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APPLICATION OF RESEARCH FINDINGS IN MANAGEMENT SCIENCE AND PRACTICE: EXPERIMENTATION AND SIMULATION

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Purpose: The paper aims to explore how research results can be effectively implemented in management science and practice, focusing on experimentation and simulation methods. The study seeks to address the gap in knowledge transfer between theoretical research and practical management applications, and to identify key methodologies that contribute to this process.
Design/methodology/approach: This research adopts a narrative and methodological approach, combining qualitative and quantitative methods. It emphasizes experimentation and simulation as core techniques for transferring research results into management practice. The paper explores theoretical foundations, presents case studies, and evaluates the effectiveness of these methodologies in practical settings. Additionally, it discusses the utility of models and theories in shaping management solutions.
Findings: The research reveals that both experimentation and simulation methods provide robust tools for understanding and addressing complex management challenges. These methods allow for controlled testing and prediction of outcomes, offering valuable insights into organizational behavior and decision-making processes. The study also highlights that the practical application of these methods requires careful adaptation to specific organizational contexts.
Research limitations/implications: Limitations include the difficulty of applying experimental methods in real-world settings, which may not fully capture all the variables present in actual organizational environments. Future research should focus on refining simulation models to enhance their accuracy and applicability across different industries and scenarios.
Practical implications: The findings suggest that the integration of experimentation and simulation into management practices can enhance decision-making, increase efficiency in strategy implementation, and improve overall organizational performance. These methods provide a structured approach to testing hypotheses and forecasting the potential outcomes of managerial decisions.
Social implications: The research has implications for improving the transparency and accountability of management practices. By utilizing experimentation and simulation, organizations can better predict and mitigate social risks associated with business decisions, leading to more socially responsible and sustainable management practices.

Originality/value: The paper contributes to the field of management science by offering a comprehensive framework for implementing research findings through experimentation and simulation. It provides valuable insights for both academics and practitioners seeking to bridge the gap between theory and practice in management.
Keywords: experimentation, simulation, management science, organizational research, decision-making.
Category of the paper: Research Paper, Case Study.

1. Introduction

The limited applicability of research results to management science and practice most often refers to the problem of knowledge transfer. This is because it can be assumed that at least part of the practical knowledge of organisational management is derived from scientific knowledge. Hence, important for practice are the translation and diffusion of research results, which are only possible if a properly conducted research process is based on appropriately selected research methods, among them the narrative approach, with a special focus on organisational discourse (Gabryś, 2016).

In scientific research, an experiment is used to: explore, to make comparisons, to explain, to provide evidence and to test the validity of evidence. Furthermore, it provides the possibility of generalisation, which in this case depends on the extent to which the operationalisations of the constructs are true to the constructs themselves (Highhouse, 2009).

Simulation is the approximate reproduction of a phenomenon or the behaviour of an object by means of a model of it. It is a procedure in which random numbers are generated according to probability. They are assumed to be associated with a source of uncertainty, such as, for example, capital expenditure sales revenue or company operating costs. The data associated with the input variables are analysed to determine the outcomes that are likely to be the output variable and the risk attributed to it (Pawlak, 2012).

The research procedure outlined has certain implications. Its universal nature also gives it many advantages. It can be adapted to both simple and sophisticated research methods, to build and test theories, to model variation and process models, to cross-sectoral and longitudinal studies, quantitative or qualitative, laboratory, simulation, archival or other observation methods (Pawlak, 2012).

The paper highlights the importance of narrative framing and the use of experimental and simulation methods in social science research processes.

2. Narrative in organisational research processes

The importance of effective research methodologies in management science, particularly those that bridge theory and practice, has been widely recognized. Experimentation and simulation are crucial methods for testing hypotheses and evaluating the impact of strategies in various organizational settings. Recent studies have expanded on these methods, emphasizing the pragmatic application of research in areas such as green logistics, sustainability, and digital transformation. For instance, Dźwigoł (2018) highlights contemporary research processes in management, while Dźwigoł and Trzeciak (2023) focus on the pragmatic methodologies that align with the implementation of research findings in real-world practices. Further, Dźwigoł et al. (2021) explore the organizational mechanisms for implementing green logistics, showcasing how simulation models can predict outcomes in strategic management. The role of environmental regulations, renewable energy, and innovation in fostering sustainable growth is also discussed by Dźwigoł et al. (2023a, 2023b). These studies demonstrate the utility of simulation in forecasting economic outcomes and enhancing decision-making processes, thereby reinforcing the relevance of experimentation and simulation in management science. Furthermore, Kharazishvili et al. (2020, 2021), Kharazishvili and Kwilinski (2022), Kwilinski (2019a, 2019b), and Kwilinski et al. (2022a, 2022b, 2023a, 2023b, 2023c, 2023d) contribute to understanding the integration of technological advancements and sustainability in management practices, further validating the use of simulation models to address complex organizational problems. These research efforts underscore the value of simulation and experimentation as tools for transferring theoretical insights into practical applications in management science.

According to B.J. Gabryś (2016) understanding the process by which research can contribute to theoretical as well as practical knowledge is one of the fundamental challenges facing proponents of management science.

The process of generating theoretical knowledge, not only in narrative terms, should allow for the clarification of key research questions, namely whether the aim of the research is to find answers to questions that concern (Gabryś, 2016):

- a description of an explanation or prediction of future events that are occurring or may occur in the organisation,
- the relevance of the research questions considered in terms of their formulation, evaluation or resulting action,
- verifying the extent to which the researcher carries out his or her activities from the point of view of an external observer, or an internal participant in events fully involved in the processes under investigation.

Stakeholder advisory science involves processes of describing, explaining or predicting phenomena in an organisation. It is based on the main principles of social science research, according to which the researcher, when seeking information, is located outside the social

system, i.e. the organisation. The researcher analyses the processes taking place in the organisation using the activity of the internal participants of the organisation. He or she completely controls and manages all elements of the research process. Typically, research processes are based on the work of a group involving internal and external stakeholders. This type of research is strongly correlated with the needs of these stakeholders, so the extent of its widespread use is less than, for example, observation methods (Gabryś, 2016).

By shaping a policy of evaluating phenomena for the needs of management practitioners, the shape of policies, programmes or models for solving practical problems is normatively determined. These activities provide an indication of research-based knowledge about the conditions for achieving efficiency as well as the possibility of success when other solutions are applied. The implementation of research usually has the character of an external review as the only way to access a lot of research without the emotional involvement of the researcher (Gabryś, 2016).

All stages, i.e. problem formulation, research design, problem solving, should take into account the multi-study nature of the research conducted. In the case of participatory research, taking into account suggested solutions for specific organisations, a highly accurate diagnosis of the organisation's problem leads to a specific solution, unique in other conditions and for another organisation (Gabryś, 2016).

According to H. Putman (1962) logical positivism or logical empiricism indicates the difficulty of considering the social sciences as objective, rational and cumulative primarily due to language, culture, social norms, ideology, mental models, or selective perceptions of reality.

Science is an intensive social process that is created by people, and therefore the above elements (separately or together) demarcate in some way the process of its creation - also in management science (Gabryś, 2016).

Social science research should emerge from strong assumptions of critical realism (especially at the philosophy of science stage). B.J. Gabryś (2016) indicates that they should be based on the following assumptions:

- there is a real world (consisting of material or mental products), but its individual perception and understanding is limited,
- facts, observations or data are grounded in a particular theory from which they derive,
- every methodological approach has a certain value - its effectiveness always lies in its skilful application in the study of a specific phenomenon,
- recognising the holistic problems of reality obliges the use of many different, as well as often differing, perspectives,
- the models that appear to be best suited to solving organisational problems will develop most rapidly, which in turn will increase the body of knowledge about the processes or phenomena in question.

It is important, as part of conducting research, to distinguish precisely between theory and research model. In the social sciences, model testing is used for this purpose (observation or theory testing is not) (McKelvey, 2002).

Models are a partial reflection of the map of cognition created by theory. They contain a set of instruments and assumptions used in the process of implementing scientific methods of observation and analysis (Gabryś, 2016).

There are two basic models in the social sciences: the variation model and the process model. Each of them starts from different epistemological assumptions, hypotheses and tools in terms of the theories and research phenomena represented. The fundamental difference between these models is in the questions they address: what is the cause and effect of the issues under investigation? and how did the issues emerge, develop and end in a particular place and time? It is worth noting that there are few studies of the narrative model compared to the vast number of studies of the variation model (Gabryś, 2016).

According to B.J. Gabryś and M. Bartnicki (2010) in definitional terms, a narrative is a spoken or written collection of interconnected events that are arranged into a story defined by those describing these events. A narrative, in most cases, is arranged around a specific order, most often around a linear order, i.e.: it has a beginning, middle stages and an ending (Gabryś, 2016). Participants regard narrative as an important part of the process of making sense of experienced organisational reality (Czarniawska, 1998).

Like the most commonly used variation model approach, the process model provides the basis for generalisation claims - however, based on quite different criteria. The narrative approach of the process model does not preclude the use of quantitative methods. On the onehand, it allows the use of any method that enables the researcher to approximate the sense of the changes taking place and the processes of development of the phenomena. On the other hand, it imposes many restrictions on the researcher, which are related to the type of data used or the nature of the models that can be applied. The process approach assumes that explanatory capacities emerge only in relation to a level of generality - not to individual cases (it is the generalising processes located in narratives, particularly in process modelling, constitute the different character of the process approach) (Gabryś, 2016).

The variation model may also rely to some extent on evoked stories, narratives or discourse, but these have the character of mini-narratives, which only reinforce the understanding of causal processes and provide an understanding of the links between individual variables. A narrative approach explains changes in terms of a sequence of events, a certain order or stage in the process in which they occurred. The thread of a given narrative, in the narrative approach, is a factor that allows generalisation (Gabryś, 2016).

The main problems and issues that the researcher must grapple with before undertaking research in terms of a process model using narrative and discourse include (Gabryś, 2016):

- at the stage of formulating the research process: meaning of the process, theories of the process, point of view, research method, observation method, source of change, study sample (unit), sample size (unit) and the design of the research process,
- in the measurement and data analysis stages of the research process: process concepts, events (cases), case selection, event measurement, event identification, process development.

The narrative approach enables the researcher to look at the process of change taking place in an organisation as a kind of argumentative game, i.e. an organisational discourse, in which individual narratives create a new line of understanding of events in the organisation (Gabryś, 2016).

In organisations, multiple paths or approaches can be followed in terms of narrative analysis. The historical approach is one of the most established paths, highlighting the temporal dimension of events and the way in which stories become part of an organisation's present or future plans. It is important to emphasise here that the stories that are told and the narratives that are constructed legitimise the decisions that are made and indicate the elements that are relevant to the researcher making the story (Gabryś, 2016).

3. Experimental method in the research process

There are many different scientific methods in management science, including those of a universal nature. This fact makes the choice of research methodology not an easy task. This is because, before deciding on its choice, it is necessary for the researcher to know the philosophical assumptions on which his scientific achievements are to be based and to understand why a particular type of research methodology is suitable for the implementation of a strictly defined scientific study (Creswell, 2009; Bryman, 2008).

In the social sciences, it has become accepted to identify three groups of research methodologies, i.e.: quantitative research, qualitative research, mixed methods (methodological triangulation). Among quantitative research, the most popular is the survey, and among qualitative research, the experiment. Despite their popularity, however, quantitative methods are criticised (Zou et al., 2014; Creswell, 2009), e.g. for their lack of objectivity, the differences between the actual behaviour of the respondents and the declarations contained in the answers given, their isolation from the real world, or their emphasis on standardised testing (Grix, 2004; Bryman, 2008). In addition to the choice of research method, it is equally important to design the research process, which should build the ground for optimisation (Davis et al., 2013):

- generalisation of results in relevant populations,
- realism in the way the environment in which the variables were observed was perceived,
- precision in the measurement of variables.

In the management sciences, the methods of experimentation, simulation or observation, due to their many advantages, should be and are successfully used as a method of conducting research and solving scientific problems (Stańczyk-Hugiet, 2014, 2016).

A scientific experiment is understood to be a repetitive cognitive procedure that involves a researcher intentionally changing a selected factor (independent variable), while controlling others (dependent variables), performed to determine, or to elicit, the effects of the change made (Stachak, 2006). It allows for factual knowledge and provides information on whether manipulating the selected variable affects the results obtained and in what way. It is particularly applicable when analysing repeated phenomena, under at least partly the same conditions. According to some methodological researchers, an experiment is a special case of observation, but differs from observation in having a more carefully developed research design, a more complex structure and the use of a more varied and broader set of research tools, which supports its inclusion among scientific methods (Pilch, Bauman, 2010).

The main objective of the experiment is to detect causal relationships between two variables/phenomena, which provides the possibility of defining causal laws (Podgorski, 2007). In order to construct such laws, it is useful to refer to the logical canons of J.S. Mill, from which practical methods of inference are derived, i.e. (Pytkowski, 1985): the method of congruence, the method of difference, the method of congruence and difference, the method of concomitant changes and the method of residuals. These methods are models for experimental research, but the greatest importance is attributed to the difference method, on which experiments in the social sciences, economics and humanities are based (Stańczyk-Hugiet, 2016).

As universal principles of scientific experimentation, one can point to (Pieter, 1967):

- the separation of the phenomenon, structure or process under analysis from secondary influences,
- defining the variables of the phenomenon under study and establishing the conditions to be actively integrated by the experimenter,
- bringing about a change in a discrete phenomenon, structure or process,
- determining the nature and extent of the induced active change - the dependent variables.

Research conducted using an experiment is too often not used in management science. Examples include research that sought to determine whether BSC increases efficiency in the strategy implementation process (Strohecker, 2007), research using a quasi-experiment using longitudinal data that was analysed in these banking organisations (Davis, Albright, 2004), or research with students playing the role of managers (de Figueiredo J., de Figueiredo R.J., 2016; Oladunynjoye, Onyeaso, 2007).

There are many different types of experiments, e.g. in marketing research there are experiments with one independent variable, i.e. quasi-experiments, real experiments and experiments with a series of measurements, and experiments with multiple independent variables, i.e.: random experiments and statistical experiments. In addition to the different types

of experiments, each experiment is also conducted under specific conditions, hence we can distinguish between: natural experiment and artificial/laboratory experiment. Considering the extent of control of the experimental situation on the part of the researcher and the way in which the results are measured, we can point to: laboratory experiment, field experiment and natural experiment (Stańczyk-Hugiet, 2016).

An essential component of an experiment is observation. The result of scientific observation is scientific observation - a description of phenomena, which is why it is referred to as the primary method of empirical cognition. It differs from simple perception in that it is an intentional and continuous. Therefore, it can be considered as a research method when it takes into account all stages of research activity - from problem definition to research report and answering research questions. Observation allows, among other things: to collect specific data, to set hypotheses, to verify and select the collected research material. In summary, observation is characterised by being purposeful, planned, systematic, objective, measuring and recording individual activities and facts, a precise description of the process of a given reality and the absence of interference of the researcher in the process being analysed (Stańczyk-Hugiet, 2016).

The way to achieve the above objectives is to design the experiment properly, i.e. in such a way that it is characterised by a high degree of internal validity and the data obtained allow the theory or hypothesis to be tested (Croson, 2005).

Among the more important principles that make up the procedure for carrying out the experiment are:

- manipulating at most one independent variable at a time,
- continuous monitoring of the phenomenon,
- minimising the impact of independent variables that distort the measurement of the dependent variable,
- measuring the dependent variable. In turn, the following can be mentioned as elements of an experimental study: the object of study, the variables, the instrumentation, the experimental design, the procedure and the statistical analysis (Stańczyk-Hugiet, 2016).

The universal procedure for conducting a scientific study by experimentation consists of the following steps (Stańczyk-Hugiet, 2016):

- identification of the research problem, as a result of which the researcher can focus on a much narrower area and investigate it accordingly,
- formulating a research hypothesis that is consistently tested and deducing consequences,
- the design of the study, which is related to sample selection, identification of variables, control of non-experimental variables, conduct of pilot studies and development of the study schedule,

- the conduct of the experiment, which is related to the manipulation of a variable that affects the experimental group and the control of the experiment, which allows the prediction of events that may occur under the conditions of the experiment and thus makes it possible to neutralise their effect on the other factors,
- data collection and coding, which becomes particularly important in quantitative research (experiments are more often quantitative than qualitative), due to the very large amount of data to be measured,
- application of statistical tests,
- the analysis and formulation of conclusions which conclude the scientific study, and in which it is important to compare the results from the experiment with those obtained in a control group or other experimental group, and the statistical presentation of the results obtained.

4. Simulation method in the research process

In Simulation is regarded as a method that uses computer software to model 'real world' processes, events, systems and operations (Law, Kelton, 1991). It can be considered as a variation of an experiment, where we assume that a model can be manipulated to obtain specific information. The models should have some characteristics of the real world, while the data for them should be longitudinal (Stańczyk-Hugiet, 2014). Furthermore, a simulation model requires the precise definition of all assumptions, relationships between variables, ways of transforming numerical values and it is based on a specific theory. The simulation method is used when it is practically impossible to analyse behavioural changes directly on a real object or when such studies are more costly (Gilbert, Troitzsch, 2005). Three groups of simulation objectives can be distinguished:

- predictive, aims to identify qualitative and/or qualitative features of the performance of the system under analysis for given circumstances,
- identification, aims to identify qualitative and/or qualitative principles or laws of operation of the system under analysis,
- rationalisation, aims to identify the conditions of operation of the system under analysis, at which the qualitative and/or quantitative characteristics of the system meet the indicated conditions of rationality.

Simulation as a research method is mainly used to simulate the effects in decision-making, e.g. in the area of strategic management, with regard to the production process, as well as in other areas of management (Dźwigoł, 2018).

Simulation methods allow solutions to be tested in a controlled environment, primarily on the basis of historical or fictional data. Types of simulation can be identified as (Dooley, 2002):

- discrete-event simulations in which events are triggered in a probabilistic and sequential manner,
- system dynamics models in which differential equations define the key system and interaction variables,
- agent-based models, where agents undertake behaviour according to specific rules, between which there is interaction.

The procedure for preparing and running the simulation is as follows (Law, 2007):

- formulation of the actual problem,
- collection of actual data,
- construction and verification of a computer model,
- carrying out pilot simulations,
- model validation,
- designing a simulation,
- carrying out simulations,
- analysis of input and output data,
- presentation of results.

A particular variation of simulation methods is computer simulation, which is supported by reasons such as:

- too costly or too dangerous to investigate a real phenomenon,
- too long to wait for the test result,
- the non-existence of the research object - its design stage.

The key elements of the computer modelling and simulation process are the real object, the experimental system, the model of the object under study and the computer with software. Computer simulations are based on mathematical models, but they reflect the researcher's knowledge of the operation and structure of the modelled system and the phenomena occurring in it (Stańczyk-Hugiet, 2016).

An important method in the group of simulation methods is agent-based simulation, in which the focus is on an agent acting according to a specific logic, while the behaviour of the whole system results from the integration of the agents with the environment and with each other. B. Heath, R. Hill and E. Ciarallo (2009) give four stages of agent simulation, i.e.:

- formulation of the problem and objectives of the simulation,
- building a conceptual model,
- translating the conceptual model into a formal model,
- carrying out simulations and analysing the results.

5. Conclusion

The study highlights the vital role of experimentation and simulation methods in advancing management science by providing structured frameworks to analyze, predict, and validate organizational processes. While these methods offer numerous advantages, including versatility and the ability to model complex systems (Gilbert, Troitzsch, 2005), they also come with challenges such as the need for substantial computational resources and the intricacies of model validation (Stańczyk-Hugiet, 2016). Despite these limitations, experimentation allows for precise control and replication of phenomena, generating actionable insights for organizations (Stachak, 2006). A well-rounded theoretical framework should not only describe but also explain the occurrence of phenomena, incorporating both stakeholder involvement and narrative approaches to provide deeper organizational insights (Gabryś, 2016; Whetten, 1989). As such, this research reinforces the importance of combining both theoretical and practical perspectives to address the complexities of modern management challenges.

Future research should focus on refining simulation models to enhance their precision and applicability across diverse industries, especially in the context of environmental sustainability and digital transformation. As demonstrated by recent studies, integrating simulation and experimentation in fields like green logistics, energy efficiency, and sustainable development has proven beneficial (Dźwigoł, 2018; Dźwigoł, Trzeciak, 2023; Dźwigoł et al., 2021). However, there is a need for more extensive research into the intersection of artificial intelligence and simulation methods to improve decision-making processes in management (Kharazishvili, Kwilinski, 2022). Moreover, further investigation into the spillover effects of green finance and urbanization on sustainable development could offer new insights into the role of digitalization in achieving these goals (Kwilinski et al., 2023a, 2023b, 2023c). By advancing these research areas, management science can continue to evolve toward more innovative, data-driven solutions that are critical in navigating the complexities of modern organizations.

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