The picture of the science - path meta-modelling. An example of management sciences

Przemysław Tomczyk
Kozminski University

Cite as:
Tomczyk Przemysław (2022), The picture of the science - path meta-modelling. An example of management sciences. *Proceedings of the European Marketing Academy*, 51st, (106861)

Paper from the 51st Annual EMAC Conference, Budapest, May 24-27, 2022

The picture of the science - path meta-modelling.
An example of management sciences

Abstract

Path models in meta-analysis are used to model relationships between variables on a multi-paper review basis. In addition to advantages such as precision and relative clarity, they also have disadvantages. These include restrictive assumptions and extraordinary labor consumption.

This article presents a study demonstrating the usefulness of a much simpler solution - path meta-modelling (PMM). This model presents the results of research in a given field in the form of a map illustrating the number of positive and negative relationships between the variables. The lack of use of effect sizes significantly simplifies the preparation of the model, reducing the number of assumptions of the classical path meta-analysis. A qualitative study conducted on a sample of 10 experienced management scientists from Europe confirms the adequacy of the results obtained through path meta-modelling and its usefulness as a tool for effective search for research gaps.

Keywords: path meta-modelling; meta-analysis; science mapping

Track: Methods, Modelling and Marketing Analytics

1. Introduction

Path modelling as a statistical method of data analysis is a widely used research tool. It enables the presentation of the direction and strength of the relationship between variables. It is used primarily in regression modelling, including structural equations analysis. In the social sciences, the path-modelling method is used as the basis for constructing conceptual models in quantitative research, as well as a result of their empirical verification. It is widely used in psychology, sociology, and management. As such, it is therefore an analysis tool used in primary research.

2. Literature background

This method is also used for secondary research, particularly meta-analytical research. A meta-analysis is a statistical analysis of sets of results from various studies, aimed at integrating existing findings (Glass, 1976). If it uses path modelling, it is then named *meta-analytic path analyses (MAPA)* (Earnest et al., 2011; Hagger et al., 2016; Möller et al., 2009) or *meta-analytic structural equation modelling (MASEM)* (Brown et al., 2008; Carr et al., 2003; Mackay et al., 2017; Zaremohzzabieh et al., 2020). Some of the path meta-analyses present the results in graphical form, but are still based on the rigours preceding the description (Earnest et al., 2011). However, the issue is that the authors of source papers rarely use exactly the same research methods and tools, and the algorithms of the research procedures they use are not always clearly revealed. This limits path modelling usability. The limitations cover the analytical methods used (e.g., multiple regression vs. structural equation modelling), simple size (small vs. medium vs. big samples), the coefficients used (standardized vs. non-standardised), statistical significance level (0,05 vs. 0,01 vs. 0,001) and others. The above limitations create a significant problem that makes meta-analytic path analysis difficult to perform, and often impossible.

There are more than 3.000 management sciences journals worldwide, publishing about 300,000 papers a year[1]. Due to the limitations described above, it's impossible to gather all the knowledge from these papers and synthesise them using classical meta-analytical methods. **The problem is** that the difference in analytical source methods makes mass synthesis impossible using classic meta-analysis methods, including path models. So **the aim of this paper is** to evaluate a less restrictive path modelling proposal. This article tests the perceived credibility of path meta-models in the management sciences. This tool makes possible the mass synthesis of scientific research results worldwide, independently of the sample and empirical methods used

[1] https://www.internauka.org/en/scopus-list [access: 30.11.2021]

in source studies. The method presented below gathers all the significant results, irrespective of whether the significance is 0,05 or 0,01, if the sample is small or large, etc. But this tool needs to be verified if it is to be credible.

3. Path meta-modelling idea[2]

The solution to the problem proposed in this article is the synthesis of empirical path models, resulting in the creation of synthetic path meta-models. A synthesis compares specific elements according to specific criteria, and it does not require the fulfilment of a number of statistical assumptions, such as meta-analysis, especially in the form of a path analysis. Moreover, it provides additional value, which differentiates it from simple aggregation. The solution proposed will therefore arise as a derivative of meta-analysis, synthesis and science mapping.

The path meta-models concentrate on searching for relationships between the same variables contained in different empirical path models, comparing them and creating meta-models, taking into account the direction of the relationship between these variables. For example, if one article found a relationship between customer satisfaction and customer loyalty, and the other one found it between customer loyalty and firm performance, it assumes there is a relationship between customer satisfaction and firm performance, mediated by customer loyalty. Figure 1 shows the graphical presentation of how the path meta-model works (simulation).

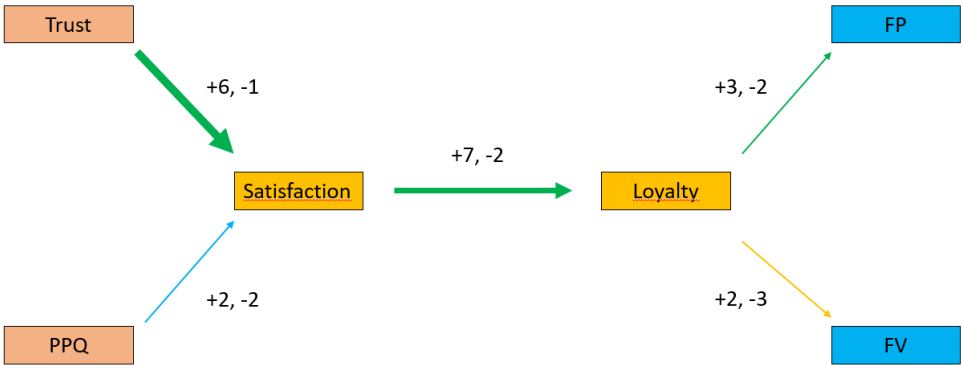

Figure 1. Path meta-model simulation

[2] The study presented in this section is fictitious. Its role is to present the idea of path meta-modelling. The real-data example is described in "Research design" section.

The path meta-model shows the relationship between six variables representing customer relationship management area taken from different studies. The positive values show the number of the relationships identified[3], when the relationship is positive, while the negative indicates the negative relationships identified. For example, trust is antecedent mentioned six times as positive in analysed studies and once as a negative. The bolded green arrow indicates the relationship is stable and, probably, is not necessary to run another research here, since the relationship is well-established. Perceived product quality (PPQ) relationship with satisfaction appears ambiguous, what the blue arrow reflects. Significant advantage of positive relationships between satisfaction and loyalty over ambiguous results on loyalty consequences (the thin, yellow arrow on firm value (FV) and thin, green arrow on firm performance (FP)), shows the clear path from trust to loyalty, mediated by satisfaction over the analysed studies.

What the results give to the researchers? Assuming that the researcher is looking for the relationship between satisfaction and loyalty identyfication, the advantages on classical meta-analytical procedures are as follows:

1. the path meta-model gives the overall picture of the analysed pair environment. It does not limit itself to certain variables like classical meta-analysis assumes. This makes the path meta-modelling more explorative, since one can easily imagine expanding the model left or right;
2. the model is not limited to subjective, conceptual assumptions. It's easy to find new relationships expanding the model as long, as it is interesting for the researcher;
3. the path meta-model helps to find, whether the satisfaction-loyalty relationship is interesting to explore (the above results say, that rather not);
4. it helps to find the research gaps among satisfaction/loyalty antecedents or consequences. For example, the relationship between PPQ and satisfaction is interesting, since the source studies results seem ambiguous.

Adding path coefficients or other strength factors could supplement the path meta-model. If so, the path meta-modelling could be an interesting proposition, but it needs verification.

[3] There could be more than one relationship between the same variables in one study. It is because the number of relationships includes the moderators.

4. Research design

As a rule, the literature tests new statistical methods (Onoma et al., 1998; Wong et al., 1997), while research methods are assessed by the scientific community and are accepted through years of practice. An example is the commonly used Churchill's procedure, which describes the process of creating measurement scales in marketing (Churchill, 1979) or the questionnaire method (Albaum, 1997). The method discussed in the article is not a statistical one, but is of an analytical nature. As such, it needs testing.

Testing credibility of path meta-modelling does not need a wide sample of articles. Even two empirical source models are sufficient to evaluate whether the path meta-model created based on this is credible or not. Two management sciences empirical path models based on regression methods covering the problem of the relationship between customer knowledge development and its antecedents and consequences (i.e. Chang et al., 2010; Jin & Chih-Yu, 2011) were presented. Figure 2 presents the empirical models included.

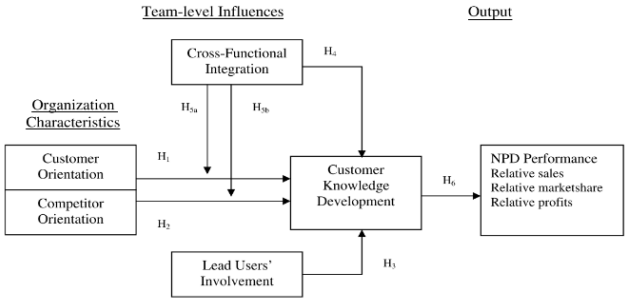

Fig. 1. The theoretical framework for studying how market orientation and team-level influences affect customer knowledge development.

(Chang et al., 2010)

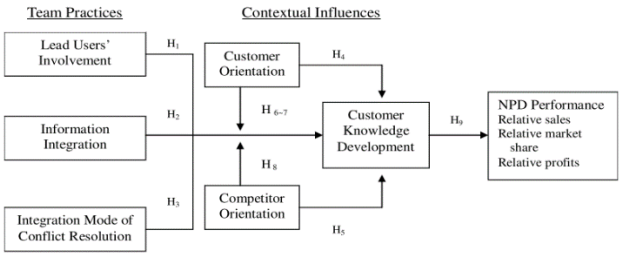

Figure 1. A framework for studying the team-level factors and its contextual influences affect customer knowledge development and NPD performance.

(Jin & Chih-Yu, 2011)

Figure 2. The empirical models applied

The path method proposed in this study reduces the complexity of the source analyses results to determine whether there is a relationship between variables, and which variables are related to each other. The credibility of path meta-model was assessed in comparison to the credibility of the source empirical path models on the basis of which the former was created. The expert judges' verification procedure was conducted on a sample of 10 experienced management scientists from universities from Poland, France and Italy. The high level of experience assured the reliable assessment of the credibility of the path meta-model presented and the great number of judges made the qualitative feedback more plausible. The research was based on the assumption that the more people agree on something, the more we can be sure of it. This is how it eliminates subjectivism in favour of intersubjectivism. Social consensus sets the direction to the best way of figuring out what the truth is (Perreault & Leigh, 1989). Figure 3 presents the path meta-model analysed.

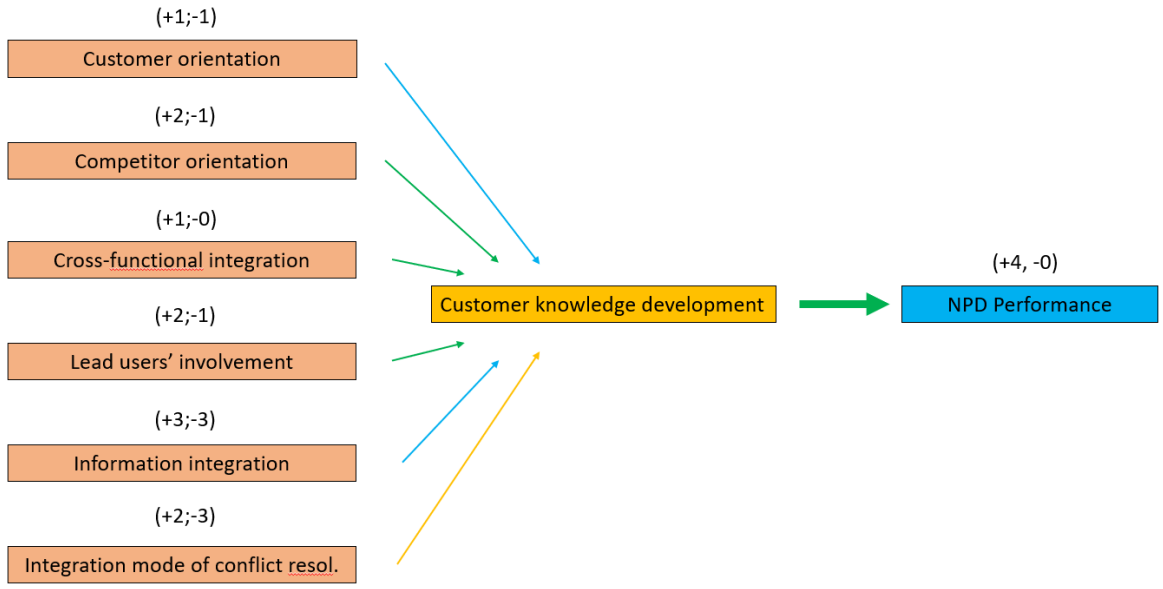

Figure 3. The evaluated path meta-model based on (Chang et al., 2010; Jin & Chih-Yu, 2011)

The relationship between antecedents and consequences and customer knowledge development shows that the positive relationship between customer knowledge development and new product development (NPD) performance is beyond dispute. Much more interesting, as a research object, seems to be the relationship between information integration and customer knowledge development, as the results presented are ambiguous. In turn, the relationship between cross-functional integration and customer knowledge development was examined only once and it certainly needs to be deepened.

The number of relationships is greater than the number of the source studies (2), since the model analysed each moderation separately. For example, information integration appears once among the empirical models, but its relationship with customer knowledge development appears six times. It is because the relationship is significantly moderated by different functions across NPD teams (marketing, R&D, overall and customer orientation). Adding the moderators could be the next step of path meta-models development.

Then, both the component models and the synthetic path meta-model were presented in detail and discussed among the participating scientists. After making sure the models were understood, the evaluation proceeded. The judges answered yes/no to the following questions/dimensions:

1. **Adequacy** – do the relationships presented on the path meta-model identify reliable relationships?
2. **Usability** – would you use such modelling for a highly ranked article to illustrate the relationships?

The nominal scales assessment tool helped to reach convergence between judgements (Perreault & Leigh, 1989). Conceptually, credibility here can be thought of as the percentage of total responses (observations) a typical judge could code consistently, given the nature of the observations, the coding scheme, the category definitions, the directions, and the judge's ability (Perreault & Leigh, 1989). The judges answered the questions and then formulated additional comments.

5. Results

The results present that the obtained path meta-model is adequate (more than 80% of scientist judges). The usability is limited due to reviewers individual preferences and comprehensiveness of the database on which it was prepared (50% of scientists judges). Moreover, table 1 presents the key answers on what does the model show what kind of problems it solves.

Participant	What does the model show?	What kind of problem it solves?
1	„hypotheses”	„shows the gap”
2	„state of knowledge”	„helps to find „dark swans”
3	„knowledge map about relationship”	„saves time”
4	„a fast way to visualize within a topic showing the connection between the variables”	„preliminary analysis”
5	„what has been done and what it says”	„controversial research study identyfication”
6	„intensity of research”	„to help position your paper”
7	„kind of literature review”	„shows what to research”
8	„likelihood of the relationship”	„helps the research proposal preparation”
9	„additive agregation of research stream”	„to have a clear idea of what to research”
10	„to what extent a variable has been asses”sed in relation to other variables	„shows ambiguities”

Table 1. The perception of the model

The additional comments show that the path meta-model also has a higher substantive value compared to the empirical models on the basis of which it was created. This value is the result of combining many models into one, which provides new knowledge about the analysed relationships, especially helps to find new and interesting research gaps. From a practical point of view, automation of the process of creating path meta-models would significantly improve scientists' work on literature reviews.

6. Implications

The adequacy of the model indicates its usefulness as a tool for mapping relationships between variables. Due to its simplicity, the method enables the creation of extensive maps presenting a picture of research results in a given field. This enables the identification of research gaps and ambiguous relationships.

7. Limitations

The research has limitations. First, the path meta-modelling approach includes relationships but omits the differences, which means the whole ANOVA/MANOVA analyses family is excluded. Second, management sciences are very dispersed. Particular constructs have different names, measures and definitions. This complicates the clarity of the path meta models obtained. Third, many variables occur only once in source studies. This means they have neither antecedents nor consequences. They will, therefore, not be included in the path meta-model. Fourth, non-linear relationships are difficult to interpret. On the one hand, they describe the relationship, but on the other hand, the relationship fluctuates. Fifth, the model does not name moderators included and does not mention original mediations. However, adding them seems not be that difficult technically.

Bibliography

Albaum, G. (1997). The Likert Scale Revisited. *Market Research Society. Journal.*, *39*(2), 1–21.

Brown, S. D., Tramayne, S., Hoxha, D., Telander, K., Fan, X., & Lent, R. W. (2008). Social cognitive predictors of college students' academic performance and persistence: A meta-analytic path analysis. *Journal of Vocational Behavior*, *72*(3), 298–308.

Carr, J. Z., Schmidt, A. M., Kevin Ford, J., & DeShon, R. P. (2003). Climate perceptions matter: A meta-analytic path analysis relating molar climate, cognitive and affective states, and individual level work outcomes. *Journal of Applied Psychology*, *88*(4), 605–619.

Chang, T.-J., Chen, W.-C., Lin, L. Z., & Chiu, J. S.-K. (2010). the Impact of Market Orientation on Customer Knowledge Development and Npd Success. *International Journal of Innovation & Technology Management*, *7*(4), 303–327.

Earnest, D. R., Allen, D. G., & Landis, R. S. (2011). Mechanisms Linking Realistic Job Previews With Turnover: A Meta-Analytic Path Analysis. *Personnel Psychology*, *64*(4), 865–897.

Glass, G. V. (1976). Primary, Secondary, and Meta-Analysis of Research. *Educational Researcher*, *5*(10), 3–8.

Hagger, M. S., Chan, D. K. C., Protogerou, C., & Chatzisarantis, N. L. D. (2016). Using meta-analytic path analysis to test theoretical predictions in health behavior: An illustration based on meta-analyses of the theory of planned behavior. *Preventive Medicine*, *89*, 154–161.

Jin, C. T., & Chih-Yu, W. (2011). New product development team practices, market orientation and customer knowledge development. *African Journal of Business Management*, *5*(18), 7702–7715.

Mackay, M. M., Allen, J. A., & Landis, R. S. (2017). Investigating the incremental validity of employee engagement in the prediction of employee effectiveness: A meta-analytic path analysis. *Human Resource Management Review*, *27*(1), 108–120.

Möller, J., Pohlmann, B., Köller, O., & Marsh, H. W. (2009). A meta-analytic path analysis of the internal/ external frame of reference model of academic achievement and academic self-concept. *Review of Educational Research*, *79*(3), 1129–1167.

Onoma, A. K., Tsai, W. T., Poonawala, M. H., & Suganuma, H. (1998). Regression Testing in an Industrial Environment. *Communications of the ACM*, *41*(5), 81–86.

Perreault, W. D., & Leigh, L. E. (1989). Reliability of Nominal Data Based on Qualitative Judgments. *Journal of Marketing Research*, *26*(2), 135.

Wong, W. E., Horgan, J. R., London, S., & Agrawal, H. (1997). Study of effective regression testing in practice. *Proceedings of the International Symposium on Software Reliability Engineering, ISSRE*, 264–274.

Zaremohzzabieh, Z., Ismail, N., Ahrari, S., & Abu Samah, A. (2020). The effects of consumer attitude on green purchase intention: A meta-analytic path analysis. *Journal of Business Research*, *October*.