RBGN REVISTA BRASILEIRA DE GESTÃO DE NEGÓCIOS
REVIEW OF BUSINESS MANAGEMENT
ISSN 1806-4892

Received on
August 8, 2014
Approved on

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Review of Business Management

DOI:10.7819/rbgn.v17i56.2069

A Distinctive Analysis of Case Study, Action Research and Design Science Research

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Responsible editor: João Maurício Gama Boaventura, Dr.
Evaluation process: Double Blind Review

ABSTRACT

Objective – This paper aims at analyzing the difference between research methods that are typical in operations management (case study and action research) with design science research.

Design/methodology/approach – The paper adopts a theoretical-conceptual methodological approach, based on an extensive literature review. The literature review focused on studies that discuss the use of Case Study, Action Research and Design Science/Design Science Research.

Theoretical framework – This paper reveals the foundations of Case Study and Action Research. Due to its recent use as a research method, *Design Science Research* is presented in greater depth.

Findings – Firstly, we present design science and design science research as paradigms and as research methods, respectively, in the field of management. Secondly, we present the difference between Natural Sciences, Social Sciences and Design Science. Thirdly, we carry out comparative analysis of research methods Case Study, Action Research and Design Science Research. Finally, we offer a set of suggestions for future research regarding the use of research methods in management, in general, and in operations management, in particular.

Contributions – The main contributions of this paper focus on reflecting about research methods used in the management field. An important contribution is expanding the repertoire of research methods for understanding and using Design Science Research. The use of this method can contribute to reduce the distance between rigor and relevance, which has been described by several authors.

Keywords – research approaches; research methods; case study; action research; design science research.

1 INTRODUCTION

The lack of attention to the relevance of scientific studies hinders the exchange of knowledge among professionals and scholars (Ford *et al.*, 2003). Consequently, relevant studies are scarce in fields in which they would be fundamental, such as management (Hughes, Bence, Grisoni, O'Regan, & Wornham 2011; Kasanen, Lukka, & Siitonen, 1993; Romme, 2003; Singhal, Sodhi, & Tang, 2014; Van Aken, 2011). In this sense, the discussion regarding rigor and relevance has been the subject of important reflections on research in management (Burgoyne e James, 2006; Manson, 2006; Pandza & Thorpe, 2010; Starkey, Hatchuel, & Tempest, 2009; Starkey & Madan, 2001; Tranfield & Starkey, 1998; Van Aken, 2004, 2005).

It is noteworthy to consider that the concept of materiality, here, is the same as defended by Starkey and Madan (2001), who claim that relevance can be understood as the ability of knowledge produced in the academy to have a significant impact also on the practical field. Rigor, in turn, in the context of this study, is understood as a necessary element for the proper use of research methods (Hatchuel, 2009). In addition, suitable rigorous methodology helps to ensure the validity of the research work and, consequently, its recognition as a serious and well-conducted study.

Attention devoted to research rigor cannot be ignored by researchers. However, their excessive concern, especially with regard to research methods, may lead researchers to neglect the relevance of their research (Hevner, March, Park, & Ram, 2004). Starkey et al. (2009) claim that relevance should be a basic condition for research in management and it can in fact be considered rigorous.

There are arguments supporting the need for greater attention to relevance. First, relevance can help differentiate studies in management from studies focused exclusively on the social field (Pandza & Thorpe, 2010). Second, for a survey to be considered successful in operations management, for example, there must be a practical contribution to the study field and this research should also be accessed by the interested community (Manson, 2006). A third argument, defended by Starkey and Madan (2001), is that an increase in the relevance of research contributes to reducing the gap that exists between theory and practice in management. Considering the need for carrying out research that is more relevant and that has the rigor required by scientific research, researchers should seek to justify and clearly establish the decisions taken while planning and carrying out research. In addition, researchers must clearly state their epistemological paradigm and the research methods that will guide it and that, consequently, increase the reliability of results.

The concern for better use of research methods in fields dealing with problems referring to operations management has motivated several papers that focus both on presenting these research methods and proposing recommendations for their use in several methodological research approaches, such as action research (Coughlan & Coghlan, 2002), *survey* type research (Forza, 2002); and case study (Voss, Tsikriktsis, & Frohlich, 2002), among others (Ellram, 1996; Hughes *et al.*, 2011; Kasanen *et al.*, 1993). In Brazil, this movement is no different (Mello, Turrioni, Xavier, & Campos, 2011; Miguel, 2007, 2012). The mentioned papers seek to guide the appropriate use of methods and procedures that will improve research, as well as research results.

Therefore, given the diversity of research methods, this paper aims to characterize and analytically distinguish typical research methods in operations management (case study and action research) and design science research. This analysis also seeks to establish a critical view of these research methods from the epistemological perspective of design science. In addition, this essay can serve as a tool for other researchers to establish the research method that is most aligned with research they want to carry out.

It should be noted that, in addition to the distinction among research methods, it is

understood that this essay also sheds light on other perspectives. First, it seeks to present the paradigm of design science in general and design science research in particular. This stems from the fact that this research method is little known by the Brazilian academic community in the field of operations management. Second, upon discussing design science and design science research, we seek to draw attention to the rigor-relevance dilemma that led a significant number of researchers from the field to reflect. Third, the development of cross-sectional papers that critically analyze research methods to further clarify and direct the choices of researchers about the repertoire of existing methods is required. Finally, the essay aims to open the discussion of the use of research methods, such as case study and action research, with a focus on design science.

These methods were chosen for the following reasons: case study is a method that, when properly carried out, provides an understanding of certain phenomena in depth, and is a common method used for empirical studies. Action research allows for a direct interaction between researcher and research object, with an intervention line in support of both, in an often prescriptive approach. Design science research, in turn, allows the researcher to not only explore, describe or explain a given phenomenon, but also to design or prescribe solutions to a given problem.

In order to meet the proposed objectives, this paper adopts a theoretical and conceptual methodological approach based on a literature review, seeking to present research methods in management in the most comprehensive way. The paper is divided into three main sections. Initially, key concepts and ways of implementation, with respect to the three selected research methods (case study, action research and design science research) are presented. Then, a summary of these methods through an analytical framework, in order to expand the portfolio of research methods that can assist researchers in general management, is presented. Finally, the conclusions of the essay, regarding the considered research methods, as well as some opportunities for future work, are presented.

2 THEORETICAL FRAMEWORK

A research method aims to guide researchers in the search for necessary answers to the proposed research problem (Saunders, Lewis & Thornhill, 2012). It should be noted that, to decide on the suitable research method for each investigation, the researcher should consider some aspects, such as (i) its contribution to address the research problem; (ii) legitimacy in the scientific community; and (iii) systematic procedures to be followed in conducting research. A coherently organized research method helps ensure the rigor of the research, reliability of results and, above all, the answer to the proposed problem (Laville & Dionne, 1999).

Moreover, the research method choice is due to a number of positions defined by the researcher from an epistemological point of view. Saunders *et al.* (2012) present this set of decisions and argue that the researcher needs to be aware of it and take the necessary decisions in this regard. These decisions, ultimately, will interfere with the researcher's attitude towards reality (Saunders *et al.*, 2012) and, by logical implication, with research results. On the one hand, the researcher can adopt a reality-observer perspective with the purpose of exploring, describing and explaining. On the other hand, the researcher can aim to intervene in reality and, therefore, solve problems and develop improvements in the systems that are being investigated. Literature distinguishes these perspectives, assigning, on the one hand, traditional sciences concerned with analysis (Le Moigne, 1994) and description, and, on the other hand, Design Science, characterized by its prescriptive nature and projection (Van Aken, 2004).

In the traditional perspective, science aims to develop knowledge of what exists, either through discoveries and/or analysis of existing objects (Simon, 1996). Moreover, it is a function

of science to help understand systems through the discovery of principles that may determine their characteristics, operation and the results they produce (Romme, 2003).

Traditional sciences are commonly divided into two other sciences: natural and social. Each of these sciences seek to achieve something different. On the one hand, natural sciences are concerned with the understanding of so-called complex phenomena, and have a mainly descriptive and analytical approach. Social sciences, on the other hand, seek to describe, understand and reflect about human beings and their actions (Romme, 2003). It is noteworthy, however, that both research sustained by social sciences and based on natural sciences seek truth. They aim to explore, describe, explain and predict the main purpose of advancing knowledge in a particular field (Denyer, Tranfield & Van Aken, 2008).

Nevertheless, it is worthwhile to note that management, in general, seeks to solve problems, or even design and build artifacts that can be used on a daily basis by professionals. Thus, a study that describes or explains a given situation is not always enough for knowledge improvement in this field. Based on this statement, the debate about design science begins. It is a science that seeks to design and prescribe solutions to real problems, actions that traditional science is not capable of addressing (Denyer *et al.*, 2008; Pandza; Thorpe, 2010; Simon, 1996). Because it presents such prescribing features and design, Design Science encompasses fields such as medicine, engineering and management (Denyer *et al.*, 2008; Simon, 1996).

It is noteworthy that the concept of Design Science was first introduced by Herbert Simon, in a book entitled "The Sciences of the Artificial" published in 1969. In his work, Simon (1996) shows the differences that can be observed between traditional science and Design Science, sometimes translated as Science of the Project, or even Science of the Artificial. It should be emphasized that Design Science is the epistemological basis that deals with the study of the artificial. Table 1 summarizes the main characteristics that differentiate natural sciences, social sciences and design science.

TABLE 1 – Summary - Natural sciences, social sciences and design science

Characteristic	Natural Sciences	Social Sciences	Design Science
Areas or fields of study	Physics, chemistry, biology	Anthropology, economics, politics, sociology, history	Medicine, engineering, management
Scientific purposes	Understand complex phenomena. Discover how things are and justify why they are this way	Describe, understand and reflect on the human being and its actions	Design. Produce systems that do not yet exist. Modify existing situations to achieve better results. Focus on solving.
Research aims conducted under this paradigm	Explore, describe, explain and predict when possible	Explore, describe, explain and predict when possible	Design and prescribe. Research is oriented to problem solving

Note. Adapted from "Explicações Científicas: Introdução à Filosofia da Ciência," by L. Hegenberg, 1969; "Design and natural science research on information technology," by S. T. March and G. F. Smith, 1995, *Decision Support Systems, 15,* 251-266; "The sciences of the artificial," by H. A. Simon, 1996; and "Developing design propositions through research synthesis," by D. Denyer, D. Tranfield and J. E. Van Aken, *Organization Studies, 29*(3), 393-413

Another issue to be highlighted is that traditional sciences seek the truth in order to improve knowledge in a particular field (Denyer *et al.*, 2008). Similarly, design science seeks the truth, but, since this science has a more pragmatic appeal, the utility is not separated from the truth, "the truth lies in the utility" (Cole, Purao, Rossi, & Sein, 2005, p. 3).

However, regardless of the scientific paradigm, for knowledge to advance through credible research, a proper use of research methods is necessary for carrying out investigation. For this reason, some research methods that are useful to research on operations management are presented in more detail.

The research methods selected for this study were case study, action research and design science research. Case study and action research methods are based essentially on the paradigm of traditional sciences. The main objectives of research carried out under this paradigm are to explore, describe, explain and, if possible, predict phenomena or existing systems (Romme, 2003; Van Aken, 2004). On the other hand, design science research is a method based on the design science paradigm, a science that deals with the design of new systems or the solution of real and relevant problems (Romme, 2003; Van Aken, 2004).

2.1 Principles of case study

One problem researchers face is selection of the methodological approach. There are assumptions and restrictions as to the choice of each method used and these must be taken into consideration. After research gaps are identified in literature and the questions of the study are developed, the researcher analyzes possible approaches, selecting the one that is most appropriate, useful and effective to address this study question or, in other words, a method that addresses it to propose/direct solutions. The use of an approach such as case study, for example, must address the research question to increase the chances of handling the issue proposed. Then, to meet research objectives, the work should be carried out with the necessary methodological rigor.

A proposal of content and sequence for carrying out a case study can be seen in Figure 1. Next, stages are described in more detail, based on Miguel (2007).

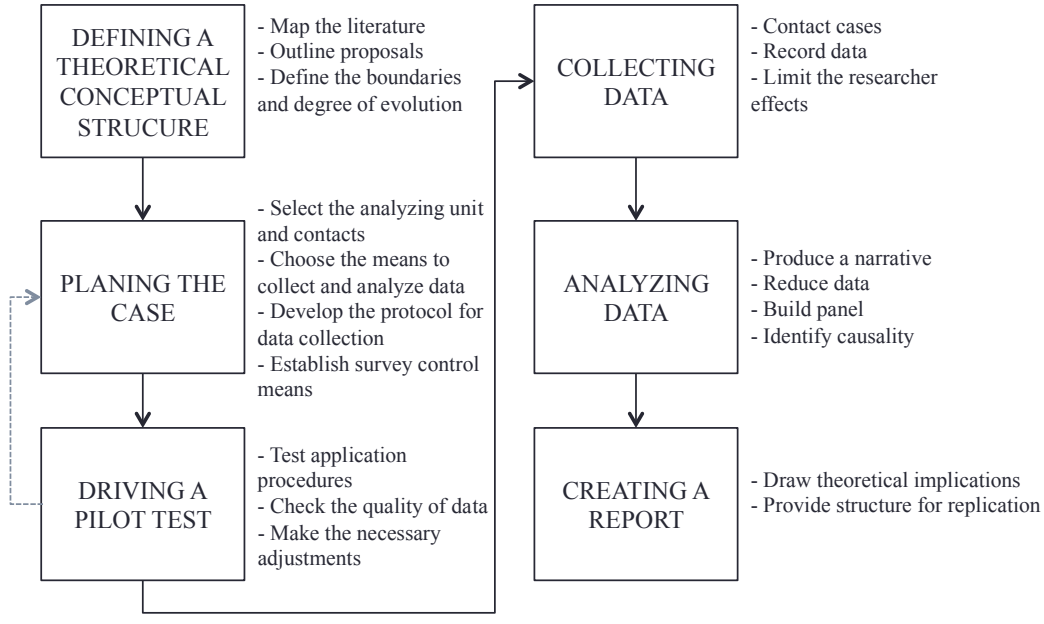

FIGURE 1 – Carrying out a Case Study

Source: "Estudo de Caso na Engenharia de Produção: Estruturação e Recomendações para sua Condução," by P. A. C. Miguel, 2007, Produção, 17, 216-229. doi:10.1590/S0103-65132007000100015

First, a reference mapping of the literature on the subject should be developed. In addition, based on the literature review, it is possible to identify gaps to justify research, as well as to extract the following constructs – or elements extracted from literature that represent a concept to be verified in the field. Based on these constructs, the propositions of the work and its objectives are defined.

With regard to the planning of cases, it is necessary to choose an analysis unit, i.e., of the case(s). At first, the number of cases, single or multiple cases (Yin, 2013), with the advantages and disadvantages of each of these types, must be established. In general, 4 to 10 cases may be sufficient (Eisenhardt, 1989). From case selection on, the methods and techniques for data collection and analysis should be established. In data collection, multiple sources of evidence (interviews, document analysis, *in loco* visits, among others) should be used. Once the techniques for data collection are chosen, a research protocol should be developed. Data analysis should also be pre-planned and clearly presented in the paper.

Another stage prescribed by the method is conducting a pilot test that, although it is not a common practice in the adoption of case study, must be carried out by the researcher even before data collection. The goal is to verify application procedures based on the protocol, aiming at its improvement. From this application, it is also possible to verify the quality of obtained data, in order to identify if they are associated with the constructs and, thus, contribute to addressing research objectives.

After the pilot test and adjustments to the research protocol, data collection begins. First, cases should be contacted, considering the main informants who are aware of the research. Before going to field, it is important to have a clear estimate of the time to be spent and the resources to be consumed. Data should be collected and recorded using the instruments defined in planning. Voice records offer a number of advantages to improve the accuracy of subsequent analysis. However, they can inhibit interviewees. Notes are also important, as well as all impressions and observations. The collection should be completed while the amount of data and information reduces and/or when data is considered sufficient to address the research question.

Based on the collected data, considering the multiple sources of evidence, the researcher must then produce an overall case narrative. In general, it is necessary to carry out data reduction, so that only what is essential and has close connections with the objectives and constructs of the research is included in the analysis. If there was recording of interviews, they should be transcribed in full, resulting in raw data. This should be done as soon as possible, so that details (for example, reactions) are not lost. The same goes for paper notes, which must be placed in one or more electronic files. Notes and recordings should be structured according to research protocol. Secondary data may also be used, for example, data referring to the characterization of the object of analysis.

All the activities in the previous stages should then be summarized in a research report. This report is the generator of (and not synonymous to) a monograph (thesis or dissertation) and/or papers (for conferences or journals). It should always be taken into account that results should closely refer to the theory, being careful not to adjust the theory to results and evidence, but the opposite, that is, results and evidence should be associated with the theory. An important contribution to the understanding of the case study in comparison to other methodological approaches is shown in Table 2.

TABLE 2 – Types of research approaches and characteristics

Requirements/Characteristic	Experiment	Survey	Case Study	Action Research
Presence of the researcher in data collection	Possible	Unusual Difficult	Usual	Usual
Small sample size	Possible	Unusual	Usual	Usual
Difficult to quantify variables	Possible	Possible	Possible	Possible
Perceptual measurements	Possible	Possible	Possible	Possible
The constructs are not pre-defined	Unusual	Difficult	Inappropriate	Possible
Causality is central in the analysis	Appropriate	Possible	Appropriate	Possible
Requires to build theory - answer questions such "how"	Possible	Difficult	Appropriate	Possible
Requires deep understanding of the decision making process	Difficult	Difficult	Appropriate	Possible
No active participation of the researcher	Possible	Possible	Possible	Impossible
Control over variables	Usual	Very difficult	Practically impossible	Practically impossible

Note. Source: "Metodologia de pesquisa em engenharia de produção e gestão de operações," by P. A. C. Miguel, 2012, p. 4

As can be seen in Table 2, each research type has different requirements, and the case study combines interesting characteristics for carrying out research and, perhaps for this reason, is relatively widespread. Other approaches are also important, such as action research, presented next.

2.2 Basis of action research

Action research is an empirical type of work, whose conception and construction should take place in close connection with the resolution of a collective problem, in which researchers and participants, representatives of the situation researched, are involved in a cooperative and participatory way (Thiollent, 2009). In general, it aims to address a research problem in an organization (Eden & Huxham, 1996). In addition, researchers working with this approach do not deal with hypotheses, but with research topics and organizational challenges (Checkland & Holwell, 1998). Expanding these statements, Coughlan and Coghlan (2002) add that action research has the following characteristics: "research in action", rather than "research on action," is participatory and simultaneous to the action; it results in a sequence of events and in an approach in search for solutions to a problem. It is also important to note that the characteristics identified above should be considered from the conception of the research, that is, it should be planned as such. In this sense, action research comprises three main phases: preliminary, conduction cycle and metaphase, illustrated in Figure 2. As can be noticed, the research conduction cycle comprises six main stages, while the metaphase is present in each of these six stages. These phases are described below.

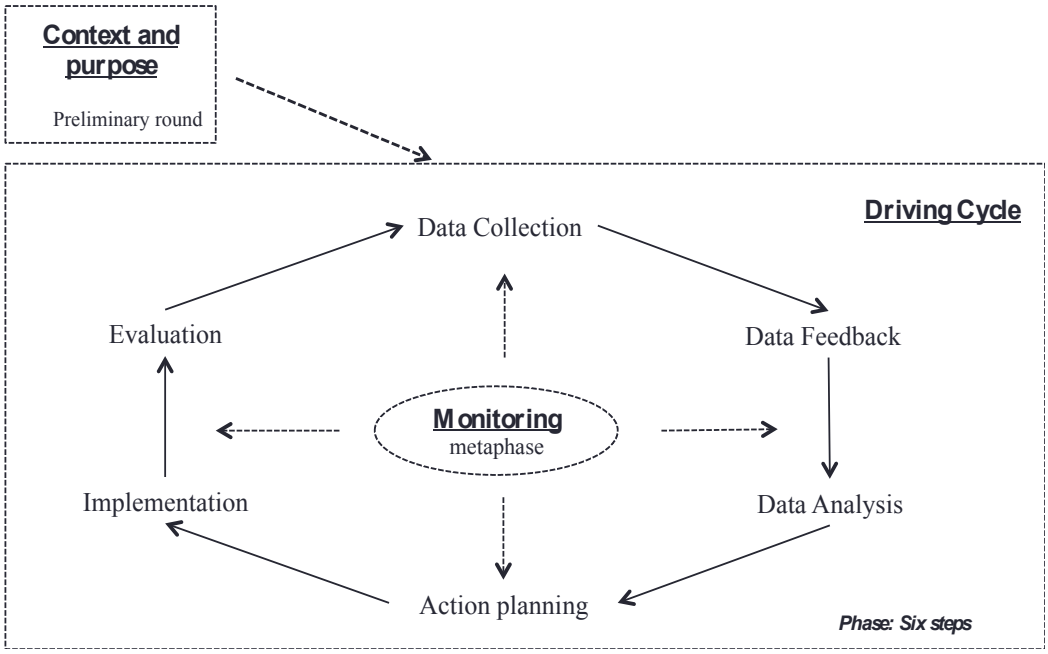

FIGURE 2 – The action research cycle

Source: adapted from "Action Research for Operations Management, " by P. Coughlan and D. Coghlan, 2002, *International Journal of Operations & Production Management, 22,* 220-240. doi:10.1108/01443570210417515

As illustrated in Figure 2, the overall action research cycle comprises the description of the phases defined by Coughlan and Coghlan (2002). The first phase (preliminary study) comprises the understanding of the context in which the research will be performed (object of analysis), as well as the purpose of carrying out the work. This phase also involves the establishment of justifications for the required action (why actions should be carried out) and justifications for the research itself (why this research should be conducted, what are the issues to be addressed, and what contribution will be generated). The second phase (conduction cycle through six stages) begins with data collection (diagnosis and/or data collected when the research is already in course) data feedback (for those involved with the research), analysis of such data (with those involved in research), action planning (definition of interventions to be made), action implementation (put into practice what was planned), and evaluation (verify whether implementation results have been unsuccessful or not, or produced the desired effects), returning to new data collection (if necessary), closing the loop. It is important to mention that these cycles are constant and sequential, i.e., they are continuous for as long as needed. Another observation is that there may be a broader cycle (for the research as a whole) and smaller cycles to specific parts of the work.

The third (meta)phase (monitoring) comprises a verification of each of the six previous stages to identify what was learned from carrying out the action research. This monitoring should be present in different ways, according to each stage of the conduction cycle. From an organizational point of view, there may be the establishment of a directing group during the conduction of action research, in this case with great interest in the practical results of the work (Coughlan & Coghlan, 2002). Still according to the abovementioned authors, on the other hand, the researcher should be interested not only in project operation, but also in the monitoring of the learning process that will lead, ultimately, to a theoretical contribution of this kind of empirical development.

2.3 Design science research

Concerning reducing the gap between theory and practice, by way of more relevant research, Van Aken (2004, 2005) advocates research that results in proposals beyond descriptions, explanations and predictions. This kind of research, with a prescriptive approach, finds support in a search method called design science research.

In fact, there are a number of methodological research approaches. Design science research is considered aa research method that devotes attention to the development of studies that aim at prescription, project and artifact building. This research method has design science as its epistemological basis, a concept which differs from traditional sciences because it concerns itself with the artificial, that is, with everything that has been designed and conceived by man.

In addition, design science is not concerned exclusively with understanding the problem, but with possible solutions. On the one hand, there is research based on the paradigm of design science, whose objective is to design artifacts and prescribe solutions to existing problems, improving or creating new systems (Van Aken, 2004). On the other hand, research based on traditional sciences studies natural or society complex phenomena in order to explore, describe, explain and, if possible, predict (Van Aken, 2004; Romme, 2003). One criticism that has been made to studies in the field of management is that they are too focused on understanding phenomena and give little contribution to developing knowledge that would help professionals solve their problems (Daft & Lewin, 2008; Ford *et al.*, 2003; Starkey & Madan, 2001; Van Aken, 2005).

In this sense, Design Science Research appears as a responsible approach because it operationalizes research that aim to design or develop an artifact, or even prescribe a solution. It is noteworthy that the research that is based on the Design Science paradigm can occur both in the academic sphere as well as within organizations (Bayazit, 2004).

According to Vaishnavi and Kuechler (2009), Design Science Research allows the development of research for many different fields. Kasanen *et al.* (1993) emphasize that this approach, though not widely used, may be appropriate for researchers in management. For example, for researchers who seek more relevant and useful studies for the solution of problems of organizations. In management, in general, and in administration, in particular, Design Science Research proved adequate because it contributed directly to reducing the gap between theory and practice, since this method addresses problems both on the interest of professionals in organizations and academic interests (Hughes *et al.*, 2011).

It can be argued, therefore, that Design Science Research establishes a systematic process that aims to design and develop artifacts that are able to solve problems, thus having a high relevance for the practical field. Also, it is a fundamental concern of Design Science Research to assess what has been developed in order to verify whether the artifact is, in fact, reaching the goals to which it proposed to (Çağdaş & Stubkjær, 2011). Thus, the development of an artifact *per se* is not sufficient to characterize an investigation as Design Science Research. It must be proved that the artifact actually achieved the objectives originally proposed by the researcher.

Another key characteristic of Design Science Research is that, although it is oriented to problem solving, it does not seek an optimal solution but rather a satisfactory solution to the problems under study. Furthermore, although the addressed problem is unique and specific, solutions obtained from the conduction of Design Science Research must be capable of generalization to a certain class of problems (Lacerda, Dresch, Proença, & Antunes, 2013; Sein, Henfridsson, Purao, Rossi, & Lindgreen 2011; Van Aken, 2004, 2005). This generalization essentially allows other researchers and professionals to make use of

knowledge generated with research using Design Science Research as a research method.

In fact, the generalization of knowledge from the conduction of Design Science Research allows even that researchers contribute to the construction and improvement of theories, not the same type of theory proposed by traditional sciences, but rather a mid-range theory or a substantive theory.

According to Holmström, Ketokivi and Hameri (2009), the development of theories from the use of Design Science Research can be divided into four stages (Figure 3). These stages show briefly the process of building a theory from its source to this stage of initial ideas, turning them into more simplified theories, and eventually into formal theories.

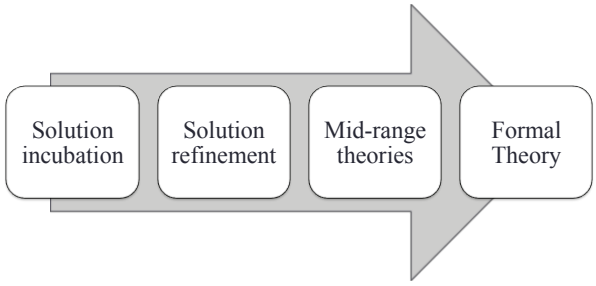

FIGURE 3 – Stages for developing theories

Source: Adapted from "Bridging Practice and Theory: A Design Science Approach," by J. Holmström, M. Ketokivi and A.-P. Hameri, 2009, *Decision Sciences, 40,* 65-88.

As can be seen in Figure 3, the first stage in the development of a theory based on Design Science is "solution incubation". This first stage aims to materialize a framework, properly representing the problem under study (Holmström *et al.*, 2009). From this framework, the researcher should be able to suggest possible solutions to the problems under study (Holmström *et al.*, 2009). These suggestions, when formalized, enable their implementation in a pilot level (Holmström *et al.*, 2009).

The second stage is "solution refinement". During refinement, solutions previously developed are tested in a real environment in order to verify whether the solution proposed by the researcher meets the criteria for a proper solution of the problem (Holmström *et al.*, 2009). These two first stages, which support the construction of a theory by carrying out Design Science Research, often occur within organizations (Holmström *et al.*, 2009). That said, it is emphasized that professionals who are in organizations usually contribute only to these first two stages. But this contribution, by itself, is not considered a recognized scientific contribution (Holmström *et al.*, 2009).

The third stage comprising the development of theories based on Design Science is called "substantive theory" or Mid-range Theory. This stage, according to (Holmström *et al.*, 2009), seeks relevance not only from a practical point of view but also from an academic point of view for the knowledge generated in the first and second stages. In this stage, activities such as evaluation of the artifact from the perspective of theory rather than practice can be performed (Holmström *et al.*, 2009).

It is worth stressing that mid-range theories are dependent on the context in which solutions have been developed, and may not be considered as general theories. That is, a mid-range theory does not intend to be generalized to all contexts, but to generalize theoretical concepts that can contribute to the topic of interest of certain research programs (Holmström *et al.*, 2009).

Finally, the fourth stage of the development of theories through Design Science Research corresponds to "formal theories", which deal with the development of theories that can be used regardless of context (Holmström *et al.*, 2009). In this last stage, still according to the abovementioned authors, scientific contribution is more important than practical relevance. In addition, formal theories are often capable of generalization.

In view of the central concepts presented so far, it is emphasized that, for a both theoretical and practical appropriate contribution, researchers who use Design Science Research as a research method should consider some essential elements. These elements are briefly shown in Figure 4.

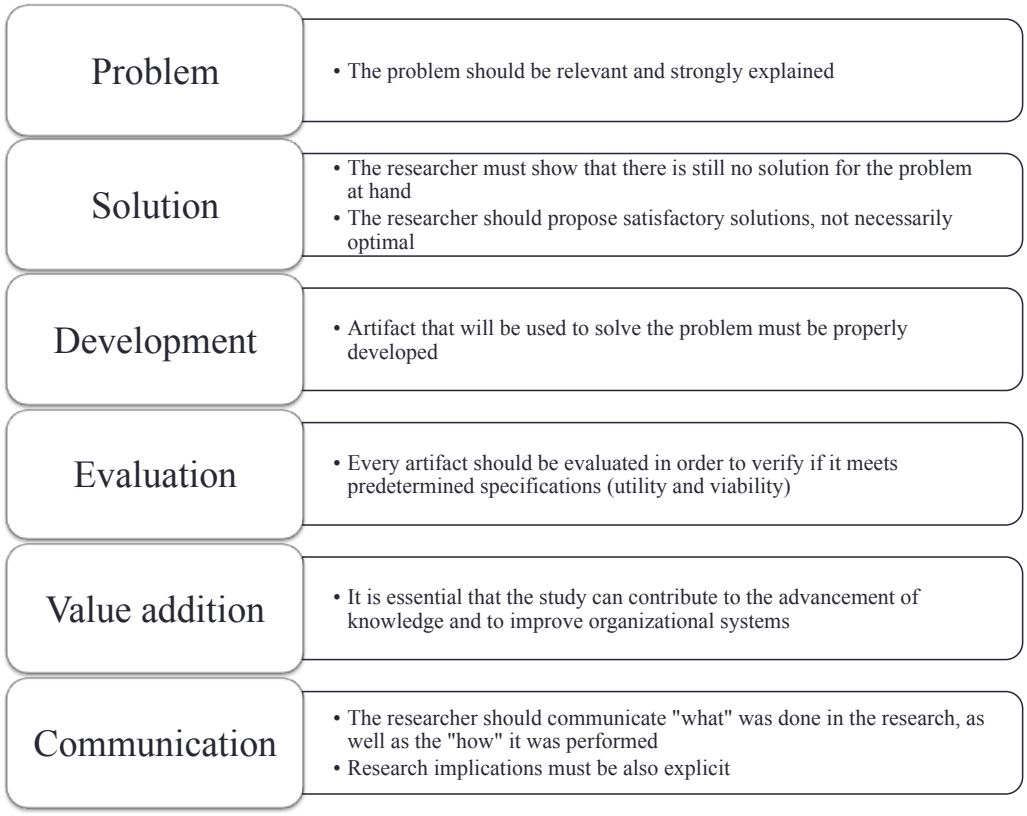

FIGURE 4 – Essential elements for proper conduction of Design Science Research

Source: Adapted from "Design Science in the Information Systems Discipline: An Introduction to the Special Issue on Design Science Research," by S. T. March e V. C. Storey, 2008, *MIS Quaterly, 32*, 725-730.

The first element pointed out by March and Storey (2008), which should be considered by the researchers that will carry out a Design Science Research, is the formalization of a problem that is truly relevant. The second element for the proper conduct of the research based on the Design Science paradigm shows that the researcher must show that there are still no appropriate solutions to solve the problem considered (March & Storey, 2008), thus justifying the importance of the proposed research.

A third element presented by March and Storey (2008) refers to the development of a new artifact that can be used to solve the problem considered. The fourth point emphasized by the abovementioned authors refers to the evaluation of developed artifacts. This evaluation must be made considering the utility and viability aspects of the artifact in order to demonstrate its validity, both practical and academic (March & Storey, 2008).

Another element that March and Storey (2008) mention as crucial for a proper conduct of Design Science Research is that research should add value to existing theoretical knowledge (contributing to the improvement of general knowledge), and improve practical situations in organizations. Finally, it is recommended that researchers, upon concluding its activities, present the implications of their results for the practical field (March & Storey, 2008).

After presenting the main characteristics of Design Science Research, the main stages recommended for a proper conduct of this method will be presented. To meet this goal, Figure 5 shows these stages.

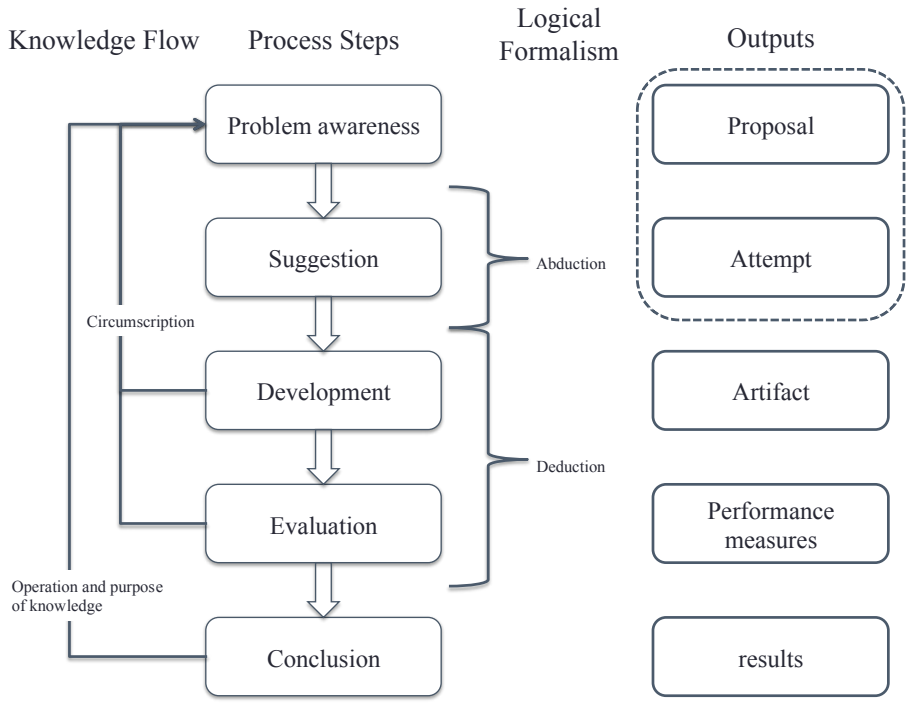

FIGURE 5 – Main stages to carry out Design Science Research

Source: "Design Research in Information Systems," by V. Vaishnavi e W. Kuechler, 2009, from <http://desrist.org/design-research-in-information-systems>

The purpose of Figure 5 is to present the main stages to be followed for the conduction of Design Science Research and the main deliverables of each stage. The first stage of the method consists in problem awareness. At this stage, in addition to clearly identify the problem of interest, which must be above all relevant, the researcher should try to understand the problem in order to identify all its sides and possible interrelations with the context in which it is inserted (Takeda, Veerkamp, Tomiyama, & Yoshikawa, 1990; Vaishnavi & Kuechler, 2009). The main deliverables of this stage refer to the formalization of the problem, its boundaries (environment external to the problem) and the considered satisfactory solutions to the problem.

In the second stage, suggestion, one or more artifact alternatives should be provided to solve the problem under study (Manson, 2006). Thus, this stage results in a set of possible artifacts, as well as in the selection of one of them to advance to the next stage, development. It is noteworthy that the suggestion stage is essentially creative (Manson, 2006) and therefore somewhat subjective. Therefore, it is recommended that protocols be developed in order to ensure the internal validity of the study. These protocols should indicate the choices of researchers and the reasons for these choices.

In the suggestion stage, some of the concepts presented by Simon (1996) regarding Design Science should be considered. Among these concepts, there is a difference between an optimal solution and a satisfactory solution. Thus, "an optimal decision in a simplified model only rarely is great in the real world. The decision maker can choose among optimal decisions in a simplified world or decisions (good enough) that are satisfactory in a world closer to reality" (Simon, 1996, p. 65). From this concept, throughout the conduction of Design Science Research, the researcher should seek satisfactory solutions that are viable. To accomplish this, solution acceptance criteria should be established

a priori by researcher and/or staff engaged in the research (Hevner *et al.*, 2004).

The third big stage for carrying out Design Science Research concerns the development of the artifact itself (Manson, 2006). It is precisely at this stage that the researcher builds the internal environment of the artifact (Simon, 1996). To build the artifact, different approaches may be used. For example, algorithms, graphics models, models etc. (Lacerda *et al.*, 2013). The product of the development stage will be the artifact itself, in its functional state (Manson, 2006).

The fourth stage of design science research covers the evaluation of the developed artifact. The evaluation aims to precisely determine how the artifact behaves in the environment for which it was designed, verifying its ability to meet the intended objective (Lacerda *et al.*, 2013). In addition, the evaluation stage should strongly consider the pragmatic validity of the artifact. That is, if the developed artifact really suits usefulness demands referring to its application in the external environment for which it was destined.

The conclusion stage, in turn, refers to the formalization of the entire research process. In this stage, all previous research stages must be synthesized, detailing their conduction process and justifying the choices made by the researcher (Lacerda *et al.*, 2013).

Finally, the last stage, communication, proposed by Peffers, Tuunanen, Rothenberger, & Chatterjee (2007), aims to present the research results to the community, both academic and organizational. This communication is key to improving knowledge of studied fields. An analysis that summarizes some important characteristics of the three mentioned research methods is presented below.

3 CHARACTERIZATION OF RESEARCH METHODS: AN ANALYTICAL VIEW

The following analytical table seeks to state the main characteristics of the research methods presented in this essay. This analysis proved to be adequate for research in management in general and operations management in particular because it can support researchers in defining the methodological framework better suited to meet the objectives of their investigation.

It is noteworthy that the methodological framework of research should not be considered a bureaucratic act (Lacerda *et al.*, 2013). On the contrary, the methodological framework should be seen as a tool to support the researcher in carrying out rigorous and relevant research. However, some researchers, in their impetus to have their studies accepted by the scientific community, eventually force certain frameworks. This is the case, for example, of the improper use by some researchers of the term "case study", as identified by Berto and Nakano (2000). It is common for studies that collect data in a single organization to implement or evaluate methods and models and even solve problems, for example, to fit research in a case study framework (Berto & Nakano, 2000). There may be studies that, by simply collecting data in companies, without meeting in depth requirements of case studies, frame them as case studies (Berto & Nakano, 2000).

Therefore, it is important to consider which other methods could accommodate this type of research (Lacerda *et al.*, 2013). It is known that, because it is a case study, framework would be somewhat inappropriate, according to the understanding of many authors who debate on the subject (Berto & Nakano, 2000; Eisenhardt, 1989; Ellram, 1996; Miguel, 2007; Voss *et al.*, 2002; Yin, 2013).

Some researchers, however, could propose that these studies, which result in some sort of intervention in an organization, are action research, for example. This could happen because action research requires a direct interaction between researchers and participants (Coughlan & Coghlan, 2002). It is important, however, to assess whether this is sufficient to frame a study as action research or not.

Given the characteristics of each research method covered by this work, it can be observed that all of them are suitable to address the problems faced by researchers in operations management in general. However, some key issues about these methods must be stressed.

In this sense, Table 3 presents a possible contribution aimed, above all, at revealing certain differences and similarities among the research methods discussed here. It is noteworthy that the main differences can be seen regarding the objectives that each method can achieve, the role of the researcher, the need or not of an empirical basis (Lacerda *et al.*, 2013), and the possibility of generalization of knowledge (Dresch, 2013, Dresch, Lacerda, & Antunes, 2015)..

TABLE 3 – Case study, action research and design science research characteristics**.**

Characteristics	Case study	Action Research	Design Science Research
Epistemological paradigm	Traditional sciences (natural and social)	Traditional sciences (natural and social)	Design Science
Objectives that can be achieved	Assist in the understanding of complex phenomena. Test or create theories	Solve or explain problems of a system generating knowledge for both practice and theory	Develop artifacts that allow satisfactory solutions to practical problems. Contribute to the building of theories (mid-range theories)
	Explore, Describe, Explain and Predict	Explore, Describe, Explain and Predict	Design and Prescribe
Main activities planned for a proper conduction of research	Define Conceptual Framework Plan cases Conduct Pilots Collect Data Analyze Data Generate Reports (Cauchick Miguel, 2007)	Plan Action Collect Data Analyze data and Plan actions Implement Actions Evaluate Results Monitor (Continuous) (Turrioni and Mello, 2012)	Define the Problem Suggest Develop Evaluate Conclude Communicate Manson (2006), Peffers et al. (2007), Takeda et al. (1990) and Vaishnavi and Kuechler (2009)
Research results	Constructs Hypotheses Propositions Descriptions Explanations	Constructs Hypotheses Descriptions Explanations Actions	Artifacts (Constructs, Models, Methods, Instantiations, Design Propositions)
Generated knowledge	On how things are or how they behave	On how things are or how they behave	On how things should be
Role of the researcher	Observer	Multiple, depending on the type of action research	Constructor and/or evaluator of the artifact
Collaboration between researcher-researched	Not required	Required	Not required
Empirical Basis	Required	Required	Not required
Implementation	Not applicable	Required	Not required
Evaluation of results obtained by research	Confrontation with theory	Confrontation with the theory	Applications, simulations, experiments with the artifact
Nature of data (collection/analysis)	Normally qualitative	Normally qualitative	May be qualitative and/or quantitative
Specificity of research results	Specific situation	Specific situation	Generalizable to a certain Class of Problems

Note. Adapted from "Design Science Research: A Method for Science and Technology Advancement," by A. Dresch, D. P. Lacerda and J. A. V. Antunes Jr., 2015; and "Design Science Research: A Research Method to Production Engineering," by D. P. Lacerda, A. Dresch, A. Proença and J. A. V. Antunes Jr., 2013, *Gestão & Produção, 20*(4), 741-761.

In addition to the main differences explained above, the epistemological paradigm distinction to which each of the methods is subjected can also be highlighted. While case study and action research are traditionally subordinated to natural and social sciences, Design Science Research is subordinated to the paradigm of the sciences of the artificial, i.e., Design Science.

Moreover, the objectives that can be achieved through the application of each one of the methods shown in Table 3 differ from each other. While case study and action research allow exploring, describing, explaining and eventually predicting a particular phenomenon, Design Science Research essentially aims to prescribe solutions or design artifacts. However, according to the purposes of the research, the possibility of using traditional research methods under the paradigm of Design Science is not discarded. There are authors such as Sein *et al.* (2011) who propose an integration of action research and Design Science Research in a method they call Action Design Research.

It can be argued that action research, when applied under the paradigm of Design Science, can contribute to the building of artifacts. This can be useful in cases in which the artifact's development depends on the interaction of those involved in the research, or in which the evaluation can only be performed in the context of the organization and with the participation of people from the environment that is being investigated.

4 CONCLUSIONS

This article sought to present alternatives to research methods that can be applied to conduct research in management and in operations management. Some researchers, with the urge to classify their research seeking a greater recognition by the academy put aside two central issues. First, research approaches only guide the construction of the working method. Due to the lack of work method, there is a difficulty to understand deeply and in detail how the research was conducted, to justify conduction decisions adopted and especially to later replicate the study. Second, some researchers do not consider the relevance of studies with a weight equivalent to the rigor of the research. The question of relevance has a special attention when considering studies in management, since the knowledge generated must have, in addition to theoretical implications, practical repercussions.

As discussed, it is possible to seek increased relevance of studies in management through the application of research methods based on design science paradigms – by applying methods such as design science research or by implementing case study and action research under a paradigm that is different from the one that is traditionally used (based on traditional sciences). It is known that case study is a methodological approach that excels in the number of applications with respect to research in operations management and administration. Thus, carrying out case studies or action research from a design science paradigm constitutes an opportunity for further research. This can occur by either formalizing existing artifacts (case studies) or collaborative construction with professionals (action research).

This paper sought to help increase the repertoire of research methods that can be used by researchers in operations management. The lack of larger and deeper discussions about the possibility of applying these methods under a traditional complementary scientific paradigm must be recognized. Studies are therefore needed to verify, mainly in practice, the possibility of using methods such as case studies and action research under the design science paradigm.

Another possibility that seems appropriate regarding studies in management is the use of design science research as a research method to support in conducting investigations aimed at designing and developing new artifacts. For example, the CANVAS tool was developed from design science and design science research. It is used by organizations. Few studies dealing with the application of this method can be identified

and, for now, these works still focus on thesis and dissertation formats. Again, there is an important need for research carried out under this guidance and published in national journals.

Finally, there are other possibilities to be explored in terms of a future research agenda. A reflection on ontology and epistemology in design science and design science research is still incipient in the national and international community. Another aspect that deserves attention and is a research opportunity is the analysis of applications of the discussed research methods. A critical assessment of whether the academic community has been using them properly or not, in the light of rigor, and what these research methods (case study, action research and design science research) prescribe. In this sense, a study of research using design science research may be the most pressing possibility to avoid the accumulation of inappropriate uses throughout its development, considering that there is a small research universe. A critical evaluation of the appropriateness or not of Design Action Research for management and operations management would be interesting. In fact, there are several directions for further research and efforts needed to improve the repertoire of research methods for the academic community.

For the consolidation of knowledge in management, knowledge generated both by scholars and in practice must be adequately communicated to all communities. This is a significant challenge. However, in a field in which relevance is a key point, there must be a defragmentation of knowledge. Fragmentation contributes to increase the gap that exists due to lack of interaction among researchers and professionals in organizations.

That is, as well as concern as to the increasing relevance of research carried out by scholars, knowledge generated must also be properly systematized so that it can be accessed by other researchers and professionals who are interested in the subject. Easy access by professionals would greatly increase the possibility of practical application of knowledge generated by universities. One way to systematize and organize the knowledge of a field such as management, for example, could be the use of evidence-based management.

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