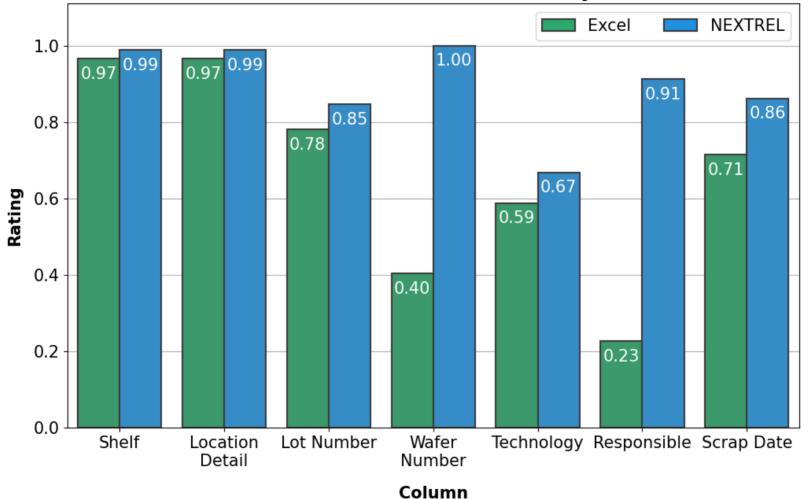
Slide 27

Motivation – Background – Goal – Method – Implementation – Evaluation – Conclusion - Backup Hian Zing Voon: Formative Evaluation of Data Management Tools on Data Quality and Usability

25 October, 2024

Backup – Objective Assessment of Data Quality





Quantitative Data Consistency

Slide 28

Selection of data from *Excel* shown to participants

v3 2 TU223344 7,8,3 CIT110305 Turan Sep-29 v3 2 TU911312 CIT120310 Turan Mar 27 v3 2 TU911313 CIT120310 Turan Mar 27 v3 2 TU911315 CIT120310 Turan Mar 27 v3 2 TU911315 CIT120310 Turan Mar 27 v3 2 TU911315 CIT120310 Turan Mar 27 v3 2 U778812.04 C9LMG Turan Mar 27 v3 2 QU778812.05 C9LMG Turan Mar 27 v3 2 QU778812.07 C9LMG Turan Mar 27 v3 2 QU778812.08 P90TPA Turan Mar 27 v3 2 GP369622 CPTZ Turan Mar 27 v3 2 GP246962 CPTZ Turan Mar 27 v3 2 QU123444.01 <td< th=""><th>Shelf 🖃</th><th>Location Detail 🕞 Lot Number</th><th>- Wafer Number</th><th>- Technology</th><th>- Responsible</th><th>Scrap Date 🚽</th></td<>	Shelf 🖃	Location Detail 🕞 Lot Number	- Wafer Number	- Technology	- Responsible	Scrap Date 🚽
V3 2 TU911312 CIT120310 Turan Mar 27 V3 2 TU911313 CIT120310 Turan Mar 27 V3 2 TU911314 CIT120310 Turan Mar 27 V3 2 TU911315 CIT120310 Turan Mar 27 V3 2 TU911316 CIT120310 Turan Mar 27 V3 2 QU778812.04 C9LMG Turan Mar 27 V3 2 QU778812.05 C9LMG Turan Mar 27 V3 2 QU778812.06 C9LMG Turan Mar 27 V3 2 QU778812.07 C9LMG Turan Mar 27 V3 2 QU778812.07 C9LMG Turan Mar 27 V3 2 QU778812.06 P9UPA Turan Mar 27 V3 2 QU778812.07 C9LMG Turan Mar 27 V3 2 QU778812.07 PUR Turan Mar 27 V3 2 QU178412.08 POTPA Turan Mar 27 V3 2 GP269622 CPTZ Turan Mar 27 V3 2 Q1123444.01 C9LMG_GG		TU889614.03	1,2,3	HSTF1200	Turan	Dec-24
V3 2 TU911313 CIT120310 Turan Mar 27 V3 2 TU911314 CIT120310 Turan Mar 27 V3 2 TU911315 CIT120310 Turan Mar 27 V3 2 TU911316 CIT120310 Turan Mar 27 V3 2 QU778812.04 C9LMG Turan Mar 27 V3 2 QU778812.05 C9LMG Turan Mar 27 V3 2 QU778812.06 C9LMG Turan Mar 27 V3 2 QU778812.07 C9LMG Turan Mar 27 V3 2 QU778812.08 C9LMG Turan Mar 27 V3 2 GP269622 CPT Turan Mar 27 V3 2 GP269622 CPTZ Turan Mar 27 V3 2 QU123444.01 C9LMG_GG Turan Mar 27 V3 2 QU123444.02 C9LMG_GG	w3	2 TU223344	7,8,3	CIT110305	Turan	Sep-25
V3 2 TU911314 CIT120310 Turan Mar 27 V3 2 TU911316 CIT120310 Turan Mar 27 V3 2 QU778812.04 CSLMG Turan Mar 27 V3 2 QU778812.05 CSLMG Turan Mar 27 V3 2 QU778812.05 CSLMG Turan Mar 27 V3 2 QU778812.07 CSLMG Turan Mar 27 V3 2 QU778812.07 CSLMG Turan Mar 27 V3 2 QU778812.07 CSLMG Turan Mar 27 V3 2 QU778812.08 CSLMG Turan Mar 27 V3 2 QU778812.08 CSLMG Turan Mar 27 V3 2 QU778812.08 CSLMG Turan Mar 27 V3 2 GP26672 POTPA Turan Mar 27 V3 2 GP269622 CPTZ Turan Mar 27 V3 2 GP2469622 CPTZ Turan Mar 27 V3 2 QU123444.01 CSLMG_GG Turan Mar 27 V3 2 QU126700 MSFET 10V Tu	w3	2 TU911312		CIT120310	Turan	Mar 27
V3 2 TU911315 CIT120310 Turan Mar 27 V3 2 TU911316 CIT120310 Turan Mar 27 V3 2 QU778812.04 OPMG Turan Mar 27 V3 2 QU778812.05 OPMG Turan Mar 27 V3 2 QU778812.06 OPMG Turan Mar 27 V3 2 QU778812.07 OPMG Turan Mar 27 V3 2 QU778812.08 OPMG Turan Mar 27 V3 2 QU778812.08 OPMG Turan Mar 27 V3 2 QU778812.08 OPMG Turan Mar 27 V3 2 QU78812.08 OPMG Turan Mar 27 V3 2 QU78812.08 OPMG Turan Mar 27 V3 2 GP26622 CPT Turan Mar 27 V3 2 GP2469622 CPTA Turan Mar 27 V3 2 QU123444.01 OPMG_GG Turan Mar 27 V3 2 QU123444.02 OPMG_GG Turan Mar 27 V3 2 QU106700 MOSFET-10 V Turan <td>w3</td> <td>2 TU911313</td> <td></td> <td>CIT120310</td> <td>Turan</td> <td>Mar 27</td>	w3	2 TU911313		CIT120310	Turan	Mar 27
v3 2 T0911316 CIT120310 Turan Mar 27 v3 2 QU778812.05 C9LMG Turan Mar 27 v3 2 QU778812.06 C9LMG Turan Mar 27 v3 2 QU778812.07 C9LMG Turan Mar 27 v3 2 P9567 UWU N Turan Mar 27 v3 2 G9269622 CPTZ Turan Mar 27 v3 2 G92469622 CPTZ Turan Mar 27 v3 2 QU123444.01 C9LMG_GG Turan Mar 27 v3 2 QU123444.02 G9LMG_GG Turan Mar 27 v3 2 QU123444.02 MOSFET 10 V Turan Mar 27 v3 2 QU106701 MOSSPR (GaN) Turan Mar 27 v3 2 QU106701 PMOSSPR (GaN) <td>w3</td> <td>2 TU911314</td> <td></td> <td>CIT120310</td> <td>Turan</td> <td>Mar 27</td>	w3	2 TU911314		CIT120310	Turan	Mar 27
v3 2 QU778812.04 C9LMG Turan Mar 27 v3 2 QU778812.05 C9LMG Turan Mar 27 v3 2 QU778812.06 C9LMG Turan Mar 27 v3 2 QU778812.07 C9LMG Turan Mar 27 v3 2 QU778812.08 C9LMG Turan Mar 27 v3 2 GP269622 CPTZ Turan Mar 27 v3 2 GP269622 CPTZ Turan Mar 27 v3 2 GP2469622 CPTZ Turan Mar 27 v3 2 QU123444.01 C9LMG_GG Turan Mar 27 v3 2 QU123444.01 MOSFET 10 V Turan Mar 27 v3 2 QU106700 MOSFET 10 V Turan Mar 27 v3 2 QU106701 MOSSPR GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) <td>w3</td> <td>2 TU911315</td> <td></td> <td>CIT120310</td> <td>Turan</td> <td>Mar 27</td>	w3	2 TU911315		CIT120310	Turan	Mar 27
v3 2 QU778812.05 C9LMG Turan Mar 27 v3 2 QU778812.07 C9LMG Turan Mar 27 v3 2 QU778812.08 C9LMG Turan Mar 27 v3 2 QU778812.08 C9LMG Turan Mar 27 v3 2 QU778812.08 C9LMG Turan Mar 27 v3 2 P99667 UWU P90TPA Turan Mar 27 v3 2 GP2269622 CPTZ Turan Mar 27 v3 2 GP269622 CPTZ Turan Mar 27 v3 2 GP2469622 CPTZ Turan Mar 27 v3 2 GP123444.01 C9LMG_GG Turan Mar 27 v3 2 QU123444.01 OSLMG_GG Turan Mar 27 v3 2 QU123444.01 MOSFET-10 V Turan Mar 27 v3 2 QU123444.01 MOSFET-11 V Turan Mar 27 v3 2 QU106700 4,56,78,9,10,11,12 MOSFET-10 V Turan Mar 27 v3 2 QU106701 MOSPSR (GaN) Turan Mar 27 v3 <t< td=""><td>w3</td><td>2 TU911316</td><td></td><td>CIT120310</td><td>Turan</td><td>Mar 27</td></t<>	w3	2 TU911316		CIT120310	Turan	Mar 27
v3 2 QU778812.06 C9LMG Turan Mar 27 v3 2 QU778812.07 C9LMG Turan Mar 27 v3 2 QU778812.08 C9LMG Turan Mar 27 v3 2 PL887026 P90TPA Turan Mar 27 v3 2 PP9667 UWU N Turan Mar 27 v3 2 GP2269622 CPTZ Turan Mar 27 v3 2 GP3696222 CPTZ Turan Mar 27 v3 2 GP2469622 CPTZ Turan Mar 27 v3 2 GP123444.01 C9LMG_GG Turan Mar 27 v3 2 QU123444.02 C9LMG_GG Turan Mar 27 v3 2 QU123444.02 MSFET-10V Turan Mar 27 v3 2 QU106700 MSFET-15V Turan Mar 27 v3 2 QU106701 MSSPET-15V Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 PMOS99R (GaN)<	w3	2 QU778812.04		C9LMG	Turan	Mar 27
v3 2 QU778812.07 C9LMG Turan Mar 27 v3 2 QU778812.08 C9LMG Turan Mar 27 v3 2 PL887026 P90TPA Turan Mar 27 v3 2 C9269622 CPTZ Turan Mar 27 v3 2 GP269622 CPTZ Turan Mar 27 v3 2 GP2469622 CPTZ Turan Mar 27 v3 2 QU123444.01 C9LMG_GG Turan Mar 27 v3 2 QU123444.02 OSLMG_GG Turan Mar 27 v3 2 QU106700 MOSFET-15 V Turan Mar 27 v3 2 QU106701 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN)	w3	2 QU778812.05		C9LMG	Turan	Mar 27
v3 2 QU778812.08 C9LMG Turan Mar 27 v3 2 PL887026 P90TPA Turan Mar 27 v3 2 P99667 UWU N Turan Mar 27 v3 2 GP2269622 CPTZ Turan Mar 27 v3 2 GP269622 CPTZ Turan Mar 27 v3 2 GP269622 CPTZ Turan Mar 27 v3 2 GP2469622 CPTZ Turan Mar 27 v3 2 QU123444.01 C9LMG_GG Turan Mar 27 v3 2 QU123444.02 G9LMG_GG Turan Mar 27 v3 2 QU123444.02 MOSFET - 10 V Turan Mar 27 v3 2 QU106700 4,5,6,7,8,9,10,11,12 MOSFET - 15 V Turan Mar 27 v3 2 QU106700 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) <t< td=""><td>w3</td><td>2 QU778812.06</td><td></td><td>C9LMG</td><td>Turan</td><td>Mar 27</td></t<>	w3	2 QU778812.06		C9LMG	Turan	Mar 27
v3 2 PL887026 P90TPA Turan Mar 27 v3 2 P99667 UWU N Turan Mar 27 v3 2 GP2269622 CPTZ Turan Mar 27 v3 2 GP3696220 CPTZ Turan Mar 27 v3 2 GP2469622 CPTZ Turan Mar 27 v3 2 GP2469622 CPTZ Turan Mar 27 v3 2 QU123444.01 C9LMG_GG Turan Mar 27 v3 2 QU123444.02 C9LMG_GG Turan Mar 27 v3 2 QU123444.02 C9LMG_GG Turan Mar 27 v3 2 QU103444.02 MOSFET - 10 V Turan Mar 27 v3 2 QU106700 MOSFET - 15 V Turan Mar 27 v3 2 QU106701 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 <t< td=""><td>w3</td><td>2 QU778812.07</td><td></td><td>C9LMG</td><td>Turan</td><td>Mar 27</td></t<>	w3	2 QU778812.07		C9LMG	Turan	Mar 27
v3 2 P9967 UWU N Turan Mar 27 v3 2 GP2269622 CPTZ Turan Mar 27 v3 2 GP269622 CPTZ Turan Mar 27 v3 2 GP2469622 CPTZ Turan Mar 27 v3 2 GP2469622 CPTZ Turan Mar 27 v3 2 QU123444.01 C9LMG_GG Turan Mar 27 v3 2 QU123444.02 C9LMG_GG Turan Mar 27 v3 4 HF151005.00 4,56,7,8,9,10,11,12 MOSFET - 10 V Turan Mar 27 v3 2 HF88800.02 MOSFET - 15 V Turan Mar 27 v3 2 QU106700 PMOS99R (GaN) Turan Mar 27 v3 2 QU106701 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 PMOS99R (GaN) Turan Mar 27 <t< td=""><td>w3</td><td>2 QU778812.08</td><td></td><td>C9LMG</td><td>Turan</td><td>Mar 27</td></t<>	w3	2 QU778812.08		C9LMG	Turan	Mar 27
v3 2 GP2269622 CPTZ Turan Mar 27 v3 2 GP3696222 CPTZ Turan Mar 27 v3 2 GP2469622 CPTZ Turan Mar 27 v3 2 QU123444.01 C9LMG_GG Turan Mar 27 v3 2 QU123444.02 C9LMG_GG Turan Mar 27 v3 2 QU123444.02 C9LMG_GG Turan Mar 27 v3 4 HF151005.00 4,56,7,8,9,10,11,12 MOSFET - 10 V Turan Mar 27 v3 2 HF88800.02 MOSFET - 15 V Turan Mar 27 v3 2 QU106700 PMOS99R (GaN) Turan Mar 27 v3 2 QU106701 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 CRD_7 Giebel, Turan Mar 27	w3	2 PL887026		P90TPA	Turan	Mar 27
v3 2 GP3696222 CPTZ Turan Mar 27 v3 2 GP2469622 CPTZ Turan Mar 27 v3 2 QU123444.01 C9LMG_GG Turan Mar 27 v3 2 QU123444.02 C9LMG_GG Turan Mar 27 v3 4 HF151005.00 4,5,6,7,8,9,10,11,12 MOSFET - 10 V Turan Mar 27 v3 2 HF88800.02 MOSFET - 15 V Turan Mar 27 v3 2 QU106700 PMOS99R (GaN) Turan Mar 27 v3 2 QU106701 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 CARD_7 Giebel, Turan Mar 27 <td>w3</td> <td>2 P99667 UWU</td> <td></td> <td>Ν</td> <td>Turan</td> <td>Mar 27</td>	w3	2 P99667 UWU		Ν	Turan	Mar 27
v3 2 GP2469622 CPTZ Turan Mar 27 v3 2 QU123444.01 C9LMG_GG Turan Mar 27 v3 2 QU123444.02 C9LMG_GG Turan Mar 27 v3 4 HF151005.00 4,5,6,7,8,9,10,11,12 MOSFET - 10 V Turan Mar 27 v3 2 HF88800.02 MOSFET - 15 V Turan Mar 27 v3 2 QU106700 PMOS99R (GaN) Turan Mar 27 v3 2 QU106701 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 PMOS99R (GaN) Turan Mar 27 v3 2 GAB87HQZ2 CARD_7 Giebel, Turan Mar 27	w3	2 GP2269622		CPTZ	Turan	Mar 27
v3 2 QU123444.01 C9LMG_GG Turan Mar 27 v3 2 QU123444.02 C9LMG_GG Turan Mar 27 v3 4 HF151005.00 4,5,6,7,8,9,10,11,12 MOSFET - 10 V Turan Aug-26 v3 2 HF88800.02 MOSFET - 15 V Turan Mar 27 v3 2 QU106700 PMOS99R (GaN) Turan Mar 27 v3 2 QU106701 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 PMOS99R (GaN) Turan Mar 27 v3 2 GABB87HQZ2 CARD_7 Giebel, Turan Mar 27	w3	2 GP3696222		CPTZ	Turan	Mar 27
v3 2 QU123444.02 C9LMG_GG Turan Mar 27 v3 4 HF151005.00 4,5,6,7,8,9,10,11,12 MOSFET - 10 V Turan Aug-26 v3 2 HF888000.02 MOSFET - 15 V Turan Mar 27 v3 2 QU106700 PMOS99R (GaN) Turan Mar 27 v3 2 QU106701 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 CARD_7 Giebel, Turan Mar 27	w3	2 GP2469622		CPTZ	Turan	Mar 27
v3 4 HF151005.00 4,5,6,7,8,9,10,11,12 MOSFET - 10 V Turan Aug-26 v3 2 HF888000.02 MOSFET - 15 V Turan Mar 27 v3 2 QU106700 PMOS99R (GaN) Turan Mar 27 v3 2 QU106701 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 PMOS99R (GaN) Turan Mar 27 v3 2 GABB87HQZ2 CARD_7 Giebel, Turan Mar 27	w3	2 QU123444.01		C9LMG_GG	Turan	Mar 27
v3 2 HF888000.02 MOSFET - 15 V Turan Mar 27 v3 2 QU106700 PMOS99R (GaN) Turan Mar 27 v3 2 QU106701 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 PMOS99R (GaN) Turan Mar 27 v3 2 GAB887HQZ2 CARD_7 Giebel, Turan Mar 27	w3	2 QU123444.02		C9LMG_GG	Turan	Mar 27
v3 2 QU106700 PMOS99R (GaN) Turan Mar 27 v3 2 QU106701 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 PMOS99R (GaN) Turan Mar 27 v3 2 GAB887HQZ2 CARD_7 Giebel, Turan Mar 27	w3	4 HF151005.00	4,5,6,7,8,9,10,11,12	MOSFET - 10 V	Turan	Aug-26
v3 2 QU106701 PMOS99R (GaN) Turan Mar 27 v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 PMOS99R (GaN) Turan Mar 27 v3 2 6ABB87HQZ2 CARD_7 Giebel, Turan Mar 27	w3	2 HF888000.02		MOSFET - 15 V	Turan	Mar 27
v3 2 QU106702 PMOS99R (GaN) Turan Mar 27 v3 2 QU106703 PMOS99R (GaN) Turan Mar 27 v3 2 6ABB87HQZ2 CARD_7 Giebel, Turan Mar 27	w3	2 QU106700		PMOS99R (GaN)	Turan	Mar 27
v3 2 QU106703 PMOS99R (GaN) Turan Mar 27 v3 2 6ABB87HQZ2 CARD_7 Giebel, Turan Mar 27	w3	2 QU106701		PMOS99R (GaN)	Turan	Mar 27
v3 2 6ABB87HQZ2 CARD_7 Giebel, Turan Mar 27	w3	2 QU106702		PMOS99R (GaN)	Turan	Mar 27
	w3	2 QU106703		PMOS99R (GaN)	Turan	Mar 27
v3 2 6ABB87HQZ3 CARD 7 Giebel. Turan Mar 27	w3	2 6ABB87HQZ2		CARD_7	Giebel, Turan	Mar 27
	w3	2 6ABB87HQZ3		CARD_7	Giebel, Turan	Mar 27

*data is altered for confidentiality purposes

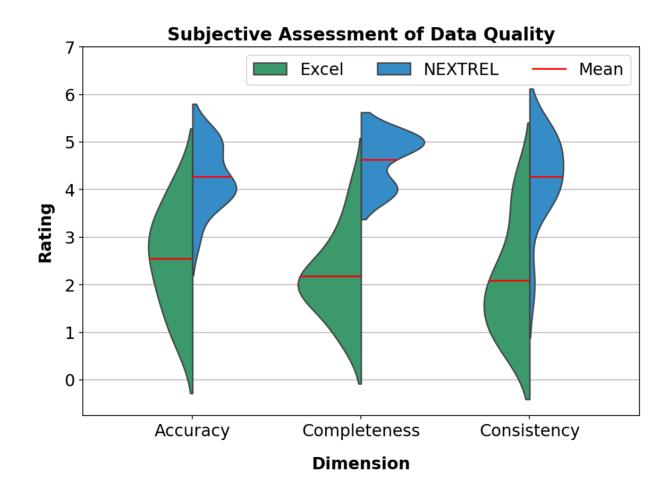
Selection of data from NEXTREL shown to participants

≡	Sample Type 🔻	Lot Number T	Wafer Number 🔻	Technology 🔻	Status T
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2	Wafer	TU180333	4	CIT001	In Storage
3	Wafer	TU180333	5	CIT001	In Storage
4	Wafer	TU180333	6	CIT001	In Storage
5	Wafer	TU180333	7	CIT001	In Storage
6	Wafer	TU180333	8	CIT001	In Storage
7	Wafer	TU180333	9	CIT001	In Storage
8	Wafer	TU285748	1	CIT002	In Storage
9	Wafer	TU285748	2	CIT002	In Storage
10	Wafer	TU285748	3	CIT002	In Storage
11	Wafer	TU285748	4	CIT002	In Storage
12	Wafer	TU285748	5	CIT002	In Storage
13	Wafer	TU285748	6	CIT002	In Storage
14	Wafer	TU285748	7	CIT002	In Storage
15	Wafer	TU285748	8	CIT002	In Storage
16	Wafer	TU285748	9	CIT002	In Storage
17	Wafer	TU285748	10	CIT002	In Storage

*data is altered for confidentiality purposes

ТЛП

Violin plot with no data range restriction



Motivation – E

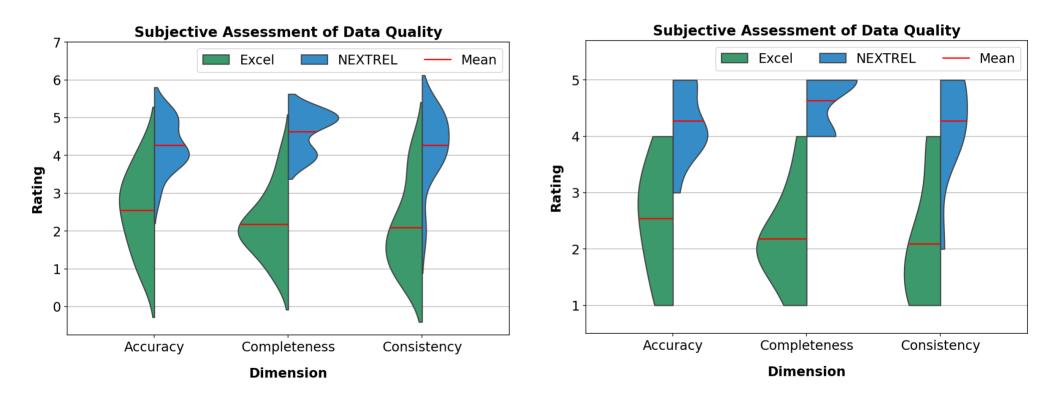
Slide 31

Motivation – Background – Goal – Method – Implementation – Evaluation – Conclusion - Backup Hian Zing Voon: Formative Evaluation of Data Management Tools on Data Quality and Usability

25 October, 2024



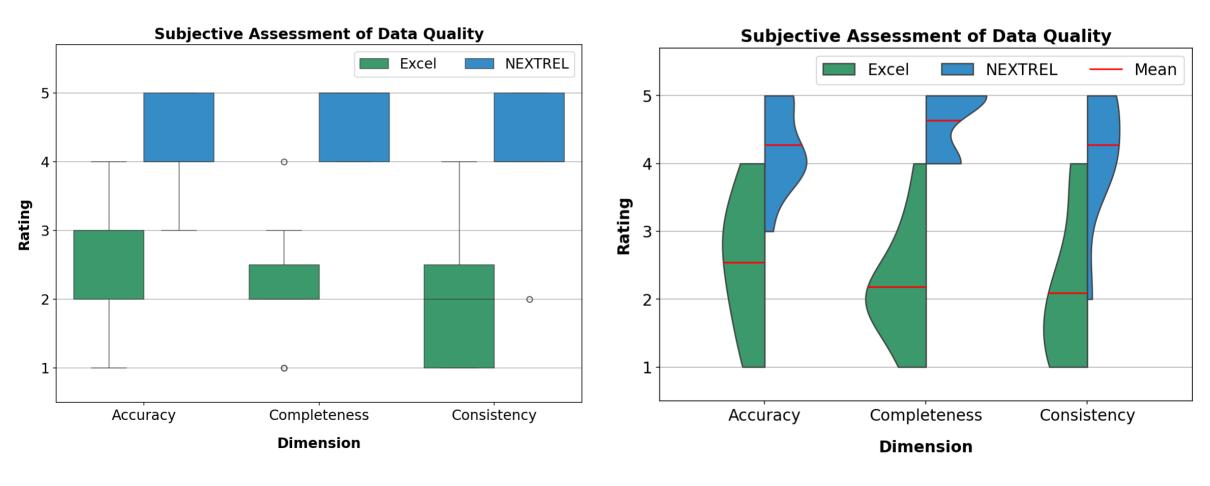
Restricting violin plot to be within data range



*both have different ranges of limit on y-axis

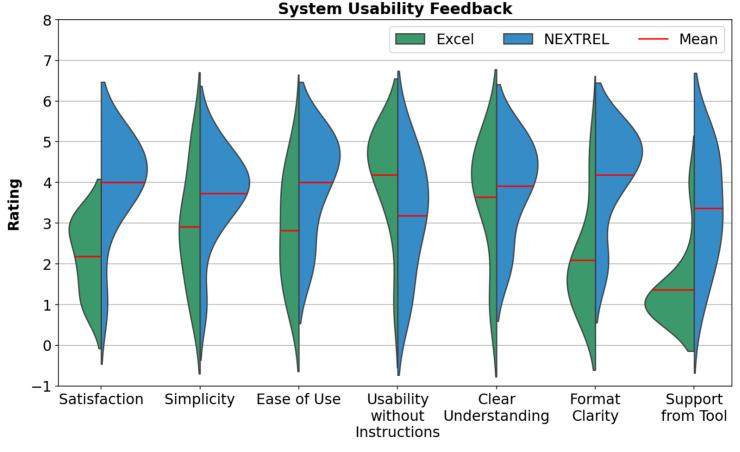
ТШ

Box plot versus violin plot



Motivation - Background - Goal - Method - Implementation - Evaluation - Conclusion - Backup

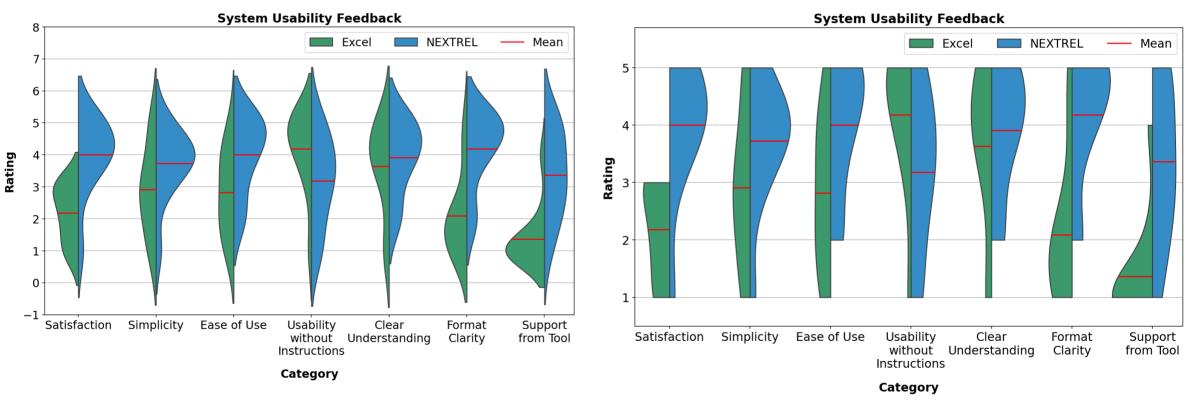
Violin plot with no data range restriction



Category



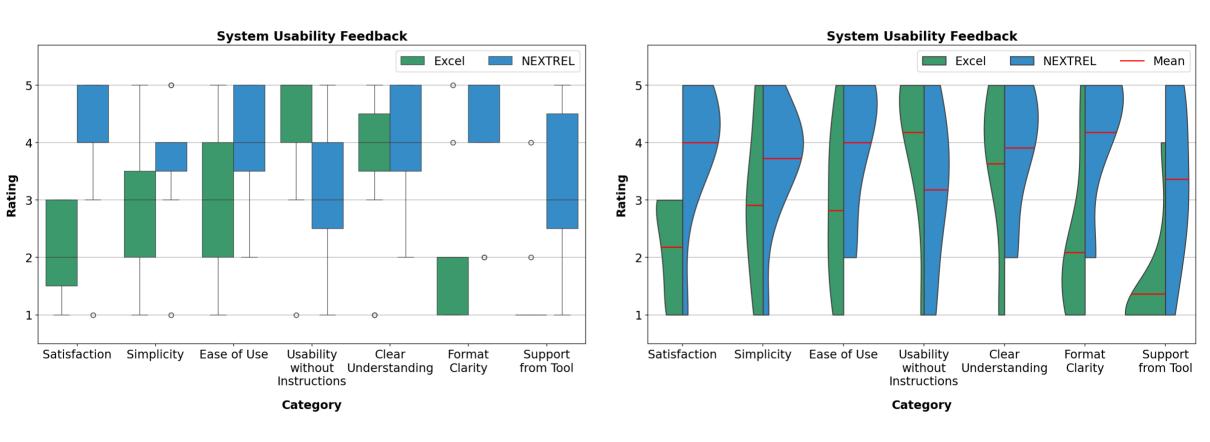
Restricting violin plot to be within data range



*both have different ranges of limit on y-axis



Box plot versus violin plot



Motivation – Background – Goal – Method – Implementation – Evaluation – Conclusion - Backup Hian Zing Voon: Formative Evaluation of Data Management Tools on Data Quality and Usability