

Normal science and its tools: Reviewing the effects of exploratory factor analysis in management

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RESUMO

Ciência normal e suas ferramentas: Revisando os efeitos dos métodos de análise fatorial exploratória em Administração

O objetivo neste estudo foi investigar como diferentes métodos de extração, de definição de fatores e de rotação da análise fatorial exploratória afetam o ajuste de escalas de mensuração. Para tanto, foi feita uma meta-análise de 23 estudos, na qual os resultados apontaram que o método de Componentes Principais proporciona maior variância explicada, enquanto o método de Máxima Verossimilhança aumenta a confiabilidade. Entre as rotações, a Varimax fornece maior confiabilidade e o Quartimax a menor correlação entre fatores. Na conclusão do trabalho são destacadas as implicações para a pesquisa quantitativa, assim como sugeridos novos estudos.

Palavras-chave: análise fatorial exploratória, confiabilidade, métodos quantitativos, *survey*.

1. INTRODUCTION

However heterogeneous, eclectic, and diverse the paradigms in the social sciences, it cannot be denied that some tend to be more visible in the academic community. The field of administration is no different: some themes and perspectives are more easily accepted, some theories are considered to be legitimate, and some rules and methodological procedures are recognized as being valid. One in particular, however much criticism it receives and however many limitations it has, is dominant in organizational analysis: the quantitative

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research paradigm. It is not difficult to confirm its ubiquity in the main international management journals, and likewise in the most prominent periodicals in the administration field in Brazil, since most theoretical-empirical studies are of a quantitative nature.

Since it is a recurring paradigm, a good part of its procedures and techniques are clearly defined and its rules are relatively well-accepted by those researchers who have mastered it, which makes it similar to what (Kuhn, 2009) called “normal science”. Since its earliest days (Cronbach & Meehl, 1955; Loewinger, 1957), the central undertaking of this research tradition has been to develop valid and reliable scales based on measuring phenomena that are inherently subjective or social. To do so researchers use data collection instruments, typically questionnaires, in which questions or statements are scored with the aim of quantitatively assessing a particular phenomenon, which is measured in different degrees on a scale (e.g. the Likert scale). In the jargon of quantitative research, these phenomena are called constructs, and one of their fundamental assumptions is their latent nature, which leads to the need to use various indicators or items for indirectly accessing them (Netemeyer, Bearden, & Sharma, 2003).

Problems inherent in the operationalization of variables by way of multiple items arise, on the one hand, when a social phenomenon is reduced to numerical scales; and on the other because of the distance between the theoretical concept and the empirical evaluation of the phenomenon (Cronbach & Meehl, 1955; Loewinger, 1957; Netemeyer *et al.*, 2003). But despite being extremely important, these substantive questions are not the only ones to affect the quality of the measuring instruments: questions of a technical nature related to the statistical procedures used for dealing with scales are also fundamental, so much so that texts like the one by (Churchill, 1979) are wholly dedicated to deliberating about a measures development paradigm.

Despite some of the problems and controversies that exist in the procedures deliberated upon by authors like Churchill [*vide* Smith’s (1999) criticism], their importance when it comes to consolidating systematic procedures in the construction of scales must be recognized, especially because such “manuals” were fundamental for spreading the use of the statistical technique for constructing scales that is generically labeled “exploratory factor analysis”. So if today we can understand quantitative analysis in social sciences to be a paradigm, we can see exploratory factor analysis as one of its research tools. Just like a telescope, these tools need adjustments and improvements, such as specifications and tests that set the limits of their use.

In view of the fact that the current rule is to assess any phenomenon by way of various items, exploratory factor analysis helps the researcher identify first of all how many dimensions a construct has, and secondly to fit each one of the items into the dimension most directly related to them.

Therefore, after assessing the dimensionality of the construct, an attempt is made to check the extent to which these dimensions are internally consistent, or reliable. The problem is that there are various options for adjusting this technique (e.g. various extraction and rotation methods), which end up raising doubts in researchers’ minds as to which is most appropriate for their use. Despite some interesting studies that discuss these questions (Aranha & Zambaldi, 2008; Guadagnoli & Velicer, 1988; Stevens, 2009), the objective of our study is to contribute towards improving the use of these tools based on a meta-analysis of twenty-three articles that were published in the administration area in Brazil, as we seek to understand how different extraction, factor definition, and rotation methods affect the fit of exploratory factor analysis.

Following this introduction there are four parts to the structure of this article: in the first we review the exploratory factor analysis procedure and its stages, where we highlight some of the issues and questions that have guided this empirical research. We then present the methodological procedures, by providing details of the data collection work, the creation of indicators, and the statistical analysis method we used. Next, we give the results of the research, by answering the questions raised in the theoretical framework. Finally, we discuss the implications of our findings for developing and refining scales in practice.

2. NOTES ON EXPLORATORY FACTOR ANALYSIS

Exploratory factor analysis (EFA) is a multivariate interdependence technique that is widely used in research in the field of administration, especially research of the survey type, and which has two primary purposes. The first is to obtain a minimum number of factors that contain the maximum possible amount of information contained in the original variables used in the model, and with the greatest possible reliability (Hair, Black, Babin, Anderson, & Tatham, 2009; Johnson & Wichern, 2007; Netemeyer *et al.*, 2003). This reduction in the number of variables is desirable when it is intended to submit the data to other multivariate analysis techniques, in which there can be no strong correlations between the independent variables, as is the case with regression techniques, thus generating a more parsimonious model (Hair *et al.*, 2009; Johnson & Wichern, 2007). Although there may be a correlation between these factors, factor analysis guarantees a concentration of the information from the original variables (Aranha & Zambaldi, 2008; Hair *et al.*, 2009). The second purpose, which is related to the first, is to identify how indicators used empirically are configured in factors that are not directly observed, representing the facets or dimensions of the phenomenon being investigated (Johnson & Wichern, 2007). In short, an attempt is made to identify how many dimensions a construct has (Netemeyer *et al.*, 2003), which is the most relevant decision a researcher has to make when carrying out factor analysis (Johnson & Wichern, 2007). It is important to emphasize that factor analysis cannot

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