Empirical research in OM: three paradigms
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Abstract
Over the past 20 years, several articles have appeared in the operations management literature that have suggested that the link between operations management academics and operations management practitioners has been weakened. It has been suggested that to improve this link, more empirical research is required. However, there are different methods for conducting empirical research. In this paper we discuss three different paradigms for empirical research in operations management: the positivist & postpositivist paradigm, mostly aligned with surveys; the interpretivist paradigm, mostly aligned with in-depth case studies; and the design paradigm, mostly aligned with solving practical problems. We discuss the different objectives and the different evaluation criteria for studies in each paradigm. We conclude that although the (post)positivist paradigm is probably the most interesting for the development of science due to the ability to generalize, the design paradigm is likely the most relevant for making the connecting with practitioners.

Keywords: empirical research, survey, case study

1. INTRODUCTION
Andrew and Johnson (1982: 144) describe how Operations Research, and its quantitative and modeling oriented approach, became important on the academic side of Operations Management but they note that "The models offered by academics did little to provide pragmatic answers". Meredith et al. (1989) make similar observations about the disconnect between Operations Management academics and practitioners. They note (Meredith et al., 1989: 299) "Our point is not that OR/MS methodology is inappropriate for research in operations […] but that is should not be the only methodology." Several authors have made a call for more empirical research, see Saladin (1985), Meredith et al. (1989), Flynn et al. (1990), Swamidass (1991) and Wacker (1998). They explain how operations management has been aligned more with operations research and modeling approaches and how the operations management community has tended to view empirical research as less esteemed than research based on mathematical modeling.
There are different types of empirical research. For example, Meredith (1998) argued for case and field research whereas Meredith, Raturi, Amoako-Gyampah and Kaplan (1989) distinguish the direct observational methodologies such as case studies, from methodologies that rely on determining people's perceptions.
In this paper, we will look at empirical research for Operations Management from an overview perspective, with two purposes. 1) To describe different scientific paradigms in order to create awareness about different methods of conducting empirical research. 2) To describe the objectives and the appropriate methods for evaluating the research results within these paradigms. This issue is particularly important since although the number of OM empirical research articles has been rising over the last 10-15 years (Scudder and Hill, 1998: 100), compared to modeling and simulation approaches, empirical research is still underrepresented in U.S. top-ranked Operations Management journals, see (Pannirselvam et al., 1999).

2. PARADIGMS
When looking at methodological approaches, it is informative to look at the paradigms that form the foundations of the different approaches. In the following we distinguish three empirically oriented approaches: positivist & postpositivist, interpretivist and design sciences.

2.1 Positivist and postpositivist viewpoint

Denzin and Lincoln (1994: 99) provide a useful insight into paradigms by distinguishing ontology, epistemology and methodology. Ontology deals with the nature of reality, epistemology deals with the relationship between researcher and research object and methodology deals with how we gain knowledge about the world. These three are, obviously, related. For positivist and postpositivist oriented researchers, the ontological viewpoint is that an apprehendable reality exists that is driven by immutable natural laws and mechanism. The researcher and research object are considered independent of each other and logically aligned with this, the preferred methodological choice is one of experimentation, manipulation and the testing of hypothesis (Guba and Lincoln, 1994: 109). The positivist and postpostivist approach can also be viewed as nomothetic, i.e. it emphasizes quantitative analysis of a few aspects across large samples in order to test hypotheses and make statistical generalizations. This is also known as the context of justification. It involves moving from general explanations to specific data. This is oriented towards the last phases of the empirical cycle as provided by De Groot (1969), see figure 1.

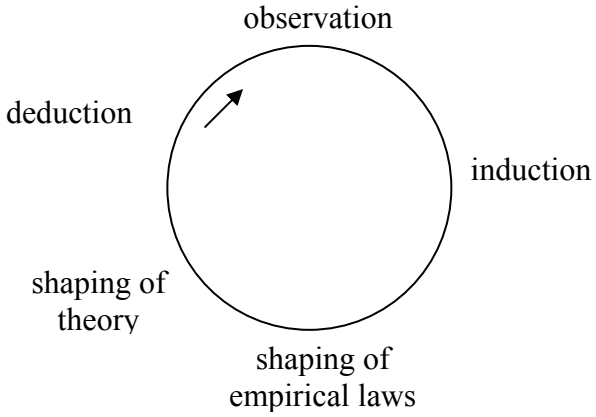

Figure 1: Empirical cycle (adapted from de Groot (1969)

With regard to empirical research in operations management the approach that falls under this category is that of survey research. Survey research often involves large samples, statistical generalizations and the researcher and respondent are considered independent. In many instances surveys are oriented towards hypothesis testing through statistical correlations. Using surveys for descriptive statistics purposes is also possible.

2.1.1 Goals

In this type of research, the goal is to have objective and generalizable results. This goal is achieved by using as much as possible objective or un-biased surveys. The surveys are sent to a representative sample of the population and, for hypothesis testing, established data analysis tools (statistical techniques) are used to be able to draw scientific conclusions.

2.1.2 Evaluation criteria

Research within this paradigm, according to what it is trying to accomplish, should be evaluated based upon the objectiveness and generalizability of the results. This means that, in essence, evaluation is concerned with: the objectivity of the survey instrument, an appropriate selection (sampling) of the respondents, and the correct application of statistical methods to determine significance of the findings.

In the literature the criteria for objectivity of the survey instrument are known as validity and reliability. Validity measures two things. First, does the item or scale truly measure what it is supposed to measure? Second, does it measure nothing else? (Flynn et al., 1990: 266). In particular construct validity measures whether a scale is an appropriate operational definition of an abstract variable or a construct (Flynn et al., 1990: 266). Internal validity Reliability measures the extent to which a questionnaire, summated scale or item which is repeatedly administered to the same people will yield the same results. Thus, it measures the ability to replicate the study (Flynn et al, 1990: 265). Flynn et al. (1990) provide several measures that allow the evaluation of validity and reliability.

The sample should be selected as randomly as possible, in order to help control against bias (Flynn et al., 1990: 260). This refers to external validity, or, establishing the domain to which a study's findings can be generalized (Yin, 1994: 33). The conclusions that can be drawn depend very much on the sample characteristics. For instance, findings can not be generalized across industries if the survey was only administered in one industry.

As an example, Flynn et al., (1990) provide an overview of statistical tools for data analysis purposes, more detailed information can be found in books dealing with statistics.

In conclusion, this type of research is much different than the modeling oriented research and should be evaluated differently. Where modeling oriented research is primarily concerned with mathematical reasoning, positivist & postpositivist oriented empirical research is concerned with reaching objective and generalizable results. The main criteria for the data collection are validity and reliability. The data analysis should be evaluated based upon the appropriateness of the statistical methods that are applied.

2.2 Interpretivism viewpoint

Another approach is interpretivism. The main difference between this approach and the positivist and postpositivist approach concerns the viewpoint on epistemology. The interpretivist viewpoint is that the researcher and research object can not be separated because of the interaction with humans such as for example in business studies. This means that objectivity does not have the same meaning as in positivist/post-positivist studies. In order to understand the world of meaning, one has to interpret it. Instruments like surveys do not fit this viewpoint because surveys only give a glimpse and do not allow interpretation based on a complex context. For interpretivist studies, it is essential that the 'story' is being told so that the correct interpretations can be made. This leads to idiographic research. Idiographic research concerns understanding, by doing in-depth research on a few cases.

2.2.1 Goal

The aim of idiographic researchers is to provide rich descriptions and/or to make theoretical generalizations. This research does not have the same emphasis on objectivity and generalizability as positivist and postpositivist research. Instead, it is much more focused on 'telling a story' where the main goal is to provide rich information. This type of research

concerns the context of discovery rather than the context of justification. It deals more with the beginning phases of the empirical cycle. Another way of viewing it is that this type of research 'builds' theories whereas the (post)positivist approach tests theories. Interpretivist studies can therefore be expected to end with hypotheses rather than to test these hypotheses.

2.2.2 Evaluation criteria

The criteria for interpretivist oriented research are not well established. It is fairly obvious that the criteria for (post)positivist studies can not be fully applied. For example external validity is inappropriate since idiographic research typically involves only a few cases. Reliability is also inappropriate since it is difficult if not impossible for another person to conduct the same case study again. Janesick (1994: 217) points out "[T]he value of the case study is its uniqueness; consequently, reliability in the traditional sense of replicability is pointless here".

The issue can be viewed as concerning a level of confidence in the findings. In positivist and postpositivist studies, this confidence is established through validity and reliability because the goals of these studies include objectivity and generalizability. The goal of interpretivist oriented research is to provide rich, in-depth descriptions that provide meaningful insights that can subsequently be tested more widely (for example through surveys).

A main concern in this type of study is that the researcher and research object can not be separated and therefore objectivity is not achieved by a separation of researcher and research object or respondent. The key here is that the goal is a 'correct' interpretation. This can be evaluated by looking at trustworthiness, authenticity (Denzin and Lincoln, 1994: 100) and credibility (Janesick, 1994: 216). Similar to the positivist and postpositivist approach data from only one respondent or one informant is deemed insufficient. However, where positivist and postpositivist approaches focus on reaching objectivity by removing the researcher from the respondent and providing an un-biased research instrument, e.g. a survey, the interpretivist approach is to immerse in the situation and to collect information from a wide variety of angles to find the 'common denominator'. This technique, known as triangulation (see for example Jick, 1979), increases the confidence in the findings. There are several different methods of triangulation. Janesick (1994: 214) mentions: data triangulation (use of a variety of data sources), investigator triangulation (use of different researchers), theory triangulation (use of multiple perspective to interpret a single set of data), methodological triangulation (use of multiple methods to study a single problem) and interdisciplinary triangulation (use of different disciplines). Furthermore, Janesick (1994: 214) points out that "[T]he researcher should describe his or her role thoroughly, so that he reader understands the relationship between the researcher and participants."

Related issues to the 'quality of the data' are issues of sampling (where data is collected) and data analysis techniques. The issue of sampling, for example for multiple case studies, is quite different than for positivist and postpositivist research because in interpretivist studies the concern isn't generalizability but to achieve meaningful and in-depth insight. Therefore, rather than trying to create an unbiased sample to allow statistical generalizations, the strategy is the opposite, i.e. specific cases are selected that are expected to increase understanding or expand theories, i.e. analytic generalization (Yin, 1994). This method of sampling is known as theoretical sampling, see for example Glaser (1978), Eisenhardt (1989) and Glaser (1992).

The emphasis in data-analysis is also different than in positivist and postpositivist studies. First, data-analysis occurs typically after data-collection in positivist and postpositivist studies but data-analysis and data-collection are more simultaneous activities in interpretivist studies. This

goes back to the method of theoretical sampling. Also, positivist and postpositivist studies are concerned with significance levels and bias, interpretivist studies do not share this concern. Data-analysis in interpretivist are concerned with how the data should be interpreted to create new insights. There are many different ways in which, in particular qualitative data, can be analyzed for this purpose. One of the first steps is to code the data. The code conceptualizes the underlying pattern of a set of empirical indicators within data (Glaser, 1992: 55). With codes in place one can look for relationships between concepts. For example Miles and Huberman (1994) provide a range of techniques for these types of analysis.
To summarize; interpretivist studies should not be evaluated on the same criteria as positivist or postpositivist studies because the goals are different. Interpretivist studies should foremost be evaluated based on whether the interpretation provided is credible. This requires that interpretivist publications contain (aside from the final result, i.e. hypothesis), detailed information on the role of the researcher and on the data collection and data analysis techniques. It should be noted that data collection and data analysis can not be strictly separated in this type of research.

2.3 Design viewpoint
A third empirical approach is that of viewing business research as a design science, see for example (van Aken, 2005). This viewpoint differs from the two above in that it isn't primarily concerned with the question; what is? Instead, it is concerned with designing solutions to practical problems. This is a question of does it (the designed solution) work? This approach doesn't follow the empirical cycle but instead a regulative cycle, see figure 2.

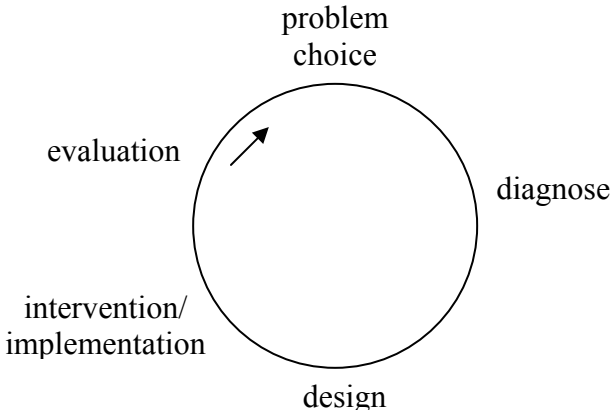

Figure 2: The regulative cycle (adapted from Van Strien (1986)

Especially because businesses are often interested in a solution for its problems, the application of a design (thought-out solution path) may have practical value, leading to a better connection with industry.
From a scientific standpoint this approach may have severe drawbacks. Jorna (1994) argues that this approach is problematic in business situations because the underlying theories about organizations are not yet well developed. In other words, because theories about organizational behaviour are not developed enough it is difficult to prescribe a certain design. Furthermore, due to the specificity of the problems, these studies are often focussed on one or at most a few

problems (cases). To allow some type of generalization from designs and their usefulness, van Aken (1994) developed the reflective cycle, see figure 3.

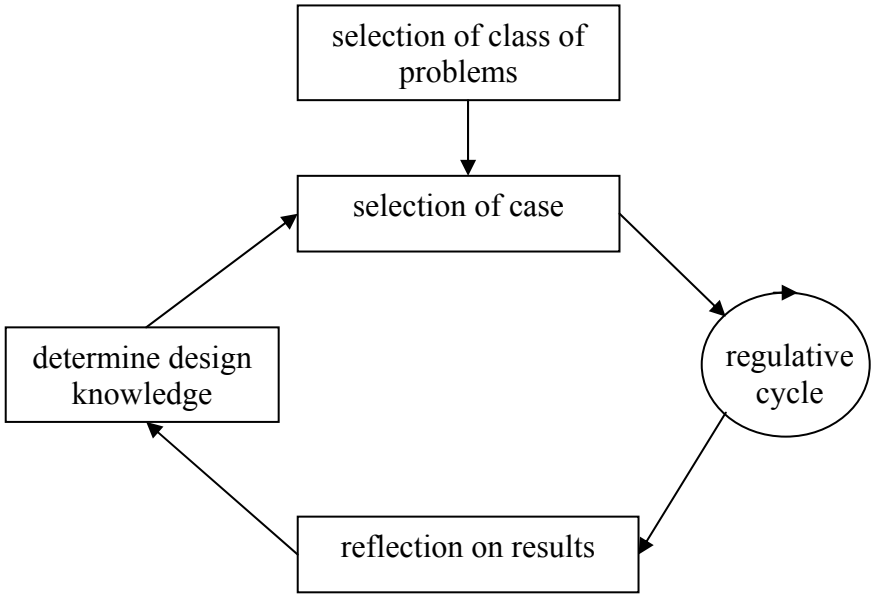

Figure 3: The reflective cycle (adapted from van Aken (1994)

Van Aken (1994) argues that knowledge in a 'design science' is created by the interaction between professionals (in practical field) and scientists. The professional solves practical problems and the scientist analyses how the professional solves the problem. The professional is aimed at solving one particular problem and the scientist is aimed at developing scientific knowledge that can be used to solve a class of similar problems. The reflective cycle uses a series of cases to develop design knowledge, based on a reflection of the results. Note that this is not about 'what is?' but rather 'does it work?' It is the linking of the results (the success of the implementation) back to the design. This generates knowledge about the particular design that was used. This knowledge is useful for the design of solutions application in other situations.

2.3.1 Goals

The primary goal in the design of a solution is assisting companies improve their situation. This primary goal is therefore not aimed at contributing to the scientific knowledge domain. Nevertheless, important lessons can be learned from this practical problem solving that can add to the existing base of scientific knowledge. In particular the evaluation of the designed solution and the implementation of that solution can provide valuable insights.

2.3.2 Evaluation criteria

What should be kept in mind in this type of study is that the primary goal is solving a practical problem. However, to make the work scientifically valuable, other evaluation criteria should be applied. The criteria for design sciences are, similar to those for interpretivist studies, less established than those for the positivist & postpositivist and modelling approaches.

It should kept in mind that a design oriented study is foremost interested in looking at 'does it work?' rather than at 'what is reality? But, for scientific purposes criteria other than practical value are relevant. For example, assume that a company decides to change towards a lean manufacturing approach. For this need (practical problem) a plan is developed based on existing theory and this plan is implemented. If the implementation goes as planned, which implicitly means that it confirms the existing theories on lean manufacturing, then the practical value may be high but the scientific value is probably be low since it only confirms, in one setting, that which is already known. However, if a new solution is devised which has not yet been reported in the scientific literature, then the feedback on this solution can provide valuable insights to the scientific of body. This concerns not only the devised solution (did it work?) but also on reality (what is?) since previously unrecognized aspects of reality may have influenced the successful outcome of the implementation leading to the identification of 'new' variables.

Another 'mistake' made with this type of study is that researchers develop a tool or mechanism to evaluate a company's performance. This tool is applied and conclusions are drawn about the company's performance instead of about the tool. This is a fatal flaw since the study in this instance is not oriented on evaluating whether the tool works correctly but rather assumes that it does. This assumption is invalid since the tool was not tested or, in other words, the tool was not calibrated. It is like designing a new ruler, putting lines on it in a random fashion and then using this new ruler to determine the length of an object. This is an invalid method because the random lines on the ruler have not been compared with objects of known lengths (calibrating) to determine whether the ruler works appropriately.

So, what should this type of research be evaluated on? In principle, just as with other approaches, it should be evaluated on its contribution to the scientific body of knowledge. This means that foremost this type of study should make it clear how it contributes to this body of knowledge (and how it relates to the existing theory) although this aspect may not have a high priority for the company involved. Furthermore, and similar to interpretivist studies, it often deals with single case situations that provide in-depth knowledge. For the findings that occur, the criteria should therefore be similar, i.e. whether it is credible. As with interpretivist studies, this means that the role of the research as well as the data collection techniques and data analysis techniques have to be clearly communicated and are major concerns in the overall evaluation.

3. CONCLUSIONS

In the recent past a number of articles have appeared that have called for more empirical research in Operations Management. In this paper, we have argued that empirical research in Operations Management can take place in three different categories: positivist & postpositivist, interpretivist, and design oriented. Each of these categories has its own assumptions and can contribute in different ways to our understanding of operations management. The three categories contain distinctly different goals and purposes and should therefore also be evaluated differently. Furthermore, we have the opinion that the three different approaches shouldn't be considered as more or less scientific but rather as a portfolio of techniques that together can help to create insight into the problems of and solutions for the field of operations management.

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