

Análisis categórico y representaciones sistémicas: posibilidades en la investigación del diseño

Maurício Elias Klafke Dick y Maíra Woloszyn⁽¹⁾

Resumen: El diseño es una actividad que implica la creación de productos, sistemas, servicios y experiencias a partir de un conjunto de necesidades e intereses. En el contexto de la investigación científica, muchas investigaciones se centran en sus procesos y prácticas. En este escenario, los investigadores suelen utilizar representaciones sistémicas para estructurar y presentar sus contribuciones. Aunque la subjetividad es inherente, pueden aplicarse algunas técnicas para demostrar rigor, especialmente en enfoques cualitativos, entre las cuales destaca el análisis categorial. Desde esta perspectiva, este artículo presenta esta técnica como un procedimiento para la construcción de representaciones sistémicas en la praxiología del diseño. Con base en un estudio de casos múltiples, se observó que el análisis categorial ayudó a identificar y organizar los componentes de las representaciones sistémicas, aclarando las relaciones entre sus elementos y la relevancia relativa de cada parte dentro del sistema en su conjunto.

Palabras-clave: diseño – investigación de diseño – investigación cualitativa – praxiología del diseño – representaciones sistémicas – modelos – frameworks – análisis de datos – análisis de contenido – análisis categorial

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1. Introduction

Design is an activity that involves problem-solving through the creation of products, systems, services, and experiences (World Design Organization, 2015). This practice became established as a profession during the Industrial Revolution to improve product quality within the context of industrialization (Cardoso, 2008) and nowadays aims to investigate the relationships between humans and artifacts and languages, enabling the development of technologies and meanings that shape daily life (Kochhann & Dapper, 2019).

Since its origin, the discipline has undergone several transformations (Manzini, 2016). According to Cardoso (2022), the introduction of information technologies was the most significant change in design practice. New tools, along with the expansion of the internet, introduced new elements, increased resource manipulation possibilities, and provided new areas of practice. They also encouraged new ways of finding, creating, manipulating, presenting, and disseminating information. As a result, Design became a transdisciplinary activity, where problems are solved and solutions co-created through creativity, ultimately leading to an improved quality of life (World Design Organization, 2015).

In general, scientific research in the Design field can be categorized into three groups (Cross, 1999): (i) design epistemology, which corresponds to the study of “designerly ways of knowing”; (ii) design praxiology, which investigates the practices and processes of design; and (iii) design phenomenology, which studies the form and configuration of artifacts. Inside this universe, it is possible to find studies that propose instruments to support the understanding and management of design processes and decision-making in design practice. This is due to the fact that design is not a simple activity: it must address a wide range of interests and needs, and to ensure it occurs coherently and on a sound basis, it requires, among other things, tools that organize and structure its activities (Baxter, 2011).

In an increasingly dynamic and interconnected scenario, characterized by the growing complexity of problems, designing involves understanding a system (Dick & Gonçalves, 2021). Given this approach, in design praxiology, it is common for researchers to use models and frameworks to systematize their contributions, as these can be defined as representations that portray or describe systems (Shehabuddeen *et al.*, 1999).

Systems are mental constructs the observer develops within a particular context, which can be represented in various ways (Alves, 2012). For instance, diagrams facilitate systems’ perception, organization, and operationalization, as it allows individuals to view the arrangement of connections, forces, and flows between its components (Vassão, 2010). However, every system is a simplification of reality, as the complexity of the real world is impossible to fully capture due to the limitations of human cognition (Vassão, 2010). In this sense, system construction relies on the author’s subjectivity and interpretation, as they select what they consider most relevant (Alves, 2012), which makes it a creative and subjective act (Vassão, 2010). Due to this interpretative nature, it is natural for the researcher to exert some influence in defining what will be observed. But in the realm of scientific research, the methods employed must ensure rigor, to guarantee that results are, among other things, consistent and verifiable (Santos, 2018).

Considering the paradigms relevant to human-centered professions, the Design field is particularly well-suited to qualitative research approaches (Roth, 1999). In turn, qualitative data processing is essentially a categorization process. Thus, within this methodological strategy, it is possible to demonstrate greater scientific rigor by adopting transparency in the choices and steps taken by the researcher (Grodal, Anteby, & Holm, 2021). Since data analysis in this type of research does not have a universally accepted routine, Yin (2016) emphasizes that diverse techniques should be fully utilized. The oldest and most widely used content analysis technique is categorical analysis (Bardin, 2016): a qualitative data processing technique that consists of operations to break down the object of study into registration units and subsequently regroup these units into categories.

In light of the above, the following research question arises: how can categorical analysis support the development of systemic representations within design practice research? To answer that, this paper presents categorical analysis as a procedure for constructing systemic representations within design praxiology. Using a multiple-case study (Yin, 2018), it describes the categorical analysis processes of two qualitative research previously conducted by these authors that applied this technique and resulted in frameworks tailored to design practice. To do so, the paper first outlines the theoretical foundations of categorical analysis, then describes the multiple-case study conducted, and subsequently details how coding, classification, and categorization processes contributed to the construction of systemic representations. Finally, it discusses the contributions of adopting this technique in design research.

2. Categorical Analysis

Bardin (2016) presents the categorical analysis technique as a support for content analysis. Content analysis is a research method that investigates diverse “discourses” through several methodological tools. Moraes (1999) explains that this analysis leads to systematic descriptions, whether qualitative or quantitative, and helps reinterpret messages and understand their meanings at a level beyond ordinary reading. The content analysis method allows for an in-depth examination of subjectivity – acknowledging the non-neutrality between researcher, research object, and context – while maintaining scientific rigor, as it adheres to systematic principles and rules (Cardoso et al., 2021). As Krippendorff (2018) states, content analysis allows researchers to make inferences that are replicable and valid (upheld in the face of evidence).

According to Bardin (2016), the different phases of this process involve pre-analysis, material exploration, and result processing. Pre-analysis is the stage where initial ideas and analysis methods are organized. It comprises establishing a schedule that may or may not be flexible and includes readings, document selection, objective formulation, and material preparation. The decisions made in this previous step are applied in the next phase: material exploration. This is the actual analysis and involves operations of coding, breakdown, and enumeration. Subsequently, in the result processing, raw data is transformed into meaningful and valid material. This may include tables, diagrams, and figures that reveal the information provided by the analysis.

Regarding the categorical analysis technique, Bardin (2016) explains that it involves coding, classification, and categorization processes by breaking down the text into units and codes classified and regrouped into categories based on analogies (Figure 1). Coding is the process of transforming raw textual data into units that represent its content or expression. These units can be presented as codes, as words, or based on counting rules. This then enables the classification of units through differentiation and grouping by similarity.

Categorization, in turn, is the process of classifying representation units into sets based on semantic, syntactic, or expressive criteria, to generate categories. These categories are classes that group elements under a generic title. According to Bardin (2016), classifying elements into categories implies understanding what they have in common. It involves isolating and distributing elements, as well as organizing messages. Through this deductive process, researchers determine the broadest classes within a theme. It is important to note that, as Kuckartz (2019) states, although interpretation plays a key role in qualitative content analysis, it is necessary, as far as possible, to reach a consensus on the meaning of statements and to define categories with sufficient precision so that different researchers can apply them consistently.

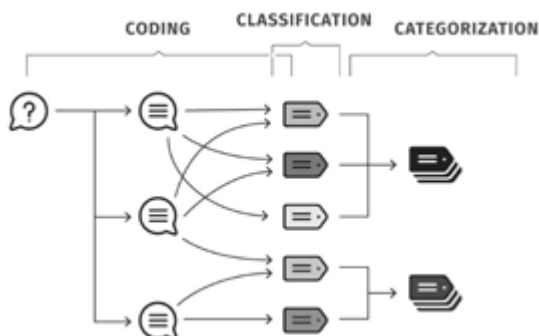


Figure 1. Systematization of coding, classification, and categorization processes. Source: authors (2026).

These analyses can be applied to different data structures, derived from verbal or non-verbal communication. Bardin (2016) classifies these domains into four axes. The first comprises written material, such as agendas, diaries, questionnaire responses, letters, and literature, among others. The second refers to oral content, such as interviews, presentations, and oral speeches. The third one deals with iconic materials, like signs, graphics, images, photographs, and paintings. And the fourth axis encompasses other semiotic codes, such as music, dance, attire, gestures, art, myths, etc.

Quantitative and qualitative approaches can be used to apply coding, classification, and categorization processes to these materials. According to Bardin (2016), the quantitative approach is based on the frequency of the appearance of certain elements in the message. These elements, provided by the content analysis method and the categorical analysis technique, allow for deductions based on numerical and statistical data, justifying the researcher's choices and boundaries.

However, the deductions and inferences made in the actual analyzed content stem from a qualitative approach. For the author (Bardin, 2016), qualitative analysis presents certain characteristics. It is especially valid for making specific deductions about an event or a precise inference variable, and not for general inferences. Moreover, the non-quantitative approach relies on non-frequency indicators that allow for inferences; for instance, presence (or absence) may constitute an index as (or more) fruitful than the frequency of appearance (Bardin, 2016).

3. Methodology

Using a qualitative approach with an applied focus, this research conducted a multiple-case study (Yin, 2018) to present categorical analysis as a procedure for constructing systemic representations within design praxiology. According to Silva and Menezes (2005), case study research involves an in-depth analysis of one or a small group of subjects, allowing for extensive detailing and understanding. To this end, we analyzed two qualitative doctoral-level design studies conducted by these authors on previous research. Both used categorical analysis to process data collected from interviews and questionnaires. The studies aimed to propose systemic representations tailored to design practice, specifically frameworks, as detailed Table 1.

Table 01. Details of the case studies. Source: authors (2026).

Original title, author, and publishing year	General objective	Data collection procedures considered in the analysis
<i>Framebook: um framework para o processo de design de livros digitais</i> (Dick, 2019)	Propose a framework for the digital book design process from a systemic perspective.	9 interviews with publishing professionals (11 hours and 33 minutes of recording)
<i>Variable Fontwork: um framework para o processo de design de fontes variáveis</i> (Woloszyn, 2022)	Propose a framework for the variable font design process.	10 interviews (11 hours of recording) and 9 questionnaires with type design experts

4. Results and Discussion

In this section, the studied cases are detailed, followed by a description of their categorical analysis processes. Finally, we present the contributions of the technique in each of the studies.

4.1 Contextualization of the Studies

The first case, a thesis titled “*Framebook: um framework para o processo de design de livros digitais*” (Dick, 2019), was based on the following research question: “How can we explain the complexity of the digital book design process, given the current publishing context?” With a qualitative focus and classified as descriptive and propositional, the research was structured into five phases: literature review, interviews with professionals, initial framework development, framework validation, and framework finalization. Categorical analysis was applied in the second phase of the research, where interviews were conducted with professionals who worked in the development of digital books, to identify the elements and relationships that influenced the design process of these artifacts, laying the foundations for developing the framework’s first version.

The second case, a thesis entitled “*Variable Fontwork: um framework para o processo de design de fontes variáveis*” (Woloszyn, 2022), had the following research question: “How to guide the design process of variable fonts considering their potential in the context of digital media?”. The qualitative, applied, interpretative, and propositional research adopted five phases: integrative literature review, prospective research with experts, initial framework development, framework evaluation, and framework finalization. Data identified in the second phase, which involved interviews and questionnaires with typography experts and type designers, were processed using the categorical analysis technique. The results from this phase indicated aspects of the variable font design process that contributed to the development of the framework’s first version.

To apply the categorical analysis technique, both studies organized data processing according to the content analysis method proposed by Bardin (2016), structured in three phases: pre-analysis, material exploration, and result processing. It is worth noting that both studies used the ATLAS.ti software during the process, a Computer-Assisted Qualitative Data Analysis Software (CAQDAS) (Yin, 2016).

Qualitative data analysis software assists in computationally managing processes that researchers often handle manually, such as data storage, management, and retrieval (Moreira, 2007). These functions are part of the coding process, which involves assigning codes to specific text segments that can overlap, allowing for the retrieval of multiple segments with a single code. Furthermore, as the researcher gains a broader perspective on the data during analysis, these software tools enable code review, including their combination or division (Moreira, 2007).

However, it is important to note that although software packages optimize and speed up the analytical process, coding within these applications isn’t fully autonomous yet. With advancements in artificial intelligence, there are already automated coding initiatives in implementation (“AI Coding powered by OpenAI”, 2025), but, overall, as Moreira (2007) previously stated, the process still relies on the researcher’s reasoning and versatility.

4.2 Pre-analysis

The pre-analysis phase involved preparing documents for exploration. Therefore, interview data (oral content) was transcribed, and questionnaire responses were compiled. Next, the contents were organized into a table to facilitate data import into the ATLAS.ti software. With this structure, the software was able to automatically identify questions and corresponding responses for each participant.

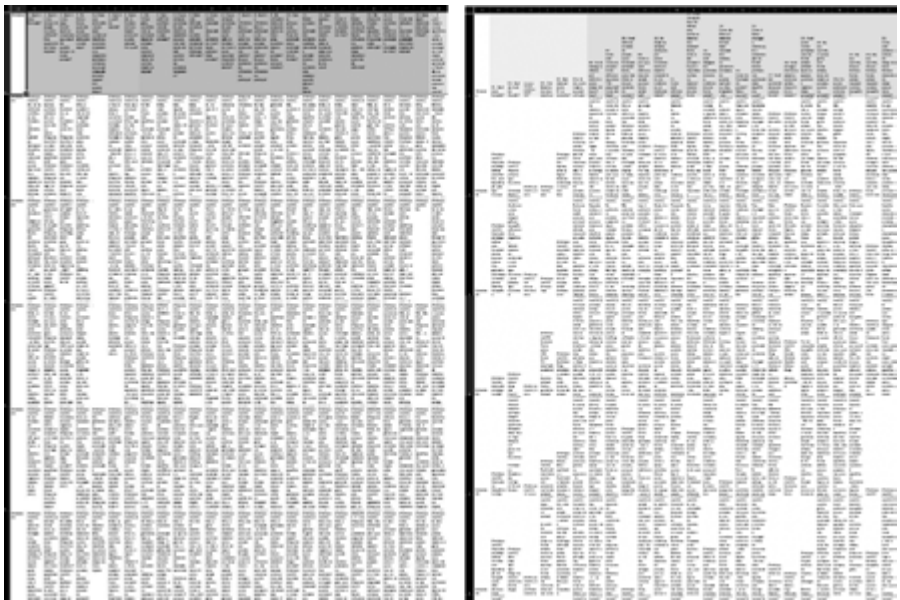


Figure 2. Data preparation for analysis. Source: authors (2026).

4.3 Material Exploration

The second phase of content analysis, material exploration, included applying the categorical analysis technique in its three stages: coding, classification, and categorization. This process consisted of four steps: code creation, code linking, code differentiation, and category creation (code groups). Code creation initially started with reading the collected data. To identify participants' contributions, both studies created codes that represented the themes of the responses. Therefore, portions of content were highlighted and marked with a word or expression that summarized or identified the topic discussed.

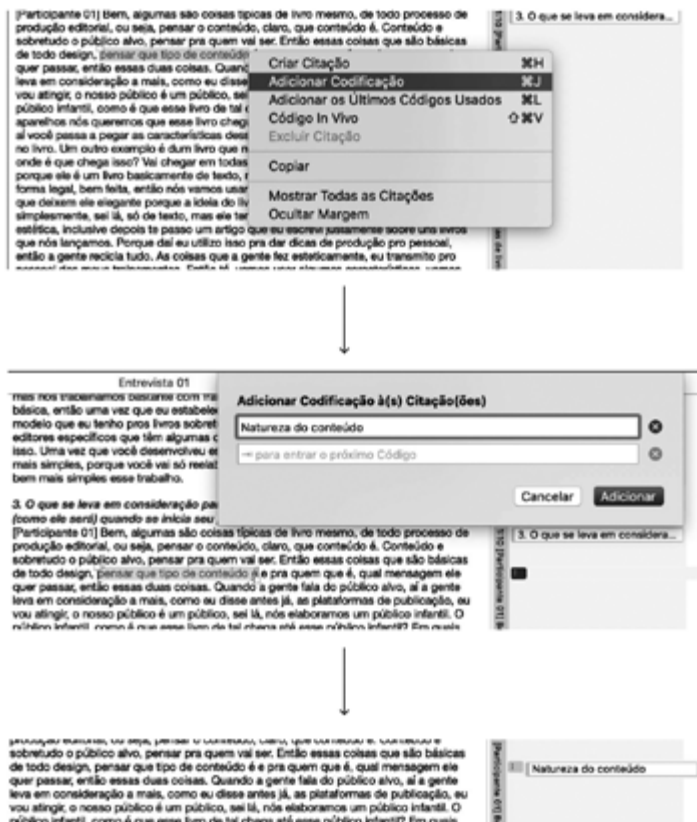


Figure 3. Data coding example. Source: authors (2026).

With this approach, researchers created new codes while also reusing existing ones when response themes recurred. Additionally, it is important to note that some codes were divided or combined during the process based on the researchers' interpretation.

As codes were defined, they were also linked, forming the second process in the coding stage: code linking. In the studied cases, the codes were linked to interview and questionnaire questions to highlight the relationship between question themes and emergent themes in participant responses. Similarly, some codes identified in responses were linked to each other when there was an evident connection from the researcher's perspective. It is noteworthy that the software used in the process also allowed for qualifying such relationships, marking linked codes as similar, contradictory, causal, or part of, among other predefined or customized associations by the researcher.



Figure 4. Possibilities of code relationships. Source: authors (2026).

In the classification stage, the third process involved differentiating codes. To achieve this distinction, the analyzed studies used color-coding, which led to an initial categorization as codes with similar themes were marked with the same color. Subsequently, in the categorization stage – the final step of categorical analysis – categories were created based on groups of codes. In this step, the classified codes were grouped by analogy – that is, by similarity – to form thematic families. These families were named to represent the theme of the constituent codes. Each code was then renamed with the family name as a prefix to facilitate identification. Figure 5 illustrates examples of categorization, classification, and coding processes in the studied cases.

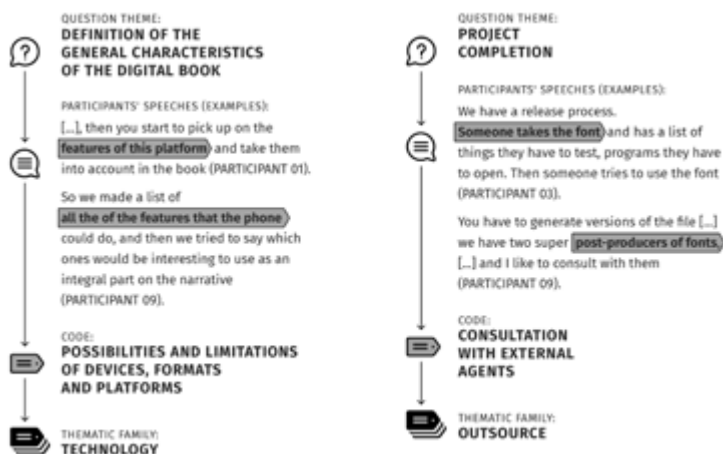


Figure 5. Examples of categorical analysis applied in the studied cases. Source: authors (2026).

4.4 Result Processing

After analysis, the results were processed to transform the data into meaningful insights relevant to the research objectives. As Bardin (2016) points out, tables, diagrams, and figures are helpful at this stage to aid the researcher in interpreting findings and drawing conclusions. In this sense, through code creation, linking, classification, and categorization, ATLAS.ti software enabled different result visualizations. In the analyzed cases, three resources were used: (i) the number of quotations coded with each code (groundedness), (ii) networks, and (iii) co-occurrence tables.

The number of quotations coded with each code allowed for observing occurrences, that is, the number of times a code was identified in the analyzed content. Therefore, this visualization enabled researchers to verify the groundedness of each code and, consequently, of the thematic families across the research, indicating their general relevance.

Networks were diagrams that allowed for visualizing the relationships between codes determined by researchers during analysis. With this feature, the software enabled a graphic display of code co-occurrence. In the studied cases, networks enabled the visualization of all codes and thematic families (indicated by colors and prefixes) present in responses to each question asked to participants.



Figure 6. Examples of codes sorted in descending order by number of linked quotations. Source: authors (2026).

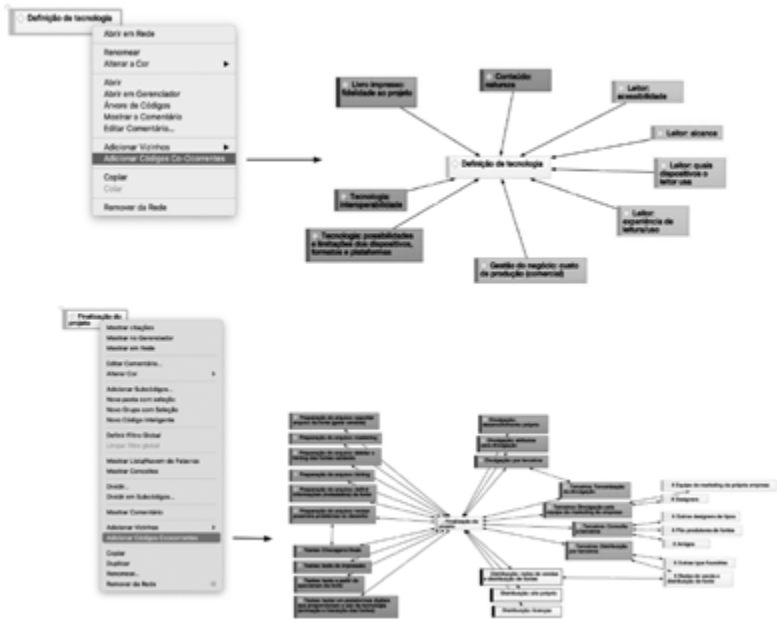


Figure 7. Examples of network diagrams generated for result visualization. Source: authors (2026).

Finally, the co-occurrence table presents the presence of two or more codes in the same portion of the analyzed content, indicating that “these codes were applied to the same quotation or these codes are on overlapping quotations” (Stewart, 2026). In the studied cases, the co-occurrence table was used to complement networks to identify the most recurrent codes for each interview and questionnaire question. This aided in perceiving the intensity of relationships between response themes and question themes (co-occurrence between response codes and question codes).



Figure 8. Examples of co-occurrence tables generated by the software. Source: authors (2026).

4.5 Contributions of Categorical Analysis

The presented process brought different contributions to the studied cases. In the first study developed by Dick (2019), the categorical analysis allowed for the identification of the main influential factors in the digital book design process at different levels of

relevance, as indicated by their recurrence in the participants’ discourse. These factors and their respective details arose from the interpretation of the codes and thematic families obtained through categorical analysis. In summary, the thematic families became the initial version of the factors, and their adapted codes resulted in what the author referred to as subfactors. The relevance of the factors, in turn, emerged from the frequency with which the thematic families appeared in the interviewees’ responses. Additionally, categorical analysis also contributed to understanding the relationships between the identified factors and the intensity of these connections.

Thus, after the other phases of the study, the research resulted in an explanatory framework, which aims to help in the perception of the complexity and planning of the digital book design process. Named Framework, the framework is displayed as a diagram that represents the system of factors influencing that process (Dick, 2019). Grouped into three regions – primary, secondary, and tertiary – the factors are visually differentiated by size, color, and position within the graphical structure of Figure 9. In his proposal, Dick (2019) also presents subfactors for each of the 13 main factors.

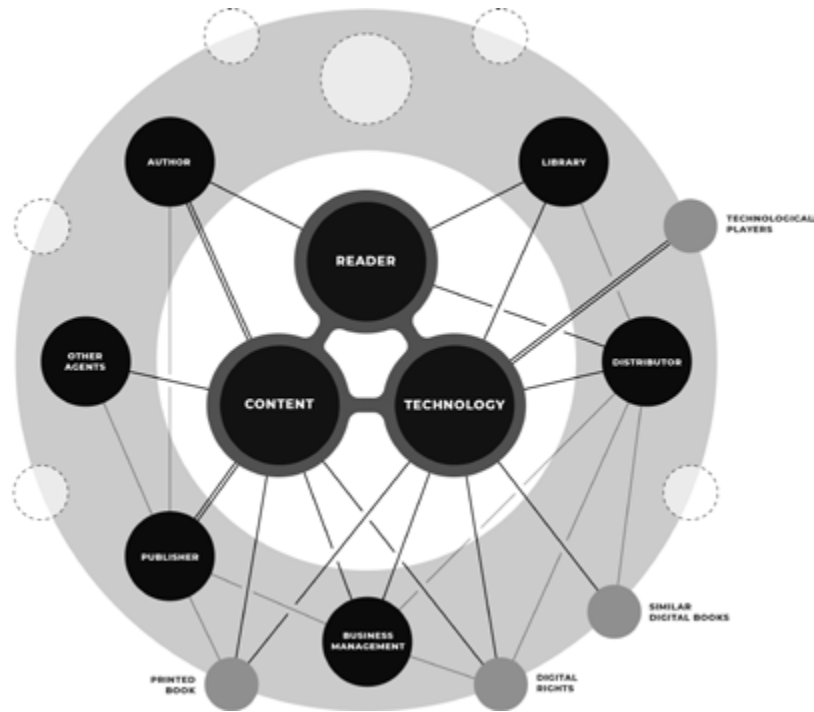


Figure 9. Framework proposed by Dick (2019). Source: adapted from Dick & Gonçalves (2019).

In the second study, Woloszyn (2022) proposed a framework for the variable font design process, where categorical analysis enabled the visualization of the main components of this process. Additionally, it marked the degree of influence of the factors involved at different moments in the variable typographic design process and clarified actions that should be taken to ensure consistent results in the design of variable typefaces.

As a result, alongside the other phases of the doctoral research, a framework was structured, comprising three design stages, ten components – related to the stage – and an iterative dimension. Named Variable Fontwork, it aims to guide variable font design projects across different categories and for audiences with varying levels of professional experience. This structure can also be utilized in various scenarios of variable font design, such as planning, conducting, and organizing both simple and complex projects of different typographic natures, carried out individually or in teams (Woloszyn, 2022).

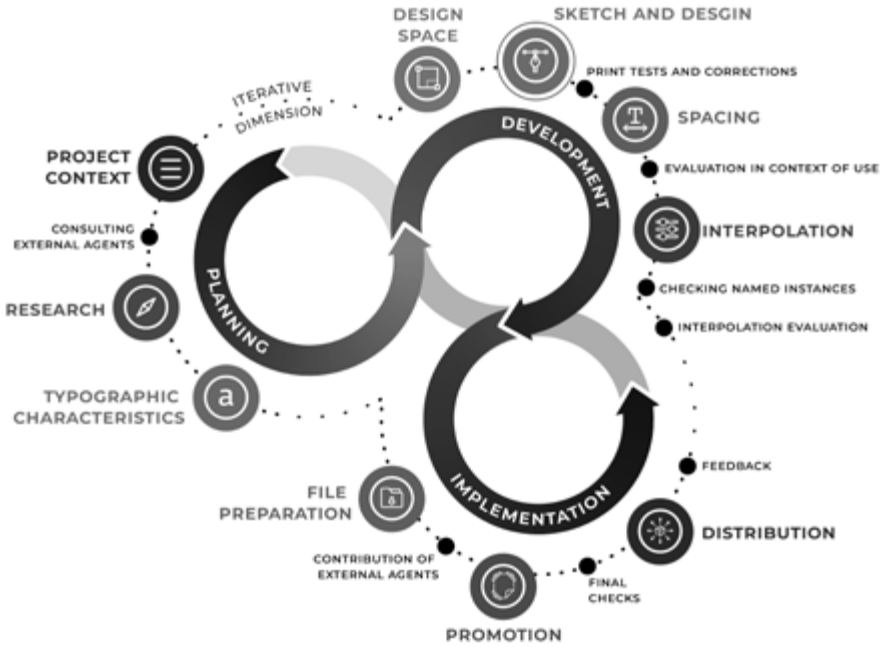


Figure 10. Framework proposed by Woloszyn (2022). Source: adapted from Woloszyn (2022).

5. Conclusion

Design research encompasses various axes of investigation, including praxiology, which focuses on studying practices and processes within the field. The results of studies in this category are often presented as systemic representations, such as models and frameworks, allowing a global visualization of a reality or a part of it. Since they are characterized as ways to portray or describe a system, it is natural for their construction to be influenced by the observer/researcher.

On the other hand, even though subjectivity is an inherent part of the scientific investigation process, different techniques can be used to demonstrate scientific rigor in conducting research and to ensure, to some extent, that the results are consistent and verifiable. Categorical analysis stands out among those with a qualitative approach. From this perspective, this study presented this technique as a methodological procedure for constructing systemic representations – such as models and frameworks – within design research, particularly in the field of design praxiology.

Based on a multiple-case study of two qualitative doctoral investigations (one addressing digital book design and the other variable font design), it became evident that the categorical analysis contributed to identifying and hierarchizing the components of the design processes under investigation in a structured and deductive manner. The adoption of categorical analysis also brought clarification regarding the relationships between each of the identified elements, as well as their degree of relevance to the overall system context. The case study also showed that the inference process relied on both analysis and synthesis, aiming to understand the system as a whole and its relationships without disregarding specific details. In this way, the technique helped researchers identify similarities, regularities, and consistencies, while still recognizing latent and unique aspects. However, it is important to highlight that categorical analysis is an iterative process that involves constant and cyclical reading, coding, merging, and replacing codes, although it is structured into three seemingly linear stages. The codes, thematic families, and their labels should be reviewed, adjusted, and refined whenever necessary to ensure they consistently represent the underlying content.

In summary, this study demonstrates how categorical analysis – through coding, classification, and categorization – supports the identification, organization, and hierarchization of elements within complex design processes. By making explicit the relationships and relative relevance among components, we argue that this technique enhances methodological rigor in qualitative design research and effectively supports the development of frameworks applicable to design practice.

Finally, it should be emphasized that the use of software for Computer-Assisted Qualitative Data Analysis (CAQDAS) – with its various features such as diagrams and quantitative data on code occurrence and co-occurrence – also contributed significantly to data interpretation and result inference. Even though dependence on the researchers' interpretative decisions remained, it provided substantial support for grounding the conclusions of the examined studies. Digital technology is constantly evolving, and such applications present increasingly powerful resources to assist researchers in qualitative

data analysis. In this sense, further studies are needed to investigate emerging technologies, such as the use of artificial intelligence in the different stages of categorical analysis, to understand their potential and limitations in the scientific investigation process within Design research.

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Resumo: O design é uma atividade que envolve a criação de produtos, sistemas, serviços e experiências com base em um conjunto de necessidades e interesses. No contexto da pesquisa científica, muitas investigações concentram-se em seus processos e práticas. Nesse cenário, os pesquisadores frequentemente utilizam representações sistêmicas para estruturar e apresentar suas contribuições. Embora a subjetividade seja inerente, algumas técnicas podem ser aplicadas para demonstrar rigor, especialmente em abordagens qualitativas, entre as quais se destaca a análise categorial. A partir dessa perspectiva, este artigo apresenta essa técnica como um procedimento para a construção de representações sistêmicas na praxiologia do design. Com base em um estudo de múltiplos casos, observou-se que a análise categorial auxiliou na identificação e organização dos componentes das representações sistêmicas, esclarecendo as relações entre seus elementos e a relevância relativa de cada parte dentro do sistema como um todo.

Palavras-chave: design – pesquisa em design – pesquisa qualitativa – praxiologia do design – representações sistêmicas – modelos – frameworks – análise de dados – análise de conteúdo – análise categorial

Abstract: Design is an activity that involves the creation of products, systems, services, and experiences based on a set of needs and interests. Within the context of scientific research, many investigations focus on its processes and practices. In this scenario, researchers often use systemic representations to structure and present their contributions. Although subjectivity is inherent, some techniques can be applied to demonstrate rigor, especially in qualitative approaches, among which categorical analysis stands out. From this perspective, this paper presents this technique as a procedure for constructing systemic representations within design praxiology. Based on multiple-case study, we observed that categorical analysis helped identify and organize the components of systemic representations, clarifying the relationships among their elements and the relative relevance of each part within the overall system.

Keywords: design – design research – qualitative research – design praxiology – systemic representations – models – frameworks – data analysis – content analysis – categorical analysis.

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Maurício Elias Klafke Dick: Tenured Assistant Professor at the Department of Design and Graphic Expression (EGR) of the School of Communication and Arts (CCE) at Universidade Federal de Santa Catarina (UFSC). Graduated in Graphic Design from Universidade Federal de Santa Maria (UFSM), holds a Master's and a PhD degree in Design from Universidade Federal de Santa Catarina (UFSC). Research interests include digital design, user experience (UX), editorial design, and information design. <https://orcid.org/0000-0002-9136-0532>

Maíra Woloszyn. Master's and PhD in Design from Universidade Federal de Santa Catarina (UFSC) and graduated in Graphic Design from Universidade Federal de Santa Maria (UFSM). Focusing on design theory and practice, research interests revolve around various aspects of the field, including typography, editorial design, and digital design. <https://orcid.org/0000-0002-0551-6212>