

A methodological approach using grounded theory in industrial engineering research applied to a study of a regional knowledge creation process

Rosalba Frias-Navarro[†] & Luz A. Montoya-Restrepo[‡]

Pontificia Universidad Javeriana, Bogotá, Colombia[†]

Universidad Nacional de Colombia, Medellín, Colombia[‡]

ABSTRACT: Regional knowledge creation (RKC) is relevant because of the changing conditions in a turbulent environment where it becomes necessary to innovate constantly. The relationship between knowledge creation and competitiveness can be regarded as a cornerstone to the strategies for regional development projects. The aim of this article is to describe how grounded theory has been used to comprehend a knowledge creation process in the context of Suyusama, a regional sustainability programme that fosters cooperation with local communities of peasants and indigenous people in Nariño, Colombia. From a systematic analysis of qualitative data, the contribution is to build theory that attempts to understand the meaning of the people's experience or to obtain details of that complex process in order to replicate or adapt the working methods of these organisations elsewhere in the world, with similar conditions of poverty and development needs. In this article, a worked example of a grounded theory project is provided by the description of sampling, data collection, data analysis and interpretation.

Keywords: Qualitative research, grounded theory, methodology, regional knowledge creation, Suyusama

INTRODUCTION

The everyday turbulent environment of a *third world country* is regularly in the news in the forms of violence, political corruption, natural disasters, legal and illegal mining destructive *exploitation* with irreversible consequences on the environment, and strikes where peasants demand higher incomes, access to education and social security. Thus, current circumstances call for the emergence of new perspectives on the present and future of under-developed countries like the ones in Latin America, and at the same time bring with them challenges and opportunities to engineering faculties to work on research that provides solutions to promote regional community work, seen here as a pivotal step to local development. To achieve this goal, engineers must understand the problems thoroughly. It is suggested that researchers consider the use of qualitative research methodologies as tools for acquiring a deep understanding, allowing them to proceed to undertake quantitative research to supplement the processes.

The above triggered the authors' research interest in regional knowledge creation processes. The importance and pertinence of these processes is not only based on the consideration of them as sources for achieving regional competitive advantage, but mainly to develop alternative ways to construct a better world for communities of peasants and indigenous people located in a specific region. Developing a region is a complex process in which many actors interact, and as a result of that, local or regional development policies can emerge. Those actors have their own strategies and goals and, therefore, the process management must take into account the specific ways of working as networks that cannot be controlled by a single actor, because their relationship is not based on hierarchies or power [1].

To carry out this research, the region called Nariño in the south of Colombia has been selected as a case. For more than two decades, participative dynamics in Nariño have been promoted to work on planning and management through the implementation of people's councils. In this framework, Suyusama (a Quechua word that means *beautiful region*), the Sustainability Programme for Regional Andean Nariño and Putumayo was created in 2004. It is the result of the articulation of the social centers of the Society of Jesus (IMCA - Instituto Mayor Campesino/Peasant Major Institute; CINEP - Centro de Investigación y Educación Popular/Centre for Research and Popular Education; SJR - Servicio Jesuita a Refugiados/Jesuit Refugee Service; Programa por la Paz - Programme for Peace), in collaboration with Pontifical Xavierian University in Bogotá, and its purpose is to contribute effectively to building local and regional economic alternatives to construct and reach the communities' *dear life* [2].

Suyusama works with the communities from the beginning of the process in the development of their life plans. From there, it escorts them through the formulation of development plans, and the subsequently development, management and implementation of strategic projects. This cycle, articulates the political agenda in the region and aims to provide information to qualify the political culture of the communities, as protagonists of their own local development [3].

For understanding the regional knowledge creation (RKC) process that takes place through the networks shaped by interactions among the communities with different types of organisations (private, public, NGOs, non-profit foundations and universities), this investigation has a human approach and the process has been interpreted here as a social practice in which the ways to create the context (or *Ba* as it is called in Japanese) to facilitate the connections in order to improve the process are permanently analysed, specifically focusing on the knowledge conversion process (SECI model) or the interaction between tacit and explicit knowledge [4].

Due to the complexity of the process and the need to find a way to explain it, a qualitative approach has been chosen, one in which grounded theory is being used as the research strategy. Its purpose is to build theory from the systematic analysis of qualitative data, and it attempts to understand the meaning or the nature of the people experience with the identified problem or to obtain details of a complex phenomenon [5]. In this article, a worked example of a grounded theory project is provided by the description of sampling, data collection, data analysis and interpretation, and the aim is to connect engineering students and researchers with a useful methodology for future considerations of academic work.

KNOWLEDGE CREATION PROCESS (KCP) - THEORETICAL FRAMEWORK

According to Kostiainen, developing a region is a complex process in which many actors interact, and as a result of that, local or regional development policies can emerge. The actors create networks where each member has its own objectives and strategies and the relationship between them is not based on hierarchies or power [1]. That scheme matches with what Harmaakorpi et al define as a regional system of innovation - a cluster composed of various organisations that operate as networks, which interact to perform activities in order to adapt, generate and extend knowledge and innovation, which are the basis of economic development in a specific region [6][7].

As Harmaakorpi and Melkas have pointed out, the intercommunication between the diverse actors in the region ends up in interactive learning processes due to the information processing from the surroundings. The key point is to evaluate the mechanisms for transforming information into knowledge, which leads to the need to consider a common regional knowledge management system in order to study how and what kind of knowledge and information is transmitted in the network. The authors question how well the SECI model can be applied in regional networks because, as manifested, the model is designed for organisations that have clear leadership and a hierarchical structure that allows for decision making and control of the processes [6]. Within this scenario regional knowledge management is linked to innovation, so the development of knowledge in the region increases regional competitiveness and achieves maximum benefits [8].

For Max-Neef, the real challenge consists of looking for alternative hypotheses to build a better world and within this framework, knowledge-based innovation can be contemplated as one source of regional development [9].

The previous two paragraphs are an example of a *theoretical framework*. For Corbin and Strauss, *...it provides a conceptual guide for choosing the concepts to be investigated, for suggesting research questions, and for framing the research findings* [5].

METHODOLOGY

According to Corbin and Strauss, grounded theory methodology and methods (procedures) are now among the most influential and widely used modes of carrying out qualitative research, when the researcher's principal aim is to generate theory by the systematic analysis of qualitative data. Grounded theory methodology (GTM) attempts to understand the meaning or the nature of the people's experience with the identified problem or to obtain details of a complex phenomenon [5]. It is an inductive and comparative approach that encourages researchers to interact persistently with their data, being constantly involved with their emerging analyses. *Data collection and analysis proceed simultaneously and each informs and streamlines the other* [10].

Figure 1 illustrates the steps taken in the project, described below from A to H. However, it is necessary to take into account that the study design is not linear, static or rigid. According to the discretion of the researcher or the analyst, some of the steps can be done at the same time. Moreover, the illustration is a guide for people who begin to use a GTM.

Formulating a Research Problem and Formulating Research Questions and Objectives

One of the more difficult things when a person decides to undertake a piece of research is deciding upon the theme for investigation. Because the researcher will have to deal with it for some time, it has to be something of interest to them. The researcher should identify a problem that he or she would like to research and, then, narrow it sufficiently to make it into a workable project [5].

In regard to the research questions, Corbin and Strauss have pointed out:

It is necessary to frame the research question(s) in a manner that provides the investigator with sufficient flexibility and freedom to explore a topic in some depth. [...] While the research questions in qualitative studies tend to be broad, they are not so broad as to give rise to unlimited possibilities [5].

Taking into account the above, the initial research questions for the study were:

- What is Suyusama?/What is the philosophical principle of the programme?
- How is the work process of Suyusama (RKC) interconnected with communities? (activities, important roles, approximate times, objectives, methodologies).
- What factors are involved in the process (RKC) and when these factors may enhance or slow down it?

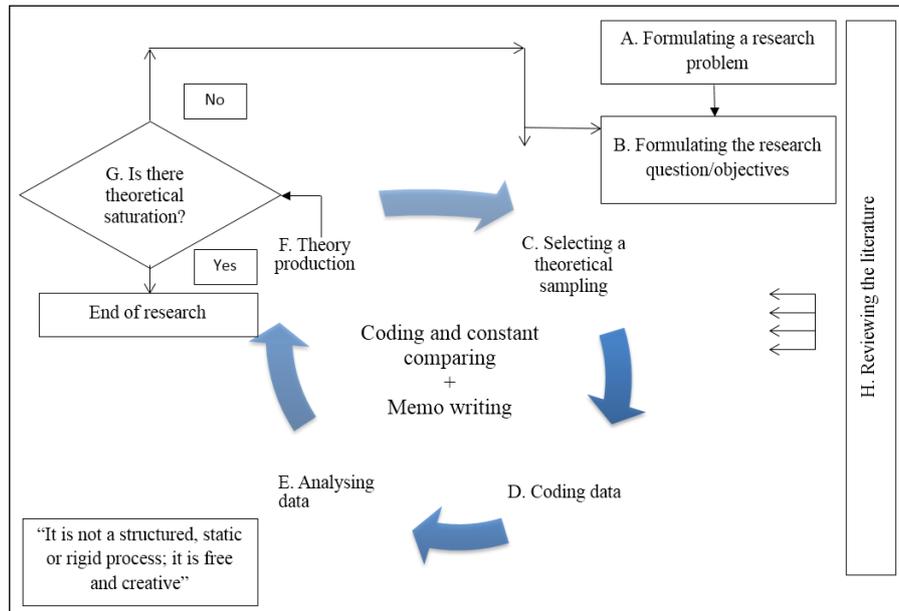


Figure 1: GTM - study design.

Selecting a Theoretical Sample

Data collection begins with theoretical sampling, which is conducted by the analyst, who collects, codes and analyses data and, then, decides which data to collect next and where to find those data, based on emerging concepts that are used to develop the theory as it emerges [11].

For the purpose of this research, the initial decisions for theoretical collection have been based on the problem area. This work has been developed in two stages: first, by doing a literature and document review on Suyusama's principles, strategies and results obtained since 2004; and second, by interviews with Suyusama's team members and people from the local community organisations. Those activities were done to describe the experiences of the participants according to their optical, language and expressions.

Table 1 illustrates the theoretical sampling during the time and some information of the collected data.

Table 1: Theoretical sampling and collected data for the study of Suyusama KCP.

#	MM/YY	Type of collected data	Quantity	Notes
1	August/2013	Audio-interview	7	5 form Suyusama/2 peasants/approaching to the region and its people
2	July/2014	Audio-interview	9	9 from Suyusama/deep approach
3	July/2014	Video-training	61	Suyusama interacting with peasant communities/how Suyusama works with communities
4	August/2014	Video-conference	1	Francisco de Roux JP/relevance of science research/the principles
5	December/2014	Audio-interview	12	Interviews with members of the Quillacinga Indigenous Council/approach to community
6	January/2014	Video-project activity	8	Work of 8 saving and borrowing groups/one of the products of knowledge creation
			98	

Collecting Data

In qualitative research there are many alternative sources of data. In this study collecting data has been developed in two stages - two objectives. The first objective was to obtain an approximation to the region and its people. For that purpose, the researcher has used interviews, videos and a document review on Suyusama's principles, strategies and results obtained since 2004.

The second objective was to comprehend the RKC process. Data have been collected by the way of observations, interviews and videos made by Suyusama's team members interacting with the people from the local community organisations. Data were obtained through facts and stories in the context where the events occur, and the aim was to be able to comprehend and to describe the experiences of the participants. During data collection, all interviews were digitally recorded and encounters were videotaped. The material has been transcribed in detail using NVivo.

Analysing Data

Analysis involves coding. That is, to take the raw data and raise it to a conceptual level. Codes are the names given to the concepts during the act of coding [5].

Coding and Constant Comparing

Data analysis is carried out through a coding process. Open coding is used to read the information and identify the comments related to the primary categories. Then, by axial coding, the categories that are the axis of analysis can be defined and, finally, selective coding refines the concepts. By coding data, it is possible to discover concepts, categories, themes and patterns, and links between them, in order to give a sense and an explanation according to the research problem statement.

In the study presented in this article, for the activities of coding and comparing, the researcher used NVivo software to expedite the analysis. It is important to note that the researcher here is the person who collects, codes and analyses data. The use of constant comparing looking for similarities and differences lets the analyst add to general properties and dimensions of one code, and also gives the material to complement the construction of the theory. Table 2 illustrates an example of the codes generated in this study.

Table 2: An example of some of the codes for the study of Suyusama KCP.

1. Knowledge creation process (KCP)	1.1. Interaction between tacit and explicit knowledge	1.1.1. Socialisation form tacit to tacit)
		1.1.2. Exteriorisation (from tacit to explicit)
		1.1.3. Combination (from explicit to explicit)
		1.1.4. Internationalisation (from explicit to tacit)
	1.2. Creating new knowledge	
	1.3. Transferring knowledge	
	1.4. Preservation of knowledge	
	1.5. Using knowledge	
	1.6. Type of KCP	1.6.1. Organisational
		1.6.2. Regional
	1.7. Factors involved in the KCP	1.7.1. Presence of armed conflict
		1.7.2. Power
		1.7.3. Opportunities to find a job
		1.7.4. Economic resources
		1.7.5. Education
		1.7.6. Commitment to change
		1.7.7. Social appreciation of knowledge
		1.7.8. Communication
		1.7.9. Public policy

Memo Writing

Memos are written records of data analysis [5]. Throughout the study and after each interview or meeting with people directly in the field, the researcher wrote memos that contain their impressions about the participant experiences or meanings. An example of a memo is presented below:

None of the people with whom I have spoken mentioned the word innovation. In general, all of them, regardless of their level of education, or, if they are peasants or indigenous, always refer to an expression reach the dear life.

To *reach the dear life* arises from the quest to understand how Suyusama operates. It led the researcher towards a review of the literature on this concept for its connection with the process of regional knowledge creation.

Theory Production

According to Bryant and Charmaz *...theorizing in GTM means developing abstract concepts and specifying the relations between them* [10]. Through the data analysis and the link of the results to existing knowledge by reviewing the literature, a detailed model of the knowledge creation process in the context of Suyusama has been constructed. A brief summary of the process is described below:

As a mentor organization, Suyusama supports communities in their processes of regional knowledge creation beginning with a participatory work originated from the formulation of their life plans. From these, and through the analysis of local resources, the territory potentialities come out to be translated into development plans, and in formulation and management of strategic projects. All this implies the encompassing of autochthonous knowledge and the dialogue and cooperation of external participants. The community members are autonomous to build their own local development proposals within a framework of regional sustainability. That includes taking into account food, environmental, cultural, social and economic security. The above fits the paradigm of la vida querida (the dear life) while preserving their memory and own knowledge.

Specific concepts and methods of working during the KCP arise from the analysis. They should be explained in detail. Some of them are *a mentor organization, dear life, Suyusama working as a catalyst for the process, how life plans* are built and how to train *project mentors* in the communities. Among concepts a possible link between the meaning of *dear life or vida querida* and *sustainability* has emerged and is being evaluated in the present.

For Glaser and Strauss, the elements of the theory generated by comparative analysis are:

First, conceptual categories and their conceptual properties; and second, hypotheses or generalized relations among the categories and their properties [11].

Theoretical Saturation

This cycle, shown in Figure 1, is carried out until theoretical saturation is found, or when it becomes possible to cycle without obtaining additional coding information.

The point in analysis when all categories are well developed in terms of properties, dimensions and variations [5].

Reviewing Literature

Although some authors state that when carrying out an investigation in which GTM is being used, it is not recommended to do a prior review of the literature. However, it has been done throughout the process of this research. This has enabled the researcher to make comparisons, constantly looking for similarities and differences between concepts. It has even allowed seeing and concluding that in an RKC process, the limits during knowledge conversion are blurred. Organisational knowledge creation models should be adapted when analysing RKC.

In this regard, Corbin and Strauss write the following:

Concepts derived from the literature can provide a source for making comparisons with data as long as the comparisons are made at the property and dimensional level, and are not used as data per se. If a concept emerges from the data that seems similar or opposite to one recalled from the literature, then the researcher can examine both concepts for similarities and differences [5].

CONCLUSIONS

Engineers should be encouraged to use qualitative research methodologies as tools for deep understanding the problems to subsequently proceed to raise quantitative research that can complement their process.

Doing this will expand their knowledge and, therefore, they would provide better solutions to problems that contribute to the development and improvement of the quality of life of people in various regions of the world, by taking into account the culture, customs and local needs and not only technical or economic considerations.

With regard to the theory generated, Glaser and Strauss have pointed out that:

The theory should provide clear enough categories and hypotheses so that crucial ones can be verified in present and future research; they must be clear enough to be readily operationalized in quantitative studies when these are appropriate [11].

This article provides an explanation of how a study evolved using grounded theory methodology. This might help other researchers in engineering to apply this methodology as a resource that can greatly improve the outcome and quality of their studies. It is suggested that researchers reflect on what Bryant and Charmaz have argued:

GTM rightly appeals to novice researchers because it encourages them to develop their own theories rather than merely fine-tuning existing ones. They may become conceptual entrepreneurs themselves rather than just work for theoretical capitalists. Nonetheless, this point obscures the fact that use of GTM, at least as much as any other method, only develops with experience [10].

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BIOGRAPHIES



Rosalba Frias-Navarro is a marketing Professor at Pontificia Universidad Javeriana - Faculty of Economics and Administrative Sciences. She is a candidate for the PhD in engineering, industry and organisations, and has a Master's degree in management, MSc, and a Bachelor's degree in agricultural engineering at Universidad Nacional de Colombia, Bogotá. Her research interests are organisations, local sustainability development, information, knowledge and innovation. She has professional experience in national and multinational companies in the areas of research and development, project management, marketing and sales.



Luz Alexandra Montoya-Restrepo was awarded a doctorate in economics sciences in 2010, a Master's degree in management in 1999 and a Bachelor's degree in business management, 1996 from Universidad Nacional de Colombia, Bogotá. She has been a member of the Mexican Academy of Administrative Sciences (ACACIA), since 2005. She was an Assistant Professor of the Economics Faculty 2000-2005, Universidad Nacional de Colombia, Bogotá and an Associate Professor of the Economics Sciences Faculty 2006-2013. Since 2013, she has been an Associate Professor in the Faculty of Mines at Universidad Nacional de Colombia.