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**FORMAT:** Paper Presentation

**THE APPLICATION OF CLUSTER ANALYSIS TECHNIQUES IN MANAGEMENT**

**RESEARCH: A REVIEW OF CHALLENGES, DEVELOPMENTS, AND OPPORTUNITIES**

## ABSTRACT

Traditionally, cluster analytic techniques have been popular across a range of pure and social science disciplines. They remain popular currently within management research, although largely limited to clustering items in factor analyses. With the emergence of a more sophisticated model-based clustering technique, latent class cluster analysis (LCCA), it has become possible to more rigorously test substantive research questions about the configurations and classifications surrounding multidimensional organisational phenomena. In this paper we outline some of the pros and cons of LCCA, selectively review the limited body of organisational research to date that has utilised an LCCA approach, and discuss how it might be beneficial to advocate its use more systematically within management research.

## TOPIC INTRODUCTION & BACKGROUND

*“The Image is more than an idea. It is a vortex or cluster of fused ideas and it is endowed with energy”*

*(Ezra Pound)*

The aim of this paper is to take stock of the status of clustering techniques in management research within the fields of organisational behaviour (OB) and human resource management (HRM). In this paper we review the development of more sophisticated clustering techniques and procedures for using them, namely latent class cluster analysis (LCCA), as well as some of the theoretical challenges and opportunities surrounding their application to OB and HRM.

The use of clustering procedures in management can be especially useful to obtain a more holistic, understanding of workplace phenomena that exist in configurations at different levels of analysis (e.g. personality profiles, organisational subcultures, the use of bundles of practices/strategies). Despite the interdisciplinary popularity of clustering techniques (e.g. clustering genes, medical symptoms, regions of brain activity, marketing segmentation of consumers, geographical crime ‘hot spots’), they remain relatively under-used within domains of organisational and management scholarship. This may stem from perceived concerns, including messy transformations to standardise multiple variables, large group or sample sizes, a lack of theory for making deductions, and the conventional preoccupation of confirming the impact of single regression predictors on outcomes.

Despite social science and organisations typically implying differentiated, configurations of elements or Gestalts, the only ‘clusters’ or combinations that get tested via conventional regression methods are at best a series of two-way and three-way interaction effects (Lawrence & Zyphur, 2011). In the current paper, we propose that LCCA represents a sophisticated form of clustering that can overcome many of the limitations of more traditional clustering techniques. We selectively review illustrative articles from management research moving in the direction of using LCCA and present them accessibly as templates for inspiring a more systematic agenda. Finally, we conclude with some future-oriented speculations about how LCCA can inform the way we think about organisational phenomena, validation, and theory-building.

## **KEY ISSUES OF PAPER**

There are various types of clustering techniques available to researchers. These include non-model based clustering techniques such as k-means clustering and hierarchical cluster analysis (from here on referred to a ‘traditional cluster analysis’) as well as model-based techniques such as LCCA (Vermunt & Magidson, 2002).

A latent class is a group of individuals whose attributes on a range of variables “exhibit more homogeneity as a cluster than the known group from which they are drawn” (Lawrence & Zyphur, 2011, p39). LCA has a number of advantages over the more ‘traditional’ cluster analytic methods. Perhaps the most significant is that it is model-based, making it analogous to, and even to some degree a subset of structural equation modelling (SEM), a more familiar technique to management scholars. This makes LCA less subjective than traditional cluster analysis, allowing it to be both confirmatory and exploratory in finding best-fitting models according to statistical (quantitative) and more substantive (qualitative) criteria (Vermunt & Magidson, 2002; Muthén, 2003). Specifically, the key advantages particular to LCCA include: its ability to include nominal, categorical, and continuous variables within complex structures without transforming variously distributed variables; the use of formal or rigorous criteria to identify a best-fitting class model (Chi-squared statistic  $L^2$ , Akaike information criterion (AIC) and the Bayesian information criterion (BIC)); the use of probabilistic model criteria that assess a model’s

‘classification quality’ of assigning individuals meaningfully to single classes; its capacity for accommodating large and small groups; and finally, its capacity for being combined with analysis of latent factors (Lawrence & Zyphur, 2011; Pastor, Barron, Miller, & Davis, 2007). The final, latter advantage allows researchers to integrate their more conventional ‘variable-centred’ analyses (e.g. regression, measurement validation, SEM associations) with LCCA ‘person-centred’ class analysis, potentially answering research questions about predictor-outcome associations and classes/types of person within a sample simultaneously (Muthén & Muthén, 2000).

One reaction of management researchers might be that such a method seems unwieldy, computationally burdensome, or ill-suited to our field. We argue that this is not necessarily so, for two reasons. Firstly, advances in computing and the availability of software (e.g. MPlus, LatentGold) mean that such analyses can now be conducted routinely using the same sample sizes and type of organisational data collection conducted routinely for SEM-based studies (Vermunt & Magidson, 2002). Secondly, the fact that a small body of work in our field has already been using LCCA techniques to answer research questions demonstrates its feasibility and applicability.

In Table 1, we present five example studies within the management discipline that use LCCA to contribute to our understanding of organisational phenomena (for space reasons, we do not include an exhaustive range of studies from the full paper here, but present these five as representative examples). Note the relative recent nature of the publications, and the fact that the most recent one appeared in the journal *Organizational Research Methods*, suggesting that the methodological and analytical nature of how to apply the LCCA technique is still relatively novel in and of itself. We might also note the impressive range of topics and sub-disciplines in evidence (HRM practices, bullying (occupational health), part-time working, and organisational demography), and also how the contributions are arguably very decisive and significant, testing and/or building major theories, as well as updating or clarifying construct domains. The person-centred (or in the case of the Wood & de Menezes paper, organisation-centred) findings constitute a particularly contextual, accessible, and data-driven set of insights.

In sum, our inspection of the organisational literature reveals that as a discipline we have been slow to catch onto the advantages of techniques like LCCA, but there appear to be clear conceptual and

analytical benefits to doing so. We conclude by expressing optimism about how LCCA might be incorporated more systematically and widely into programs of research, practice and training.

**TABLE 1. Studies Using Latent Class Cluster Analysis (LCCA) in Studying Organisational Phenomena**

Authors	Topic	Finding	Contribution
Wood & de Menezes (1998)	High Commitment HRM practices	Organisations fit into four homogeneous classes that vary in their overall use of High Commitment HRM based on widespread information disclosure and performance appraisal	Direct evidence that HRM is applied in a relatively systematic, synergistic way, rather than a fragmented, ad-hoc way
Notelaers, Einarsen, de Witte, & Vermunt (2006)	Exposure to bullying at work	Identification of six classes of bullying victim at work that vary in severity, prevalence, and work-related nature of bullying experienced	Moved from ‘victims vs. non-victims’ to a more differentiated conceptualisation of workplace bullying with higher validity than traditional classifications
De Jong et al. (2007)	Motives for accepting part-time employment	Identification of three types of part-time worker based on motivation: involuntary, stepping-stone, and non-involuntary	Appreciating that motivations for part-time work arrangements are more complex than the voluntary-involuntary dichotomy suggests
Gerber, Wittekind, Grote, & Staffebach (2009)	Contemporary career orientations	Exploratory and confirmatory class analysis confirmed four types of contemporary career orientation: traditional/promotion; traditional/loyalty; independent; disengaged	Traditional career values may well be more prevalent than many have argued. Slow employee- and culture-specific changes in these types is useful information for wider society
Lawrence & Zyphur (2011)	Identifying organisational faultlines (diversity)	Employees form relatively strong subgroups based on demographic distributions within an organisation	Most rigorous empirical testing of the attribute interdependence theory of faultlines to date

## CONCLUSIONS & CONTRIBUTIONS

In sum our paper demonstrates how traditional clustering techniques have advanced, namely in the form of LCCA, and that these analytical procedures offer great rigour, accessibility, and potential for ongoing investigation into a range of areas within management scholarship. Like a social network approach, clustering and classes as analytical mindsets allow us to theorize and represent phenomena in

new ways (e.g. profiles, interdependent attributes) and generate new quantitative and qualitative insights not offered within the confines of other methods (Zyphur, 2009).

We believe that teaching, researching, and disseminating using an LCCA approach alongside more conventional approaches like SEM has great potential for advancing organisational science. If we take a substantial topic like teams, it has taken many decades of messy theorizing to subjectively understand team types, and there remains an analytical bias towards understanding teams as relatively static and validating their existence as convergent entities based on similarity and agreement, despite ongoing theorising about differentiated team types, profile dynamics, and multidimensional specialisations within teams (Cronin, Weingart, & Todorova, 2011; Hollenbeck, Beersma, & Schouten, *in press*). The same barriers to understanding requiring analytical shifts are arguably also in evidence for other topics, including organisational subcultures, structures, and multiplex distributions of employee attributes.

Finally, we do note that as well as opportunities, at least three challenges remain in taking full advantage of techniques such as LCCA. Firstly, profiles can be compared longitudinally over time and/or across contexts, although this isn't being addressed much thus far, and may place an extra burden on researchers at this time. As researchers we are often interested in showing that measurable phenomena are relatively stable. Nonetheless, a method referred to as 'configural frequency analysis' is starting to be used in order to assess the stability versus changes in latent profiles at the sample-level (e.g. Tuominen-Soini, Salmela-Aro, & Niemivirta, 2011). Secondly, LCCA is connected to a wider family of methods (e.g. latent growth curve modelling, mixture models) that are discussed statistically in other disciplines, but may be messy within the context of a single investigation. Nevertheless, like other scholars, we believe that debate on how to use LCCA in conjunction with various qualitative, quantitative, longitudinal (e.g. growth curves or trajectories), and social network methodologies can be fruitful (Lawrence & Zyphur, 2011). Finally, the challenge of building and developing theory in dialogue with these techniques remains. It is worth reflecting on where theories on configurations and profiles are appropriate, and how to continue to build new theories (e.g. demographic faultline theory, personality profiles) that take our understanding beyond the influence of isolated regression predictors.

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