Towards Lean EHR Usability Heuristics for Behavioral Health Providers

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Abstract

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This thesis research sought to determine whether Lean principles and practices make applicable heuristics for evaluating electronic health record (EHR) usability for behavioral health providers. Over the past 10, years EHRs have quickly become part of standard practice in health care yet there is serious concern regarding their direct impact on provider efficiency, job satisfaction and burnout. A review of the literature highlights a notable lack of content regarding the EHR usability needs of behavioral health providers. I utilized contextual inquiry and qualitative analysis to identify the EHR usability needs of behavioral health providers. Furthermore, my research followed a validated domain-specific usability heuristic development methodology to attempt to establish Lean heuristics. The results of this study formed a set of EHR usability heuristics for behavioral health providers. Findings concluded that Lean principles and practices

contributed significantly to specific and applicable rules in the resulting heuristics to improve EHR usability.

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Chapter 1. INTRODUCTION

In the past decade, the United States health system has experienced a rapid transition to digital records. Seven years following the passage of the HITECH Act in 2009, the number of hospitals utilizing an EHR increased by over 733% (Adler-Milstein & Jha, 2017). As EHRs became part of standard practice following the passage of the HITECH Act, there was the expectation that EHRs would lead to improved care quality, safety and efficiency (Cailouet, 2012; Evans, 2016). However, during this large-scale adoption of EHRs, there quickly rose concern around the original hype of the HITECH Act as provider job satisfaction and burnout increased (Friedberg et al., 2014; Shanafelt et al., 2015).

Research has demonstrated that increased cognitive strain is a major contributor to provider burnout (Sinsky et al., 2017). Additionally, multiple studies have identified that health care staff attribute the cognitive strain experienced from the use of EHRs as a primary workload stressor (Meeks et al., 2014; Mosaly et al., 2018; Zhang, Franklin, Walji, Zhang, & Gong, 2014). Although health systems have seen substantial benefits from the use of EHRs, their usability has been found to be unacceptable by health care providers (Mosaly, Mazur, & Marks, 2016). The reality remains today that EHR usability is generally quite poor (Melnick et al., 2020). Unfortunately, these frustrations with EHRs often lead to increased risk in both user burden and provider burnout (Krenn & Schlossman, 2017). As stated by Melnick and colleagues (2020), "if EHR usability does not improve, increasing complexity could lead to compounded unintended effects on patient safety and physician burnout" (p. 485). Improving EHR usability is of great importance to solving provider burnout and frustrations.

EHR usability studies, including those previously referenced, provide some insight into how EHRs can be adjusted to improve user workloads and reduce burnout (Bae & Encinosa, 2016). These insights give EHR designers the start of pitfalls to avoid. For example, EHR designs can result in workflows where data entry is time consuming, visual displays are cluttered and/or presentation of information is found to be confusing (Howe, Adams, Hettinger, & Ratwani, 2018). Ultimately it is still up to the vendor to translate provider requirements into their own user experience design. As EHRs evolve, it becomes ever more critical that vendors can deliver relevant requirements in an intuitive manner that does not result in compromising cognitive burden. Though major advances have been made through the application of socio-technical theory in health IT topics, there still exist significant knowledge gaps regarding the understanding of providers' needs in the context of EHR-enabled health care delivery (Sittig & Singh, 2017). Zhang and colleagues, (2016) suggested that an inspection tool be developed to analyze existing EHRs for the cognitive strain they place on providers. These inspection methods have shown to be effective resources for both designers and evaluators in validating that an EHRs design will be found usable by providers as end-users (Tarrell, Grabenbauer, Mcclay, Windle, & Fruhling, 2015). Vendors realistically could utilize these assessments as a guide to designs EHRs found by providers to be highly usable and to increase efficiency.

Human-Computer Interaction (HCI) experts have long studied the usability of information systems; their research provides lessons learned and techniques to improve the usability and efficiency of EHR designs. One such technique, a heuristic evaluation is a well-established usability inspection method where reviewers assess a product against a set of heuristics to identify and classify usability violations (Dobre et al., 2017; Zhang, J., Johnson, Patel, Paige, & Kubose, 2003). These principles are referred to as 'heuristics' as they are more rules of thumb whose

adherence to improves the probability of delivering a usable product to the intended user. Heuristic evaluations are widely used as a discount method to identify usability problems efficiently and effectively for a particular product (Quiñones & Rusu, 2017). According to Anganes, Pfaff, Drury and O'Toole (2016), heuristic evaluations are one of the most widely utilized usability evaluation techniques, second only to that of observational usability evaluations. Heuristic evaluations have been found highly useful as they can be applied both inexpensively and quickly (Anganes et al., 2016). Thus, heuristic evaluations can be used where other usability evaluation techniques cannot because of time or cost constraints (McGrath, 2013). Not only are heuristic evaluations relatively quicker when compared to evaluations techniques requiring user involvement, they have been found to be highly accurate. Research has concluded that even users not formally trained in usability principles can effectively perform heuristic evaluations as 90% of identified problems by novice EHR users were validated by HCI experts (Tarrell et al., 2015). With the trend of software development cycles to become ever shorter it has been suggested that the use of heuristic evaluations will increase in importance in the future (Anganes et al., 2016). Moreover, the utilization of EHR specific heuristic evaluations align with the recommendations by Zhang and colleagues as previously discussed.

The underlying assumption of a heuristic evaluation is that the established pre-determined, applicable, and agreed upon heuristics are relevant to the application domain being evaluated. Traditionally HCI experts, including medical usability researchers, have focused on the utilization of Nielsen's 10 Usability Heuristics (aka Nielsen's heuristics) as their heuristics of choice (Fuentes, 2017). However, considering each application domain contain features and usability requirements that differentiate it from other [types of] applications, traditional heuristics, such as Nielsen's heuristics, are often not suitable to specialized domains including aeronautics or medical

applications (Quiñones, Rusu, & Rusu, 2018). Because of the broad and generally complex use of an EHR, there is a need for the establishment of more specific EHR usability heuristics across different medical specialties (Tarrell et al., 2015). Most significantly research has been performed on the usability needs of medical physicians. For example, EHR usability studies by Lanham and colleagues (2014), Wright and Marvel (2012) and Khairat and colleagues (2018) focused on traditional medical provider specialties in traditional medicine, not covering usability needs of behavioral health providers. One specialty that lacks in their understanding of usability needs as evident by the lack of literature is that of behavioral health providers.

In efforts to improve operational efficiency, health systems around the globe have adopted process improvement methodologies such as those found in *Lean* methodology (aka the Toyota Production System) (Costa & Filho, 2016). As described by Toyota Motor Corporation (2019), *Lean* is a "system based on the philosophy of achieving the complete elimination of all waste in pursuit of the most efficient methods" (para. 1). *Lean* methodology is a technique often utilized for the improvement of socio-technical processes, that is processes that involve interaction between people and some form of technology (Pasmore, Winby, Mohrman, & Vanasse, 2019). Concluded as part of a comprehensive literature review, researchers found that *Lean* is effective at different scales of implementation—in a single operation to an entire supply chain process (Panwar, Nepal, Jain, & Rathore, 2015). Multiple research efforts found the use of *Lean* methodologies in EHR workflow efforts resulted in improved user efficiency, improved care quality and a reduction of errors (Bosse & Kelly, 2016; Dinkins, Mcveigh, Arnold, & Banta, 2018; Neelakantan, 2018). Considering the *Lean* methodology has proven effective in guiding the delivery of consumer value and waste reduction, *Lean* principles show considerable promise to act as a general guide to reduce the EHR workflow waste and user burden.

1.1 RESEARCH GOAL

The primary goal of this research was to identify an overarching set of usability heuristics which can serve to guide the design and evaluation of EHRs, specifically those used by behavioral health providers. The main research question addressed was—"which, if any, *Lean* principles and practices are applicable usability heuristics for behavioral health providers?" This research focused on workflow process in the EHR and on suggesting a set of usability heuristics guided by *Lean* principles and practices where applicable. EHR use is naturally complex considering the function they must serve, plus these functional requirements can vary depending on the specialty of the provider (Zhang et al., 2016). Therefore, it was considered paramount in this research for the development EHR heuristics to obtain usability data directly from the user.

To meet this goal two studies were performed as part of this research to achieve the following aims and to answer the following research questions:

Aim 1—Investigate and describe the usability needs of behavioral health care providers for effective use of an EHR.

RQ1: What are the features and characteristics of a usable EHR for behavioral health providers?

Aim 2—Define usability heuristics utilizing *Lean* principles and practices in the domain of EHRs used by behavioral health care providers.

RQ2: Using *Lean* principles and practices were applicable, what are the usability heuristics which can guide design and evaluate a usable EHR for behavioral health providers?

The studies employed to answer these questions demonstrated the use of qualitative methods in conjunction with theoretical concepts to assess provider usability needs and identify applicable usability heuristics. To present these objectives, this thesis is structured as follows:

Chapter 2 presents the literature review that motivated this research; Chapter 3 outlines the research method used; Chapter 4 details the methods and results for **Aim 1**; while Chapter 5 details the methods and results for **Aim** 2; Chapter 6 includes research findings and discussion, suggests future research then offers the concluding remarks of this research.

1.2 Relevance and Significance

Regarding the utilization of *Lean* as a tool for assessing an EHR's effectiveness, there exist numerous principles and practices which can potentially be utilized. Such methodologies include the utilization of Define, Measure, Analyze, Improve and Control; process mapping and time-series analyses (Bosse & Kelly, 2016; Neelakantan, 2018). However, the main reasons *Lean* initiatives fail is due to the utilization of the wrong *Lean* principle(s) to solve a problem (Costa & Filho, 2016). Moreover, the implementation of *Lean* often requires some degree adaptation to ensure it best serves the processes unique needs (Panwar et al., 2015). This research can help guide additional efforts seeking to utilize *Lean* for the sake of assessing an EHR for usability and efficiency.

Usability heuristics have been established for acting as a general design guideline and evaluation explicitly for EHR applications (Tarrell et al., 2015). Yet, this has not been done taking into consideration the distinct usability requirements of behavioral health providers. To create usability heuristics applicable to behavioral health providers this research sought to better understand the usability of this group. These heuristics can significantly affect the development of solutions in the behavioral health software industry with the realistic potential to be utilized in other medical specialties. Additionally, these heuristics may play a significant role in the selection of EHRs by behavioral health clinics.

Provider burnout is a phenomenon that has a profoundly negative effect on the US health care system (Domaney, Torous, & Greenberg, 2018). Moreover, considering the EHR usability heuristics in this study are established on a framework of waste reduction, where compliant with these heuristics, providers may see a reduction in commonly experienced waste. It is plausible that this reduction in waste would ultimately reduce provider burnout. Future studies are required to validate this reality.

Chapter 2. BACKGROUND

In chapter 1 I outlined the rationale for this research for the creation of *Lean* usability heuristics for behavioral health providers. This chapter presents the findings from the literature across three areas to both contribute to the research and to support an understanding of the following chapters. The first section of this chapter details the utilization of heuristics in health care and their gaps. Moreover, this section provides the reasoning for the method utilized to develop the usability heuristics done in this study. The second section describes general usability consequences experience by providers along with research gaps on providers' usability needs. The third and final section of this chapter reviews *Lean'*s role in health care and presents the *Lean* principles and practices covered in the literature. It is these principles and practices that the study for **Aim 2** utilized in the selection of applicable usability heuristics.

2.1 USABILITY HEURISTICS

2.1.1 *Usability Heuristics in Health Care*

It is difficult for non-providers to fully appreciate the complexity of their tasks are, how poorly we understand said tasks and how easily even honest people can make different conclusions of requirements and needs (Lanham et al., 2014). This reality creates a substantial risk in being able to achieve providers' objectives in the design of an EHR. The National Institute for Standards and Technology (NIST) strongly advices that EHR vendors follow a human-centered design process (Schumacher & Lowry, 2010). Heuristic evaluations are a valuable component of the human-centered design process—identifying usability problems that can risk users' satisfaction with the technology (Turner-Bowker et al., 2011). Heuristic evaluations are especially of value in uncovering concerns where designers and developers are unaware of optimal design practices

(Kellogg et al., 2017). Studies demonstrate that the utilization of both user testing or heuristic evaluation can be helpful in the identification of distinct usability problems (Hasan, Morris, & Probets, 2012). Both approaches are likely to identify problems missed by the other. To obtain a comprehensive understanding of existing usability problems user testing and heuristic evaluations should be used together.

To evaluate a specific domain, several researchers have attempted to adjust Nielsen's heuristics to accommodate the specific requirements of that domain. Nielsen's heuristics are shown in Table 2.1. In the domain of EHRs, Nielsen's heuristics has been augmented by AHRQ, HIMSS and NIST to describe the usability requirements for care providers. Though based on Nielsen's heuristics the focus and approach taken by each of the EHR heuristics varied.

Table 2.1. Nielsen's 10 Usability Heuristics

ID	Heuristic
H1	Visibility of system status
H2	Match between system and the real world
H3	User control and freedom
H4	Consistency and standards
H5	Error prevention
H6	Recognition rather than recall
H7	Flexibility and efficiency of use
H8	Aesthetic and minimalist design
H9	Help users recognize, diagnose and recover from errors
H10	Help and documentation

(Nielsen, 1994)

Developed in 2009 by a specially convened EHR Usability Task Force, the HIMSS heuristics was the first set of usability specifically for use with EHRs (Belden, Grayson, & Barnes, 2009). This task force, comprised of medical and health information technology experts, performed a literature review of usability principles, focusing on those related specifically to EHRs

where available (Belden et al., 2009). Ultimately, most of their resulting heuristics fell within the domain of both Nielsen's heuristics along with the also well-established Shneiderman's Eight Golden Rules usability heuristics (Tarrell et al., 2015). Outside the Nielsen-Shneiderman heuristic set, the HIMSS task force did suggest a new heuristics category titled 'Effective Information Presentation.'

In 2009, AHRQ in similar fashion to HIMSS also commissioned a task force to study heuristic evaluation and usability analysis of EHRs (Armijo, McDonnell, & Werner, 2009). The AHRQ task force established a broad set of heuristics, breaking them into two distinct categories—general design principles and those principles found to be unique to EHRs (Armijo et al., 2009). For general design principles, serendipitously members of the AHRQ task force also recommended the use of the Nielsen and Shneiderman heuristics like the HIMSS usability task force. The category of EHR specific principles covered the topics of information visualization, graphic design, supporting collaborative work practices, default values and EHR navigation (Armijo et al., 2009). Of all the proposed EHR usability heuristics, the AHRQ set has the most significant expansion beyond the traditional Nielsen and Shneiderman heuristic frameworks (Tarrell et al., 2015). Additionally, the final AHRQ report went beyond the establishment of usability heuristic evaluations and included applying use case development along with several actual use case scenarios.

Like HIMSS and AHRQ, NIST established a of team of medical and usability experts to produce their own set of usability heuristics. The *Technical Evaluation, Testing and Validation of the Usability of EHRs* report, otherwise known as NIST 7804 was released in 2012. Using several rounds of gathering public comments, the usability heuristics included in NIST 7804 match almost exactly with the original Nielsen heuristics (Lowry et al., 2012). One exception to this is the

expansion of the error heuristic to more specifically describe the types of errors that must be considered in the use of EHRs (Lowry et al., 2012). Furthermore, the NIST 7804 heuristic evaluations scored interface problems on the likelihood of error and the error severity identified rather than its impact on usability (Lowry et al., 2012). Though identifying the potential of errors within an EHR design is a positive, usability experts express that this perspective adds complexity in the evaluation (Tarrell et al., 2015). These doubts come from the fact that HCI analysis are often not qualified to assess the potential effects of EHR errors; additionally, usability problems can exist, yet they do not pose a risk for error (Sittig & Singh, 2017).

As stated by Unertl, Holden and Lorenzi (2016) across the different types of medical specialties there exists an immense number of workflow needs. Moreover, they suggested that usability and effective workflow design are paramount contextual factor for a successful implementation of an EHR. The development of usability heuristics comprehensive enough to cover a broad number of workflows runs the high risk of missing the usability nuances critical to individual medical specialties. For example, general physicians interact with an EHR differently than an emergency department physician compared to that of a behavioral health provider. Without applicable heuristics the evaluation will neglect to highlight the important usability constraints that are necessary to an effective evaluation. Tarrell and colleagues (2015) concluded that the different EHR heuristics just discussed have limited agreeance on their guidelines though they are intended to be specific for the evaluation of EHRs.

2.1.2 *Usability Heuristic Development*

Outside the domain of EHRs, there are numerous examples in the literature for the development of domain specific usability heuristics. To identify the processes taken to develop domain specific heuristics, Hermawati and Lawson (2016) identified 70 distinct studies building domain

specific usability heuristics. Across these studies it was determined that there was a lack of standard practice in developing domain specific heuristics; furthermore, most studies do not include the reasoning for the methods they follow to develop usability heuristics (Hermawati & Lawson, 2016). Researchers determined that heuristic development generally consisted of two-stages--extraction of usability information and transformation of this information into heuristics (Hermawati & Lawson, 2016). Multiple systematic review shows that, while there is pattern on how usability heuristics are established for specific domains, both the rigor and robustness of these studies vary from one to another (Hermawati & Lawson, 2016; Quiñones & Rusu, 2017). Often domain specific usability heuristics are crafted based on the researchers' own extensive experience or by adapting methods typically utilized for other purposes (Quiñones, Rusu, Roncagliolo, Rusu, & Collazos, 2016).

Studies assessing the utilization of heuristic development processes have come to a common conclusion, there is a lack of adherence to any kind of validated heuristic development methodology (Lechner, Fruhling, Petter, & Harvey, 2013; Quiñones & Rusu, 2017). Nonetheless, following a formal process to develop heuristics is important to develop effective and efficient sets of heuristics to evaluate usability (Jimenez, Lozada, & Rosas, 2017). Ineffective heuristics fail to find usability problems; while inefficient heuristics fail to find more usability problems than existing sets, will identify non-critical problems or are not specific to the domain being evaluated (C. Jiménez, C. Rusu, S. Roncagliolo, R. Inostroza, & V. Rusu, 2012).

Over the past decade there has been a handful of attempts to establish formal and rigorous methods for the creation of domain specific heuristics. Seeking to answer in 2016—do current usability heuristic development methodologies propose a formal and systematic process to specify and validate usability heuristics, in 2017 researchers identified four studies suggesting

a systematic process for developing domain specific heuristics (Quiñones & Rusu, 2017). Yet the researchers concluded that these methodologies lacked the specifics and clarity necessary to be effective formal specifications. Inostroza and colleagues (2016) also concluded at the time of their research that there currently did not exist any formal methodology for specifying and validating usability heuristics. Quiñones, C. Rusu and V. Rusu (2018); and Figueroa, Jiménez, Allende-Cid and Ledger (2019) both built on these previous studies and established two formal methods for developing domain specific heuristics. These methods, built upon previous research and experience, represent effective and rigorous methods for developing and validating domain specific usability heuristics.

2.2 EHR USABILITY

EHRs have existed for multiple generations, however, not until approximately 2010 did their prevalence really increase (Mennemeyer, Menachemi, Rahurkar, & Ford, 2016). There has been insignificant time to both identify and resolve the greatest usability limitations and barriers with EHRs (Bowman, 2013). This section of the literature review highlights empirical findings in the usability characteristics of health care providers, EHRs usability concerns and where gaps in research still exist.

2.2.1 *The EHR Consequence*

With the passing of the HITECH Act in 2009, the Department of Health and Human Services was authorized to establish programs to improve health care quality, safety and efficiency through the promotion of health IT in the form of EHRs and electronic health information exchanges (Adler-Milstein et al., 2017). Following the passage of HITECH there was substantial private and public investment to fund both the development and adoption of EHRs across the country. The

investment in health IT was made on the premise, backed by compelling empirical evidence, that EHRs lead to improved quality and efficiency of care (Adler-Milstein & Jha, 2017). As EHRs began to be adopted, some of their strengths quickly became apparent. For example, higher levels of EHR adoption has been associated with increased performance regarding process adherence to different value-based purchasing rules. Process adherence was found to go from 88.2% to 94.4% following the full implementation of an EHR (coefficient = 0.22) (Adler-Milstein, Everson, & Lee, 2015).

Research has demonstrated EHRs come with the trade-off often in the form of net efficiency loss by the provider in the course of records management (Khairat et al., 2018). The adoption, usability and functionality of EHRs have failed to live up to the promise of increased provider productivity (Krenn & Schlossman, 2017). Khairat et al. (2018) found that 72% of care staff sampled did not find that their EHR was able to improve their workload. Additional studies have found that more than half of care staff surveyed feel burned because of the EHR (Meeks et al., 2014). Emergency medicine physicians have been found to spend close to half their shift on data entry, resulting in over 4,000 clicks per day (Khairat et al., 2018).

Cognitive strain results from overly complex navigation, inconsistent application workflows, excessive mouse clicks (Bae & Encinosa, 2016; Herndon et al., 2017). A survey of over 1,700 physicians found that more than 75% of physicians reported EHRs increased the time it takes to review, plan, order and document care (Khairat et al., 2018). A 2017 study performed by the American Medical Association found that because of their frustrations with EHRs 1 in 5 physicians were either planning to reduce their hours worked or quit practicing altogether (Sinsky et al., 2017). At a time when health care resources are becoming ever scarcer this burden from the EHR cannot be accepted as the status quo.

Typical designs of EHRs have created several safety concerns for its end users. An additional theme in the literature regarding EHR burnout is the failure to meet information display needs (Cohen et al., 2020). A study by Meeks and colleagues (2014) found that the most reported safety concern was a mismatch between the information needed by the end-user and the actual content that was displayed. For example, this could come in the form of the user being required to review multiple screens to determine status of an order or the priority of required tasks. These unmet information needs of actual content displayed are not only a serious safety concern, but a common frustration for providers and increases the total time to perform their job (Meeks et al., 2014; Tanner, Gans, White, Nath, & Pohl, 2015). A study performed across 209 primary care practices found that the mismatch of information or information display errors within the EHR resulted in the unintended consequences of delays in treatment, dosing errors and even failure to detect fatal illnesses (Tanner et al., 2015).

A growing concern is that of the integrity of the actual clinical data (e.g., medications, labs) and documentation within the EHR (Murphy & Reddy, 2017). These integrity concerns cover missing, inaccurate, incomplete, or even an excessive amount of data also known as note bloat (Kahn et al., 2018). The form design for clinical data entry has been found to influence whether relevant data making it into the EHR but being entered in the wrong location (Kahn et al., 2018). When there are data integrity concerns across a patient or an entire population, EHR functions also lose integrity, risking patient safety and care quality. Such risks include incomplete clinical decision support or medication interaction checks; moreover, providers' ability to make the correct medical decisions is limited (Cifuentes et al., 2015; Lavin, Harper, & Barr, 2015; Murphy & Reddy, 2017). At a larger scale, incomplete data limits the extent to which the health of a

population can be managed and limits the potential in research (Hripcsak, Forrest, Brennan, & Stead, 2015).

At the same time that the health care industry is concerned with the integrity of clinical data and documentation, there is an increase in the required data to be collected in clinical documentation; this increased expectation is especially problematic for behavioral health care providers (Matthews, 2017). Unfortunately, as the documentation requirements increase for a provider, the risk of provider burnout and poor data integrity increases (Matthews, 2017). Furthermore, research demonstrates that increased documentation requirements create a time burdens on providers and limit their time with patients (Munyisia et al., 2013). Recognizing the serious effects data integrity can have on patient care, EHRs designers must understand how to accommodate increasingly complex workflows, including data collection, resulting in high data integrity while ultimately reducing provider burden.

2.2.2 *High-Value Return Opportunities in EHR Usability*

Even with highly usable EHRs, the reality remains that administering care is complex and thus EHRs have an inherent degree of complexity. Even technology proficient providers are inefficient in a usable EHR if they are unfamiliar with the time saving features (Raglan, Margolis, Paulus, & Schulkin, 2017). Outreach and training for providers in their use of an EHR have both been found to increase efficiency and satisfaction with the EHR (DiAngi, Stevens, Halpern-Felsher, Pageler, & Lee, 2019; Ramsey et al., 2016). Nonetheless, as EHRs evolve training is typically a recurring job and often perceived as an interruption for providers. EHRs that can embed training and proactively inform providers of opportunities to improve efficiency not only improved efficiency and provider satisfaction but also improved best practices (DiAngi et al., 2019).

The quality and utility of an EHR is reliant upon the tool having alignment with workflows, tasks and the cognitive processes of the users (Howe et al., 2018). Unfortunately, EHRs often lack functionality necessary to support the workflows unique amongst behavioral health providers. Woodson and colleagues (2018), concluded that general EHRs often leave behavioral health providers in need of: 1) automation and tracking of paper-based screenings; 2) documentation for behavioral health history; 3) accessibility to social and medical history applicable to behavioral health issues; and 4) quickly document and track patient progress.

As described herein, the literature does cover topics of EHR usability considerations for behavioral health providers. Yet these research efforts often focus on specific use-cases such as collaboration amongst primary care and behavioral health providers. In the review of the literature there was a notable lack of content regarding general usability and functionality needs for behavioral health providers in their use of an EHR. Of the final 16 studies included in this portion of the literature review, three of them (18.75%) had incorporated the role of behavioral health providers, none of which though explored broad usability considerations of behavioral health providers.

2.3 LEAN

The *Lean* methodology is a management approach for improving the efficiency of processes based on systems of interrelated socio-technical (mix of people and technology) practices (Bortolotti, Boscari, & Danese, 2015). *Lean* is a popular and beneficial technique for any sector that is process driven (Costa & Filho, 2016). This section of the literature review explores the different principles and practices under the *Lean* umbrella followed by the utilization of *Lean* within the health care industry.

2.3.1 *Lean Principles and Practices*

Although *Lean* is holistically simple, its broad forms of implementation make it difficult to define (Osterman, 2020). The concept of *Lean* has been interpreted in many different ways (Arlbjørn & Freytag, 2013). *Lean* has been described as having both philosophical and practical dimensions embedded across three levels of *Lean* thinking—philosophy, principles and practices and tools as shown in Figure 2.1 (Arlbjørn & Freytag, 2013; Hines, Holweg, & Rich, 2007). The *Lean* philosophical thinking extends beyond the principles, practices and tools used for process improvement and waste reduction, but also entails principles in organizational culture. Such cultural principles include but are not limited to establishing trust amongst and between teams and employee development (Dorval, Jobin, & Benomar, 2019). I did not review Lean cultural principles as part of this study.

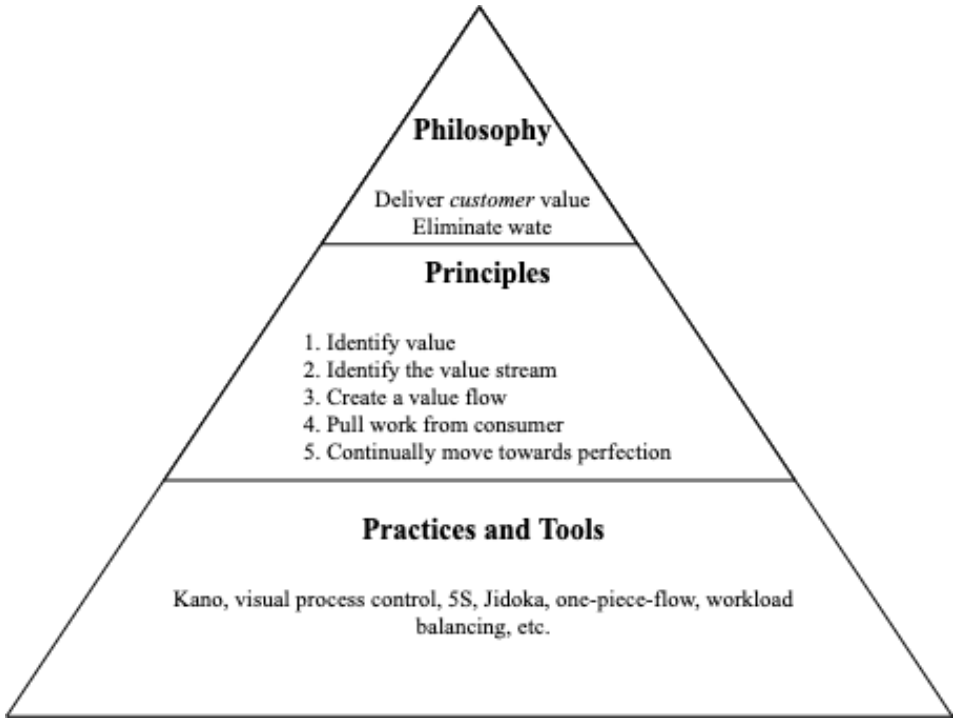

Figure 2.1. Levels of *Lean* thinking by Arlbjørn and Freytag (2013); and Hines et al. (2007)

The core philosophy of *Lean*, the first level of *Lean* thinking, is developing customer value and eliminating waste (Hines et al., 2007; Ohno, 1988). This philosophy typically occurs through continual improvement of processes through the removal of non-value adding actions, or 'waste' (Ohno, 1988). Taiichi Ohno, the initial creator of *Lean* at Toyota, originally defined seven categories of waste, later adding an eighth. These categories of waste have been adapted for use in the health care setting (NHS Institute for Innovation and Improvement, 2007). Table 2.2 defines these categories of waste along with providing examples of their application in the health care setting.

Over the 20th century many companies throughout North American, Europe and Japan were stuck searching for a formula for sustainable growth and success; over this time organizational leaders lost sight of consumer value and how to create it (Womack & Jones, 1996). Seeking ways to accurately deliver value, Womack and Jones (1996) found that by focusing on existing processes, products and outdated definitions of value, leaders create waste and often stagnation resulted. In their research efforts Womack and Jones researched the Toyota Production System and established five principles for adding value, outlined in Table 2.3. These five principles make up the second level of *Lean* thinking (Hines et al., 2007; Womack & Jones, 1996). These principles focus first on value then on efficiency; ranging from the identification of the consumer value, removal of non-value adding through the analysis of the value stream and aligning the process of value creation and delivery with a demand-pull system to establish flow (Lyons, Vidamour, Jain, & Sutherland, 2011).

Table 2.2. *Lean* categories of waste

Waste	Definition	Example
1. Transportation	Movement of people or products that are not actually required to perform a process	*Transportation:* • staff walking to the other end of a ward to pick up notes • central equipment stores for commonly used items instead of locating items where they are used
2. Inventory	All goods, components, work in progress and finished products that cannot produce value.	*Inventory*: • excess stock in storerooms that is not being used • patients waiting to be discharged • waiting lists
3. Motion	Individuals or equipment moving more than necessary to perform a job. In contrast to transportation, motion refers to the damage and costs inflected on what creates the product.	*Motion*: • unnecessary staff movement looking for paperwork, • not having basic equipment in every examination room
4. Waiting (Delay)	Waiting for the next process step.	*Waiting for:* • Patients, staff results, prescriptions and medicines • doctors to discharge patients
5. Overproduction	Production of an element or product before it is being asked for or required.	*Overproduction*: • requesting unnecessary tests from pathology • keeping investigation slots 'just in case'
6. Over-processing	Doing more work than necessary to produce a functioning good or service.	*Over-processing:* • duplication of information • asking for patients' details several times
7. Defects	Effort required in inspecting for and fixing defects.	*Corrections*: • readmission because of failed discharge • repeating tests because correct information was not provided
8. Non-utilized Talent*	Not effectively utilizing, or at all, the talent and skill set of the workforce.	*Non-utilized Talend:* • failure to train providers in new diagnostic techniques • providers performing jobs below their licensure

*Not part of the original seven categories of waste
(NHS Institute for Innovation and Improvement, 2007; Ohno, 1988)

Table 2.3. Waymack & Jones five *Lean* principles

Principle	Definition
1. Value	Identify and specify the value desired by the customer.
2. Value stream	Identify the value stream for each product/service providing that value and, challenge all of the wasted steps.
3. Flow	Make process flow continuous. With a complete flow, the focus on the consumer deliverable (e.g., a "cure") is never left out of sight from beginning to completion. Standardize processes around practices which allow them to run more smoothly and free up time for creativity and innovation.
4. Pull	Utilize task pull between all process steps where a continuous flow is not possible. Focusing on customer demand/value and trigger events backwards through the value stream.
5. Perfection	Move towards process perfection so non-value adding activities are removed from the value chain thus the number of steps, amount of time and information needed to serve the consumer continually falls.

(Womack & Jones, 1996)

As *Lean* has grown in popularity there exists evidence to the introduction of additional practices that full under the *Lean* umbrella (Panwar et al., 2015). These additional practices often fall under the third layer of *Lean* thinking, practices and tools (Hines et al., 2007). Multiple systematic reviews plus grey literature from well-established *Lean* practitioners identified 21 different practices and tools and are shown in Table 2.4 (Costa & Filho, 2016; George, Rowlands, Price, & Maxey, 2005; Panwar et al., 2015). According to Radnor and colleagues (2012), *Lean* practices and tools are classified based on their purpose, including—assessment, improvement and monitoring. Costa and colleagues (2016) describe these categories as follows:

- Assessment practices are used in the review existing organizational processes performance in regards of their waste, flow and/or capacity to add value.
- Improvement tools are used for supporting and improving processes.
- Finally monitoring tools are used to measure processes and any improvements made, or the lack thereof.

Table 2.4. *Lean* practices and tools classification

Classification	Lean practices and tools
Assessment	5 Whys
	Systematic problem solving
	Process mapping
	Value stream mapping
	Gemba walking
	Kano
Improvement	5S's
	Spaghetti diagram
	Workload balancing
	Andon
	Jidoka
	Kanban
	One-piece-flow
	Poka-yoke (Mistake-proofing)
	Heijunka (Production leveling)
	Reduced changeover time
	Group layout
	Total preventative maintenance
	WIP
	Visual process controls
Monitoring	Visual Management

(Costa & Filho, 2016; George et al., 2005; Panwar et al., 2015)

Literature suggests that *Lean* practices are not industry specific and particularly 5S, work standardization and visual control are used extensively in process heavy industries (Panwar et al., 2015). 5S itself is a methodology that contains five sub-practices with the objective of reducing waste and optimizing productivity through maintaining an orderly workspace (Chandrayan, Sharma, & Solanki, 2019). The 5S practices are described in Table 2.5. 5S is referred to as the five keys to a total quality environment and is the often the first *Lean* practice implemented in organizations (Chandrayan et al., 2019; Osada, 1991). This practice aims to instill values of neatness, standardization, organization, cleaning and discipline into an organization (Osada, 1991).

Table 2.5. 5S

5S Practice	Objective
1. Seiri (sort out)	Sorting of the clutter through the removal of all items that clearly do not belong in the working area and leaving only those required to complete the current task.
2. Seiton (set in order)	Also referred to as straighten, is the arrangement of necessary items in an efficient placement/order, often utilizing ergonomic principles. In meeting this objective everything has a home and is in its home.
3. Seiso (shine)	Is the thorough cleaning of a work area, tools and other equipment so that it is always in a nearly new state. A clean workspace easily exposes defects and creates an aesthetic that can boost morale.
4. Seiketsu (standardize)	Establishes that what has been to sort out, set in order and shine becomes standardized.
5. Shitsuke (sustain)	Ensuring that the organization continues to improve workspace efficiency through the utilization of the other 5S practices.

(Chandrayan et al., 2019)

2.3.2 *Lean Efficiency Gains in Health Care*

Around the world there is growing pressure on public services to increase efficiency through the adoption of concepts and methodologies commonly associated with manufacturing. A review of the literature found that 51% focused their efforts on the *Lean* methodology, with 35% stating their use being in the health care sector (Radnor et al., 2012). Figure 2.2 shows the frequency to which *Lean* practices and tools are utilized within the health care setting according to their classification, i.e., assessment, improvement and monitoring (Costa & Filho, 2016). A separate systematic literature review found that in health care the implementation of *Lean* has tended to involve the application of a narrow selection of practices and tools (Radnor et al., 2012). These techniques are often utilized as part of a 'rapid improvement event' rather than a broader system-wide philosophy for improvement (Radnor et al., 2012).

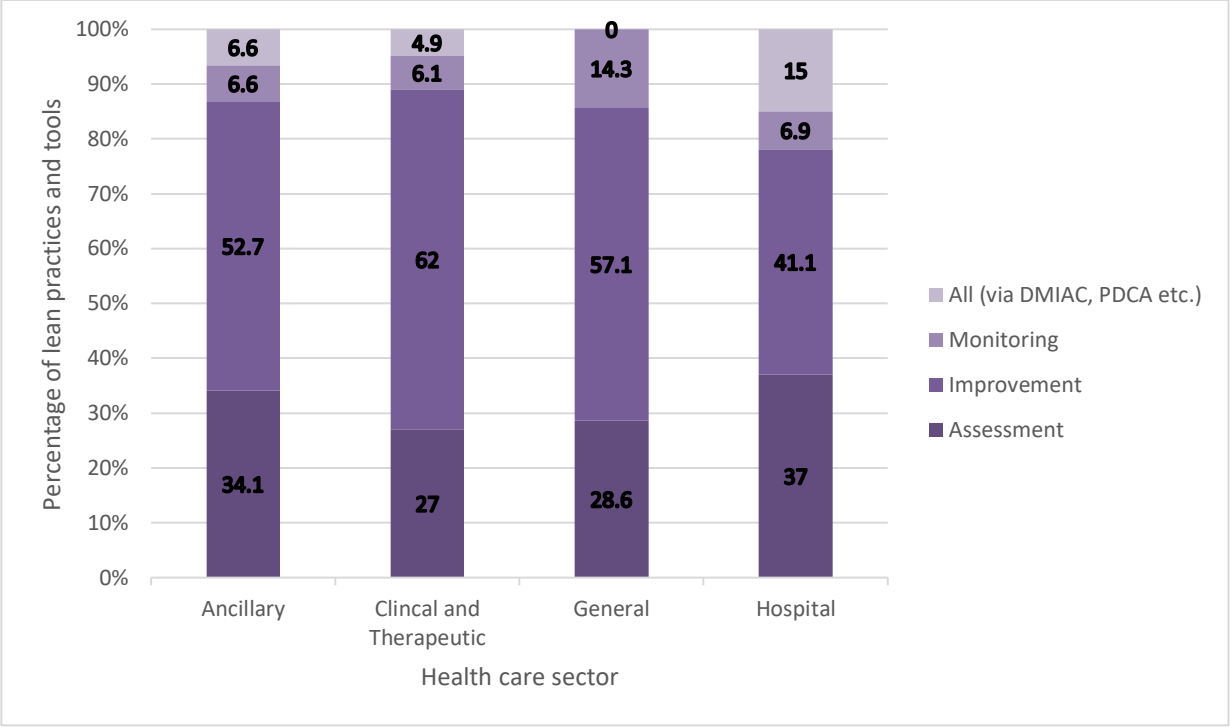

Figure 2.2. Percentage of *Lean* practices and tools by Costa and Filho (2016)

There is growing evidence on *Lean*'s impact on both tangible outcomes such as quality, cost and time as well as intangibles such as increased employee motivation and customer satisfaction (Radnor et al., 2012). *Lean* principles and practices and capable of improving the ability for individuals to perform their job as well as to facilitating to process innovations (Fagerlind Ståhl, 2015). Physicians are often difficult to engage in development work including process improvement initiatives (Lindskog, Hemphälä, & Eriksson, 2017). Examining the effectiveness in the utilization of *Lean* practices and tools by providers and employees, Lindskog and colleagues (2017) found promise in the use of 5S, visual follow-up boards and value stream mapping. The use of and these practices resulted in increased engagement by provider and employee in suggesting ideas for process improvement even were resources were scarce. Providers reported that these practices acted as remedies in overcoming inhibitors factors to creativity (Lindskog et al., 2017).

To address the issue of overly complex navigation and task completion experienced in EHRs, the *Lean* method has been utilized to redesign inefficient components of EHRs. Following *Lean* practices of the define, measure, analyze, improve and control (DMAIC) framework, the Mayo Clinic modified their existing patient care documentation system within the EHR; the results of their quality improvement initiative were a reduction in time spent using the EHR from 2.8 hours per day to 1.9 hours per day per therapist (Dinkins, McVeigh, Arnold, & Banta, 2018). Moreover, in a separate quality improvement initiative performed by Bosse and Kelly (2016), utilizing *Lean* methods researchers redesigned certain workflows in an EHR module to eliminate 10 nonessential inputs, remove 21 redundancies and remove nine overhead functions.

2.4 SUMMARY

This literature review highlighted that though EHR usability heuristics have been established, they lack focus on the needs of behavioral health providers. Additionally, the final results of these heuristics aligned closely with Nielsen's heuristics. Historically the creation of domain specific usability heuristics often lacked rigor in the methods in which they follow. Quiñones and colleagues (2018) established a validated method for developing applicable and accurate domain specific usability heuristics. Though there is a notable number of published research efforts exploring the usability needs of medical providers, there is a lack of research for these general needs for behavioral health providers. *Lean* has proven itself a diverse tool for quality and efficiency improvement in the health care sector, including improving EHR workflows. Additionally, this literature review identified over 40 different *Lean* principles and practices which can be classified as general foundational principles, waste classification, tools and workspace management. These different principles and practices have the potential to be utilized as heuristics in the right context.

Chapter 3. APPROACH

3.1 Overview

Following a formal process to develop heuristics is very important to develop effective and efficient sets of heuristics to evaluate usability (Jimenez et al., 2017). The research I report followed the process of developing formal heuristics for behavioral health providers utilizing the method outlined by Quiñones and colleagues over two peer-reviewed articles (Quiñones et al., 2018; Quiñones & Rusu, 2019). This method was developed for the purpose of creating domain-specific usability and user experience heuristics; moreover, the methodology it outlines has been utilized over several different case studies and has been validated through expert opinions (Quiñones & Rusu, 2017; Quiñones et al., 2018). This thesis project utilized qualitative analysis for the identification of usability needs of behavioral health providers. This chapter outlines the methods taken for the creation of *Lean* thinking usability heuristics for behavioral health providers in their use of an EHR. The specific details of the methods taken to meet **Aims 1 and 2** can be found in their associated chapters. This research project was reviewed and approved by the University of Washington IRB as shown in **Appendix B**.

3.2 Heuristics Creation Outline

The process for developing formal usability heuristics following the method defined by Quiñones (2018) and colleagues and was executed over a series of 5 stages as shown in Figure 3.1. **Aims 1 and 2** of this research were accomplished with the completion of these 5 stages. These stages can be briefly described as:

- **Stage 1- Exploration**: Domain information useful for the development of usability heuristics were collected along with the identification of *Lean* principles and practices

through a review of the literature. Domain information includes usability and user experience attributes and general and specific application features (Quiñones et al., 2018). A review of literature for domain information is critical to the success of developing domain specific heuristics – otherwise the proposed heuristics are being developed in a silo (Quiñones & Rusu, 2017). Details regarding this stage are presented in Chapter 4.

- **Stage 2 – Contextual Inquiry and Usability Description**: Additional domain information were collected through the direct observation of behavioral health providers utilizing an EHR following the practice of contextual inquiry (Holtzblatt & Beyer, 1997). Results were analyzed using template analysis to obtain a deeper understanding of usability needs specific to behavioral health providers (Crabtree & Miller, 1999). Details regarding this stage are presented in Chapter 4.
- **Stage 3 – Domain Information Summary:** The most important topics needed for the creation of usability heuristics from both stage 1 and 2 are highlighted and prioritized. Domain information collected in stage 1 was further refined based on insights from stage 2 (Quiñones & Rusu, 2019). Additionally, baseline usability heuristics were identified used to adapt into the final domain specific usability heuristics for behavioral health providers. Details regarding this stage are presented in Chapter 4.
- **Stage 4 – Mapping**: Usability needs and user experience (UX) attributes of behavioral health providers were matched with (Quiñones & Rusu, 2019):
    1) Applicable features used by behavioral health providers in an EHR
    2) Applicable *Lean* principles and practices

3) If exists, a relevant heuristic taken from the baseline usability heuristics identified during stage 3.

Details regarding this stage are presented in Chapter 5.

- **Stage 5 – Selection and Specification**: Each specific feature and usability need specified in stage 4 were reviewed to determine whether to keep the relevant heuristic associated with the feature, to adapt the relevant heuristics, or to create a new heuristic (Quiñones & Rusu, 2019). If the heuristic were to be adapted or newly created, associated *Lean* principles and practices were considered. Finally, the formal specification of usability heuristics was created. Details regarding this stage are presented in Chapter 5.

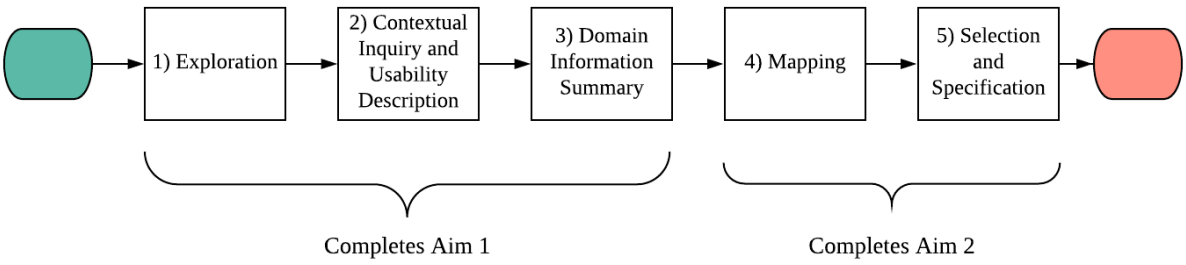

Figure 3.1. Usability heuristics creations process for behavioral health providers.

Chapter 4. AIM 1

4.1 Overview

This chapter is divided into three different sections; one section for each of the first three stages to build usability heuristics for behavioral health providers. The first three stages of this research complete **Aim 1**. Stage 1 identified usability and UX attributes used for this study along with a systematic literature review and established an initial template used for analysis. Stage 2 included the collection of usability data from behavioral health providers through the use of contextual inquiry. During stage 3 template analysis was performed on collected participant data. The content of this chapter describes the methods taken to complete and the results for the first aim of this study:

> **Aim 1**—Investigate and describe the usability needs of behavioral health care providers for effective use of an EHR.

The research question stated for this study was as follows: What are the features and characteristics of a usable EHR for behavioral health providers?

Heuristic development methods do not all require user input, especially if these data can be found through previous experiments within the literature (Hermawati & Lawson, 2016; Quiñones et al., 2018). However, as covered in Chapter 2, a review of the literature regarding EHR usability needs shows limited research regarding specifically behavioral health providers. As this thesis research is focused on behavioral health providers, I deemed it unnecessary to utilize strictly the literature available, but to additionally collect usability data directly from behavioral health providers. Contextual inquiry is a user-centered method used to gather unarticulated knowledge of work practices that have become both habitual and invisible, thus is not generally described in market characterizations (Holtzblatt & Beyer, 1998). This unarticulated knowledge

is extremely valuable when defining usability heuristics (Figueroa et al., 2019). For this reason, it was selected as the technique for collecting usability data from behavioral health providers.

A common approach to the analysis of qualitative content is through thematic analysis, where a coding scheme is established to capture the dominant themes present within qualitative data (Attride-Stirling, 2001). To answer the question in **Aim 1**'s study, the relatively new development in qualitative data analysis research technique of template analysis for structured qualitative data was utilized (Crabtree; Waring & Wainwright, 2008). Thematic analysis is well suited to obtain a clear understanding of the basic content of text. Template analysis "emphasizes the use of hierarchical coding but balances a relatively high degree of structure in the process of analyzing textual data with the flexibility to adapt it to the needs of a particular study" (Brooks, Mccluskey, Turley, & King, 2015, p. 203). Template analysis was selected as the most appropriate form of thematic analysis because of its utilization of preidentified themes and flexibility to add new themes as they present themselves in the analysis of the content. Furthermore, the utilization of hierarchical themes lends itself well to the exploration of applicable usability heuristics (Quiñones et al., 2018). Prior to coding textual data from the contextual inquiry, the initial creation of the template was established through the identification of a priori themes from relevant literature reviewed in the exploration stage.

4.2 Stage 1—Exploration

Domain information necessary for developing usability heuristics as defined by Quiñones and colleagues (2019) can be split into two different categories—broadly defined usability and UX attributes, and the specific features of the application necessary for effective and efficient use of the application. This stage began with identifying baseline usability and UX attributes.

4.2.1 *Usability and User Experience (UX) Attributes*

Usability attributes are the general components that assess how easy a user interface is to use (International Organization for Standards, 2019). The well-established usability principles defined by the International Organization for Standardization's (ISO) 9241 - Ergonomics of Human-System Interaction were chosen for use in this study and are shown in Table 4.6. Where usability attributes assess how useful a system is from its own perspective, UX attributes are concerned with how users experience a system from their own perspective (Rogers, Preece, & Sharp, 2019). With the multifaceted nature of UX there exist several proposed attributes from various authors to broadly describe nature of the UX for different systems (Quiñones et al., 2018). Often, these proposed sets of UX attributes contain numerous terms with overlapping meaning (Rogers et al., 2019). For this study the UX attributes from usability.gov, see Table 4.6, were chosen as there is little overlap amongst the attributes and their use has contributed to several usability studies (Rogers et al., 2019; usability.gov, 2020).

Usability and UX attributes were utilized both to guide theme generation of the a priori template from existing literature and while analyzing the data collected during the contextual inquiry of behavioral health providers in their use of an EHR.

Table 4.6. Selected Usability and User Experience Attributes

	Attribute	Source	Description
Usability	Effectiveness	ISO 9241	Accuracy and completeness with which users achieve specified goals.
	Efficiency	ISO 9241	Resources expended in relation to the accuracy and completeness with which users achieve goals.
	Controllability	ISO 9241	The system allows for control over the interactions within the UI, including the speed, sequence and individualization of the interaction.
	Error tolerance	ISO 9241	The system assists the user in avoiding errors and in case of identifiable errors treats them tolerantly and assists the user when recovering from errors.
	Learnability	ISO 9241	The system supports discovery of its capabilities and how to use them, allows exploration of the interactive system, minimizes the need for learning and provides support when learning is needed.
User Experience	Useful	usability.gov	System is original and fulfills user needs.
	Usable	usability.gov	System is easy to use.
	Desirable	usability.gov	The design and identity of the system is used to evoke emotion and appreciation.
	Findable	usability.gov	Content within the system is navigable.
	Accessible	usability.gov	The system is accessible to users with disabilities
	Credible	usability.gov	Users trust what is contained within the system.

4.2.2 *Systematic Literature Search*

This systematic literature review was done as part of the process to answer research question 1—what are the features and characteristics of a usable and useful EHR for behavioral health providers? A thorough search of the literature was performed for the purposes of identify a priori themes. The planning and conducting of the literature review followed the process suggested by Tranfield, Denyer and Smith (2003). While the review of the literature utilized template analysis (Crabtree & Miller, 1999). Information sources for the literature included peer-reviewed journals and dissertations. Digital libraries searched included University of Washington Library Search (as can be found at https://lib.washington.edu) and Google Scholar. Table 4.7 lists the terms searched. Literature that focused on behavioral health providers was sought where possible. As stated by

Kano, users' expectations and preferences in their use of software change over time, therefore literature was collected within the last eight years, 2012 – 2019 (George et al., 2005). The reference list of full text articles was hand searched for other studies of relevance which were not identified through the electronic searches.

Table 4.7. Search Terms

No	Search Term
1*	("EHR uses" OR "EHR functions" OR "EHR user attributes")
2*	("EHR usability" OR "EHR user experience" OR "EHR Satisfaction")
3*	("EHR burden" OR "EHR burnout")
4*	("EHR" AND ("documentation workflow" OR "documentation"))
5	("EHR" AND ("design" OR "design guidelines" OR "heuristics"))
6	("EHR" AND "Lean")

* Indicates the search term was queried both with and without 'AND ("behavioral health" OR "mental health")'

Inclusion criteria for literature included quantitative or qualitative empirical research studies which either explored or evaluated:

- the usability preferences or barriers of EHR users
- usability of health care IT systems in use or recently implemented
- expectations of EHR functions necessary for providers to meet their objectives
- characteristics or features of the EHR that lead to satisfactory use

Opinion, discussion pieces and non-English articles were excluded.

During the scan of the search results article titles and abstracts were reviewed for relevance and I identified 87 non-duplicate articles. Only the first 10 pages of each search term were reviewed. At this time all the initially identified articles were independently assessed against the inclusion and exclusion criteria. After of which I excluded 58 articles based on another review of

titles, abstracts and the research methods, leaving 29. Of those, nine articles were excluded after full-text reading and an additional four articles were excluded during data extraction, leaving a total of 16 articles included in this review (see Figure 4.1). Of the final 16, three of them (18.75%) had incorporated the role of behavioral health providers, albeit none of which explored broad usability considerations of behavioral health providers.

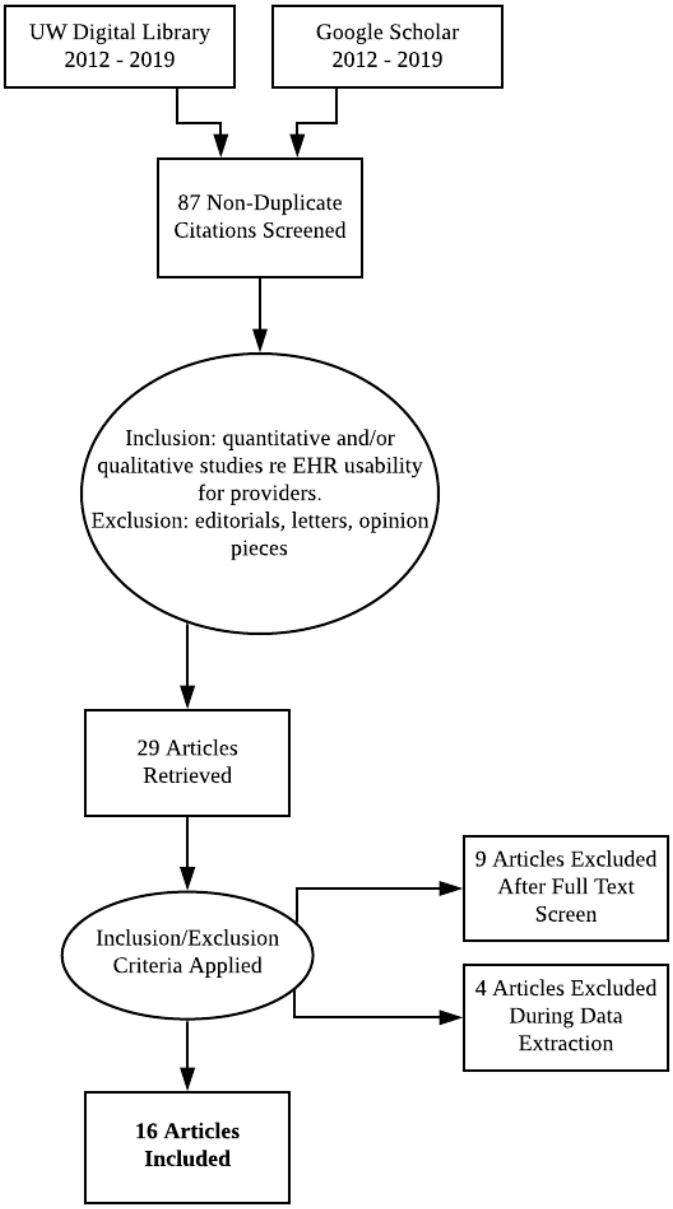

Figure 4.1. Flow diagram and results from literature review.

4.2.3 *Narrative Review*

The EHR screen design has been shown to have a broad impact on users' cognitive capacity. Khairat and colleagues (2018) found a significant relationship between screen design and temporal demand levels, overall perceived workload and effort applied to find information. Providers tended to be satisfied with the EHR when it required less effort to interact with (Khairat et al., 2018). Providers generally desire simple tools and are willing to sacrifice efficiency gains for increased cognitive comfort and less training (Hanauer, Mei, Law, Khanna, & Zheng, 2015). Zahabi, Kaber and Swagnetr (2015) found that information entry and navigation as two tasks that frequently suffer with usability issues. Regarding information entry research has found that interface design should make data entry as natural as possible for providers (O'Brien, Weaver, Settergren, Hook, & Ivory, 2015; Zahabi et al., 2015). Interfaces that use free-text inputs rather than discrete forms reduce disruptions between the provider and patient during encounters (Zahabi et al., 2015).

Working to understand the differences in EHR preferences and frustrations amongst emergency department (ED) physicians, researchers identified common usability themes. Preferences included navigation shortcuts, auto population of smart phrases in clinical notes, consistent layout and system customizations (Khairat et al., 2018). Moreover, clinical documentation features including smart phrases, dictation and spell and grammar checking were perceived by providers to have a high impact on efficiency (Rizvi et al., 2017). Frequent frustrations included the reasoning and frequency behind EHR alerts, adjusting orders once placed and the number of mouse clicks to complete common tasks; moreover, system speed and reliability could quickly cause frustrations (Khairat et al., 2018). Middleton and colleagues (2013) found

that a lack of meaningful system messages, system status visibility, useful error messages and input forgiveness to result in provider frustration with the EHR.

Multiple research efforts have described that EHRs focus on information collection without consideration for extraction as a common cause for poor information presentation within the EHR (Howe et al., 2018; Krist et al., 2014). Providers have a need for dashboards that can synthesize and prioritize data across all relevant records (Krist et al., 2014). Such dashboards are seen as effective as they efficiently depict a patient's or population's health story in a manner that does not require scanning individual records (Cifuentes et al., 2015). EHRs that have the capacity to extract semantical data are suited to deliver meaningful views that aggregate data for quick data consumption across different operational and clinical scenarios. That being said, researchers have demonstrated that data aggregation can result in cognitive strain. The display of information within an EHR can easily become cluttered, confusing (e.g., unlabeled), historically irrelevant or inaccurate (Howe et al., 2018).

Exploring innovations that improve the efficiency of providers in their use of an EHR, researchers found that data extraction used for auto-population saved providers significant time to complete clinical documentation (Guo, Chen, & Mehta, 2017). Moreover, with the use of auto-population instead of providers copy and paste a previous report or assessment there was less note bloat and clinical documentation became more readable (Guo et al., 2017). Nonetheless, the use of auto-population and copy and paste can result in concerns with integrity, resulting in cognitive burden and unnecessary chart review (Tsou et al., 2017). To reduce these concerns, it has been recommended that all copied information should clearly identify the source of the information (Zahabi et al., 2015).

Integrated teams have been found to have specific communication and care coordination needs such as shared care plans, task coordination amongst patients receiving integrated care and a secure medium for communication (Cifuentes et al., 2015). EHRs with task functions in their care plans were seen as helpful in supporting communication and coordination between providers (Cifuentes et al., 2015). Nonetheless, EHRs typically do not have templates which supports a shared care plan for both primary care and behavioral health (Cifuentes et al., 2015). Moreover, even where EHRs do support integrated care plan templates, coordination functionality between providers utilizing different EHR will suffer if there is not a high degree of interoperability established (Howe et al., 2018). Not only do providers embrace features that support collaboration not only in the care setting, but also have been found to be eager to share and utilize personal EHR customizations amongst providers (Hanauer et al., 2015).

A feature of the EHR that has proven itself to reduce errors and adverse events amongst other clinical benefits is clinical decision support. However, this feature has been found to be met with less enthusiasm by providers due to alert fatigue (Makam et al., 2014). Multiple longitudinal studies seeking to understand how providers respond to clinical decision support found a downward response rate to these alerts over time (Ancker et al., 2017; Embi & Leonard, 2012). Clinical decision support alerts were found easier to use when important text is clear and distinct in its appearance, when the alert was appropriately timed and placed, the alerts are passive and includes obvious actions to follow next steps (Richardson et al., 2017).

4.2.4 *Initial Template Analysis and A Priori Template*

The process of template analysis on the 16 articles involved the identification of themes through careful reading and rereading of these data. Theme identification is a form of pattern recognition within the data, where emerging themes become the categories for analysis (Crabtree

& Miller, 1999; King, 2004). The a priori template was based on the review of these articles. Themes were identified based on features and characteristics of use of the EHR that either enabled or hindered the provider in meeting the previously identified usability and UX attributes as listed in Table 4.6. Key themes identified in the data were organized into hierarchical clusters, consisting of themes, sub-themes and codes (Crabtree & Miller, 1999). The usability and UX attributers were not used as themes themselves as any one theme has the potential to be associated with more than one usability or UX attribute. For example, the theme of "accessible via mobile device" can very well be related to both the UX attributes of useful and desirable (Brooks, McCluskey, Turley, & King, 2015).

Analysis of the literature identified during the systematic literature search identified 13 themes along with 13 specific codes, forming the a priori template. The themes which immerged in this template described both generally what providers seek in a usable EHR and also how EHR design flaws can negatively impact their job function. Themes describing desirable features included 'customizable documentation', support for 'peer communication', 'system reliability,' 'visibility of data origin,' 'accessible via a mobile device,' a 'lightweight user interface' (UI), 'voice dictation,' 'effective presentation of information' being sought after to manage care for both individuals and populations, 'quick actions,' 'quick references' and 'task management.' Alternatively, two themes described the negative outcomes resulting from poorly designed EHRs including 'alert fatigue' and 'distracting from providers interaction with the patient.' Which can not only be a distraction during the patient visit but can ultimately distract from, and thus, compromise the provider/patient relationship (Meyerhoefer et al., 2018). In the design of an EHR, it is not only valuable to understand what providers are seeking in a usable EHR, but to appreciate the negative outcomes that can occur from an inadequate design, as to avoid. These a priori themes

and codes were used as a foundational template in which to build upon during the analysis of the data collected during the contextual inquiry data collected in the following stage (Crabtree & Miller, 1999). The a priori template, shown in Table 4.8 were also associated with the previously established usability and UX attributes.

Table 4.8. A Priori Template and Associated Usability and UX Attributes

Theme/Code	Usability Attributes	UX Attributes
Alert fatigue	Controllability	
Customizable documentation	Controllability, Effectiveness, Efficiency	Useful, desirable
Peer communication	Effectiveness, Efficiency	Useful
System reliability	Error tolerance	Credible
Fault tolerant	Error tolerance	Credible
System status	Error tolerance	Credible
Visibility of data origin	Effectiveness	Credible
Accessible via mobile device	Efficiency, controllability	Useful, usable, desirable
Light weight UI	Efficiency	Useful, usable, findable
Consistent UI	Efficiency	Usable, findable
Unclutter	Efficiency	Usable, findable
Quick navigation	Efficiency	Usable
Voice dictation	Efficiency	Useful, desirable
Distracts providers interaction with the patient	Effectiveness	
Distracts from building relationship with patient	Effectiveness	
Effective presentation of information	Efficiency	
Logical grouping of data		Findable
Data driven views	Effectiveness	Useful
Quick Actions	Efficiency	Usable, desirable
Copy & Paste	Controllability	
Quick Reference	Efficiency	Findable
Auto-population	Efficiency	Findable
Clinical Resources	Efficiency	Findable
Search	Efficiency	Findable
Task management	Effectiveness	Useful
Scheduling		

4.3 Stage 2—Contextual Inquiry

Contextual inquiry was conducted with nine behavioral health providers across two-different roles, mental health and substance use disorder (SUD) treatment, from six different health care agencies. All health care practices and thus participants used the same EHR vendor. The participants were briefly interviewed and then observed while conducting routine clinical documentation and tasks outside of the patient encounter. Each observation session lasted between 1-2 hours. Observation sessions were done in-person. I, the principal investigator, conducted each session.

4.3.1 *Participant Recruitment*

Participants representative of behavioral health care providers across different roles were sought for this study as research shows that user-centered design is more effective if multiple roles and perspectives are explored (Ratwani et al., 2018). Participants in this study included the different provider specialties of SUD treatment and general mental health. Additionally, participants within each specialty included both supervisors and non-supervising providers. Table 4.9 shows the matrix of roles of the included participants and Table 4.10 shows the socio-demographic characteristics of the participants. Recruiting was done using purposive sampling and with snowball sampling where gaps in specific behavioral health roles existed. Inquiries were made with behavioral health providers known by the myself about their interest in participation. The average number of years practicing amongst participants was 10 years while average number of years using an EHR was seven years. See Figure 4.2 for the distribution of years practicing and use of an EHR. These inquiries were further screened based off the perceived level of interest and expected contribution, e.g., ability to articulate their use of an EHR. The inclusion and exclusion criteria for participants are as follows:

- Inclusion criteria:

  - 5-years of experience in the field of behavioral health.
  - 1-year of experience in the use of an EHR.
  - Agrees to be audio recorded.
- Exclusion Criteria:
  - Primary source of patient records is recorded outside of the specified EHR.
  - Does not do their own clinical documentation, e.g., uses a transcriptionist.
  - Refusal to give informed consent.

The participant sample size was determined based on data saturation and having a balance of behavioral health roles. Thematic saturation was met when observational data collected from additional participants no longer resulted in newly identified emergent themes (Glaser, 1965). Theme pervasiveness was not incorporated into the determination of thematic saturation; as requiring a code or theme to be pervasive can rule out legitimate concerns or ideas which can contribute to a larger theme but only shared by a few participant (O'Reilly & Parker, 2013). Through the course of nine observations, data saturation occurred with the sixth participant where the final theme was identified. Saturation was validated with the seventh, eighth and ninth participant.

Table 4.9. Matrix of Participant Roles

	SUD	**General**	*Total*
Supervisor	2	2	4
Independent	2	3	5
Total	4	5	9

Table 4.10. Socio-Demographic Characteristics of Participants

Variable	
Participants Health Care Practices	
Practice 1	22%
Practice 2	11%
Practice 3	33%
Practice 4	11%
Practice 5	11%
Practice 6	11%
Sex	
Female	44%
Male	56%
Experience	
Mean Years practicing (SD)	10.33 (7.65)
Mean Years using EHR (SD)	7.11 (4.37)
Supervisory Role	
Supervisor	44%
Non-supervisor	56%
Specialty	
General behavioral health	56%
Substance use disorder	44%

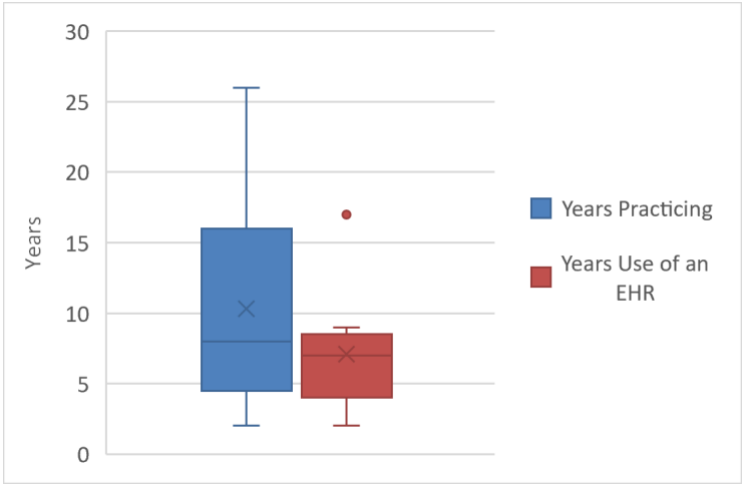

Figure 4.2. Distribution of participants experience in years

4.3.2 *Participant Observations*

The contextual inquiry was conducted according to guidelines outlined by Holtzblatt, Wendell and Wood (2005). Observation sessions followed a master-apprentice model where the participant, the master, performs routine tasks in their natural environment to both preserve context and observe usage of that environment with a focus on the use of the EHR. I, the apprentice, sought to understand what the participant is working to accomplish, how the work gets done and why the work must be done a certain way. Each session was comprised of 4 parts:

1. **Introduction**: Involves both personal and study introductions along with informed consent. To better understand the participants context while also building rapport, participants will be asked for an explanation of their current role, years practicing, years using an EHR, if they supervise and primary focus (i.e. general behavioral health or SUD).
2. **Brief semi-structured interview**: Participants were asked a series of questions regarding their use of their EHR such as detail of routine day-to-day tasks, how use of their EHR impacts their ability to efficiently complete these tasks, which portions of the EHR are utilized most frequently how the EHR is used around the patient. The interview guide can be found in **Appendix C**.
3. **Observation**: Participants completed commonly performed tasks in the EHR while I observed. Tasks included any outstanding work required of them to perform in the EHR including but not limited to clinical documentation, chart review and scheduling. During this time extensive notes were collected on their use of the EHR. Data collection was aimed at identifying distinct patterns of participants' EHR use. Questions were asked only when necessary. Supporting artifacts were collected but

first de-identified if necessary. Furthermore, as the observations were done outside of patient encounters, participants were asked to provide a brief retrospective of certain interactions with the EHR while working with the patient.

4. **Wrap-up**: Participants were asked to provide any last thoughts in the use of the EHR to complete their tasks along with ideas on how to improve the use/efficiency thereof. Major themes of the observation were quickly summarized and validated with the participant.

Data from these sessions were collected through hand-written notes, the collection of artifacts and via audio-recordings. Transcription of audio-recordings occurred within 48-hours following the observation, at which time any necessary de-identification was done. No personal health information was taken via digital photos or from the collection of physical artifacts. Example of an artifact collected is a template used to collect handwritten notes during patient encounters.

4.4 Stage 3—Analysis and Interpretation Stage (Domain Information Summary)

The process of performing template analysis continued after the first three observations were completed. The analysis of the participant data went through a series of steps to ensure the textual data was analyzed thoroughly and with rigor. The sequence for coding and analysis followed can be found in Figure 4.3 and is described hereafter (Crabtree & Miller, 1999; King & Brooks, 2017).

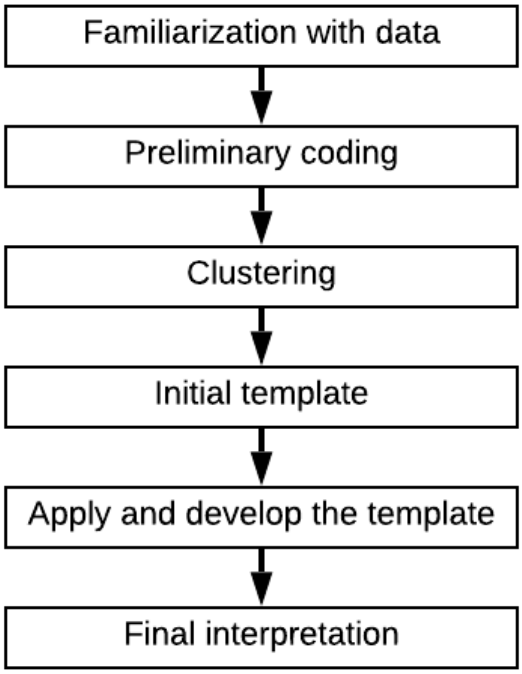

Figure 4.3. Data coding and analysis sequence.

Familiarization with the data occurred immediately following the first observation. As previously described, within the first 48-hours following the observation the audio recording was transcribed. Notable segments from the observational data that described the features and characteristics that either enable or hinder the participants use of the EHR were tagged. Moreover, specific features that supported or opposed the usability attributes listed in Table 4.6 were also tagged. Because the participants of this study comprised of providers with different roles, the first three participants selected for observation represented a good cross-section of those roles as suggested by King and Brooks (2017). Storage of, coding and the analysis of the qualitative data were done in the qualitative analysis software developed by academics at UCLA—Dedoose.

Following the completion of the third observation, the complete observational data were re-read to begin *preliminary coding.* As expected, while inspecting the initial set of observational

data, several new concepts arose that did not fit with the a priori codes and themes found in previous research; these new concepts were formed as in vivo codes (Crabtree & Miller, 1999). These in vivo codes were organized in the analysis software, Dedoose, along with the a priori themes and codes. Following the guidelines and King and Brooks (2017), I took caution to ensure that codes and themes were distinct and contained little overlap. Excerpts from the initial observational data were assigned a thematic code within Dedoose.

With base themes and codes identified in the observational data, the process of *clustering* of the initial themes and codes into meaningful groups began. The initial clustering of themes occurred with the first three observations of the participants. Different ways to organize the identified themes and codes from within the observational data were explored (Crabtree & Miller, 1999). During this process I sought out top-level themes that both clearly and accurately demonstrated the details contained within its associated sub-themes and codes (King, 2004). Some theme titles suggested themselves easily, others required additional time and deeper review of the data to conclude on a title that satisfactorily represented its meaning. In the utilization of template analysis, the a priori themes were perceived as tentative and open to modification (King & Brooks, 2017). Thus, the themes and codes identified in the literature was not assumed to be top-level themes for any specific cluster. The hierarchy of codes from the observational data and a priori codes comprised of the highest-level of codes representing major themes and lower-level codes represented more focused, narrower themes (Crabtree & Miller, 1999).

The main stages between template analysis, especially clustering and the formation of the *initial template* can be fuzzy (King & Brooks, 2017). The initial template took shape as the hierarchy of themes emerged during clustering. The initial template was determined complete as the hierarchy of themes/codes within that template was becoming notably rich with regards to the

insights they provided to the research question as described by Hardy, King and Rodriquez (2014). With the completion of the initial template its themes and codes were reapplied across the entire initial observational data. The initial template can be found in **Appendix D**.

Subsequently, with the collection of additional observational data I moved on to *apply and develop the template*. Using the established codes, line-by-line coding was performed on the subsequent observational data. During this process, segments of text insightful to answering the research question were marked with the relevant code(s). Parallel coding was done on segments of text where the content of the segment was associated with more than one distinct theme or code (Crabtree & Miller, 1999).

As suggested by King and Brooks (2017), having a well-represented cross-section of data to compose the initial template appeared to have simplified the process of applying that template to subsequent observational data. However, certain excerpts taken during line-by-line coding could not be incorporated into the template. These excerpts were tagged for consideration when the template was being reviewed and modified. Hardy and colleagues (2014) describe the target of a final template being when it provides a rich and comprehensive depiction of the entire observational data and where there was little overlap amongst the themes. Thus, modifications to the template were made to accomplish this end. Modifications would come in the form of adding or removing themes, merging themes, or changing themes scope (Crabtree & Miller, 1999). Following any adjustment to the template, I would reapply the updated template against all previous observation transcripts. Iterations of this process produced the findings described in the following 'Results' section of this chapter.

Throughout the development of the template, I was the sole coder. To ensure integrity in the coding and thus the template, it was determined to establish intercoder reliability. A second

coder conducted content analysis on a subset of excerpts taken from the observational data, subset being 12.8% of the entire excerpt data set. Intercoder reliability was evaluated in terms of the agreement of the code associated with each excerpt between me and the second coder (kappa = 89.2%). The second coder worked as a software product owner with experience in software usability. Coding discrepancies were addressed through description updates to the code book. Following the development of a rich and comprehensive template plus the achievement of a satisfactory intercoder reliability score the template was considered final.

4.5 RESULTS

The elements within the final template describe the user needs of behavioral health care providers in their use of an EHR. With the establishment of this information **Aim 1** is complete. The insights obtained from these observations were used to describe the domain information necessary to define domain specific usability heuristics (Quiñones et al., 2018). More than just being used in completing **Aim 2**, these data can be used to provide deeper and richer insights into the usability needs of behavioral health providers for future research or EHR design initiatives. The structure of the *Interpretation* sub-section is focused on the main themes found from final template.

4.5.1 *Interpretation*

The final template can be seen in Table 4.11 and consists of 6 themes, 18 sub-themes and 39 codes. Themes being most broad and over compassing concepts while codes being the most specific concepts within a theme or sub-theme (King & Brooks, 2017). The final template describes the characteristics of an EHR that influenced behavioral health providers perspective of an EHR's usability and is interpreted as follows:

Table 4.11. Final template.

1. **Learnability**
   - **1.1. Guides user**
   - **1.2. Feature support**
     - 1.2.1. Exposure to new features
2. **Work management**
   - **2.1. Collaboration**
     - 2.1.1. Protected patient-communication
     - 2.1.2. Work moves [flows] between providers
     - 2.1.3. Provider-to-provider communication
     - 2.1.4. Clinical documentation review
     - 2.1.5. Messaging
   - **2.2. Feeling of accomplishment**
   - **2.3. Workload (task) organization**
     - 2.3.1. Task management automation
     - 2.3.2. Scheduling
     - 2.3.3. Task visibility
3. **Information seeking**
   - **3.1. Interaction with data**
     - 3.1.1. Meaningful filters
     - 3.1.2. Search
   - **3.2. Effective information display**
     - 3.2.1. Data driven views
     - 3.2.2. Outcomes tracking
     - 3.2.3. Meaningful ordering
     - 3.2.4. Surface and aggregate of data
   - **3.3. Highlight metadata**
     - 3.3.1. Visibility to the status of an entity
     - 3.3.2. Visibility to the age of data
     - 3.3.3. Visibility of data origin
   - **3.4. Notable number of mouse clicks**
4. **System reliability**
   - **4.1. Fault tolerant**
   - **4.2. Secure**
   - **4.3. User error prevention**
   - **4.4. System status indicator**
5. **Natural**
   - **5.1. Contextually appropriate data entry**
     - 5.1.1. Quantitative assessment data entry
     - 5.1.2. Text narratives over discrete forms
   - **5.2. Desirable input/output medium**
     - 5.2.1. Accessible via mobile device
     - 5.2.2. Touch
     - 5.2.3. Voice to text
   - **5.3. Flexibility & control**
     - 5.3.1. Adaptive
     - 5.3.2. Customization
     - 5.3.3. Editability
6. **Workflow accelerators**
   - **6.1. Quick Actions**
     - 6.1.1. Auto-population
     - 6.1.2. Shortcuts
     - 6.1.3. Text macros
   - **6.2. Quick Reference**
     - 6.2.1. Clinical Record
     - 6.2.2. Clinical or assessment criteria
     - 6.2.3. Compliance requirements

Learnability. Provider expresses that to utilize the EHR to its fullest potential they need to be informed (e.g., application embedded training) about the functionality of the EHR. Considering the broad and the likely complex nature of EHR functionality, the use of the EHR can be drastically

underutilized if the software does not lend itself to be quickly learned by its users, especially providers. Moreover, participants demonstrated this concern of underutilization of the EHR does not decrease over time pass with the EHR—"*we've been around a long time, but we don't know everything about* [the EHR]" (P151, general behavioral health, supervisor). As this participant explained after 10 years of use with their current EHR, they still lack confidence in their understanding and utilization of its full potential. This participant also explains the serious consequences of this reality— "*people that don't understand how to use it, it can cause more and more burnout and frustrations*" (P151, general behavioral health, supervisor). Participants described different sub-themes that make a learnable EHR, including 'feature support' which exposes the capability of the EHR, so users know they are fully and appropriately utilizing their EHR. "*I probably use the most basic things in the EHR . . . I've thought about circling back with the vendor*" (P231, general behavioral health, non-supervisor). Additionally, providers expressed a desire for the EHR to 'guide users' in the functions being completed—"*one thing I do like is the red prompts. I like that my clinicians can look at their prompts and kind of get an idea of where they need to go*" (P152, SUD, supervisor). When an EHR has a mechanism to ensure providers are fully informed of the systems capability such as through the utilization of system guides and embedded feature support, the usability of the EHR likely improves.

Work management. All nine participants in this study demonstrated challenges they face in managing their varying workload. "*It can be a challenge sometimes with EHRS to keep track of things for example like when a treatment plan update is due*" (P152, SUD, supervisor). Every participant commented on features in the EHR that would aid in their 'workload organization', becoming prominent sub-theme in work management. Such comments included "*[the EHR] sends us reminders on when treatment plans are due, automatically*" (P120, general behavioral health,

supervisor). Providers can spend a notable time organizing their work "*every day, I write down who I'm seeing, what their insurance is and then a quick note if the paid their copay*" (P231, general behavioral health, non-supervisor). Additionally, "*our clinical director puts tasks together for all the staff*" (P211, general behavioral health, non-supervisor). Participants highlighted the reality that work performed in behavioral health treatment often requires 'collaboration' amongst the care team and the patient. "*I'll get a text from a patient, if there was a specific app for our patients . . . that then everything they're messaging gets uploaded and becomes part of their record*" (P231, general behavioral health, non-supervisor). Thus, often features in an EHR need to account for such collaborative efforts. Participants demonstrated that they sought after activities which would lead to a 'feeling of accomplishment'. "*I start here, that seems like I can accomplish something with that, it takes away stress*" (P211, general behavioral health, non-supervisor). EHR features that aid in the management of providers workload have the realistic potential to increase provider efficiency and reduce wasted time.

Information Seeking. As just described, a lot is required of behavioral health providers, creating likelihood of having a high cognitive load. The way information is presented in the EHR can impact the providers cognitive load and their productivity. Moreover, participants would comment or demonstrate how a poor information architecture can result in a 'notable number of mouse clicks.' "*I feel I spend a lot of time in our EHR going, I know that's in here somewhere*" (P181, SUD, supervisor). Participants demonstrated characteristic necessary for 'effective information display'—"*I don't think [the EHR] orders information meaningfully*" (P41, general behavioral health, non-supervisor). Small information display issues can cause serious frustrations for providers. In addition, participants commented on the need to see information aggregated from different sources within the EHR. "*The report is great. . . . we can see on a patient's record what*

are we missing, what's approved and what's not approved" (P152, SUD, supervisor). "*A couple key things I wish I could send them before our meeting, then it would be awesome if that could score and then be accessible in their chart*" (P231, general behavioral health, non-supervisor). But more than just having visibility to this information participants sought to 'interact with data' presented in the EHR, such as searching and filtering. "*I look for different keywords*" (P152, SUD, supervisor). A note of caution made by some participants was the need for the EHR to 'highlight metadata' to establish the source, context and integrity of the information presented. "*There are things that I just can't tell if they were auto populated*" (P120, general behavioral health, supervisor). As these participants demonstrate they have an appreciation for the capabilities of modern software and desire to have the needed information presented appropriately in order to complete their task at hand.

System Reliability. As can be expected when working with medical records behavioral health providers have high expectations when it comes to the reliability and integrity of their EHR. Participants demonstrated a desire for the data they generate and interact with to be 'secure'. "*My biggest concern with technology is the protected health information . . . . . that has to be done through email and is hopefully encrypted*" (P181, SUD, supervisor). Additionally, participants showed little tolerance for system errors, demonstrating a need for a 'fault tolerant' EHR. "*A note will disappear . . . it causes stress and anxiety, oh my gosh where did this go*" (P152, SUD, supervisor). In addition to an EHR being 'fault tolerant' participants sought confirmation and feedback from 'system status indicator.' "*Some notes don't show me that it has saved, and it would be really nice if they would because . . . for some reason it doesn't connect when I click the little save button, I've lost notes*" (P71, SUD, non-supervisor). Comments were even made for the desire for 'user error prevention features to increase data integrity. A simple example was

demonstrated by participants as they expressed concerns with records not "*spell checked*" or "*not correct sentences*" (P211, general behavioral health, non-supervisor; P181, SUD, supervisor). Providers can be put at ease when they have confidence their EHR is being proactive in ensuring data integrity on a range of different concerns both small and big.

Natural. Behavioral health providers expect their EHR to reflect their real-world workflows. Participants often described feeling constrained by rigid EHR forms or that the EHR did not provide for 'contextually appropriate data entry'; this is problematic when attempting to record clinical documentation during the patient encounter.

> *The conversation doesn't flow in that order, you know, I don't like to do my assessment where I feel like I have to be so prescriptive. I want to be able to kind of go back and forth I'll take notes on that, somebody will suddenly bring up their depressive episode when we were talking about something completely different. I still want to get that information down and not have to repeat the question and have the client go through that information again*. (P152, SUD, supervisor)

Participants criticized that these rigid forms can result in feeling like the content they record in clinical documentation is both "*fragmented*" and/or "*redundant*" (P121, SUD, non-supervisor). Participants also demonstrated the need for engaging with the EHR utilizing 'desirable input/output mediums', or different physical mediums depending on the job they are trying to accomplish. "*I would much rather do this with an iPad*" (P120, general behavioral health, supervisor). Additionally, participants showed interest in the use of the mobile phone to accomplish voice dictation (P231, general behavioral health, non-supervisor; P121, SUD, non-supervisor). Participants also demonstrate the need for 'flexibility and control' to match the EHR

to what is natural to them personally—"*it would be nice if I could combine them somehow, instead of having two text boxes*" (P211, general behavioral health, non-supervisor).

Workflow accelerators. Behavioral health providers desire tools in the EHR that can simplify and speed up the completion of their different tasks. Though every patient encounter is unique, the actions taken by behavioral health providers have common patterns. These 'quick actions' were sought after by participants. As stated by a participant regarding the ideal creation of a progress note: "*the note prepopulates who I am, who the client is, their diagnosis, time, therapeutic modality, goals and objectives*" (P41, general behavioral health, non-supervisor). One such 'quick action' participants commented on the use of pre-population of known information into a new entity on a patient's chart. "*My schedule shows that it is a 45-minute session, so just do the math for me . . . that's something that I think can be auto populated*" (P120, general behavioral health, supervisor). Rightfully so, behavioral health providers can easily feel their time is wasted if they are entering redundant data. Additionally, text macros were seen as a popular shortcut, "*let me click to build my note*" (P231, general behavioral, non-supervisor). Alternatively, the inputs behavioral health providers must consider during treatment are quite broad, from regulatory and payer requirements, to information previously collected on a patient. 'Quick references' to this type of information was a sub-theme found to be helpful by participants "*I like that the other clinicians and I can look at these red prompts and get an idea of what needs to be collected*" (P152, SUD, supervisor).

Table 4.12 presents the code frequency by participant. These counts demonstrate the most frequent items and gaps present by relative weighting. This analysis utilized parallel coding of the excerpts taken from the observational data whereby I would potentially classify more than one code with one excerpt as described by King (2004). Evan though hierarchical coding was done,

because of parallel coding the summation of code frequency cannot be done hierarchically. Alternatively, **Appendix E** contains simple code presence by participant, showing an equal distribution of concepts across the sample of behavioral health providers. This perspective ensures that the relevance of a concept is not overlooked by participants who were highly focused, thus repetitive, on specific themes and codes. Across participant groups, see Table 4.13, of 1) supervisors and non-supervisors and 2) general behavioral health and SUD providers, there was some variation in findings. However, these variations came largely on their emphasis and was not great enough to be considered as conflicting.

Table 4.12. Code Frequency by Participant

Participant ID	P120	P152	P181	P121	P211	P231	P41	P151	P71	Totals	
Learnability	1	1			1	2	1	3		9	5%
Guides user	1	1					1			3	
Feature support	1				1	2	1	3		8	
Exposure to new features	1					2		2		5	
Work management	2	4	6	4	8	4	3	7	2	40	21%
Collaboration		1	4		4	1	2	2	1	15	
Protected patient-communication					1	1	1			3	
Work moves [flows] between providers		1			1					2	
Provider-to-provider communication		1	4		1		1	3	1	11	
Clinical documentation review			3					3		6	
Messaging		1	1		1		1		1	5	
Feeling of accomplishment				2	1					3	
Workload (task) organization	2	3	2	3	4	3	1	4	1	23	
Task management automation	1	1	2	1	2	1		1	1	10	
Scheduling	1	2		2	3	1	1		1	11	
Task visibility	1	1	1	1	1	1		2		8	
Information seeking	2	4	3	4	2	3	5	10	1	34	18%
Interaction with data		2	1					3		6	
Meaningful filters		1						2		3	
Search		1	2							3	
Effective information display		1	1	1	1	1	4	6	1	16	
Data driven views				1		2	1			4	
Outcomes tracking				1		2	1			4	
Meaningful ordering							1	1	1	3	

Participant ID	P120	P152	P181	P121	P211	P231	P41	P151	P71	Totals	
Surface and aggregate of data		1	1	1	1		2	4		10	
Highlight metadata	2	1	2	3	1	1		3		13	
Visibility to the status of an entity	1			2	1	1		3		8	
Visibility to the age of data	1		1	2						4	
Visibility of data origin		1	2	1						4	
Notable number of mouse clicks			1				1	2		4	
System reliability		2	4	1			3	1	1	12	6%
Fault tolerant		1					1	1	1	4	
Secure			1	1			1			3	
User error prevention		1	3							4	
System status indicator							1	1	1	3	
Natural	4	4	7	11	7	6	6	7	4	56	29%
Contextually appropriate data entry	1	3	4	7	1	4	3			23	
Quantitative assessment data entry	1					3				4	
Text narratives over discrete forms		2	3	5	1	1	3			15	
Desirable input/output medium	2			3	3	1	2	5	1	17	
Accessible via mobile device	1			1	1		1			4	
Touch					1			2		3	
Voice to text	1			2	2	1	1	3	1	11	
Flexibility & control	1	1	5	5	3	2	1	2	3	23	
Adaptive	1				1			1	3	6	
Customization			1	1	2	2		1		7	
Editability			1	1						2	

Participant ID	P120	P152	P181	P121	P211	P231	P41	P151	P71	Totals	
Workflow accelerators	8	5	6	3	4	5	2	3	4	40	21%
Quick Actions	6	1	3		2	4	1		3	20	
Auto-population	3					1	1		1	6	
Shortcuts	2	1	2		1	1			1	8	
Text macros	1		1		1	2			1	6	
Quick Reference	2	4	4	2	2	1	1	3	1	20	
Clinical Record				1		1	1	1		4	
Clinical or assessment criteria		1	3							4	
Compliance requirements	1	3		1	2			3	1	11	

Table 4.13. Code Frequency by Supervisory Role and Specialty

	Supervisor		Specialty	
	Supervisor	Non-Supervisor	General	SUD
Learnability	5	4	8	1
Guides user	2	1	2	1
Feature support	4	4	8	
Exposure to new features	3	2	5	
Work management	19	21	24	16
Collaboration	7	8	9	6
Protected patient-communication		3	3	
Work moves [flows] between providers	1	1	1	1
Provider-to-provider communication	8	3	5	6
Clinical documentation review	6		3	3
Messaging	2	3	2	3
Feeling of accomplishment		3	1	2
Workload (task) organization	11	12	14	9
Task management automation	5	5	5	5
Scheduling	3	8	6	5
Task visibility	5	3	5	3
Information seeking	19	15	22	12
Interaction with data	6		3	3
Meaningful filters	3		2	1
Search	3			3
Effective information display	8	8	12	4
Data driven views		4	3	1
Outcomes tracking		4	3	1
Meaningful ordering	1	2	2	1
Surface and aggregate of data	6	4	7	3
Highlight metadata	8	5	7	6
Visibility to the age of data	2	2	1	3
Visibility of data origin	3	1		4
Visibility to the status of an entity	4	4	6	2
Notable number of mouse clicks	3	1	3	1
System reliability	7	5	4	8
Fault tolerant	2	2	2	2
Secure	1	2	1	2

	Supervisor		Specialty	
	Supervisor	Non-Supervisor	General	SUD
User error prevention	4			4
System status indicator	1	2	2	1
Natural	22	34	30	26
Contextually appropriate data entry	8	15	9	14
Quantitative assessment data entry	1	3	4	
Text narratives over discrete forms	5	10	5	10
Desirable input/output medium	7	10	13	4
Accessible via mobile device	1	3	3	1
Touch	2	1	3	
Voice to text	4	7	8	3
Flexibility & control	9	14	9	14
Adaptive	2	4	3	3
Customization	2	5	5	2
Editability	1	1		2
Workflow accelerators	22	18	22	18
Quick Actions	10	10	13	7
Auto-population	3	3	5	1
Shortcuts	5	3	4	4
Text macros	2	4	4	2
Quick Reference	13	7	9	11
Clinical Record	1	3	3	1
Clinical or assessment criteria	4			4
Compliance requirements	7	4	6	5

4.5.2 *Domain Information*

With the completion of the analysis from the contextual inquiry **Aim 1** was complete answering the question: what are the features and characteristics of a usable EHR for behavioral health providers? These features and characteristics of an EHR include: a system where users can quickly become familiar with its capabilities and they are able to make good use of those features, an EHR

with high ‘learnability.’ Behavioral health providers desire EHR features that can aid in their ‘work management’ across the diverse types of tasks that are required of them. Potentially because of their large workload these providers focus on tasks where they felt they could accomplish the objective. ‘System reliability’ is a concern for behavioral health providers and thus desire EHR features and characteristics that can ensure integrity and reliability. Behavioral health providers immense about of information on their patient panel through the EHR, thus they seek features that can aid in ‘information seeking’ through effective display of information, rich interactions with these data, and exposure to the metadata of this information. Providers seek for the characteristics of an EHRs to adapt to their ‘natural’ work environment and can have little tolerance for designs that do not accommodate their natural interactions and workflows. EHR features that provide ‘workflow accelerators’ such as quicks actions and reference are popular with behavioral health providers.

Additionally, the information from this analysis was used to form a domain summary necessary to begin identifying usability heuristics in stage 4. As described by Quiñones and Rusu (2019), information derived from both the literature review and the contextual inquiry stages were grouped, classified as either a general or domain specific feature, associated with applicable usability and UX attributes and then prioritized based on importance to the user using a scale of 3 levels (3: highly important, 2: somewhat important and 1: not important). I determined prioritization based on the prevalence of themes and codes along with the prevalence of associated usability and UX attributes. Prioritization was based on Options for usability and UX attributes can be found in Table 4.6. See Table 4.14 for a summary of the domain information established. For the purposes of creating usability heuristics the selected features and characteristics should be broad enough to provide rich detail yet constrained to not result in an overwhelming number of

heuristics (Quiñones et al., 2018). Quiñones and colleagues (2018) recommends between 10 to 16 usability descriptors. Therefor I selected the ‘learnability’ theme and 10 sub-themes to broadly described the desired features and characters of a usable EHR for behavioral health provider. The Higher Order Theme column in Table 4.14 shows the associate root-level theme for the selected feature/characteristic. Observational data plus themes and sub-themes frequency and relative presence was utilized for selecting the features/characteristics presented in the domain summary. Additionally, observational data was referenced to support associations made between the themes/features established in the template, the selected usability and UX attributes and priority.

Table 4.14. EHR Domain Usability Summary

Feature/Characteristic	Usability Attribute	UX Attributes	Classification	Priority	Higher Order Theme
Learnability	- Learnability	- Useful - Usable	General	2	Learnability
Collaboration	- Effectiveness - Efficiency	- Useful	Specific	2	Work management
Workload management	- Effectiveness	- Useful - Desirable	Specific	3	Work management
Effective Information display	- Effectiveness - Efficiency	- Useful - Findable	Specific	3	Information seeking
Highlight metadata	- Effectiveness - Efficiency	- Findable	General	2	Information seeking
System reliability	- Error tolerance	- Credible	General	3	System reliability
Contextually appropriate data entry	- Effectiveness - Efficiency	- Usable - Desirable	Specific	3	Natural
Desirable input/output medium	- Efficiency	- Useful - Desirable	General	2	Natural
Flexibility and control	- Controllability	- Useful	General	3	Natural
Quick actions	- Efficiency	- Usable - Desirable	Specific	3	Workflow accelerators
Quick reference	- Effectiveness - Efficiency	- Usable - Credible	Specific	3	Workflow accelerators

Chapter 5. AIM 2

5.1 Overview

This chapter is divided into two different sections; one section for each of the last two stages to build usability heuristics for behavioral health providers as described in Chapter 3. The content of this chapter describes the methods taken to complete and the results for the second aim of this study:

> **Aim 2**—Define usability heuristics utilizing *Lean* principles and practices in the domain of EHRs used by behavioral health care providers.

The research question stated for this study was as follows: Using *Lean* principles and practices were applicable, what are the usability heuristics which can guide design and evaluate a usable EHR for behavioral health providers?

5.2 Stage 4—Mapping

This stage began with the selection of baseline usability heuristics which were utilized to build the EHR usability heuristics from. Quiñones & Rusu (2019) advise that baseline heuristics be selected from a similar domain if existing, otherwise Nielsen's Heuristics can be utilized. For this study AHRQ usability heuristics were selected as they utilized Nielsen's Heuristics yet were reframed for use in the evaluation of an EHR (Tarrell et al., 2015). The AHRQ heuristics can be found in Table 5.15. Each features and characteristic defined from the domain information presented the results of stage 3, see Table 4.14, was then matched with heuristic from AHRQ, if applicable. These baseline heuristics are advised to be within a similar domain if existing, otherwise Nielsen's Heuristics can be utilized.

Table 5.15. AHRQ Usability Heuristics

Heuristic	Detail
Software User Interaction	Design characteristics directly support the user-system interaction. Most important to this category is the ability to provide necessary system information to the user when needed. This information includes system status, appropriate feedback and task-based support.
Learnability	Design minimizes the learning curve associated with system use.
Cognition Facilitation	Design reduces the cognitive load placed on users based on the task being performed.
User Control and Software Flexibility	Design provides responses to user actions and is adaptable.
System-Real World Match	Design matches the way that naturally represents the expectations and previous knowledge of the intended user. Ensuring appropriate terminology, consistency in icons and functions.
Graphic Design	Design uses graphical elements to convey information and to create effects.
Navigation and Exiting	Design supports both the user's mental model and allow for easy reversal of actions to allow for effective navigation.
Consistency	Design elements provide standards and reliable terminology, actions and layouts.

(Armijo et al., 2009)

During this stage Quiñones & Rusu (2019) describe that additional design elements can be correlated with the identified features and characteristics. This is where I incorporated *Lean* principles and practices. The principles and practices highlighted in the literature review were considered during this study. Usability and UX attributes were considered the align different *Lean* principles and practices with the reviewed features and characteristics. For the convenience of the reader these principles, practices and tools have been aggregated in **Appendix A**. Each feature and characteristic from the domain information was associated with applicable *Lean* principles

and practices. The associated AHRQ heuristics and *Lean* principles and practices became the potential behavioral health EHR usability heuristics in the next stage. The resulting mappings from the completion of this stage can be found in Table 5.16. From the final template established in stage 3, nine of the 18 sub-themes were directly included in the mapped features and characteristics. Another, six sub-themes were covered through the inclusion of the 'learnability' and 'system reliability' themes. The remaining three sub-themes of 'interaction with data,' 'notable number of mouse clicks' and 'feeling of accomplishment.' These sub-themes were not included as the pervasiveness and frequency of these sub-themes were limited. Furthermore, there is design overlap within the sub-theme 'effective information display' and both that of 'effective information display' and 'notable number of mouse clicks.'

Table 5.16. Mapped Features to Applicable Heuristics and *Lean* Principles

Feature/Characteristic	**Usability Attribute**	**UX Attributes**	**AHRQ Heuristic**	**Lean Principles/Practices**
Learnability	- Learnability	- Useful - Usable	Learnability	Visual management
Collaboration	- Effectiveness - Efficiency	- Useful	System-Real World Match	Optimize the whole
Workload management	- Effectiveness	- Useful - Desirable	System-Real World Match	Visual process controls, reduce change over time, pull, flow, one-piece flow, WIP
Effective Information display	- Effectiveness - Efficiency	- Useful - Findable	Cognition Facilitation	5S, visual management
Highlight metadata	- Effectiveness - Efficiency	- Findable	Graphic Design	Visual management
System reliability	- Error tolerance	- Credible	Software User Interaction	Poka-Yoke
Contextually appropriate data entry	- Effectiveness - Efficiency	- Usable - Desirable	System-Real World Match	
Desirable input/output medium	- Efficiency	- Useful - Desirable - Accessible	System-Real World Match	
Flexibility and control	- Controllability	- Useful	User Control and Software Flexibility	Total preventive maintenance
Quick actions	- Efficiency	- Usable - Desirable	Navigation and Exiting	Deliver fast
Quick reference	- Effectiveness - Efficiency	- Usable - Credible	Software User Interaction	Motion

5.3 Stage 5—Selection and Specification

The final stage began with a review of the selected AHRQ heuristics and the *Lean pri*nciples done in the stage 4. For each of the potential heuristics it was determined which source to use, the AHRQ heuristic or *Lean* principle, if any (Quiñones & Rusu, 2019). Specifically, I determined whether to 1) 'keep' the potential heuristic as is, 2) 'adapt' the heuristic to better align with the needs of the behavioral health provider, 3) 'combine' the heuristic with another or 4) to 'eliminate' and replace with the definition of a new heuristic (Quiñones & Rusu, 2019). As stated by Quiñones and colleagues, potential heuristics are selected on their ability to "clearly and correctly evaluate a characteristic of the specific domain" (2018, p. 125). The selected EHR usability heuristics for behavioral health providers is shown in Table 5.17.

The definition of AHRQ Learnability heuristic clearly states the objective of a learnable system:

> Minimizing the learning curve associated with system use is essential to ensuring continued and efficient use of software functions. As users spend minimal time training or consulting manuals much of the burden of system usability is focused on the display and embedded software support. (Armijo et al., 2009, p. 8)

This heuristic correctly describes the learnable characteristic which is sought by behavioral health providers and thus was selected. The *Lean* practice of visual management has a lot of emphasis on a making a system easy to learn through visual indicators (Parry & Turner, 2007). Therefore, to add clarity on what makes a learnable system according to *Lean*, this heuristic was adapted to incorporate the *Lean* visual managements approach for learnable system.

The collaborative features described by the observed behavioral health needs were quite diverse. These features ranged from provider to patient messaging "*everything that* [the patient

is] *messaging gets uploaded and becomes part of the record*" (P231, general behavioral health, non-supervisor); to reviewing and signing clinical documentation of other providers; or even working together to complete a clinical document— "[our different specialties] *have a shared treatment plan*" (P181, SUD, supervisor). The AHRQ heuristic of system-real world match states the "interfaces serve as representations of systems, process and items that exist in the real world" (Armijo et al., 2009, p. 9). This heuristic however lacks the clarity of the collaborative context in which behavioral health providers operate. The *Lean* heuristic of 'optimize the whole' clarifies that EHR users require collaboration to contribute to their broader objectives (Wright, C., 2017).

The previously discussed 'system-real world match' AHRQ heuristic guides system interfaces to match "the processes . . . . in the real world" (Armijo et al., 2009, p. 9). Yet, this heuristic lacks the clarity and specifics to the workload management needs described by behavioral health providers. Management of work items can certainly pose challenges for providers "*it is easy for work to quickly stack up*" (P211, general behavioral health, non-supervisor). Additionally, providers explain that it was desired that the EHR "*sends us reminders on when the treatment plans are due, automatically*" (P120, general behavioral health, supervisor). Additionally, collaborative workflows also demonstrated the need for workload management: "[this] *triggers a flow that will send the person a task with* [these requirements attached]" (P151, general behavioral health, supervisor). Alternative to AHRQ, the *Lean* practices for visual work, one-piece flow and work-in-progress (WIP) limitations guide work management practice to expose and track work, guide in appropriate use of automation and keeping work items moving efficiently (George et al., 2005; Panwar et al., 2015; Wright, 2017) . These practices better aligning with the provider's needs.

The observed providers discussed how the EHR interface and the presentation of information impacted their efficiency. AHRQ heuristic of cognition facilitation describes that an EHR should be designed to reduce the cognitive load users experience; additionally, designs should be aligned with tasks user is trying to accomplish, appropriate information displayed and visualizations used effectively (Armijo et al., 2009). This heuristic lacks in its description of how this should be accomplished for behavioral health provers. Providers described in their observations how 'information display' impacted their efficiency—"*There is no reason for the way the patients are listed*" (P71, SUD, non-supervisor). "*I'll want to write something . . . from their doctor referral. So I go back to their record and find the content*" (P181, SUD, supervisor). The 5S principles defines that items and information needed by users should be placed for high visibility; arranged for efficient and ergonomic interactions; and standardized for consistency (Chandrayan et al., 2019). Additionally, providers expressed the value in seeing the metadata of the entities which they work with— "*I want to make sure that it's approved before I continue*" (P211, general behavioral health, non-supervisor). Quiñones and colleagues (2018) explained that final heuristics set should target having little overlap as possible. The visual management principle describes the importance of data exposure, including that of metadata (Parry & Turner, 2007). Therefore, the feature of 'highlight metadata' was incorporated with the 'effective informative presentation' characteristic to reduce overlap.

The AHRQ heuristic to describe the characteristic of 'system reliability' was described as the EHR provides system status, feedback and task-based support. This explanation for system reliability was considered to be lacking when examining the reliability needs described by providers "*notes not saving, you'll have timeouts*" (P152, SUD, supervisor). "*I don't know why* [the EHR] *is slow today*" (P41, general behavioral health, non-supervisor). Additionally, concerns

were expressed how user mistakes could impact data integrity, "*it's driven by people . . . and mistake occur*" (P152, SUD, supervisor). The *Lean* poka-yoke principle more accurately describes the need for systems to both expose and prevent system errors. However, the poka-yoke does not cover system reliability in the form of security, "*this is hopefully encrypted*" (P181, SUD, supervisor). Thus, the final poka-yoke heuristic was expanded to include security design needs.

The need for 'contextually appropriate data entry' and a 'desirable input/output medium' was a common theme amongst providers. "*It's challenging when strengths, needs, abilities and preferences could be addressed as part of the presenting condition. Or it could be part of the mental status exam. But here it feels fragmented*" (P121, SUD, non-supervisor). Additionally—

> I don't like these text boxes, because the flow can be so weird, . . . clients never talk about what you want them to talk about. When they start running off about something else, I can't make note of that without being like, wait a minute, let me find the spot to put that. (P181, SUD, supervisor)

More than just the form input controls utilized, providers expressed how they preferred to physically interact with the EHR, "*I'd rather do this on an iPad*" (P120, general behavioral health, supervisor). The AHRQ heuristic of system-real world match best described these needs. Designs serve as representations of systems, processes and items that exist in the real world (Armijo et al., 2009). Though this description was lacking and was expanded by adding additional context in the final heuristic set, there were no *Lean* principles that correctly described these needed EHR characteristics.

The AHRQ heuristic correctly described the 'flexibility and control' characteristics needed by behavioral health providers. This heuristic suggests users are in control of the EHR and have the flexibility to tailor the system to meet their needs (Armijo et al., 2009). This heuristic lines

closely with the *Lean* practice of total preventative maintenance, where function maintenance and operational parameters are controlled by the end user (Costa & Filho, 2016). However, this *Lean* practice places emphasis on exposing this control to its users (Costa & Filho, 2016). This exposure comes in the form of informing the user of the control they have and to what modification have been made. This broader description for control aligns with providers comments such as "*I know this can be done, but I need to circle back with the EHR and be like hey how can I make my own EMDR note?*" (P231, general behavioral health, non-supervisor). Additionally, within the treatment plan "*the clinical stuff has been deactivated, but the clinical staff doesn't know*" (P181, SUD, supervisor). Therefore, due to total preventative maintenance having slightly more applicability and clarity, it was chosen as the more relevant heuristic.

Providers demonstrated the use of 'quick action' features as those that enabled them to perform common actions with minimal to no effort on their part. "*I have to click those buttons every time when for 99% of my clients, those are the buttons I'm going to click. I wish it would just automatically have those buttons clicked for me*" (P120, general behavioral health, supervisor). AHRQ usability heuristics simply describes that "shortcuts should be supported" (Armijo et al., 2009, p. 8). Alternatively, in the context of behavioral health providers, the *Lean* principle of deliver fast adds simple clarity to describe how to utilize shortcuts effectively, as simple mechanism within a system which focus on immediate needs; avoiding complex mechanisms as they add confusion (Wright, 2017). When time small gains occur frequently, they quickly add up to large time savings. Again, with the slight increase in clarity, the *Lean* principle was selected over the AHRQ heuristic.

The software user interaction AHRQ heuristic technically describes 'quick reference' need as providing necessary information to the user (Armijo et al., 2009). Nonetheless, it lacks the

specifics described by behavioral health providers. "*That's what this paper is for. . . . in black is a requirement from Optum's audit tool. As I do an assessment I just go through and address those.*" (P121). As content such as regulatory requirements and clinical resources are often sought after, these resources should be quickly accessible when needed by the provider. Otherwise, movement within the EHR, or in external resources, occurs as the provider hunts for the content needed. As movement is a core form of waste, reducing movement to access these resources reduces time wasted navigating the application. The *Lean* principle to reduce movement was adapted to highlight the need to reduce movement (i.e., navigating) to gain access to resources and content required to complete a specific task.

Table 5.17. Selection of New EHR Usability Heuristics for Behavioral Health Providers

Heuristic Name	**Heuristic Source**	**Action**	**Behavioral Health Feature/Characteristic**
Learnability	AHRQ	Adapt*	- Learnability (refine the AHRQ heuristic using concepts from *Lean* visual management practices)
Optimize [for] the whole	Lean	Adapt	- Collaboration
Follow *Lean* work management practices (i.e., visual process control, reduce change over time, pull, one-piece flow and WIP)	Lean	Adapt	- Workload management
Follow *Lean* principles for effective information display (i.e., visual management and 5S)	Lean	Adapt	- Effective UI display - Highlight metadata
Poka-Yoke (mistake-proofing)	Lean	Adapt	- System reliability
System-Real World Match	AHRQ	Adapt	- Contextually appropriate data entry - Desirable input/output medium
Total preventive maintenance	Lean	Adapt	- Flexibility and control
Deliver fast	Lean	Adapt	- Quick actions
[Reduce] transportation	Lean	Adapt	- Quick reference

* Adaptation will include the inclusion of concepts from applicable *Lean* principles and practices.

Of the eight AHRQ heuristics, seven were mapped with an applicable behavioral health feature/characteristic. However, only two of these seven heuristics were included in the final usability heuristics for behavioral health providers. From the 41 identified *Lean* principles and practices, 13 were mapped to an applicable behavioral health feature/characteristic. Of those 13, there were 12 principles and practices that were adapted and merged in the final usability heuristics for behavioral health providers. All of the proposed heuristics, from both AHRQ and *Lean*, were adapted to add context to how it applies to the needs of behavioral health providers. Each of the behavioral health EHR usability feature and characteristic was covered by a single final heuristic; exceptions to this includes the characteristic of 'Effective information display and highlight metadata' those were covered under the single heuristic of '**Follow *Lean* principles for effective information display**' and the characteristics of 'contextually appropriate data entry and desirable input/output medium' where covered under the single heuristic of **'System real-world match'**.

While referencing *Lean* literature, AHRQ EHR usability heuristics and the observational data collected in **Aim 1**, I wrote and thus established the formal specifications for behavioral health providers. Final usability heuristics are shown in Table 5.18. A level of detail was provided to help understand the guideline better; nonetheless as these are heuristics it is advised to keep the details relatively brief (Quiñones et al., 2018). With the completion of the specifications of the EHR usability heuristics for behavioral health providers the research question for **Aim 2**: "Using *Lean* principles and practices were applicable, what are the usability heuristics which can guide design and evaluate a usable EHR for behavioral health providers?", was answered.

Table 5.18. EHR Usability Heuristics for Behavioral Health Providers

Heuristic Name	**Details**
Learnability	Design minimizes the learning curve associated with system use. Interfaces need to be usable and embedded software support utilized where appropriate (Armijo et al., 2009). Where applicable visual indicators are utilized for easily digestible information. EHR features and functions are visually surfaced as to minimize training necessary to understand the EHR capabilities (Parry & Turner, 2007).
Optimize [for] the whole	The delivery of behavioral health services requires collaboration by the provider not only with the patient, but other providers, support staff, friends and family to the patient, etc. Systems are 'optimized for the whole' when individuals are able to engage with the broader context (Wright, 2017). For behavioral health providers this includes but not limited features for collaboration, communication and handoff features.
Follow *Lean* work management practices (i.e., visual process control, reduce change over time, pull, one-piece flow and WIP)	Design minimizes the work necessary by the provider to manage and maintain their workload while also supporting work management best practices. Steps in a process and the state in the process which a work item resides are highly visual (Wright, 2017). The steps to move (i.e., complete current task and identify and start next task) are minimized and automated where appropriate (Wright, 2017). Users' work items only become active when *they* explicitly start the work item (George et al., 2005). Work items represent the entire tangible deliverable (Panwar et al., 2015). The provider is encouraged to limit the amount of work they have in progress at a single time (George et al., 2005). These rules should be applied where applicable.
Follow *Lean* principles for effective information display (i.e., visual management and 5S)	EHR is designed to reduce the cognitive load experience by the user. As required by the task at hand only data which adds value to the process is displayed (Wright, 2017). Information should drive action and insight (Parry & Turner, 2007). Processes are clearly presented in a visual manner (Parry & Turner, 2007). Clutter is minimized or eliminated (Chandrayan et al., 2019). Display real estate is maximized to show all or as much of the information possible which is necessary to complete the task (Chandrayan et al., 2019; Parry & Turner, 2007). A colorful and physical visual control system is utilized (Parry & Turner, 2007). These rules should be applied where possible.
Poka-Yoke (mistake-proofing)	User mistakes are prevented or mitigated wherever possible (Pötters, Schmitt, & Leyendecker, 2018). When mistakes or errors occur either by the user or by the application the user is notified and data entered in the EHR is preserved.

System-Real World Match	Designs serve as representations of systems, processes and items that exist in the real world (Armijo et al., 2009). Ensure appropriate terminology and consistency in design (e.g., font, icons, functions) (Armijo et al., 2009). Different mediums for interfacing with the application are available including desktop, touch, voice input, tablet and phone. The appropriate input fields are utilized for the context of the data being entered, i.e., standard input controls are used quantitative data whereas minimal free form text controls are used to collect a broad amount of qualitative data.
Total preventive maintenance	Users are empowered to maintain the system (Costa & Filho, 2016). Easy reversal of actions is available. Users are able to tailor the system to meet their needs.
Deliver fast	Immediate gratification is granted where appropriate (Wright, 2017). Shortcuts are available to commonly performed actions allow for the quick completion of different jobs.
[Reduce] motion	Time spent moving and navigating around the EHR is minimized if not removed (Ohno, 1988). Needed resources to complete a task are quick available without having to leave the working view.

Chapter 6. DISCUSSION AND CONCLUSION

6.1 DISCUSSION

The primary question for this thesis, which, if any, *Lean* principles and practices are applicable usability heuristics for behavioral health providers, was answered with the selection of the optimal usability heuristics for behavioral health providers early in stage 5. *Lean* principles and practices make applicable heuristics in the evaluation of an EHR's usability for behavioral health providers. These principles and practices include learnability, optimize the whole, visual process control, reduce change over time, pull, one-piece-flow, WIP, visual management, 5S, poka-yoke, total preventive maintenance, deliver fast and reduce motion. AHRQ established eight usability heuristics for the evaluation of an EHR, yet only two remained in the final nine heuristics created in this research effort in the context of EHR usability for behavioral health providers.

Lean is a versatile management system with ample evidence showing its effectiveness in value identification, analysis of the efficiency of a physical workspace, forming culture promoting growth and productivity, reducing waste on a production line, etc. (Panwar et al., 2015). This study demonstrates that *Lean* also has alignment with assessing the effectiveness and usability of software, specifically the EHR. As described in stage 5, *Lean* principles and practices were often selected over the AHRQ heuristic as they added clarity to the characteristic of usability for behavioral health providers. These results further add to the evidence that *Lean* methods have a place in the waste reduction initiatives being performed in health care. These results highlight that with the large number of *Lean* principles and practices, the *Lean* methodology contains a breadth of different tools to improve the efficiency of different socio-

technical operations. It was across this broad scope of *Lean* principles and practices that additional clarity was added to the final EHR usability heuristics for behavioral health providers.

It should be recognized that of the 41 potential *Lean* methods selected, there were 12 that were actually utilized. Leaving 71% of the potential *Lean* methods selected not being applicable to the evaluation of an EHR for behavioral health providers. There further exist many more *Lean* principles and practices that cover other aspects of achieving high operational performance, such as respect people, yet not aligned with this particular research. This should highlight the fact that there is risk in the utilization of an unsuitable *Lean* principles and practices where resources are utilized but does not actually result in any waste reduction. These results further enforce the claim made by Costa and colleagues (2016) previously reference, being a risk in *Lean* success is the implementation of the wrong practice or practice. Utilization of *Lean* principles and practices should be properly vetted and adapted if necessary, to be suitable to the operation seeking waste reduction and/or further alignment with true value delivery.

Validation of these heuristics was out of scope of this project and thus an important aim for future research. This study utilized the human centered design practice of contextual inquiry to identify the different features and characteristics that make a usable EHR for behavioral health providers. The results of this study found six themes and 12 subthemes of the features and characteristics explicit to behavioral health providers that make an EHR usable. ISO breaks down the usability of a technological system based on its ability to meet five different attributes: effectiveness, efficiency, controllability, error tolerance and learnability (International Organization for Standards, 2019). Additionally, a positive user experience is based on the system's ability to meet five attributes including useful, usable, desirable, findable, accessible and credible (usability.gov, 2020). Across the identified themes and subthemes of a usable EHR

each usability and user experience attribute were covered. Optimal heuristics were identified, often utilizing *Lean* principles and practices, to describing the criteria for meeting these usability characteristics and features. Therefore, it seems highly plausible that adhering to these guidelines, behavioral health EHRs will be found highly usable.

A notable point of discussion regarding behavioral health providers usability needs with their EHR is with the theme of 'natural' interaction. This theme described the need for interactions with the EHR to align with and adapt to the real-world context in which the providers operate. This theme also comprised 29% of all excerpts taken from the contextual inquiry. Behavioral health providers are not opposed to collecting clinical documentation during the patient visit, "*I just write out when the client starts talking about something, I just type it in* [the EHR], *I just type whatever they're telling me however it sorts of flows*" (P181, SUD, non-supervisor). Yet, when the EHR does not accommodate the flow in which treatment occurs during the patient encounter or does not have a suitable medium for data entry, the EHR is deemed too distracting and clinical documentation will occur sometime post encounter. Due to busy schedules with back-to-back appointments, this documentation may not be completed for over 24-hour following the visit (P211, general behavioral health, non-supervisor). Even outside the EHR, there may be no tangible collection of documentation during the patient encounter, "*I just take mental notes*" (P152, SUD, supervisor). Time constraints on providers and clunk data entry can easily result in not just waste of time recording clinical documentation outside patient encounters, but also data integrity concerns. Thus, this research suggests that EHR vendors appropriately prioritize this characteristic of usability not just for behavioral health providers but across the industry.

According to Marckini, Samuel, Parker and Cook (2019), providers who experienced burnout had lower scores of personal accomplishments. One way that burnout can form with behavioral health providers is when they become overburdened with outstanding work items. "*Honestly, after a while it's like I don't care. They're not going to get done*" (P121, SUD, non-supervisor). However, this overburdened stress can be diminished as providers recognize their accomplishments, "*I start here, that seems like I can accomplish something with that, it takes away stress*" (P211, general behavioral health, non-supervisor). These and related comments suggest that EHR features which enable efficient management of one's workload and present a sense of accomplishment can realistically diminish the feeling of burnout.

Potential discrepancies were observed between supervisors and non-supervisors. For example, supervisors referenced the need for provider-to-provider communication 2.6 times more and the need for quick reference content 1.9 times more than non-supervisors. Alternatively, general behavioral health providers commented on the desire for alternative input/out methods 3.6 times more than SUD providers. This suggests these different roles may have find greater value in certain features and characteristics in an EHR. However, the sample of behavioral health providers by supervisory status and specialty was not large enough to conclusively state that discrepancies exist.

Rolón, Chavira, Orozco and Soto (2015) in a study based on evaluating business process models in health care stated that workflow technology is an area of "continuous quality improvement" (p. 5604). As technology advances in the form of artificial intelligence etc. provider expectations of what makes an EHR usable can change. The applicability of these heuristic may very well have a shelf-life. Research in the distant future may be required to refine the EHR usability heuristics for behavioral health providers.

6.2 LIMITATIONS

The process of template analysis is best suited for multiple coders. However, project constraints in this study only allowed for a single coder, limiting potential observations and insights obtained from the observations of behavioral health providers. Additionally, local regulations on behavioral health and substance use treatment and different funding sources have an impact on the way providers administer care. This study engaged with behavioral health providers in the state of Idaho, potentially limiting the usability perspectives influenced by regulations of other regions. Potential discrepancies between supervisory and non-supervisor participants were observed. For example, twice as many comments were made by supervisors than non-supervisors regarding the need for 'quick reference' features. However, the sample of distinct supervisors and distinct non-supervisors was not large enough to make any conclusion regarding these discrepancies. Following the recommendation of the '10±2' rule, observational data from approximately 10 supervisors and 10 non-supervisors would be necessary to make such insights (Hwang & Salvendy, 2010).

6.3 FUTURE RESEARCH

Although this research confirms *Lean* has a natural place as usability heuristics of an EHR, the effectiveness of these heuristics as a tool for evaluators and the impact that they have on providers are still in question. Moreover, this research poses additional questions that need further investigation. These research opportunities are described below:

1. As previously discussed, this research effort was unable to validate the effectiveness of these heuristics as a tool to be used by usability experts. As described by Quiñones and colleagues (2018), new usability heuristics should validate for their effectiveness and

efficiency for usability experts in the evaluation the usability and UX of applications within their domain. Ineffective heuristics may fail to identify critical usability issues. Future research can follow Quiñones and colleagues (2018) method to validate the effectiveness of the usability heuristics defined in this research.

2. Future research should further explore if EHRs that adhere to these *Lean* usability heuristics are able to reduce waste experienced by behavioral health providers in their use of an EHR. These forms of waste reduction could present themselves as a reduction in: time spent in the EHR or providers perception of cognitive load in the use of the EHR. Moreover, future studies can evaluate the impact this has on provider burnout.
3. Certain *Lean* tools are quite constrained or literal in their implementation. For example, the use of daily management boards, a technique that uses a templated board for daily accountability which has proven itself effective to increase performance and meet targeted goals (Berlanga & Husby, 2017). Future research can explore how the utilization of such *Lean* tools explicitly within the EHR can impact the efficiency of providers not just within the EHR but broadly across their entire job role.

6.4 CONCLUSION

As EHRs quickly became part of the standard practice of health care over the last 10 years there quickly rose concern around the original hype of their use as provider job satisfaction and burnout increased. Research has demonstrated that EHRs cause cognitive strain on health care staff and is often a primary work stressor. Though EHRs have improved the efficiency of care delivery as a whole, their usability is considered unacceptable by health care providers. Improving EHR usability is of great importance to solving provider burnout and frustrations.

HCI experts have found usability inspection methods effective resources both for designers and evaluators in validating that a software's design will be found usable by its end-users. A heuristic evaluation is a well-established technique where reviewers assess software design against a set of heuristics to identify and classify usability violations. However, the effectiveness of a heuristic evaluation is based on their relevance and accuracy for describing the usability needs of a certain domain of applications and users. This research sought to better understand the usability needs of behavioral health providers and to develop usability heuristics for this demographic. Furthermore, this research sought to understand which *Lean* principles and practices were suitable heuristics for behavioral health providers.

In the creation of behavioral health usability heuristics, AHRQ's usability heuristics were established as the foundation heuristics. However, of the eight AHRQ heuristics, seven mapped to a desirable behavioral health EHR domain feature and two were adapted as usability heuristics. Alternatively, 12 of the 13 mapped *Lean* principle and practice were selected and adapted as usability heuristics for behavioral health providers. These principles and practices included learnability, optimize the whole, visual process control, reduce change over time, pull, one-piece-flow, WIP, visual management, 5S, poka-yoke, total preventive maintenance, deliver fast and reduce motion.

This research project contributes to the little existing literature by further characterizing the usability needs of behavioral health providers. Utilizing contextual inquiry and qualitative analysis, this research identified six themes that describe generally the nature of use and the characteristics of a usable EHR for behavioral health providers. The development of these heuristics utilized the method by Quiñones and colleagues for the creation domain specific usability heuristic. This process utilized the information collected from the literature review of

providers EHR needs and from the contextual inquiry study to ensure the heuristics created were optimal for the behavioral health context.

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APPENDIX A—LEAN PRINCPLES, PRACTICES AND TOOLS

Classification	Principle/Practice	Definition
8 Forms of Waste	1. Transportation	Movement of people or products that are not actually required to perform a process
	2. Inventory	All goods, components, work in progress and finished products that cannot produce value.
	3. Motion	Individuals or equipment moving more than necessary to perform a job. In contrast to transportation, motion refers to the damage and costs inflected on what creates the product.
	4. Waiting (Delay)	Waiting for the next process step.
	5. Overproduction	Production of an element or product before it is being asked for or required.
	6. Over-processing	Doing more work than necessary to produce a functioning good or service.
	7. Defects	Effort required in inspecting for and fixing defects.
	8. Non-utilized Talent	Not effectively utilizing, or at all, the talent and skill set of the workforce.
5 Lean Principles	1. Value	Identify and specify the value desired by the customer.
	2. Value stream	Identify the value stream for each product/service providing that value and, challenge all of the wasted steps.
	3. Flow	Make process flow continuous. With a complete flow, the focus on the consumer deliverable (e.g., a "cure") is never left out of sight from beginning to completion. Standardize processes around practices which allow them to run more smoothly and free up time for creativity and innovation.
	4. Pull	Utilize task pull between all process steps where a continuous flow is not possible. Focusing on customer demand/value and trigger events backwards through the value stream.
	5. Perfection	Move towards process perfection so non-value adding activities are removed from the value chain thus the number of steps, amount of time and information needed to serve the consumer continually falls.
Tools:		
Assessment	5 Whys	
	Systematic problem solving	
	Process mapping	
	Value stream mapping	
	Gemba walking	
	Kano	
Improvement	5S	
	Spaghetti diagram	

	Workload balancing	
	Andon	
	Jidoka	
	Kanban	
	Optimize the whole	
	One-piece-flow	
	Poka-yoke (Mistake-proofing)	
	Heijunka (Production leveling)	
	Reduced changeover time	
	Group layout	
	Total preventative maintenance	
	WIP	
	Visual process controls	
	Deliver fast	
Monitoring	Visual Management	
5S	1. Seiri (sort out)	Sorting of the clutter through the removal of all items that clearly do not belong in the working area and leaving only those required to complete the current task.
	2. Seiton (set in order)	Also referred to as straighten, is the arrangement of necessary items in an efficient placement/order, often utilizing ergonomic principles. In meeting this objective everything has a home and is in its home.
	3. Seiso (shine)	Is the thorough cleaning of a work area, tools and other equipment so that it is always in a nearly new state. A clean workspace easily exposes defects and creates an aesthetic that can boost morale.
	4. Seiketsu (standardize)	Establishes that what has been to sort out, set in order and shine becomes standardized.
	5. Shitsuke (sustain)	Ensuring that the organization continues to improve workspace efficiency through the utilization of the other 5S practices.

APPENDIX B—IRB APPROVAL

UNIVERSITY of WASHINGTON
HUMAN SUBJECTS DIVISION

IRB APPROVAL OF APPLICATION

September 27, 2019

Dear Jayte Boehler:

On 9/27/2019, University of Washington IRB Committee B reviewed the following application:

Type of Review:	Initial Study
Title of Study:	The Utilization of Lean Principles and Practices in Usability Evaluations of the Electronic Health Record for Mental Health Providers
Investigator:	Jayte Boehler
IRB ID:	STUDY00008342
Funding:	None
IND, IDE, or HDE:	None

IRB Approval

Under FWA #00006878, the IRB approved your.

- **Depending on the nature of your study, you may need to obtain other approvals or permissions to conduct your research. For example, you might need to apply for access to data or specimens (e.g., to obtain UW student data). Or, you might need to obtain permission from facilities managers to approach possible subjects or conduct research procedures in the facilities (e.g., Seattle School District; the Harborview Emergency Department).**
- Your application qualified for expedited review ("minimal risk"; Category 6 and 7).
- Under the Revised Common Rule this IRB approval is valid until study completion. In other words, there is no expiration date and you are not required to submit Continuing Review Reports to maintain your approval. However, you are still required to (1) obtain IRB approval before making any changes (modifications) to your research, and (2) provide the IRB with any Reportable New Information such as breaches of confidentiality or unanticipated problems. *Note: Our current Zipline software must display an expiration date for all IRB-approved studies, so we have programmed the system to display the expiration date of 1/2/3456 for studies that will not expire.*
- This approval applies only to the activities described in your application (including any references to specific grant sections). It does not include other activities that may be described in your grant or contract.
- .

Determinations, waivers, and regulations
The IRB made the determinations and waivers listed in the table below. Note that any granted waivers of consent or parent permission do not override a subject's refusal to provide broad consent.

Requirement	Determination or Waiver
Documentation of consent	Waived
HIPAA Authorization	Waived for incidental use of PHI during Electronic Health Record demonstration

Location of documents
Use the consent forms that were approved and stamped by the IRB. They can be downloaded from the Final column under the **Documents tab** in Zipline.

Thank you for your commitment to ethical and responsible research. We wish you great success!

Sincerely,

Shawn Query, CIP
Review Administrator, Committee B
squery@uw.edu
206.221.0265

APPENDIX C—INTERVIEW GUIDE

General Questions	Per Task (OPTIONS)
How long have you been practicing? How long have you been using an EHR? What are the different day-to-day tasks that you complete in the EHR? Briefly, how do you keep track of this work? Is there anything not being done in the EHR which you feel should be? E.g., it is done on paper. How do you feel about clinical documentation? How does the EHR impact that feeling? What could **change** that feeling? When do you do your paperwork? (e.g., assessments, progress notes) What kind of support, if any, do you find helpful in completing this task within the EHR? What tasks are you performing today?	Why? (if not obvious) How do you feel the EHR helps **facilitate** you in performing this task? How do you feel your **efficiency** is improved by the EHR? How does the EHR feel like a **barrier** in performing this task? What do you feel to be **in-efficient,** prevents you from meeting your **requirements and**/or **frustrating**? Are there common **mistakes** that occur when trying to complete this task? When is the ideal time to perform this task? And if not now, what are the barriers to performing at that time? What kind of **errors** do you come across in completing clinical documentation and how do these errors impact your ability to perform your job? Can you demonstrate?

APPENDIX D—INITIAL TEMPLATE

Initial template with hierarchy of themes, sub-themes and codes from the observational data collected during contextual inquiry sessions.

1. Collaboration

1.1. Protected patient-communication

1.2. Provider-to-provider

1.2.1. Clinical documentation review

1.2.2. Messaging

2. EHR Work Patterns

2.1. Distracts providers interaction with the patient

2.2. Document during patient encounter

2.3. Documents outside the patient encounter

2.4. Patient engages with provider and EHR

2.5. Tasks quickly stack up

3. Information seeking

3.1. Data driven views

3.1.1. Outcomes tracking

3.1.2. Population reporting

3.2. Effective information layout

3.2.1. Meaningful filters

3.2.2. Meaningful ordering

3.2.3. Surface and aggregate of data

3.2.4. Traverse levels/dimensions of data

3.2.5. Visibility to the status of an entity

3.3. Highlight metadata

3.3.1. Visibility to the age of data

3.3.2. Visibility of data origin

4. Natural

4.1. Accurate terminology & phrasing

4.2. Flexibility & Control

4.2.1. Adaptive

4.2.2. Text narratives over discrete forms (Natural data entry)

5. Other

5.1. Alert fatigue

5.2. Feeling of accomplishment

5.3. Functionality support

5.3.1. Exposure to new features

5.4. System reliability

5.4.1. Fault tolerant

5.4.2. Responsive

5.4.3. System status indicator

5.5. Workload (task) management

5.5.1. Due dates

5.5.2. Scheduling

5.5.3. Task visibility

6. Workflow accelerators

6.1. Input/Output controls

6.1.1. Accessible via mobile device

6.1.2. Touch

6.1.3. Voice to text

6.2. Quick Actions

6.2.1. Auto-population

6.2.2. Shortcuts

6.2.3. Text macros

6.3. Quick Reference

6.3.1. Clinical Record

6.3.2. Reference compliance requirements

6.4. Search

6.5. Simple interface

6.5.1. Application consistency

6.5.2. Declutter

6.5.3. Minimal number of mouse clicks

APPENDIX E—CODE PRESENCE BY PARTICIPANT

Participant ID	P120	P152	P181	P121	P211	P231	P41	P151	P71	Totals	
Learnability	1	1			1	1	1	1		6	12%
Guides user	1	1					1			3	
Feature support	1				1	1	1	1		5	
Exposure to new features	1					1		1		3	
Work management	1	1	1	1	1	1	1	1	1	9	19%
Collaboration		1	1		1	1	1	1	1	7	
Protected patient-communication					1	1	1			3	
Work moves [flows] between providers		1			1					2	
Provider-to-provider communication		1	1		1		1	1	1	6	
Clinical documentation review			1					1		2	
Messaging		1	1		1		1		1	5	
Feeling of accomplishment				1	1					2	
Workload (task) organization	1	1	1	1	1	1	1	1	1	9	
Task management automation	1	1	1	1	1	1		1	1	8	
Scheduling	1	1		1	1	1	1		1	7	
Task visibility	1	1	1	1	1	1		1		7	
Information seeking	1	1	1	1	1	1	1	1	1	9	19%
Interaction with data		1	1					1		3	
Meaningful filters		1						1		2	
Search		1	1							2	
Effective information display		1	1	1	1	1	1	1	1	8	
Data driven views				1		1	1			3	
Outcomes tracking				1		1	1			3	
Meaningful ordering							1	1	1	3	

Participant ID	P120	P152	P181	P121	P211	P231	P41	P151	P71	Totals	
Surface and aggregate of data		1	1	1	1		1	1		6	
Highlight metadata	1	1	1	1	1	1		1		7	
Visibility to the age of data	1		1	1						3	
Visibility of data origin		1	1	1						3	
Visibility to the status of an entity	1			1	1	1		1		5	
Notable number of mouse clicks			1				1	1		3	
System reliability		1	1	1			1	1	1	6	12%
Fault tolerant		1					1	1	1	4	
Secure			1	1			1			3	
User error prevention		1	1							2	
System status indicator							1	1	1	3	
Natural	1	1	1	1	1	1	1	1	1	9	19%
Contextually appropriate data entry	1	1	1	1	1	1	1			7	
Quantitative assessment data entry	1					1				2	
Text narratives over discrete forms		1	1	1	1	1	1			6	
Input/output uses	1			1	1	1	1	1	1	7	
Accessible via mobile device	1			1	1		1			4	
Touch					1			1		2	
Voice to text	1			1	1	1	1	1	1	7	
Flexibility & control	1	1	1	1	1	1	1	1	1	9	
Adaptive	1				1			1	1	4	
Customization			1	1	1	1		1		5	
Editability			1	1						2	
Workflow accelerators	1	1	1	1	1	1	1	1	1	9	19%

Participant ID	P120	P152	P181	P121	P211	P231	P41	P151	P71	Totals
Quick Actions	1	1	1		1	1	1		1	7
Auto-population	1					1	1		1	4
Shortcuts	1	1	1		1	1			1	6
Text macros	1		1		1	1			1	5
Quick Reference	1	1	1	1	1	1	1	1	1	9
Clinical Record				1		1	1	1		4
Clinical or assessment criteria		1	1							2
Compliance requirements	1	1		1	1			1	1	6