

Use of QFD (Quality Function Deployment) in Mobile Application Design for Perioperative Services: An Exploratory Study

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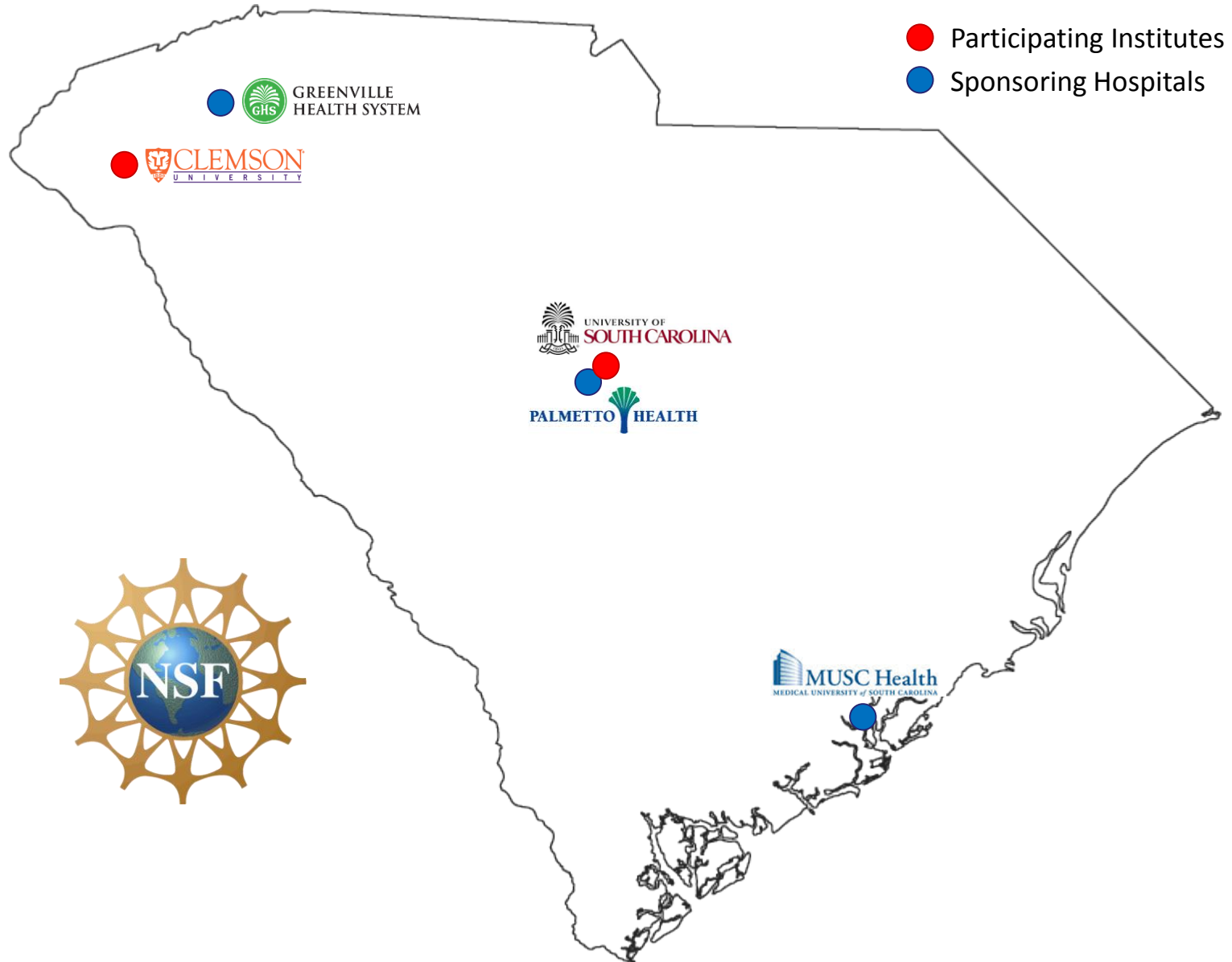
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Introduction





■ Mobile App Development

- Purpose: To improve coordination of perioperative staff and increase patient throughput
- Platform: Android
- Test devices: Nexus 7 & 10, Samsung Galaxy Notes



■ Target Processes: Perioperative services

- Pre-Op
- OR (Operating Room)
- PACU (Post Anesthesia Care Unit)

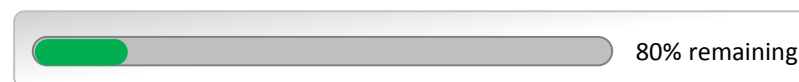
■ Research Question

- Is QFD (Quality Function Deployment) useful for identifying design requirements of mobile applications for perioperative services?

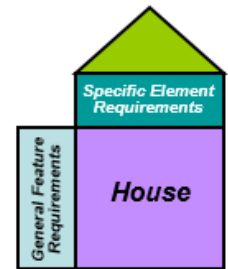
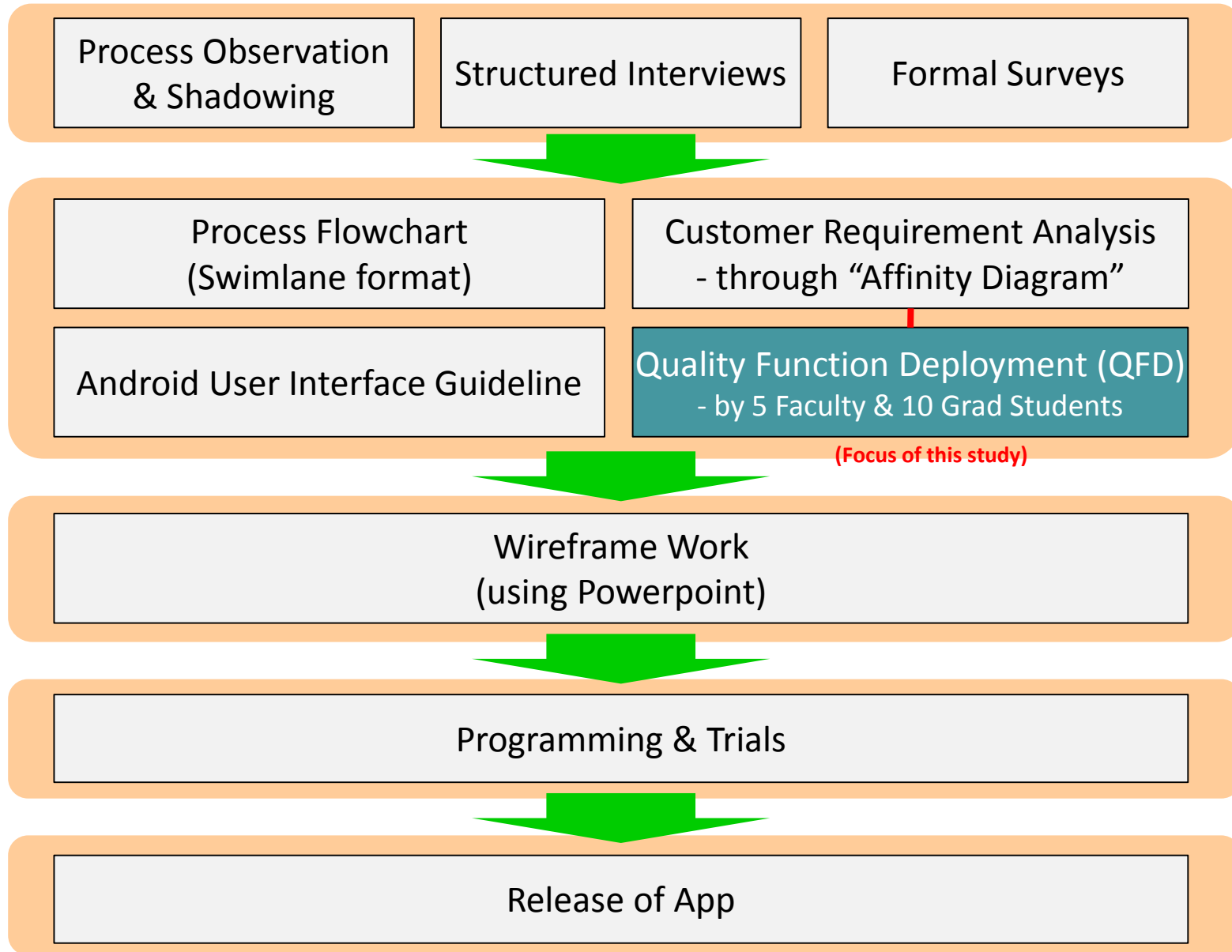
■ Research Gap - Literature Review

Research on QFD			Industry Sector	
			Healthcare	Manufacturing & Others
Product Type	Hardware (tangible) / Service		Hauser, 1993 Chaplin et al., 1999 Gremyr & Raharjo, 2013 ...	Sullivan, 1986 Swackhamer, 1985 Adiano & Roth, 1994 ...
	Software	Non-mobile	Hallberg et al., 1999 Ahmed et al., 2006 ...	Chang, 1989 Richardson, 2001 Franke & Weise, 2011 ...
		Mobile App	Focus of this research	Research Opportunity

Mobile App Development



Steps of App Development Processes



Currently, we are here.



Examples of Wireframe Work - PACU Status

PACU Bed & Patient Status

Bed #	Patient:	Nurse:	Bed Status:
Bed #1	Tom Jones (00345)	Kathy Smith	Occupied
Bed #2	Jim Brown (10099)	Kathy Smith	Occupied
Bed #3	--	--	Vacant
Bed #4	Bill Evans (11008)	Jane Davis	Reserved
Bed #5	Mary Hartman (10856)	Jane Davis	Occupied
Bed #6	Patricia Watson (11322)	Jane Davis	Reserved
Bed #7	Linda Baker (10877)	Laura Williams	Reserved
Bed #8	David Winston (10112)	Laura Williams	Occupied
Bed #9	--	--	Vacant

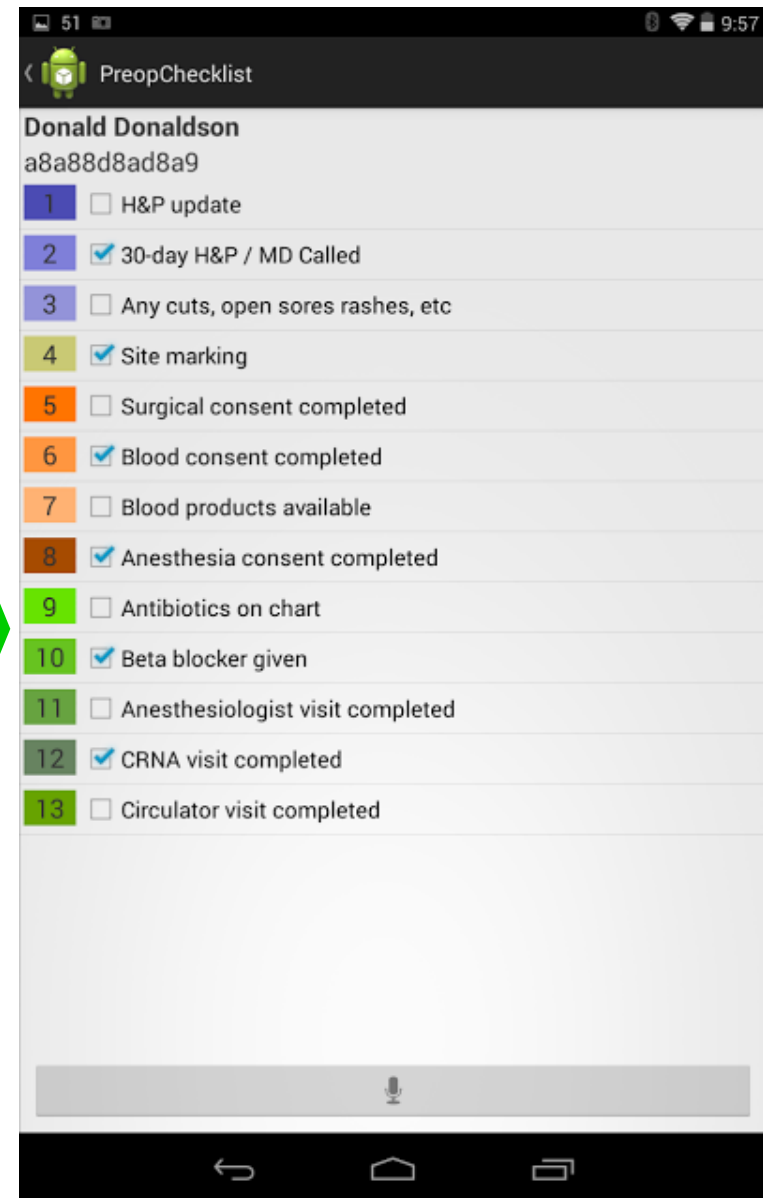
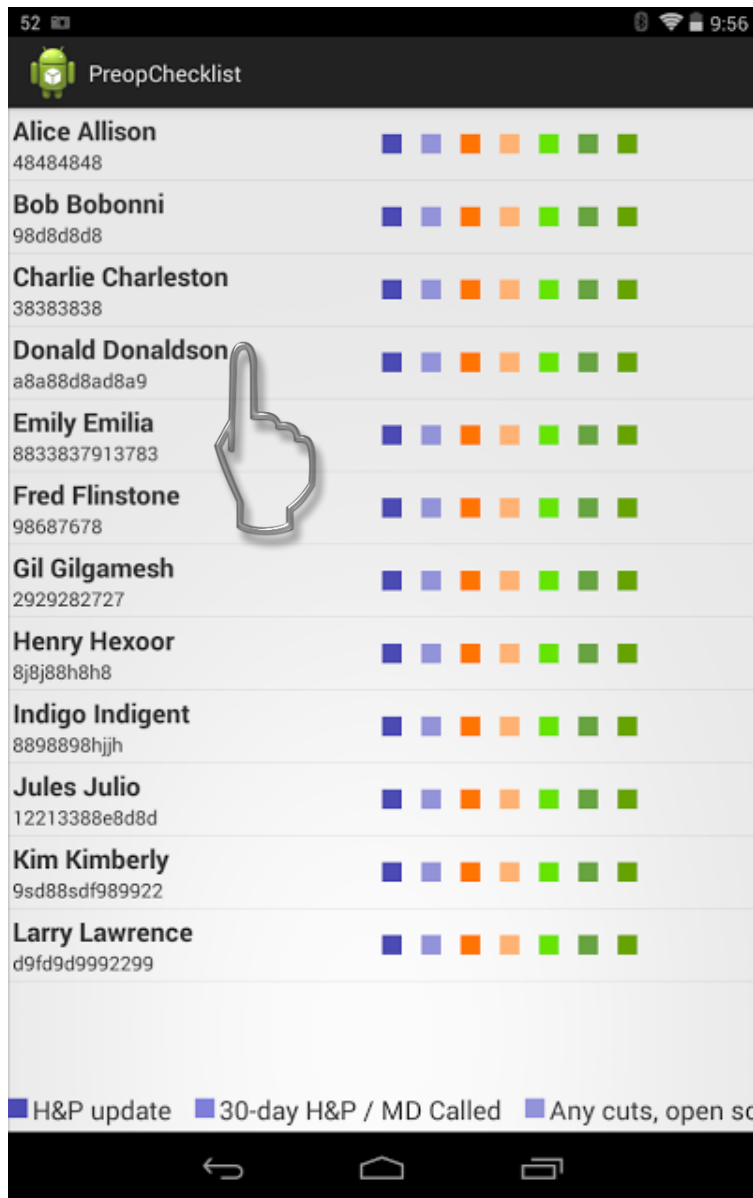
PACU Bed #3 - Patient Condition Check

Patient Name:
 Patient #:
 OR #:
 Surgeon Name:
 Procedure:
 Anes. Name:
 Entry Time:

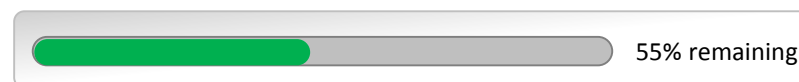
PARS (Post Anesthesia Recovery Score: Discharge \geq 8)

		Score in Minutes					
	PARS Item	Adm. Score	30	60	90	120	D/C Score
I	Activity						
II	Respirations						
III	Circulation						
IV	Consciousness						
V	Pulse						
Total							

Examples of Test Screens - PreOp Checklist

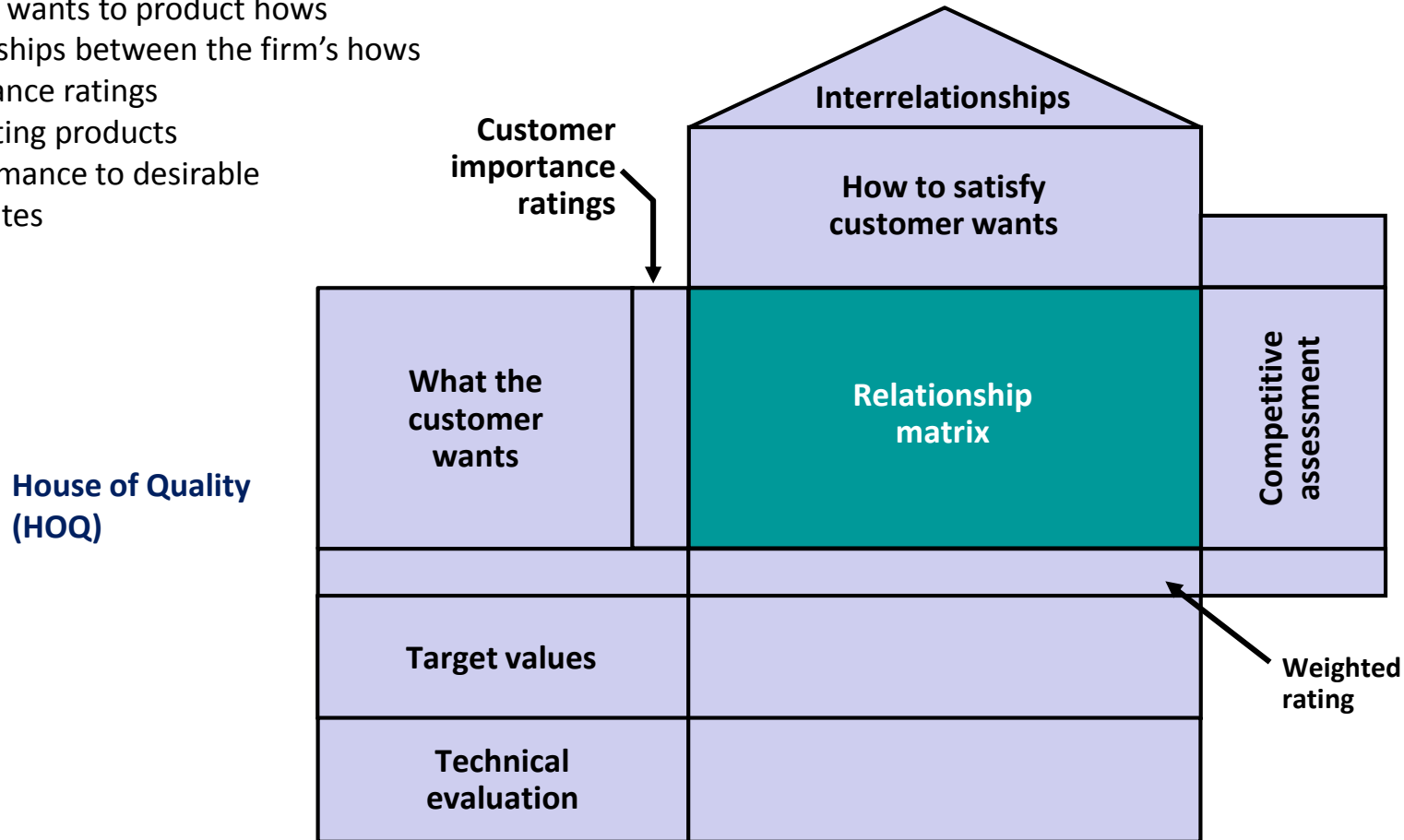


Quality Function Deployment (QFD)

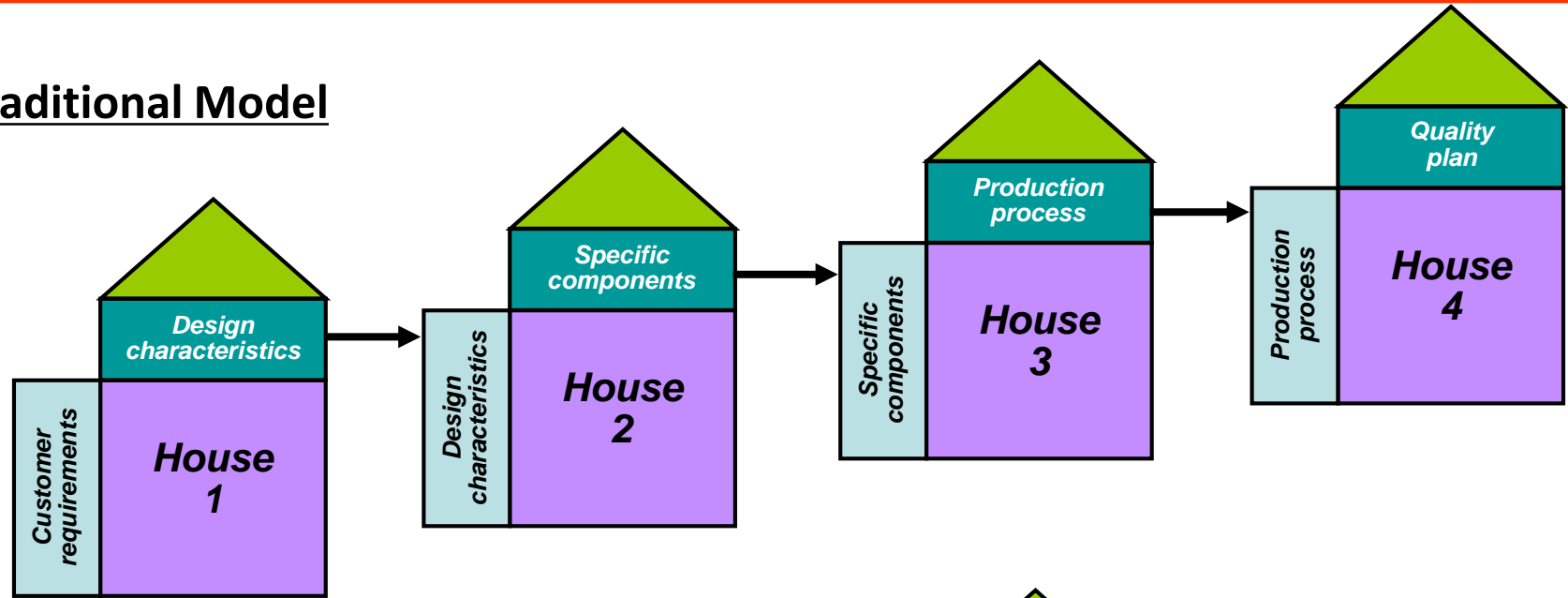


- Quality Function Deployment (QFD): an overall concept that provides a means of translating *customer requirements* into the appropriate *technical requirements* for each stage of product development and production (Sullivan, 1986).

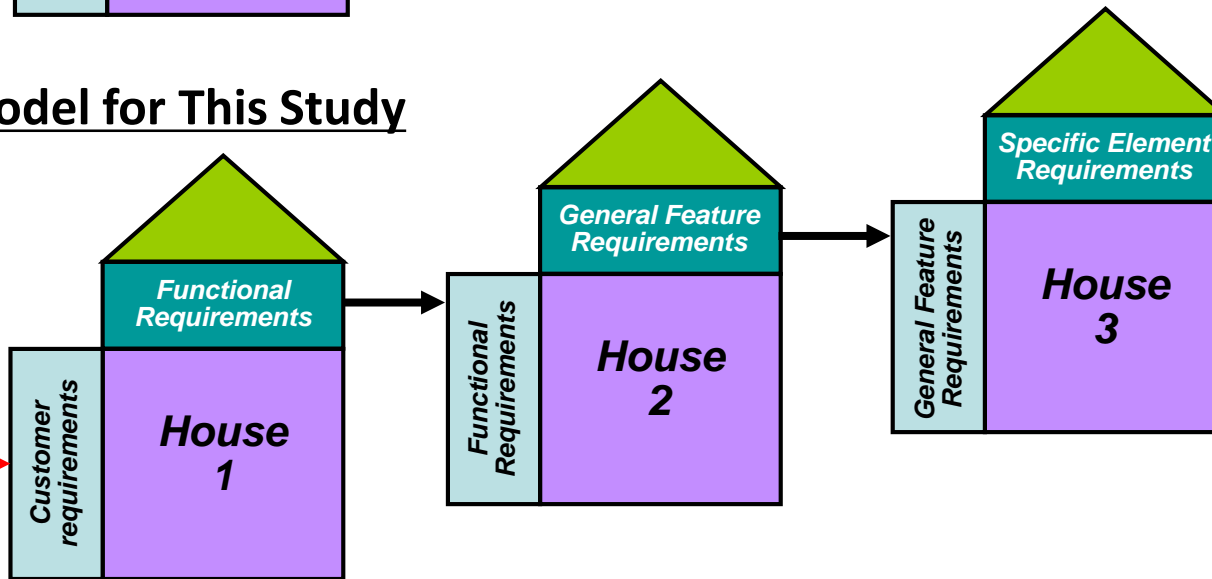
- Identify customer wants
- Relate customer wants to product hows
- Identify relationships between the firm's hows
- Develop importance ratings
- Evaluate competing products
- Compare performance to desirable technical attributes



Traditional Model



Model for This Study



QFD Results



HOQ Relationship Matrix (1) - Customer Requirements and Functional Requirements

○	Strong Relationship	9
○	Moderate Relationship	3
▲	Weak Relationship	1

Row #	Relative Weight	Weight / Importance	Customer Requirements	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
			Functional Requirements Customer Requirements	Easy to read	Easy to select information or pages	Information displays provide insights	Off-line decision support	Display shows all resources required for procedure	All staff have own mobile device	Staff enter their status into mobile device	Device can be carried hands free to patient bedside	Must be able to wash between patients	Does not require turning back to patient to enter data	GPS reports location of surgeon	Surgeon receives notice about patient requirements	Information about patient status in OR is shared	Easy to enter patient status during procedure	Easy data input	Ability to look at consent form	Ensures safety guidelines followed	Easy movement between pages (home button and current location indicator)	Checklists when possible	Easy to use voice recognition	Ability to read other electronic records	Ability to search database	Overview of patient status on one screen	Keyboard input allowed
1	4.6	4.0	Efficient managerial decision making	○	○	○	○	▲	▲	○	▲				○	○	○					▲		○	○	○	○
2	4.6		From Affinity Diagram	○	○			○																			
4.4			Caregiver-patient relationship																								
4	4.5	4.0	Assists with surgeon's arrival																								
5	4.8	4.2	Coordination to assure the PACU is prepared for a patient prior to arrival	○	○			▲																			
6	4.7	4.2	Reduction of the need to make phone calls					○																			
4.4			Effective process performance (update/guideline/patient consent)																○	○	○			○	○		
9	4.6	4.1	Communication among peri-operative functions	○																							
10	4.7	4.2	Easy access to patient status	○	○																						
11	4.5	4.0	Communication of the progress of procedures in the OR	○	○																						
12	4.8	4.2	Efficient information retrieval		○																						
13	4.9	4.3	User interface - Efficient information input	○			○																				
14	4.9	4.3	User interface - Efficient surgeon input	○			○								○		○	○					○	○			○
4.6			User interface - Compatible w with the OR work context																								
17	4.9	4.3	Patient status - Efficient process performance																								
18	4.7	4.1	Patient status - Gathering of pre-arrival information	○																							
19	5.0	4.4	Easy to use - software	○	○																						
20	4.8	4.3	Easy to use - hardware																								
21	4.5	4.0	Easy to use - voice recognition capabilities																								
			Max Relationship Value in Column	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9
			Weight / Importance	355.2	255.4	255.7	87.2	106.5	303.3	181.5	267.4	177.9	49.3	143.3	223.9	268.1	356.4	431.8	151.3	133.9	248.2	361.0	319.8	505.9	318.9	354.1	252.2
			Relative Weight	5.8	4.2	4.2	1.4	1.7	5.0	3.0	4.4	2.9	0.8	2.3	3.7	4.4	5.8	7.1	2.5	2.2	4.1	5.9	5.2	8.3	5.2	5.8	4.1



1
 Ability to read other electronic records
 505.9



2
 Easy data input
 431.8



3
 Checklists when possible
 361.0

○	Strong Relationship	9
○	Moderate Relationship	3
▲	Weak Relationship	1

HOQ Relationship Matrix (2) - Functional Requirements and General Feature Requirements

Row #	Relative Weight	Weight / Importance	General Feature Requirements	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24
			Functional Requirements	Distinction in Font Color	Distinction in Font Type	Distinction in Font Size	Distinction in Background Color	Distinction in Icon Color (differentiate colors between adjacent icons)	Legend Layout	Sequence of data - same across multiple screens	Check box & Push Icon Available	Progress bar color code / with room location	Predicted Analytics using current data	Screen that lists personnel and equipment for the patient	Small enough to fit in pockets	Screen Protector	Touch Screen	Voice Recognition	Keyboard input on the screen	Function of using GPS information	Distinctive Message Arrival (sound, blink, vibration)	Pull data from OR Max	Ability to scan and attach document	Time-out checklist / Safety checklist	Content Page / Home Button / Search Box	Current Location Indicator (Item selection in system)	Constant Update of Patient Location (pulling info from OR Max)

1	5.8	355.2	Easy to read	○	○	○	○	○	○	○	▲	○	▲	▲	▲												
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2	4.2	255.4	Easy to select information or pages	○	○	○	○	○	○	○	○	○	○	○	○												
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3	4.2	255.7	Information displays provide insights	○	○	○	○	○	○	○	○	○	○	○	○												
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4	1.4	87.2	Off-line decision support	▲	▲																						
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5	1.7	106.5	Display shows all resources required for procedure																								
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6	5.0	303.3	All staff have own mobile device																								
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7	3.0	181.5	Staff enter their status into mobile device	▲	▲	▲	▲	▲																			
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8	4.4	267.4	Device can be carried hands free to patient bedside									○	○	○	○	○	○	○									
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9	2.9	177.9	Must be able to wash between patients																								
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10	0.8	49.3	Does not require turning back to patient to enter data																								
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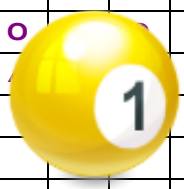
11	2.3	143.3	GPS reports location of surgeon																								
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12	3.7	223.9	Surgeon receives notice about patient requirements																								
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13	4.4	268.1	Information about patient status in OR is easy to read																								
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14	5.5	356.4	Easy to enter patient status during procedure	○	○	○	○	○	○	○	○	○	○	○	○												
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431.8			Easy data input																								
17	2.2	133.9	Ensures safety guidelines followed	▲	▲	▲	▲	▲																			
361.0			Checklists when possible																								
505.9			Ability to read other electronic records																								
22	5.2	318.9	Ability to search database																								
23	5.8	354.1	Overview of patient status on one screen	▲	▲	▲	▲	▲	▲	▲	▲	○															
24	4.1	252.2	Keyboard input allowed																								
			Max Relationship Value in Column	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	
			Weight / Importance	206.0	206.0	206.0	206.0	206.0	206.0	232.8	261.0	168.3	54.5	84.3	82.2	61.6	222.4	229.8	219.9	81.1	96.3	408.4	279.9	40.4	103.9	141.5	177.5
			Relative Weight	4.9	4.9	4.9	4.9	4.9	4.9	5.6	6.2	4.0	1.3	2.0	2.0	1.5	5.3	5.5	5.3	1.9	2.3	9.8	6.7	1.0	2.5	3.4	4.2



1
 Pull data from OR Max (Existing Database)
 408.4



2
 Ability to scan and attach document
 279.9

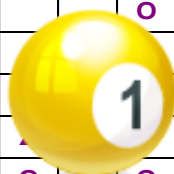


3
 Check box & Push Icon Available
 261.0

Strong Relationship	9
Moderate Relationship	3
Weak Relationship	1

HOQ Relationship Matrix (3) - General Feature Requirements and Specific Element Requirements

Row #	Relative Weight	Weight / Importance	General Feature Requirements	Specific Element Requirements	1	2	3	4	5	6	7	8	9	10	11	12	13	14	15	16	17	18	19	20	21	22	23	24	25		
1	4.9	206.0	Distinction in Font Color	Wave length is greater than 60 nm apart for the adjacent colors.	⊕	⊖	⊖	▲	▲	⊖																			⊖	⊖	
2	4.9	206.0	Distinction in Font Type	Each level of information has different font type (or boldness).		⊖	⊖																								
3	4.9	206.0	Distinction in Font Size	Each level of information has different font size		⊖	⊖																								
4	4.9	206.0	Distinction in Background Color	Non-selecting (or selected) screen & choice (button/icon) is grayed out.																											
5	4.9	206.0	Distinction in Icon Color (differentiate colors between adjacent icons)	Active area is brighter than non-active area.	⊕	▲	▲																								
6	4.9	206.0	Legend Layout	All legends are with swap-in.																											
7	5.6	222.8	Sequence of data - same across	Order of legends is same as the icon/button order.																											
261.0	Check box & Push Icon Available			Standard data sequence used																											
10	1.3	54.5	Predicted Analytics using current data	Standard check box & button used																											
11	2.0	84.3	Screen that lists personnel and equipment for the patient	Patient name is always with progress bar and with room.	▲	▲	▲																								
12	2.0	82.2	Small enough to fit in pockets	Algorithm to predict a potential problem or delay			⊖																								
13	1.5	61.6	Screen Protector	Symbol to indicate the potential predicted problem (e.g. exclamation mark)																											
14	5.3	222.4	Touch Screen	Lists of resource requirement for each surgery type	⊖	⊖	⊖																								
15	5.5	229.8	Voice Recognition	Device size 7 inch or smaller																											
16	5.3	219.9	Keyboard input on the screen	Screen protector that fits the screen size attached	▲	⊖	⊖																								
17	1.9	81.1	Fuction of using GPS information	All commands can be entered by touching buttons/icons/checkboxes/keyboards																											
408.4	Pull data from OR Max			All commands can be done by voice recognition.																											
279.9	Ability to scan and attach document			Ability to read and report GPS information																											
22	2.5	103.9	Content Page / Home Button / Search Box	Location identified on a type of map or building layout	▲	⊖	⊖																								
23	3.4	141.5	Current Location Indicator (item selection in system)	Option (based on preference) of sound, color, blink, vibration for message arrival	▲	⊖	⊖																								
24	4.2	177.5	Constant Update of Patient Location (pulling info from OR Max)	Automatically update OR Max information every 10 or 15 minutes (both ways)	⊖	▲	▲																								
			Max Relationship Value in Column	Camera button on an appropriate screen with attachment function	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	9	
			Weight / Importance	Home Button of the App available at the bottom of the screen	328.7	375.2	381.1	323.1	344.7	294.4	228.8	336.6	231.4	230.9	150.6	207.9	279.9	69.5	38.2	417.4	304.6	45.5	254.3	188.9	194.4	283.0	274.7	320.9	232.1		
			Relative Weight	Search box available on the top of the screen	5.2	5.9	6.0	5.1	5.4	4.6	3.6	5.3	3.7	3.6	2.4	3.3	4.4	1.1	0.6	6.6	4.8	0.7	4.0	3.0	3.1	4.5	4.3	5.1	3.7		



All commands can be entered by touching buttons/icons/checkboxes/keyboards



Each level of information has different font type (or boldness).



Active area is brighter than non-active area.

From HOQ #2

417.4

375.2

381.1

344.7

- Affinity Diagram (Customer Requirements from interview and survey results)
 - User interface - Compatible with the OR work context
 - Caregiver-patient relationship
 - Effective process performance (update/guideline/patient consent)

- 1st House of Quality (Functional Requirements)
 - Ability to read other electronic records
 - Easy data input
 - Checklists when possible

- 2nd House of Quality (General Feature Requirements)
 - Pull data from OR Max
 - Ability to scan and attach document
 - Check box & Push Icon Available

- 3rd House of Quality (Specific Element Requirements)
 - All commands can be entered by touching buttons/icons/check boxes/keyboards
 - Each level of information has different font size & font type.
 - Active area is brighter than non-active area.

Findings & Conclusion



Confirmed Advantages

- Help prioritize design features based on quantitative scores
- Help make a consensus for a large group

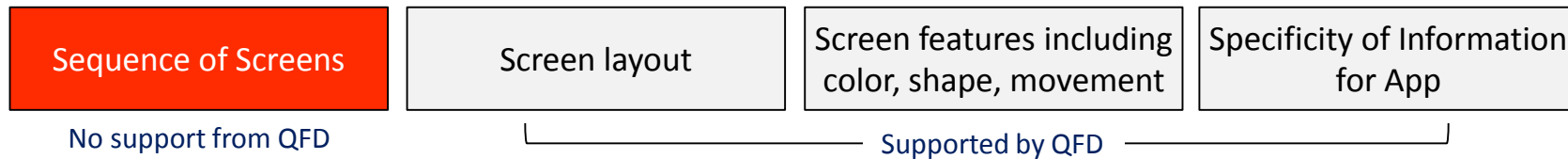
Limitations - Findings

- Does not assist identifying screen design sequence; rather, identifies feature requirement items
 - The project team relied more on the swimlane flowchart* to figure out the sequence of screens.



*Flowchart

Development of mobile app for perioperative processes



- Nature of the scoring and deploying methods used in QFD: the most frequently & highly correlated output items with the corresponding input requirements are the most common items => not necessarily helpful for designing innovative features.

- Continuous Studies for Investigating Common Weaknesses of QFD
 - Nature of QFD method - Inherent limitations on certain design requirements
 - Continuous investigation on usefulness of QFD in designing sequential requirements

- More empirical studies on applying QFD to mobile app development

Thank you!

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