Case Study 1: Metrics, the Customer Grid, and Usability Specifications

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In this section, we organizational strategies that should be part of every development team’s toolkit. We highlight using the customer grid and usability specifications table to organize metrics and a testing plan.

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etting up and managing a usability assessment can seem overwhelming, particularly for those on a budget and without administrative support, study coordinator, or simulation lab. Given this reality, we echo the sentiments of usability expert, educator, author, and consultant Steve Krug: “*studies do not have to be a big production”*(Krug, 2009). A one-person operation can test 3 users and gain valuable insights to improve designs, guide implementation, or inform training programs. However, any project, regardless of the scale, needs a clear game plan. It is crucial to identify usability measures important to product adoption, define these measures in explicit terms, and set benchmarks for success.

We’ve included a case study of an electronic health record (EHR) template supporting emergency department (ED) documentation. This study illustrates the approach our team used to evaluate usability dimensions. We describe three tools: (1) a **customer grid** to select quality metrics; (2) a **usability specification table** to operationalize the goals as usability metrics; and (3) a **usability-goal traceability scoreboard** connecting usability back to quality and the high-level project goals(**Figure CS 1.1**). Different stakeholders may gravitate to specific tools; executive sponsors may care most about the customer grid and how metrics reflect business goals whereas technology specialists and designers may use the usability specifications table to inform design activities. However, informaticians, product managers, and UX specialists will likely need to understand all three to have a comprehensive understanding of the project.

**Figure CS 1.1.** Overview of the instruments described in this case study.

## Project Brief

The National Program Office of Emergency Medicine within the Department of Veterans’ Affairs sponsored an initiative to standardized patient encounter documentation in emergency departments (**Figure CS 1.2**). At baseline, ED departments in VA hospitals could design their own note templates for documenting patient encounters. This distributed governance model gave local stakeholders the autonomy to customize templates according to local workflow and stakeholder needs. However, this also permitted wide variability across the enterprise. As a result, it was nearly impossible to standardize new initiatives, aggregate data for enterprise dashboards, or compare quality between sites.

The sponsors of this initiative had four high-level business goals: (1) the note should meet documentation standards and best-practices for interprofessional communication; (2) the note should capture structured data to drive enterprise-wide business analytics; (3) the note must support accurate coding and billing; and (4) the note should reflect or support clinical decision making. It was also implied that the ED template must scale for nationwide deployment and maintenance. Recognizing the inherent challenge of large-scale change management, and the potential for usability missteps, The National Program Office retained the VA Office of Human Factors Engineering (OFE) to assist with requirements analysis, template specifications, and prototype testing.

**Figure CS 1.2.** Current state and future state of ER documentation project.

## Revisiting the Value Proposition

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## Customer Grid

Individuals implementing any innovation need to clearly articulate their goals, the customer’s expectations, measures of success, and methods for collecting and displaying data. This is equally true for usability evaluations. Because it can be challenging to secure management commitment or a dedicated UX budget, it becomes crucial to illustrate how UX practices meet business goals. A customer grid is an efficient way to lay out improvement options and link them to customer goals, influenceable metrics, and measurement methods.

The customer grid is a longstanding technique used in healthcare quality improvement. Although its origins are obscure, the premise is based upon statistical process control methods introduced by Shewart, and later, Deming (Seidl & Newhouse, 2012). The World Health Organization promoted the grid to illustrate how statistical process control measures trace back to customer expectations and business goals (World Health Organization, 2011).

Typically, before we develop – or at least finalize – a grid, we have a general understanding of the workflow. The current state workflow enables us to quickly identify the key process steps relevant to the planned future state, system performance, and our quality goals. In **Figure CS 1.3**, we have a simplified future state workflow. These process steps are used to fill out the first column of our customer grid.

**Figure CS 1.3.** Future state workflow and process steps for the ER documentation project.

We have included an example of a customer grid for documenting an emergency room encounter (**Table CS 1.1**). The business goals – (1) support accurate coding and billing; (2) capture structured data; (3) support clinical decision making; and (4) foster communication – were not originally in a measurable form. To convert them into metrics, we listed the process workflow and key process steps (shown in the left column). We then identified the “customers” for the output of each step. We quantitatively described what it meant to meet customer’s expectations. This measure of success is the **key quality characteristic** or **key performance indicator** (listed in the second from right column). Finally, we identified the display metric for a dashboard or report card (right column). We will explore these display methods in future chapters.

TAble CS 1.1. Example customer grid outlining the goals and measures for an emergency medicine note template. Although we outline the entire workflow, the bold text identifies the metrics that operationalize the sponsor goals.

| **Process step** | **Desired outcome** | **Customers for process** | **Customers’ expectations** | **Measure of success** | **Best display method** |
| --- | --- | --- | --- | --- | --- |
| Nurse interviews and triages patient | Nurse gathers timely and accurate information from the patient | Patient  ER provider\* | Nurse completes a medication review with patients  Nurse gathers information before ER provider assessment, so that it is available at time of assessment | % of encounters where nurse attempted to collect a medication and allergy history  % of time nurse assesses patient at least 15 minutes before ER provider\* | p chart  p chart |
| Nurse documents in EHR the chief complaint, vital signs, and medication history\* | Nurse documents the exact chief complaint and MR in EHR before ER provider starts note; uploads vital signs to EHR before ER provider starts note\* | ER provider\* | Nurse documents’ chief complaint  Nurse documents a complete MR and updates allergies in EHR before ER provider writes orders  Nurse collects vitals for review before ER provider sees patient | % of nurse notes with chief complaint entered before ER provider note started  % of encounters with MR documented before ER provider note started  % of encounters with vital signs entered before ER provider note started\* | p chart  p chart  p chart |
| ER provider assesses patient and writes orders | ER provider has all clinical information available to write safe, accurate, and appropriate orders | ER provider  Patient  Pharmacist | The ER provider can immediately review MR history and vital signs  The patient receives correct medications for disease without untoward reaction  The medication history and allergy lists are available when pharmacists verify orders. | # of times the MR or vitals were unavailable before ER starts assessment  # of adverse medication reactions despite a documented medication allergy  # of times pharmacist calls ER provider for change in orders based upon documented allergy | u chart  G chart  u chart |
| ER provider writes EHR encounter note | ER provider starts note with pre-populated data fields and can complete note efficiently | ER provider  Hospital provider or PCP\*  HIMS  Enterprise executive | Parts of the note are automated  ER provider can quickly enter a note  **The next provider knows the clinically important events**  **The documentation supports the complexity of care reported**  **The executive can run a report showing diagnoses managed in ER** | % of ER provider notes that include MR, vitals, and chief complaint  Total time required for ER provider to complete note  **% of ER encounters with notes completed and PCP identified as additional signer before hospitalist evaluation**  **% of ER encounters with accurate documentation**  **% of ER encounters where structured diagnoses in documentation match diagnoses managed** | p chart  histogram  p chart  p chart  p chart |
| ER provider completes EHR encounter form | ER provider documents the correct complexity of care | HIMS  Enterprise executive | **The ICD-10, CPT codes, and resident supervision modifiers permit billing at highest appropriate level**  **The ICD-10, CPT codes, and resident supervision modifiers accurately reflect complexity of care** | **% of ER encounters with codes that match the complexity documented in notes**  **% of ER encounters where structured diagnoses in documentation matches coded encounter forms** | p chart  p chart |
| HIMS reviews note and encounter form | HIMS submits documentation to third party insurers to collect for ER services rendered | Payors  Enterprise executive | Documentation supports the amount of reimbursement claimed  Payors approve and reimburse for all services rendered | # of claims denied  Revenue generated from ER encounter reimbursements per month\* | u chart  XmR chart |
| Next provider reviews details of ER encounter | Next provider of care receives timely summary of ER encounter | Patient | **Patient receives appropriate and timely care** | **# MR discrepancies on first inpatient day**  **% of patients discharged from ER receive follow up calls from clinic within 3d of visit** | u chart  p chart |

Electronic health record (EHR); emergency room (ER), health information management specialist (HIMS); medication/allergy reconciliation (MR); primary care provider (PCP)

There are several important points to highlight with this customer grid. First, because we described the process from end-to-end, we included many steps that do not directly involve use of the ED note template. Nevertheless, it is important to understand how the ED note may interact with all processes and stakeholders. Second, we have included in bold text those expectations and measures that directly link to the note and the business goals.

Each goal should be a measure we can count. Table **CS 1.2** indicates how we converted the business goals into quantitative measures. Some of the measures reflect the proportion of successful events divided by all opportunities, whereas others are counts of defects or process failures. Some goals are composites of several measures.

Table CS 1.2. Mapping the high-level business goal to key quality measures identified in the customer grid for overall quality.

|  |  |
| --- | --- |
| Business goal | Key quality measure |
| Note supports accurate coding and billing | encounters with accurate documentation  all encounters seen in ER |
|  | *plus* |
|  | encounters where documentation matches codes  all encounters in ER |
| Leaders can mine data in notes | encounters where all diagnoses evaluated during  visit are documented in note using structured fields  all encounters in ER |
| Note improves communication between providers | number of notes completed before hospitalist  assessment and with primary care provider copied to note  all encounters in ER |
| Note supports decision making | number of medication discrepancies on first inpatient day  for all patients admitted from ER |
|  | *plus* |
|  | number of patients receiving  follow-up call within 3d of ER evaluation  all patients seen in ER and discharged |

## Usability Specification Table

In the last example, we developed a clear idea of the business goals and performance measures. However, these are not necessarily UX metrics; they are quality metrics. Quality metrics reflect the performance of system, whereas UX metrics characterize the interaction between the user and the device. UX measures are specific to the human-computer interface. In the example above, many measures represent system outputs, but may not reflect user perceptions. This is an important distinction because both user perceptions and outputs influence system performance. In the Effective Technology Use (ETU) model, we see that user perceptions of the interface directly influence consistent and high quality use of the product (**Figure CS 1.4**) (Holahan, Lesselroth, Adams, Wang, & Church, 2015). If the whole system is not meeting standards, the root cause may relate to UX.

**Figure CS 1.4.** The Effective Technology Use model describing factors mediating technology adoption.

It is important to precisely and explicitly measure UX dimensions most likely to impact user perception, adoption, and performance. To do this, we create a usability specification table (Albert & Tullis, 2013). This is a common UX method for operationalizing usability. The table defines UX criteria by aligning dimensions with metrics and data collection methods. Each row in the table defines a range of values with thresholds for failure and success. While the team may not actually measure every usability attribute, seeing all dimensions in one place is useful for managing development of complex systems and identifying where design trade-offs need to be made. In **Table CS 1.3**, we list potential UX measures for the ER template. We included the three measures of usability described by the International Organization for Standardization (ISO) – effectiveness, efficiency, and satisfaction – and additional measures described by Whitney Quesenbery including desirability, error tolerance, and learnability (Barnum, 2010). In this example, we included one additional measure looking at ease-of-use because it precisely maps to the ETU model. However, we could have used a composite of other measures, such as efficiency and learnability, to operationalize ease-of-use. Notably, we did not include other usability measures often important in healthcare – safety and trustworthiness. These tend to be salient in studies of decision support, data visualization, or therapeutic delivery systems.

TAble CS 1.3. Example usability specification table for an emergency medicine note template.

| **Usability dimension** | **Measured value** | **Measurement instrument or method** | **Baseline performance**  **(pre-implementation)** | **Target performance**  **(post-implementation)** | **Worst acceptable level**  **(post-implementation)** | **Best display method** |
| --- | --- | --- | --- | --- | --- | --- |
| Effectiveness | Notes include chief complaint, MR, allergies, diagnoses, treatments administered, and PCP notification | Chart abstraction instrument with double-pass verification by two trained reviewers | 80% of notes include all six elements | 95% of notes include all six elements | 80% of notes include all six elements | Stacked bar chart |
| Efficiency | Number of mouse clicks to complete note | Mouse and keystroke collection using screen recording software | Average 5 mouse clicks with standard deviation of 2 clicks | Average 5 mouse clicks with standard deviation of 2 clicks | Average 7 mouse clicks with standard deviation of 2 clicks | Paired frequency distribution |
| Engaging  (i.e., desirability) | Average score | Net Promoter Score | Score +25 | Score > 35 | Score < 0 | Stacked bar charts of promoters, passives, and detractors |
| Error tolerance | Number of dialog elements that ER provider cannot complete | Direct observation with ordinal scale for errors | No errors or assists | No errors or assists | No errors; less than 2 assists | Frequency distribution |
| Learnability | Length of time required to complete ER note over three successive trials | Time-motion data collected with screen recording software | Average time per note 7.5m and no note longer than 10m | Average time per note 7.5m and no note longer than 10m | Average time per note 8m and no note longer than 12m and all notes complete | Frequency distribution of geometric means plotted over trials |
| Satisfaction | Average overall score | Post-session SUS | Overall average score 80 | Overall average score 80 | Overall average score 70 | Frequency distribution |
| Ease-of-use | Average score | Post-session SMEQ | Average score 15 | Average score 15 | Average score 35 | Frequency distribution |

Emergency room (ER); primary care provider (PCP); System Usability Scale (SUS); Subjective Mental Effort Question (SMEQ)

## Goal Traceability Scoreboard

We need to combine these sets of measures into one coherent plan. Frequently, high level goals and performance metrics are important to the organization but they are not directly influenceable. Conversely, though UX measures can be affected by design decisions, they don’t necessarily move the needle on enterprise performance goals. To demonstrate the cost-effectiveness of UX research and the return-on-investment, we must link influenceable UX measures (i.e., lead measures) to key process measures or enterprise performance measures (i.e., lag measures). To do this, we will use organize everything into a scoreboard called a goal traceability matrix. Based upon McChesney and colleagues’ popular business execution strategy, the matrix helps identify what actions are needed that will increase the probability of achieving your strategic goals (McChesney, 2012). **Table CS 1.4** is an example of linking lead UX measures to lag performance measures. In this example, we selected four lag measures (i.e., key quality characteristics from our customer grid) linked to the project brief and four lead measures (usability specifications from our usability specifications table) that trace to the strategic goals for the note template. It is rarely necessary to map every usability measure or every quality measure. Indeed, sometimes measures should be held “in reserve” and only acted upon in future project phases or as program objectives are updated. While we identified many more measures during creation of the customer grid and the usability specification table, time and resources will limit the scope of most project assessments. Therefore, it can be helpful for key stakeholders to rank and select measures based upon the overall impact to the product goals.

TAble CS 1.4. Example goal traceability matrix linking strategic goals to lead measures and lag measures.

| **Strategic goal** | **Lag measure**  **(key quality characteristic)** | **Lead measure**  **(usability specification)** | **Metric** | **Collection method** | **Display statistic** |
| --- | --- | --- | --- | --- | --- |
| Note improves communication between providers | % of ER encounters with notes completed and PCP identified as additional signer before hospitalist evaluation | Learnability or efficiency of note completion | Length of time required to complete ER note | Time-motion data collection using screen recording software | Frequency distribution of geometric mean |
| Note supports decision making | # MR discrepancies on first inpatient day | Effectiveness capturing key clinical data | Notes include chief complaint, MR, allergies, diagnoses, treatments administered, and PCP notification | Chart abstraction instrument with double-pass verification by two trained reviewers | Stacked bar chart |
| Note supports accurate coding and billing | % of ER encounters with accurate documentation | Satisfaction with system usefulness, information quality, and interface quality | Average overall score | Post session SUS | Frequency distribution |
| Note can be data mined by leaders | % of ER encounters where structured diagnoses in documentation match diagnoses managed | Error tolerance for entering structured diagnoses data | Number of dialog elements that ER provider cannot complete | Direct observation and ordinal scale for errors | Frequency distribution |

Emergency room (ER); primary care provider (PCP); medication and allergy reconciliation (MR); System Usability Scale (SUS).

In the scoreboard above, we elected to organize each row according to the high-level strategic goals of the project brief. This may make the most sense in command-control or hierarchical organizations where senior executives and management set priorities and project budgets. However, many healthcare organizations may have a matrix structure with multiple managerial accountability, several core competencies (e.g., care delivery and health advocacy), or a horizontal network of clinical stakeholders with relative autonomy (e.g., hospitalists and surgeons). In these situations, it may make sense to organize the scoreboard according to key stakeholders or roles. Each row of the table captures the relevant pain point, goal, or lever of change. In Table CS 1.5, we listed each stakeholder contributing to the future state process or impacted by system performance.

TAble CS 1.5 Example of goals traceability matrix organized by each customer traced through to the value proposition.

| **End user** | **Problem or scenario** | **Stakeholder expectation** | **Baseline usability performance** | **Target usability performance**  **(lead measure)** | **Quality impact or business goal**  **(lag measures)** | **Assessment strategy** |
| --- | --- | --- | --- | --- | --- | --- |
| ER triage nurse | Nurse needs to accurately document medications, allergies, chief complaint, and vital signs | Nurse efficiently documents the chief complaint,  MR, vital signs, and allergies in EHR before ER provider sees patient | Nurse completes each note in less than 10m | Nurse completes each note in less than 10m | % of ER provider notes that include MR, vitals, and chief complaint | Observation and time motion |
| ER provider | Provider needs to enter the information as quickly and easily as possible | The notes efficiently captures the complexity of care, clinical impressions, and plan | Average time per note 7.5m and no note longer than 10m | Average time per note 7.5m and no note longer than 10m | % of ER encounters where structured diagnoses in documentation match diagnoses managed | Time-motion data collection |
| Pharmacist | The correct allergy list, medication list, and clearance are available | The pharmacist has a medication history and allergy list available when confirming orders | 80% of nurse or ER provider notes include allergies and MR | 95% of nurse or ER provider notes include allergies and MR | # of clarification calls placed by pharmacist to physician | Chart abstraction instrument with double-pass verification by two trained reviewers |
| Next provider in care | Provider needs to be able to readily find key information to support decision making | The next provider knows the clinically important events | Overall average score 60 | Overall average score 80 | % of ER encounters with notes completed and PCP identified as additional signer before hospitalist evaluation | Post session SUS |
| Patient | The patient receives correct medications and therapies | Patient receives appropriate and timely care without disruption in continuity | 80% of notes include diagnosis, treatments administered, and PCP notification | 95% of notes include diagnosis, treatments administered, and PCP notification | # MR discrepancies on first inpatient day | Chart abstraction instrument with double-pass verification by two trained reviewers |
| HIMS | The documentation must support the highest level of billing possible | Documentation supports the amount of reimbursement claimed and payors reimburse for all services rendered | 70% of ER encounter codes match complexity documented in notes | 90% of ER encounter codes match complexity documented in notes | % of ER encounters with codes that match the complexity documented in notes | Chart abstraction comparing notes with encounter forms |
| Executive | The documentation must permit abstraction of coded diagnoses | The ICD-10, CPT codes, and resident supervision modifiers accurately reflect complexity of care for staffing and resource planning | Average SMEQ score 15 | Average SMEQ score 15 | % of ER encounters where structured diagnoses in documentation matches coded encounter forms | Observation, chart abstraction and post-session SMEQ |

Medication reconciliation (MR); electronic health records (EHR); emergency room (ER); primary care provider (PCP); Computer System Usability Questionnaire (CSUQ); Subjective Mental Effort Question (SMEQ)

## Conclusion

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## References

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