

Is Enterprise Modeling a Data Analysis Method?

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Abstract

Qualitative research in organizational contexts has been dominated by descriptive methods such as thematic and qualitative content analysis for structuring the data, and visualization methods such as concept mapping for presenting the results. Similarly, conceptual modeling, and its specialization, enterprise modeling, includes both analytic and visualizing features. Despite the similarities, enterprise modeling is not considered to be a research method. The aim of this paper is to use literature sources to compare enterprise modeling's core features with the respective features of thematic analysis and concept mapping. This is done as a means to suggest the establishment of conceptual and enterprise modeling among the qualitative data analysis methods. The results indicate common and tangent aspects in terms of common objectives, input, procedure and cognitive mechanisms, outcome and context. This indicates enterprise modeling being a cognate of established analysis methods in qualitative research.

Keywords

Enterprise modeling, Conceptual modeling, Thematic analysis, Concept mapping, Qualitative method, Data analysis

1. Introduction

The demands of modern research regarding data analysis are constantly increasing and a variety of research methods have been established as a means to address this challenge. Specifically concerning the area of organizational research, which is a subset of the research that belongs to social sciences, qualitative methods for data collection and analysis are prominent in the field, for example thematic analysis [1, 2]. Nevertheless, the ever-changing organizational context [3] is a source of complexity in the research designs associated to the study of such phenomena. The diversity of research approaches that are associated to qualitative data analysis is also increasing to match the needs of analyzing increasingly complex organizational phenomena.

An interesting fact lies in the de-facto identification of certain methods as data analysis methods while alternative methods remain on the fringe of methodological validity and credibility. This means that there are methods that are considered efficient, however, they are not established as part of the family of data analysis methods used for qualitative research. This is probably a result of tradition, and the absence of clearly defined criteria on what comprises a data analysis method and how to classify a method as a data analysis method or not. Historically and philosophically, the criteria defining qualitative research and its established methods have been flexible and susceptible to change [4].


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Conceptual Modeling (CM) [5], and its specialization, Enterprise Modeling (EM), are such cases. EM is commonly used and specialized to tackle problems and issues that are defined within organizational contexts [6].

Our hypothesis is that CM and its subsets, including EM, bear significant common features with qualitative analysis methods to a degree that allows them to be considered cognate methods and potentially be established as data analysis methods. To the best of our knowledge, the scientific literature does not include any justification for excluding CM and EM from the list of established data analysis methods, especially if we take into consideration the amount of similarities between the approaches. Therefore, the aim of this paper is to explore the potentials of establishing CM and EM as research methods for qualitative data analysis.

The rest of the paper is structured as follows. Section 2 provides a brief description of the topics discussed in this paper. Section 3 presents the methodological decisions involved, Section 4 elaborates on the similarities and differences of descriptive data analysis and CM, Section 5 discusses the findings, and Section 6 provides concluding remarks.

2. Background

2.1. Qualitative Data Analysis Methods and Thematic Analysis

Qualitative analysis concerns the analysis of textual, visual or audio data. It can be driven deductively, using a conceptual framework or by the data itself, with an inductive process [7]. The division of qualitative data analysis methods results in three main categories, (i) the socio-linguistics methods, such as discourse and conversation analysis, (ii) theory development methods, such as grounded theory, and (iii) descriptive and interpretive methods, e.g. content [8, 9] and thematic analysis [10]. Other traditions of qualitative research include narrative analysis and phenomenology [7]. In this paper, we focus on thematic analysis used for organizational research, as it bears resemblances with enterprise modeling.

Thematic analysis is a specific descriptive and interpretive qualitative data analysis method, used to organize, analyze and report themes within data [1]. Every style of thematic analysis consists of two main processes: (i) defining and (ii) organizing themes into a conceptual structure that represents the relationships between the themes [2]. It is inductive when the identified themes are derived from the data set, and deductive or theoretical when the analysis is driven by an existing theoretical framework. When the nature of the created themes is mainly descriptive and explicit, they are called semantic, and when they represent underlying meanings in the dataset, they are called latent. Three approaches exist in thematic analysis. The realist approach reports experiences, meanings, or realities in a straightforward way, the constructivist approach reports them as effects of social situations and the contextualist approach is a hybrid of the former two [1]. The procedural steps taken while thematic analysis are: (i) familiarizing yourself with your data, (ii) generating initial codes, (iii) searching for themes, (iv) reviewing themes, (v) defining and naming themes, and (vi) producing the report [1]. An appropriate coding technique, used to initiate thematic analysis is descriptive coding [11].

2.2. Conceptual and Enterprise Modeling

From an abstract perspective, during conceptual modeling, a network of concepts which mutually define each other is worked out, in other words, the set of related concepts create a language that constitute the domain of discourse and each concept has a unique role in it. An important point is that a conceptual model is an utterance specifically created for a specific audience and purpose, and may be valid only for a specific time period, thus, a model's quality can be defined as its suitability for the intended audience and purpose in a specific context [5].

EM concerns the creation of models that capture organizational aspects that are relevant for a given modeling purpose e.g. processes, goals, concepts or business rules [6]. Thus, an enterprise model commonly consists of interconnected conceptual models that focus on particular organizational aspects. Any public or private organization can benefit from the application of an EM method. Additionally, models are valuable for (i) modelers, because of their interest not only understanding but also applying a modeling method, (ii) researchers, because of their interest in evaluating and potentially adapting a modeling language and method, e.g. in a domain-specific version, and (iii) tool vendors, because of their interest in tool development of a specific language and method [12]. UML [13] and BPMN [14] are examples of popular modeling standards that maybe used for EM.

3. Methodology

The aim of this study is to conduct a structured theoretical comparison between EM/CM and descriptive data analysis methods using literature sources in order to explore the potential of establishing EM as a data analysis method. Being a preliminary exploration of a topic, a secondary objective of this paper is not to provide any solid proof, but to motivate follow-up research on the topic and set the basis for it.

Taking into consideration the state of EM as a specialization of CM, any proof or indication of CM being a data analysis method will also apply to EM, therefore, in this paper, instead of delimiting the scope to organizational research, the discussion not only includes features that are specialized to EM, but also characterize CM in general.

Another point that needed to be taken into consideration is the plethora of descriptive data analysis methods that exist, in conjunction with this study's feasibility and limited available resources, in terms of time, effort, and page restrictions. For this reason, CM cannot be compared individually with several methods, thus, generic features of descriptive analysis methods have been used. We focused on the prominent representatives of the genre, i.e. thematic analysis and concept mapping. The features that have been used for the comparison are (i) Objectives, (ii) Input, (iii) Cognitive mechanisms used while applying the method, (iv) Outcome, and (v) Context. These features are often encountered in the literature for describing analysis methods.

4. Analysis of Features

This section presents a structured analysis of the core features of the two approaches, their similarities, and their differences.

4.1. Objectives of the Analysis

Basic qualitative research is an approach in which the interest of the researchers is to solve a problem, affect a change and identify relevant themes. It covers a wide spectrum of objectives, from exploration to confirmation [7]. Being a group of approaches, qualitative research aims for the analysis of collected data and the provision of a detailed, in-depth, socio-contextual description and interpretation of a given researched topic [15]. A broad range of approaches with variations in concepts, assumptions and analytical rules is covered by the term qualitative research, but despite the degree of variation, all qualitative methods contribute by describing and interpreting complex phenomena, developing and revising understanding, not simply verifying previously elaborated theories or conclusions [15].

Answering research questions or achieving research goals while in parallel conceptualizing the researched phenomenon are the aims of both CM [16] and qualitative research [7]. CM aims to elicit, capture, document and communicate the given researched phenomena, while reducing the complexity [17]. Complexity is reduced by bridging individual conceptualizations and perspectives [18] using models, therefore communication is fostered. Using models may fulfill additional objectives, for example, problem solving and forcing designers to make their domain understanding explicit, along with explicating knowledge since models stimulate discussion and critique [19]. Similarly, objectives of CM and thematic analysis in organizational research are (i) capturing and documenting complex aspects in an understandable and explicit form, (ii) developing a common understanding and (iii) communication of the result.

4.2. Input

Regarding the input feature, commonalities are identified not only in the methods applied for collecting data for analysis, but also in the source, and the roles involved when it concerns organizational research.

The *methods* and *sources* that are used for the collection of qualitative data in organizational research are commonly encountered both in CM projects and research that involves thematic analysis. A few well-known examples of established strategies for collecting data used in thematic analysis and CM are case study, action research, and exploratory survey research, which are popular in both types of research projects [6, 4]. Regarding the methods used to collect the data, all types of interviews, focus groups, documents analysis and observation are not only suggested but also commonly encountered in the literature as methods compatible with both approaches [6, 4].

Regarding the participant *roles* involved in projects where CM and thematic analysis are applied, they usually concern staff and stakeholders knowledgeable about the problem domain and familiar with the specific researched problem, like managers on the operational or strategic level and subject experts, process owners, staff responsible for designing future processes or implementing changes, IT and corporate managers, and other responsible experts and decision-makers [6]. This is often associated with the selected sampling strategies for expert key informants, whose selection is driven by purpose and convenience [4, 20].

To summarize, CM and thematic analysis share similar inputs when it comes to the sources commonly used, the methods for data collection and the roles involved.

4.3. Cognitive Mechanisms

From a cognitive perspective, the procedure of applying analysis methods to collected data includes a variety of mechanisms that are common for CM and thematic analysis. The essential common cognitive mechanisms that are discussed in the literature are: (i) Classification, (ii) Abstraction, (iii) Reasoning types, and (iv) Iteration.

Classification has long been recognized by cognitive psychology and linguistics as essential for human adaptation and survival [21]. Most qualitative approaches include a common data organization element which concerns the process of data reduction, known as coding. The coding process is facilitated by recognizing and classifying different types of codes, in particular: (i) Conceptual code, referring to key elements, domains and dimensions of the given studied phenomenon, (ii) Relationship code, referring to links between elements, domain and dimensions, (iii) Participant perspective codes, referring to participant's positive, negative opinion or indifference about a particular experience, (iv) Participant characteristic code, referring to general characteristic of a participant, and (v) Setting code, referring to general characteristic of the place in which the phenomenon has happened [15]. This classification helps researchers to organize codes and enables detailed comparison prior to the following analytical steps. In a similar way, applying classification during CM, the following terminology is used: (i) Instance, referring to a symbol designating the perceived existence of a thing in the world or the mind of individuals, (ii) Property, referring to an instance's characteristic, (iii) Concept/Class, referring to a set of properties, and (iv) Relationship, referring to links between instances and classes [21]. There are also special cases of relationships, like specializations, generalizations, compositions and aggregations [13]. The basic classification between concepts and their relationships is thus common between CM and thematic analysis and drives the analysis in both cases.

The term instance is relevant to another common cognitive mechanism, in particular, *abstraction*. In thematic and qualitative content analysis, having identified codes in the data, the researcher raises the perspective to a more general level to form categories. On an even more general level, the categories are used to form themes and sub-themes [15]. Abstraction, whose history in computer science is long [22], is traditionally associated to CM, because during the application of CM methods, abstraction is applied in order to reduce complexity to achieve a specific purpose [17]. A class is formed by abstracting our knowledge about instances [21]. In a similar way, applying abstraction on a set of classes can result in the formation of a super-class/sub-class or meta-class, depending on the objective of the task, for example, updating a model or developing a meta-model [17]. A noteworthy aspect is that classes or categories, and meta-classes or themes are not formed simply because they exist, but because of their meaningfulness and relevance to the given research question or problem [21]. In descriptive qualitative analyses or CM applications, there seems to be similarity in the processes of identifying codes or instances in the raw data, then applying abstraction to form categories or classes, and increasing the level of abstraction to form sub-themes and themes or sub-classes and super-classes/meta-classes respectively. The degree of similarity should be further researched.

As mentioned earlier, thematic analysis may be inductive or deductive. These are driven by *reasoning types* that also apply to CM. An *inductive* analysis is not driven by any existing framework, meaning that the raw data are driving the results and only relevance is affecting the process. In a similar way, in CM, inductive reasoning concerns the development of meta-models

and models using collected data. *Deductive* reasoning is used when the analysis is driven by an existing framework. This means that coding is performed but the codes are assigned and associated to pre-existing categories and themes. In CM practices, any instantiation of a meta-model is a deductive process, where information is structured according to a pre-existing meta-model. For example, when doing process modeling (using, for example, BPMN) the modeler may look for activities and events in the data. In case there are relevant data that do not fit any existing class, the meta-model needs to be expanded with additional classes. This applies to thematic analysis as well. A framework can be expanded according to new categories and themes that may emerge and don't fit with the existing ones. Thus, the process of creating, expanding or instantiating a conceptual structure seems to bear significant similarities in qualitative analyses and CM that should be further explored too.

The update of a conceptual structure, either in qualitative data analyses or CM requires revisiting earlier findings. This is an obvious similarity between the two approaches and it concerns the *iterative* nature of the approaches. There is a consensus on the iterative nature of both the modeling process [23] and qualitative data analysis methods [2]. Finally, a difference that can be considered essential between CM and thematic analysis is that the guidelines of thematic analysis require a thorough documentation and illustration of the progress of the analysis while the cognitive mechanisms are applied on the data [15], a requirement which is not hard for CM.

4.4. Outcome

On an abstract level, the main outcomes of applying a data analysis method to a collected dataset is a conceptual structure, which consists of a conceptualization and a representation, and this is common both for CM and thematic analysis.

A representation can be internal or external. Internal representation are mental models, which are defined as models that simply exist in the mind [24]. The term visualization refers to external realization and representation in terms of text or diagrams [24]. In contrast to text, diagrams enable fast visual search and the reduction of verbal information to key terms, which both support semantic processing and task decomposition [19]. Such visualizations are considered to increase understanding [24].

Concept maps are diagram visualizations. They are visual representations of concepts and relationships between them, represented as nodes and node-linking lines. The lines are often labeled to improve the descriptive capability of the map [4]. Concept mapping has been promoted as a research method, specifically when it concerns the generation of conceptual structures to support organizational research, planning and program evaluation [25].

Similarly, a model in CM is an abstraction of reality and the act of building one can be described as the process of developing a system of relations, since the results consists of entities and the relationships between them [24]. Modeling is a "fundamental way in which human beings understand the world" [26] and it can be considered as a subset of problem solving [24].

The main differences between CM and thematic analysis when it comes to output lie in the fact that models are created using languages that include additional rules, which provide a higher descriptive power than concepts maps. Such rules concern, for example, UML's relationship types of generalization, aggregation and composition [13], which are not part of the traditional

concept mapping techniques. Therefore, both concept maps and models are diagrammatic visualizations that consist of concept nodes and relationships between them, however, concept maps are well-known as qualitative data analysis techniques, while conceptual and enterprise models are not, despite their significant similarities.

4.5. Context

While CM and descriptive qualitative data analysis methods have no specific application context, EM is a specialization of CM that is based on its specific context. The application context of EM is organizational research. Likewise, thematic analysis, is ever-present in qualitative research in organizational context, exists in method textbooks and research articles and is also taught in business, management, and organizational study programs of all educational levels [2]. We here conclude that while EM is generally confined to an organizational context, thematic analysis's applicability is extended, yet, it is prominent in organizational research.

The common topics that comprise the domain of organizational research are the organizational structure in terms of units, processes and divisions, and its relevance to the researched problem, the identification of specific areas where the problem is encountered, how and where it manifests, who is and who should be involved in the exploration of the problem phenomenon, in terms of roles and units, the dependencies between the actors in the organization, coordination of organizational challenges, business vision and design, existing IT and enterprise architecture, corporate and IT strategy development, etc. [6].

4.6. Summary of the Common Features

A summary of the discussed features is shown as a diagram in Figure 1. The arrows depict generalizations and the lines simple relationships. Blue color reflects concepts associated to CM, red reflects concepts related to descriptive qualitative data analysis methods and purple reflect on common concepts.

5. Discussion

The initial preliminary analysis has indicated that the similarities and common features between CM/EM and thematic analysis exist and seem to be too many to ignore. The fact that there are also differences between the two approaches, especially when it concerns the application processes, does not mean that the hypothesis is wrong, since a lot of significant differences also exist among the officially established qualitative analysis methods. The only aspect that may potentially restrict the establishment of CM as a qualitative analysis method is the absence of a required detailed and comprehensive report of the methods' application process, that is, compared to methods like thematic analysis, where every step needs to be documented in detail to avoid ambiguities.

A potential impact of establishing CM as a data analysis method will be an update in methodological requirements in academic writing. From our experience, in papers or theses where CM and EM methods have been applied for analysis, the authors or students are forced to describe the process in terms of established qualitative analysis methods in order to ensure research

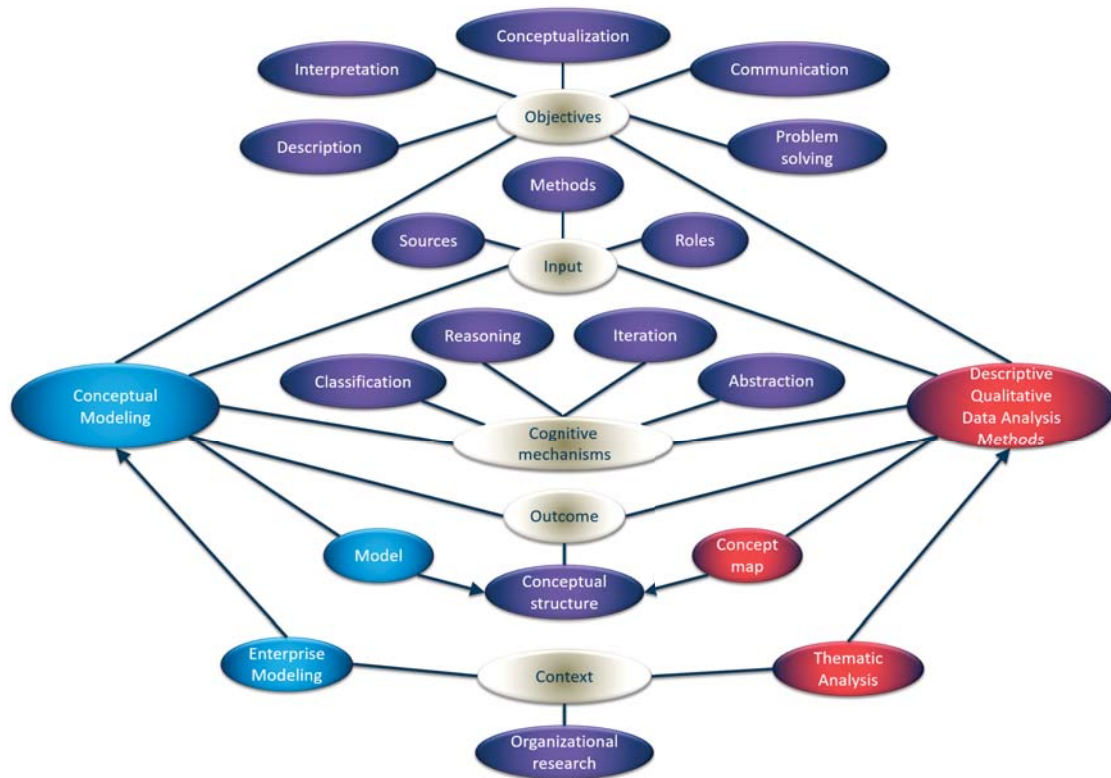


Figure 1: A diagrammatic depiction of the common features.

validity. Establishing CM as a data analysis method can facilitate the task of describing research validity in projects that involve CM.

The preliminary conceptual mapping of the common features between CM and qualitative data analysis that has been presented in this paper indicates potential directions for theoretical and methodological research on CM in order to expedite the process of integrating it with the group of scientific data analysis methods.

A noteworthy point is that the boundaries between the cognitive mechanisms of CM and thematic analysis are not perfectly clear. This is a point that needs to be taken into consideration while elaborating on the idea suggested in this paper. In particular, abstraction and classification seem to require additional decomposition for the definition of clear boundaries and a more solid justification of the overlapping aspects between CM and descriptive data analysis methods. An initial set of criteria for classifying a method as data analysis has been introduced, but the nature of this preliminary exploration suggests a more thorough inquiry for improved results in terms of efficiency and validity.

6. Conclusion

This paper explored if CM and EM have the potential to be established as qualitative data analysis methods. For this reason, a structured comparison has been performed, using common and tangent aspects of the two seemingly different approaches. This paper does not claim to provide any solid proof, conversely, the results provide a mere indication that CM/EM and thematic analysis are cognate methods. We aspire not only to continue this work with practical experimentation on our hypothesis but also to motivate researchers to elaborate more on this idea since the findings of this paper have not disproved the initial hypothesis, on the contrary, an initial basis has been set for further research.

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