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PEOPLE, PROCESS, AND TECHNOLOGY IN CLINICAL DECISION SUPPORT SYSTEMS: A META-ANALYSIS

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PEOPLE, PROCESS, AND TECHNOLOGY IN CLINICAL DECISION SUPPORT SYSTEMS: A SYSTEMATIC LITERATURE REVIEW

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ABSTRACT

Clinical Decision Support Systems (CDSS) assist physicians in making more effective and well-informed decisions for their patients. By exploring systematic literature reviews focusing on acceptance, adoption, avoidance, and resistance of CDSS, this systematic literature review identifies and extends the work done by researchers in the past. The investigation spanned various academic databases from January 2016 to April 2021. A conceptual model guided the classification of literature into the dimensions of People, Process, and Technology (PPT). The analysis revealed the range and evolution of research relating to CDSS and clarifies trends for practitioners and Information Systems (IS) researchers. The study concludes with recommendations to further advance CDSS acceptance, adoption, avoidance, and resistance by focusing on the PPT dimensions. We found that 1) technology has been identified as the main component in the studies more often than people and process and 2) adoption and acceptance have been constructed as the focus of the theoretical frameworks much more than avoidance and resistance.

Keywords

clinical decision support systems, computerized decision support, acceptance, adoption, avoidance, resistance, people, process, technology.

INTRODUCTION

Clinical Decision Support Systems (CDSS) are designed to improve healthcare delivery by enabling physicians to make better medical decisions through clinical knowledge, patient information, and relevant health information (Osheroff et al., 2012; Sutton et al., 2020). CDSS can provide information and recommendations with scientific knowledge to physicians for their patients' well-being (Aljarboa & Miah, 2017; Hunt et al., 1998).

Physicians use these systems to make timely decisions and manage external factors that affect their decision-making process (Lynn, 2019; Schwartz & Cato, 2020; Tonekaboni et al., 2019). Innovative products such as a CDSS and accessibility to evidence-based information give physicians the best opportunity to identify the most effective options for patients (Moja et al., 2019). The People Process Technology (PPT) model is used to improve the organization as a whole (Prodan et al., 2015). The PPT is operationalized through the physician actor, the process of patient care, and the incorporation of CDSS as the technology as shown in Figure 1.

An exploratory search of the literature yielded two identified gaps in the current body of research. First, there is a heavy focus on the technology in the literature and less on the people and process. . Therefore, there is a need to systematically analyze the current state of systematic literature reviews (SLRs) to enable the past to inform the future.

Second, for systems to be further adopted and accepted by physicians, it is essential to understand the breadth and depth of the SLRs on CDSS research. From theoretical and practical perspectives, researchers must periodically review methods used and provide insights into which methods have been and should be utilized in a given research field (Ayal & Seidman, 2009; Haried et al., 2019). A systematic literature review is a form of study for evaluating and interpreting all available research relevant to a particular research questions (Kitchenham & Charters, 2007). This study provides researchers and practitioners the opportunity to learn from the past and provide a foundation for the future of CDSS research. .

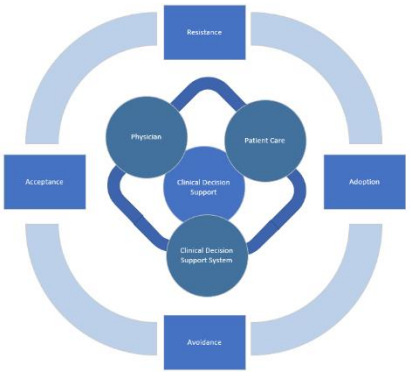

Figure 1: Conceptual Framework

This work addresses the gaps by reviewing and analyzing SLRs on CDSS using the keywords: acceptance, adoption, avoidance, and resistance. The conceptual framework in Figure 1 describes the context and scope surrounding our research. Therefore, we posit the following research questions: *To what extent are People, Process, and Technology identified as the main components to construct theoretical frameworks in the research on acceptance, adoption, avoidance, and resistance of CDSS? And to what extent are acceptance, adoption, avoidance, and resistance constructed as the focus of the theoretical frameworks in the research?*

This study aims to classify SLRs on CDSS into PPT categories while being bound by the four factors acceptance, adoption, resistance and avoidance. The following section discusses the methodology. Next, the publication statistics and the classification of papers are presented. This article concludes with a discussion of the findings, potential implications, and future research directions.

To conduct a comprehensive SLR, we followed the guidelines of Kitchenham & Charters (Kitchenham & Charters, 2007) in accordance with the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines (Page et al., 2021).

Search Strategy

A search was conducted for publications focusing on acceptance, adoption, avoidance, and resistance of CDSS from PubMed, IEEE and Web of Science from January 2016 to April 2021. The following generic search terms were compiled for each database: ("clinical support system*" OR "clinical information system*" OR "clinical decision support" OR "health information system*") AND (acceptance OR adoption OR avoidance OR resistance). This search included Title and Abstract fields.

Inclusion/Exclusion Criteria

Studies were required to be SLRs to be included in the study. Full paper reviews categorized the SLRs into two categories: 1) SLRs; 2) Other types of literature reviews. The analysis and results focus on the SLR category.

Results

Study Selection

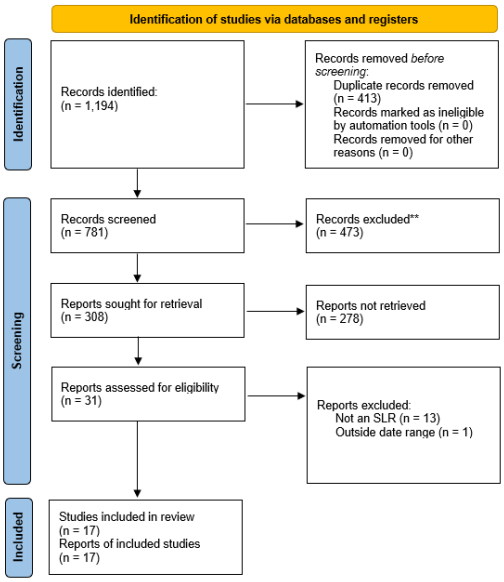

Figure 2: PRISMA chart

Figure 2 depicts the PRISMA Process phases of identification, screening, eligibility, and inclusion. The identification process resulted in the collection of 1,194 articles. The total number of papers was 781 after duplicates were removed. Following that, a paper eligibility evaluation was completed. First, the articles were screened based on title and abstract; next, the remaining articles underwent full-text review for eligibility based on the inclusion and exclusion criteria. Two authors independently evaluated a randomly selected sample of studies. The titles and abstracts were screened using preset eligibility criteria.

There were 31 articles included in the study for synthesis. After analyzing the articles, seventeen articles were identified as SLRs and remained for analysis.

Publication Statistics

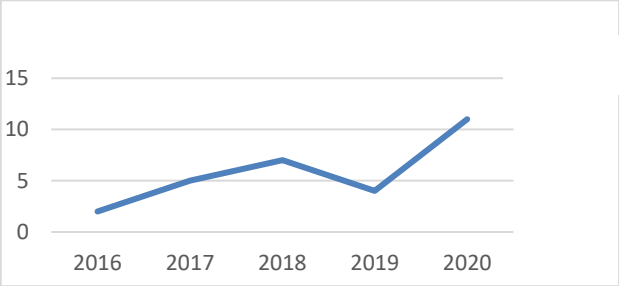

Figure 3: Articles per year

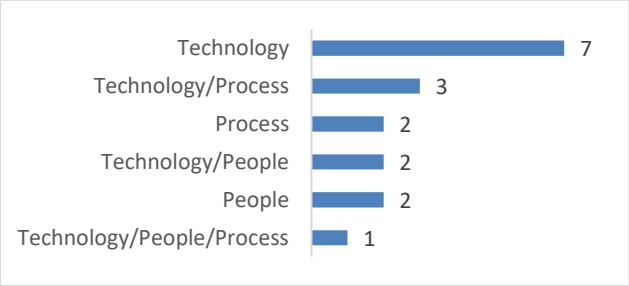

Figure 4: Socio-technical classification

Table 1 shows the classification of articles by the dimensions of People, Process and Technology, and the research focus of each investigated paper.

Table 1: Classification of Articles

Author(s)	Model Dimension	Research Focus
(Araujo et al., 2020)	People	Adoption
(Borum, 2018)	Technology/People	Resistance
(Carvalho et al., 2020)	Technology	Acceptance
(Christopoulou et al., 2018)	Technology	Adoption
(Cresswell et al., 2017)	Process	Adoption
(Eden et al., 2018)	Technology	Resistance
(Feldman et al., 2018)	Technology	Resistance
(Ferdousi et al., 2020)	People	Acceptance
(Giraldo et al., 2017)	Technology	Adoption
(Granja et al., 2018)	Technology/People/Process	Resistance and Adoption
(Han et al., 2020)	Technology/People	Adoption
(Laka et al., 2020)	Technology/Process	Acceptance
(Medic et al., 2019)	Technology/Process	Adoption
(Petrina et al., 2020)	Process	Adoption
(Poly et al., 2020)	Technology	Acceptance
(Rahimi et al., 2019)	Technology/Process	Acceptance
(von Wedel & Hagist, 2020)	Technology	Adoption

Figure 3 shows that there is a positive trend upward. Figure 4 displays the number of times each article was classified into the PPT dimensions. The most classified scheme was technology (seven articles), followed Process (two articles) and People (two articles). Six of the articles included more than one scheme, the majority focusing on both technology and Process.

DISCUSSION

People should be a central focus of system research, development, and utilization but were represented with only six occurrences across the three categories of People (2), Technology – People (2) and People - Technology - Process. Araujo et al. (2020) found professional barriers identified in the adoption of CDSS from nurses. Another study, Ji et al. (2021), performed a mixed-methods study that found it valuable to evaluate clinicians' attitudes toward the perceived benefits of new AI-enabled CDSS implementation when considering the systems' perceived benefits for the patients. Without focusing on what the users of the systems want will create more resistance and avoidance from the user base (Walter & Lopez, 2008). Systems developed with the best technology must consider the users of the system. Researchers and practitioners should focus on these crucial pieces of CDSS development to create a more intuitive design that is easier to use to drive adoption and acceptance of CDSS systems. From the analysis, there appears to be an opportunity to increase research in the people segment of our classification scheme.

Process is an essential component of CDSS usage and was categorized as six articles from the Process (3), Technology – Process (2) and People – Technology- Process (1) categories. CDSS has been incorporated into the clinical workflow to guide physicians and clinicians in decision-making and following guidelines (Araujo et al., 2020). Laka et al. (2020) explored CDSS and the different Process of reducing antibiotic prescribing within different healthcare settings. Cresswell et al. (2017) reviewed existing and emerging approaches in CDSS for promoting the appropriate use of antibiotics. Assisting physicians and clinicians with process-oriented tasks was not the most common classification in our analysis, which enables improvement. Process Interventions should be further explored to improve the appropriate use of giving medications, treating patients, accurate diagnosis, and finding more innovative solutions (Cresswell et al., 2017; Cresswell & Sheikh, 2012). Saad et al. (2016) reported that 17.2% of the patients being treated for chemotherapy experienced medication errors and that those errors occurred during

the prescription stage. Committees and users should be involved in the Process and discussion of new protocols embedded in CDSS and in parallel with the physicians and clinicians utilizing the system (David et al., 2008; Holle & Boehnke Michaud, 2014; Rahimi et al., 2019; Shulman et al., 2008; Sim et al., 2001). Further, researchers and practitioners could benefit from designing frameworks or guidelines to enhance processes or provide a solution that will enable clinicians and physicians to have a more effective solution to a current problem.

Technology is often investigated in acceptance, adoption, avoidance, and resistance (Poly et al., 2020; Sutton et al., 2020). Medic et al. (2019) studied different machine learning techniques in CDSS. Eden et al. (2018) categorized the effects of different types of systems. According to Middleton et al. (2016) and Mehta et al. (Mehta et al., 2021), technology is a significant consideration in CDSS due to their interactive design to assist physicians and clinicians in reaching clinical decisions helping prevent adverse events or medical errors while reducing healthcare costs. Esmaeilzadeh's (2020) findings indicate that physicians and clinicians are more susceptible to AI when the individual can be persuaded to adjust their beliefs by creating more technological opportunities for them. CDSS design is necessary to assist with the clinical care process and the local workflow (Araujo et al., 2020).

Limitations

This study is not without limitations. The IT artifacts were not analyzed in depth from a PPT standpoint which could have potentially provided deeper insight into user-centered design and enabled a deeper focus of how and how well each system is designed. The search was limited to academic databases PubMed, IEEE and Web of Science, limiting the findings. The coding of the literature results as systematic reviews is threatened by misclassification, which was minimized by having two authors code the studies with input from the other two authors to resolve any issues with the classification. The final limitation is utilizing academic subscription databases as our only source of literature.

CONCLUSION

We examined SLRs on CDSS with a boundary of acceptance, adoption, avoidance, and resistance. Technology is the current primary focus with a narrow focus on people. Future research should focus on exploring the adoption and interaction of nurses with these systems during the development and planning stages (Araujo et al., 2020). More studies are also needed on processes such as the effectiveness of ePrescribing functionalities (Cresswell et al., 2017) and processes that facilitate CDSS uptake in different settings (Laka et al., 2020). Additionally, technology development may include the an effective knowledge management system that can provide more accurate and relevant drug-allergy interaction alerts for improving patient safety (Poly et al., 2020).

Researchers and practitioners continue to move forward and develop innovations focused on PPT. Therefore, studies in the future must look at these three dimensions and ensure that they are incorporated in future CDSS research.

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