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Prediction of Convergent and Divergent Determinants of Organisational Development

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Abstract: *Different scholars study organisational development through prismatic lenses of various determinants. Despite extensive analysis, it was found that there is little evidence to date on the measurement, analysis and prediction of organizational development using digital tools. The knowledge gap revealed the potential to define convergent and divergent determinants of organisational development. The study in the context of predicting convergent and divergent determinants of organisational development is divided into two parts - the definition of determinants for the surrogate model and the construction of the prediction model. In this publication, the first part is presented. Considering the different approaches to measuring organizational success, the determinants of processes and company competences emerge. Although organisational development represents one of the focal points, its determinants tend to be recorded and analyzed only over the medium or long term, precluding a short-term conditional parameter adjustment. This publication explores the convergent and divergent determinants of organisational development by conducting a quantitative and qualitative publication analysis and network analysis. The conceptualized organisational development model specifies the described determinants by extending them with further parameters, which can be applied for prediction using algorithms based on artificial intelligence. Based on the publication results, network analysis, and structural equation modelling, 13 determinants and 42 parameters were identified. These show a high degree of interconnectedness, highlighting the approach of divergent and convergent determinants in the overall construct of organisational development. These determinants and parameters form the framework for surrogate models and can serve as input or forecast data for different algorithms. Furthermore, a conceptual model for predicting organisational development, formulated based on defined parameters using machine learning, is presented. The second part of the study will be presented separately, a framework based on artificial intelligence was created for analyzing the current state of organisational development and predicting the next development scenarios based on the findings.*
Keywords: digital twin, organisational development, culture, change, determinants.
JEL Classification: L22, O39.

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Introduction

A determinant describes the decisive factor for the object or situation under investigation. The determinants converge when the same objective is achieved due to the similarity of their orientation. In contrast, divergent determinants have various, even opposite, characters, representing a phenomenon or by superposition of which the best solution can be achieved. As factors of influence, the determinants can be described by different parameters. Organisational development has multi-causal parameter relationships that directly or indirectly reflect the dynamics of the functional organisational areas. Depending on the scientific formulation of the organisational development, the perspective and focus of the investigation are changed. In this research, for the consideration of all relevant perspectives, the investigation of organisational development is supplemented by the consideration of organisational culture and organisational change.

Methodology and Research Results

To achieve a more feasible distortion, a publication and network analysis of the published research results was conducted. The researchers had previously established the efficiency and relevance of the methods and tools, thereby providing evidence to support the chosen decision. The initial research comprised the initial data collection for selected terms and filtering of the search results according to their temporal relevance and document type. It was conducted within the Scopus database. The network analysis of publications was conducted in Gephi, applying the Fruchterman Reingold algorithm. In addition, during the results screening, VosViewer was used to highlight the density of the networks. The first block was related to organisational development. The publication analysis for "determinant*" AND "organi*ation* development" resulted in 71 hits, which were limited to predefined criteria by subject area (Business, Management and Accounting, Social Sciences, Economics, Econometrics and Finance), document type (article, conference paper) to 27. The analysis in Gephi revealed five thematic clusters corresponding to the three density clusters in VosViewer (Figure 1). The analysis shows that the most important determinants relate to the areas of **human** (individuality, lifestyle) and **community** (group, diversity, (interpersonal) communication, cooperation, social aspects, social policy, behavior, capital, care, psychology) leadership, **motivation**, decision, knowledge (education, competence), safety, risk factors, business factors (economic aspects, growth, firm size), strategy (sustainability, quality, resources), performance (productivity, job performance).

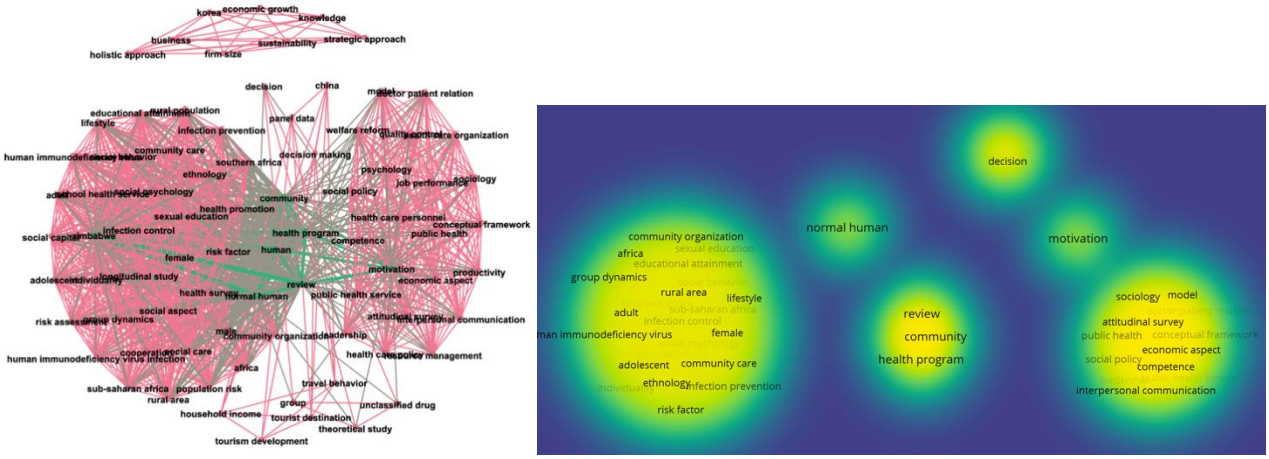

Figure 1. Visualization of Key Word Networks with Gephi and Their Density with Vosviewer for "Determinants of Organisational Development"

Source: Systematized by the author based on (Scopus, 2021)

The secondary publication analysis for "determinant*" AND "organi*ation* culture" yielded 764 results. They were limited to 213 by refinement according to the subject area (Business, Management and Accounting, Social Sciences, Economics, Econometrics and Finance), document type (article, conference paper) and excluding keywords that refer to the country or research method. Reflecting the topic under investigation, VosViewer crystallizes five larger network clusters and Gephi twelve. The difference results from the degree of connection between individual nodes: in the case of VosViewer, the number of

connections was reduced to two (compared to one in the case of Gephi) to visualize density. The network exported in the network analysis of keywords with Gephi shows the causal structure in Figure 2.

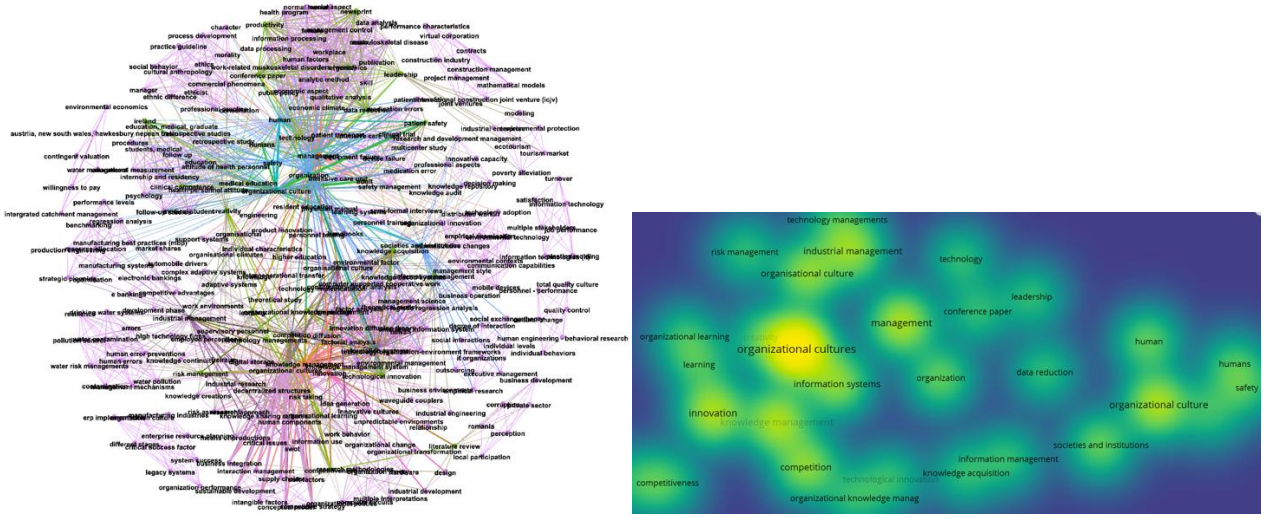

Figure 2. Visualization of Key Word Networks with Gephi and Their Density with Vosviewer for "Determinants of Organisational Culture"

Source: Systematized by the author based on (Scopus, 2021)

These clusters define the following specification areas of determinants of organisational culture: **innovation**, technology, **knowledge** (education), competition, organisation, management (industrial, informational), information, human, creativity, learning, safety, society, leadership, and risk. The third block of analyzed publications focuses on "determinant*" AND "organi*ation* change". The total number of 316 papers was limited to 184 when filtered with similar criteria. The Gephi network comprises 14 clusters, whereas VosViewer – has six (Figure 3). The analysis revealed the factors in the following areas: **human** personnel (human relations, competition), society, innovation, organisational culture, **decision**, **management**, knowledge (learning, education), workplace, economics, information technology, manufacturing, research and development, performance, technology (adaption, change), corporate strategy (sustainability, development), organisation (change, culture, restructuring).

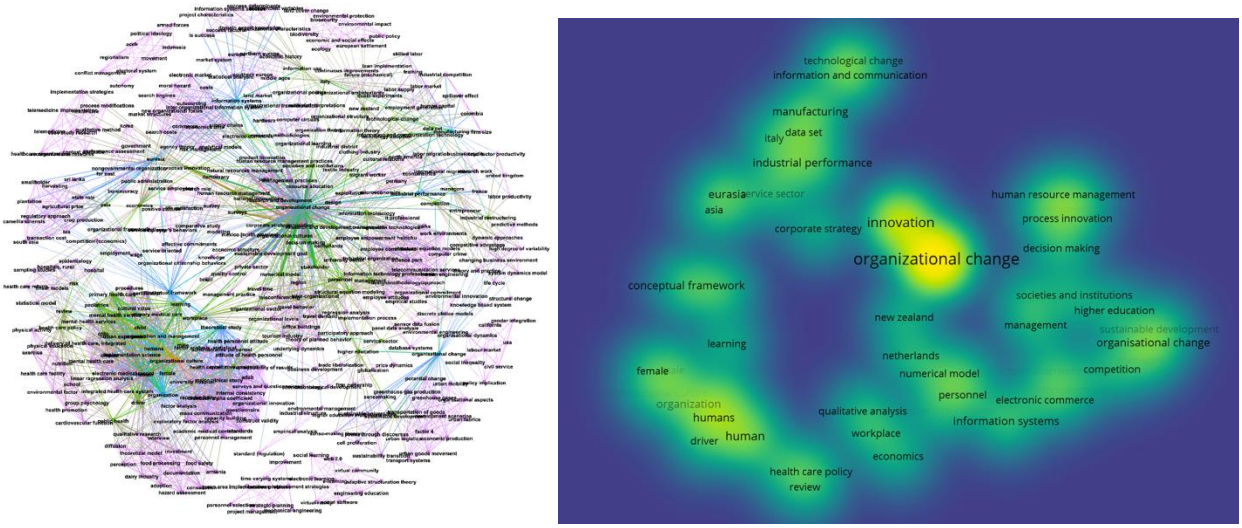

Figure 3. Visualization of Key Word Networks with Gephi and Their Density with Vosviewer for "Determinants of Organisational Change"

Source: Systematized by the author based on (Scopus, 2021)

According to the analyzed publications, the unification allows grouping the individual narrowly oriented determinants. The parameters of organisational development refer to different areas, which cover several aspects and can be determined in one of three ways: directly, using sensors (user applications, edge devices, etc.) or the empirical collection and by secondary analysis of input data (calculated/simulated). This data is used for learning or training purposes for artificial intelligence methods (machine learning), which is used to

forecast future trends. The findings obtained were underlined by the results of the qualitative publication analysis. Nafchi and Mohelska emphasize the necessity of implementing determinants of organisational culture in the context of Industry 4.0 (Nafchi & Mohelska, 2020). The publication review of Errida and Lotfi revealed further parameters that can complement the examples in Table 1 (Errida & Lotfi, 2021). The results obtained from publication and network analysis constitute a framework for a surrogate model for determinants of organisational development. Further investigation of formal expressions of convergent and divergent determinants and corresponding parameters of organisational development revealed the parameter-determinant combinations (Table 1, Formula (1)).

The SEM method allows, based on the data about the intensity of parameter input at different dimensions, to determine their importance for the overall construct through the calculated weights. Relying on the study results, it follows that the parameters with the highest weighting belong parameters presented in Table 1. The number of parameters obtained was intentionally limited to three of the most informative for each determinant. From the majority of the publications examined, the basis for the selection of the respective parameters formed (Ahlf et al., 2019), (Allen et al., 2007), (Bansal et al., 2017), (Bischoff, 2016), (Demigha, 2021), (Guajada, 2016), (Hermann, 2019), (Ilseven & Puranam, 2021), (Lamb, 2020), (Mangitung et al., 2022), (Marta et al., 2021), (Mercer et al., 2021), (Mishra et al., 2019), (Neto et al., 2021), (N. N., 2020), (Reutzel et al., 2018), (Sambharya & Goll, 2021), (Soto et al., 2021), (Tam & Fung, 2012), (Wynn & Rao, 2020), (Zhao et al., 2017), (Vasyltsiv et al., 2021). The authors of these publications have provided a holistic overview of the influence of the parameters they studied on the other parameters, determinants, or organisation.

Table 1. Summary of Convergent and Divergent Determinants of Organisational Development as Results of the Publication and Network Analysis and Structural Equation Modelling

Determinants	Parameters
Convergent	
Human (H)	Number of individual (lifestyle) activities per employee (for every year): na Number of enriched suggestions for improvement per employee (for every year): nin Degree of individualization of work equipment (share of individual adapted working equipment to the number of employees):kin
Knowledge (Kn)	Competence score (share of individual competencies in the total competencies of organisation): cs Effectiveness of organisational learning: Nol Training rate (share of the number of implemented to the planned trainings): φt
Motivation (M)	Effectiveness of motivation (degree of utilization of implemented motivational measures, reflected in successful achievement of the planned activities. In this case, the performance of all subordinate units and employees is summarized.): EM • Need fulfillment (individual need satisfaction level): ned • Employee motivation (Median degree of employee motivation): MeD • Group motivation (Median degree of group motivation): MgD • Organisational motivation (Degree of organizational motivation): MoD
Organisational characteristics (OC)	Size of the organisation by number of employees: ne Size of the organisation by annual revenue: nar Age: oa Intensity/orientation of resources: reint
Social characteristics (SC)	Diversity score (share of the individuals of specific characteristic in the total number of individuals): DS Communication intensity degree (difference between actual and optimal intensity of communication): Nci Effectiveness of conflict resolution measures (number of successful resolved/unresolved conflicts): EC
Strategy (St)	Realization degree (Effectiveness of strategy): Nst Degree of technologization: $Ntech$ Innovation rate: InR
Functional factors - related to functional units (Ff)	Degree of product diversification: $PrdivD$ Ranking Index: RI Fluctuation rate (Number of employees leaving the company to the number of members at the beginning of the period and the new employees): FlR

Table 1 (cont.). Summary of Convergent and Divergent Determinants of Organisational Development as Results of the Publication and Network Analysis and Structural Equation Modelling

Performance (Pf)	Target productivity (target, current): Pt, Pc Productivity (target, current): Pt, Pc Duration (target, current): dt, dc Individual performance (employee, leader): Pe, Pl
Leadership (L)	Intensity of leadership: InL Span of control: SpC Delegation limit: LiD
Job (J)	Level of job satisfaction: JS Individual performance (employee, leader): Pe, Pl Degree of job enrichment: JE
Decision (D)	Effectiveness of decision making: EDM Duration of decision conversion: dDC Sum of Rights (decisions): $Right$
Divergent	
Risk (Ri)	Number of planned/implemented information risk measures: $Nirm$ Number of planned/implemented occupational safety training courses: Nst Losses due to financial risks: Lfr
Safety (Sa)	
Change (Ch)	Degree of resilience (degree of resilience of an organisation to internal or externally driven crises): ReD Team change performance (): $NPte$ Change index: ChI
Resilience (Re)	

Source: Systematized by the author based on (Scopus, 2021)

In addition to these determinants resulting from the publication and network analyses, organisational characteristics were included as they are useful for further research and surrogate model building. The dependencies of individual determinants and parameters among each other are not clear from the relation of the surrogate model. Therefore, the structural equation modelling method was conducted to ensure transparency concerning the interdependence of different parameters and, thus, determinants. For this purpose, semopy was applied. The following formula set maps the correlations in Table 2 of summed determinants and parameters.

$$
\begin{aligned}
&\mathrm{H} \sim \mathrm{na} + \mathrm{nin} + \mathrm{kin} + \mathrm{Nol} + \mathrm{EM} + \mathrm{MeD} + \mathrm{MgD} + \mathrm{MoD} + \mathrm{Nci} + \mathrm{EC} + \mathrm{FlR} + \mathrm{JS} + \mathrm{Pe} + \mathrm{Pl}\\
&\mathrm{Kn} \sim \mathrm{CS} + \mathrm{Nol} + \varphi\mathrm{t} + \mathrm{EC} + \mathrm{InR} + \mathrm{EDM} + \mathrm{EM} + \mathrm{reint} + \mathrm{DS} + \mathrm{dDC}\\
&\mathrm{M} \sim \mathrm{EM} + \mathrm{MeD} + \mathrm{MgD} + \mathrm{MoD} + \mathrm{na} + \mathrm{kin} + \mathrm{Nol} + \mathrm{SpC} + \mathrm{FlR}\\
&\mathrm{SC} \sim \mathrm{DS} + \mathrm{Nci} + \mathrm{EC}\\
&\mathrm{St} \sim \mathrm{Nst} + \mathrm{Ntech} + \mathrm{InnR} + \mathrm{kin}\\
&\mathrm{Ff} \sim \mathrm{PrdivD} + \mathrm{RI} + \mathrm{FlR} + \mathrm{reint}\\
&\mathrm{Pf} \sim \mathrm{Pt} + \mathrm{Pc} + \mathrm{dt} + \mathrm{dc} + \mathrm{Pe} + \mathrm{Pl} + \mathrm{MeD} + \mathrm{MgD} + \mathrm{MoD}\\
&\mathrm{L} \sim \mathrm{InL} + \mathrm{SpC} + \mathrm{LiD} + \mathrm{Right} + \mathrm{Pe} + \mathrm{Pl} + \mathrm{EM} + \mathrm{EDM}\\
&\mathrm{J} \sim \mathrm{JS} + \mathrm{Pe} + \mathrm{Pl} + \mathrm{JE} + \mathrm{EM} + \mathrm{EDM} + \mathrm{SpC} + \mathrm{LiD}\\
&\mathrm{D} \sim \mathrm{EDM} + \mathrm{dDC} + \mathrm{Right} + \mathrm{Pe} + \mathrm{Pl} + \mathrm{MeD}\\
&\mathrm{Ri} + \mathrm{Sa} \sim \mathrm{Nirm} + \mathrm{Nst} + \mathrm{Lfr} + \mathrm{Ntech} + \mathrm{FlR} + \mathrm{dDC} + \mathrm{InL}\\
&\mathrm{Ch} + \mathrm{Re} \sim \mathrm{ReD} + \mathrm{Npfe} + \mathrm{ChI} + \mathrm{Nst} + \mathrm{EM} + \mathrm{Nol} + \mathrm{oa}\\
&\mathrm{OC} \sim \{\mathrm{ne};\ \mathrm{nar};\ \mathrm{oa};\ \mathrm{resint}\}
\end{aligned}
\tag{1}
$$

The appendix presents figures obtained by analysis with semopy, which depicts the interrelationships of all selected organisational development determinants. Significantly, such parameters as EM, Pl, Pe, Nol, MeD and EDM have the highest intensity of use with diverse determinants.

Considering the difficulty of measuring the effect of the sets of determinants on each other in every single organisation and the progress of organisational development for it, the concept of an algorithm based on machine learning forms a possible solution for the following analysis and prediction of organisational development. Based on the surrogate model and the structural equation model for convergent and divergent determinants of organisational development, the algorithm with the structure illustrated in Figure 4 was developed.

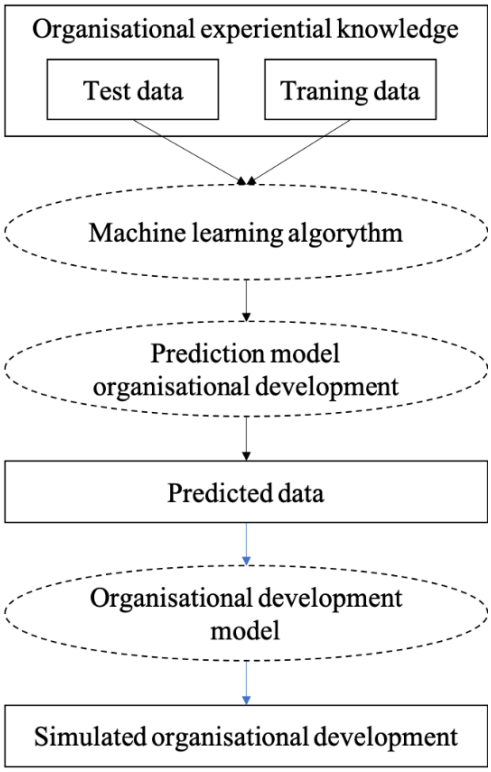

Figure 4. Construction of a Concept for an Algorithm for the Analysis of Organisational Development Parameters and Prediction of Organisational Development Scenarios

Source: Compiled by the author

Conclusions

Determinants of organizational development include numerous facets of organizations, which relate not only to general organisational and individual factors but also to other areas. The determinants can be arranged according to their parameters in the system and technology models adopted for integrating and constructing neural networks. Publication and network analysis and structural equation modelling were applied to identify the determinants and their influence on organisational development using parameter analysis. A surrogate model was formulated based on obtained study results, which can be used for analysis and prediction purposes. Furthermore, scientists and practitioners can use the analysis results for further research in the digitalization of the economy or individual business.

Conflicts of Interest: Author declares no conflict of interest.

Data Availability Statement: The reporting results that support the data and references are not publicly.

Informed Consent Statement: Informed consent was obtained from all subjects involved in the study.

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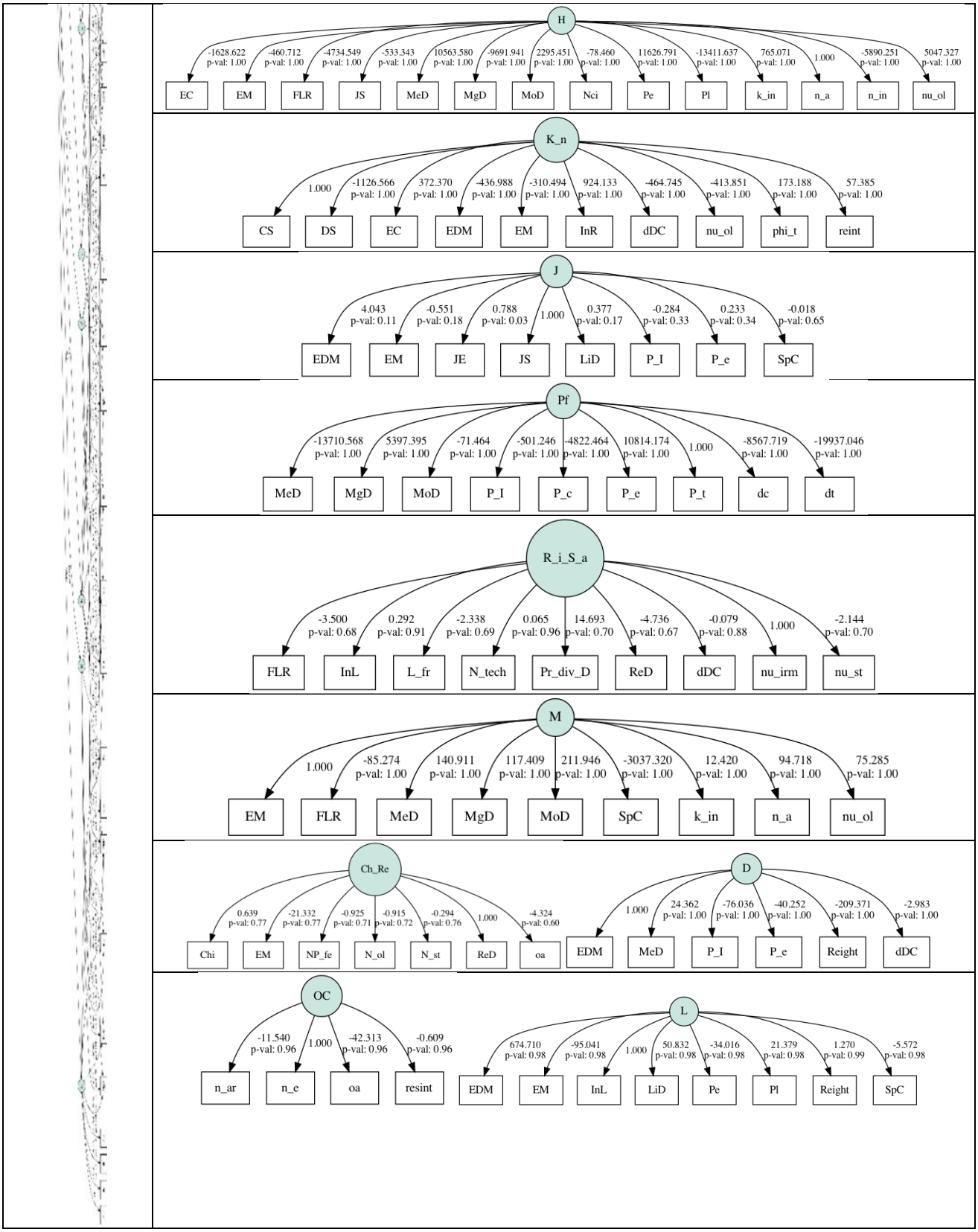
Appendix (Visualisation of correlations between dimensions and parameters using SEM)



Source: Compiled by the author using semopy