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The Use of Experimental Methods by IS Scholars: An Illustrated Typology*

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Accepted Paper

Abstract:

This article aims at making an updated typology of recent experimental studies in the IS literature on the period 1999-2019. Based on a full-text search within the Association for Information Systems (AIS) "basket" of eight top IS journals (EJIS, ISR, JAIS, ISJ, JIT, JMIS, JSIS and MISQ), this research gathered 392 articles and highlights the use of 5 different types of experiments in IS, mainly: artificial simulations, laboratory experiments, field experiments, online experiments (scenario simulation game-based; brainstorming-based...) and natural experiments. Each category is discussed through the perspective of its degree of control, and technological realism. Results show the significant predominance of laboratory experiments over field and natural experiments on the period. This, in turn, stresses the preferred tendency followed by IS scholars to perceive experimental methods as a way to control the source of variations of variables under study. In addition, this paper provides a better understanding of the context of use of a specific experimental method. Overall, it is shown that laboratory experiments (including scenario-based lab experiments) are mainly used, in a deterministic manner, to assess or test the impact of an IS on human decision-making or behaviour. By contrast, artificial simulations experiments are more appropriate to study emergent phenomena and to make predictions, often providing key insights about quality and effectiveness of IS.

Keywords:

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Methodology ; IS ; Meta-research; Experimental method ; Behavioural Science ; Experimental Economics

1 Introduction

It was only recently that the use of economic experiments to study human decision-making has been discussed systematically in the IS literature (Gupta et al., 2018). Yet, the adoption of experiments by IS scholars is not innovative and the value that the methodology offers for IS issues has been established three decades ago (Benbasat, 1989). Although the experimental method has always played a significant role in theory building and theory testing, it has often been underestimated as there is a lack of systematic study of economic experiments as a potential method in IS. Overall, experiments do not only have the ability to confirm pre-existing models and hypotheses, but also open avenues for future research by exploring emerging IS-related issues. Kaplan (1964, p. 144) defines experimentation as "a process of observation, to be carried out in a situation especially brought about for that purpose". This research design traditionally refers to the experimenter's willingness to study a specific event throughout the implementation of a defined treatment, and the creation of resembling condition - without expecting for its natural occurrence or for a simulation of a real-life situation.

In this case, the researcher expresses his need to control the sources of variation of the observed variables. The use of an experimental setting allows him to have precise measurements of all variables, and therefore to produce valuable and replicable results. For instance, the IS researcher must be able to track the variation that caused the changes in the purchasing behaviour of the subject by creating an artificial e-commerce environment and simulating real-purchase conditions.

For this reason, the laboratory framework is usually associated with the experimentation strategy. In a room expressly equipped and designed for research, researchers can easily identify cause-and-effect relationships and still provide practical insights to a specific research question (Mason, 1989). The control of independent variables is ensured, as well as the reduction of data pollution. Yet, results obtained in artificial laboratory environments are usually challenged for their presumed lack of external validity (Fromkin and Streufert, 1976). Put differently, results drawn from experiments are often considered as hardly applicable to the "real-world" context.

Because of the importance of external validity and the production of practical knowledge in MIS, researchers often face the dilemma between results' robustness (experimental control, internal validity) and their practicality (generalizability, external validity) (Mason, 1989; Stone, 1978; Blackburn, 1987). On the one hand, technical and statistical control provides reasonable rigor, reliability and replicability, but on the other hand, realism is limited and can reduce the usefulness and relevance of the research in real life for practitioners. Hence, the type of experiments designed by the researcher will largely determine the overall methodological approach.

In order to overcome the limitations of laboratory experiments, IS researchers have been providing reliable results on individual and organisational responses to technological initiatives, using field and natural settings to test and develop theories. In this regard, field experiments have been seen as a bridge between laboratory experiments and natural experiments (Stone, 1978). In particular, the natural appearance of data without manipulation by researchers contradicts the natural experiments of those in the laboratory and in the field (see section 2.2). More recently, the diffusion of the internet and web-based technologies (such as social platforms and e-commerce sites) led IS researchers to shift their research towards online settings and to develop a new genre of "online experiments".

Accordingly, this paper aims to provide an overview of the variety of experimental methods recently used

in the IS field, highlighting the degree of control and technological realism of each. This paper specifically examines the following items over a 20-year period (1999 to 2019): 1) research objective, 2) empirical methodological approach, 3) its advantages and limitations, 4) the degree of control, and 5) the technological realism of experimental tasks and conditions. For each category of experiments - laboratory, field, online and natural - several sub-categories have emerged from our meta-research. The heterogeneity lies mainly in the adaptation of instruments and methods to the research objectives and questions, as well as in the trade-off between internal and external validity. In this sense, the principles, methods and tools of behavioural sciences - encompassing a wide range of fields such as cognitive science, psychology, social neuroscience, behavioural economics, social psychology, as well as methods such as agent-based modelling or social network - are often used sporadically. As a consequence and as argued elsewhere (see Boudreau et al., 2001; Straub, 1989), a lack of methodological standards - as regards experimentation - in IS research, persists despite the efforts that have been made in instrument validation.

Overall, this paper has two main objectives. First, it seeks to provide an updated typology of experimental methods in IS over the last twenty years (1999-2019). Based on a systematic literature review, this typology offers meta- and sub-categories of experimental methods used by IS scholars, their associated definitions and conceptualisations, as well as their respective weight in the literature (section 2). Second, in a more explanatory perspective, it aims at formulating lessons from this descriptive typology. The main idea is here to provide a better understanding of the use of specific experimental methods for an appropriate IS setting - for instance testing the impact of a technological device on behaviour versus making predictions on the use of an emergent IS (section 3).

2 An illustrated typology of experimental studies in the IS field

In general, when one refers to experimental method, one instinctively thinks of a common framework, the laboratory. To a large extent, this association probably explains the confusion between the terms "laboratory" and "experimentation" in the literature. However, according to Fromkin and Streufert (1976), these two terms refer to two different notions: the research framework (the laboratory) and the research strategy (experimentation, experiment).

Experiments differ from simulations, as they tend to impose a strictly controlled environment. To a large extent, where simulations involve an artificial production of data, experiments produce an artificial / controlled situation; yet collecting observed behavioural and interactional data among the experiment's participants (Mingers, 2003, p. 238). Based on a large collection of IS articles and a full-text search within the AIS (Association for Information Systems) (section 2.1), we provide here a typology of experiments in IS over the period 1999-2019.

Traditionally, experiments have been recognised to generate values in the following five ways (1) testing theories and exploring the causes of their failure, (2) finding empirical regularities as a basis for new theory, (3) comparing environments and institutions, (4) evaluating policy proposals, and (5) testing new mechanisms (Smith, 1994). In a more specific value creation regarding the IS field , Gupta et al. (2018) provide an interesting classification of experiments and their usefulness: 1) acquiring information – experiments are used to better understand how agents seek information to make better decisions; 2) processing information – experiments are used to study the manner in which agents process information; 3) valuing information – experiments help understanding how the variations in the valuation of information by economic agents affect system outcomes.

2.1 Method and data collection

The eclectic nature of the IS field, as regards its methods, reflects a need to constantly build a dialogue with other fields. In this interdisciplinary perspective, IS researchers show a tendency to borrow methodological approaches from other fields in social sciences, such as behavioural economics and psychology. This multi-settings methodological approach unquestionably provides valuable ways to study emerging technological phenomena, but it also represents an inevitable effort to address a large number of issues related to the validity and practicability of results.

Despite a growing tendency to use experimental methods in the IS field, the literature is lacking a recent updated typology of experimental studies. As a result, experimental methodologies used in IS may lack clarity when they are defined; especially regarding the formal rules and the conduct of the experiments. The most recent studies concerned with this issue sought to provide clarity, tracing the main research trends and highlighting the methodological advantages and issues of a specific type of experiment (e.g. Karahanna et al., 2018; Boudreau et al., 2001; Gupta et al., 2018). As an example, Boudreau et al. (2001) underline the need for instrumental validation in quantitative and positivist research to solve the general problem of rigor in IS research by also focusing on laboratory experiments. Therefore, a typology of experimental studies in IS appears particularly relevant to increase the quality of scientific research based on experimental methodologies.

As a result, this study follows the three-phases process set out by Cumbie et al. (2005) for the conduct of a meta-research. First, we identified and downloaded individual articles from ScienceDirect, Scopus and Google Scholar search engines, using terms such as "experiments"; "economic experiments"; "experimental research" and "experimental economics". We limited this search to 8 journals (EJIS, ISR, ISJ, JAIS, JIT, JMIS, JSIS and MISQ) selected within the Association for Information Systems (AIS) "basket" of eight top IS journals. We used only one inclusion criterion when selecting articles: at least one of the terms listed above must appear in the title, abstract and/or keywords of the article. Each article in the initial compilation has been examined to remove articles that were not relevant. We made decisions about including or excluding articles that incidentally mentioned "experiment" in the text. The final set of publications included 392 articles that conducted an experiment in IS over the period 1999-2019.

Table 1: Structure of 392 collected articles in 8 top IS Journals using terms as "experiments" and similar terms (1999-2019)

Journal	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	TOTAL / JOURNAL
EJIS	2	2	0	4	0	0	3	0	2	1	1	1	3	1	1	2	1	2	0	1	0	27
ISJ	0	1	0	0	0	0	0	0	1	0	0	1	1	2	0	0	4	1	0	1	1	13
JIT	1	0	0	0	1	1	0	2	0	1	0	1	1	0	0	0	0	1	2	0	0	11
JMIS	3	2	4	7	2	4	5	2	3	6	5	0	3	5	3	8	8	7	2	5	8	92
JSIS	0	0	0	2	0	0	0	0	1	1	1	1	1	0	2	0	1	2	2	0	4	18
MISQ	3	3	2	2	1	1	3	8	5	2	7	8	9	6	5	6	3	4	11	8	5	102
ISR	1	5	1	1	1	3	3	4	2	4	3	5	2	4	9	6	8	8	5	7	13	95
JAIS	0	0	0	0	0	0	0	0	0	2	1	1	2	1	3	4	5	2	3	5	5	34
TOTAL / YEAR	10	13	7	16	5	9	14	16	14	17	18	18	22	19	23	26	30	27	25	27	36	392

The first result shows that JMIS, ISR and MISQ are significantly more involved with experimental research than the other IS journals. To a large extent, this is consistent with the editorial policy of EJIS, ISJ, JIT, JAIS and JSIS that are more opened to empirical surveys and case-studies. Second, this table shows the growing tendency to publish experimental papers in IS Journals, as overall, the number of papers more

than doubled over the period.

These descriptive statistics have been complemented with the identification of the design, definition and research object of each experimentally-based article. This identification led us to establish a substantial list of heterogeneous types of experiments and to produce meta-categories of experiments in IS that are exposed in the next section.

2.2 Categories of experiments in IS

The analysis of the 392 articles gathered in 8 top-IS journals highlights the use of 5 different types of experiments in IS, mainly: artificial statistical simulation experiments, laboratory experiments, field experiments, online experiments and natural experiments. Details of these categories can be found in the Appendix. The five categories have been listed from the more to the least controlled ones.

- **Artificial statistical simulation experiments:** These are also called "modelling experiments" and are based on a system dynamics methodology. The research design implies the artificial production of statistical data that could better capture the evaluation of a specific IS in a simulated environment.

- **Laboratory experiments:** These experiments present a varying degree of internal validity depending on the degree of freedom of the underlying setting of the experiment. Fromkin and Streufert (1976) identify various types of laboratory experiments: standard laboratory experiments[1], free simulations[2], experimental simulations[3]. According to this categorization, we identify standard laboratory experiments. In addition, we describe scenario-based experiments and simulation games, which are other terminologies to define experimental simulations, and free simulations. These typologies differ along different dimensions, such as: control, and real world realism.

  Behavioural control by the researcher is key but may accommodate different levels of behavioural constraints. Laboratory experiments aim to control the source of the variation of different types of variables. This category of experiments has been pioneered by Vernon Smith's induced-value theory, that emphasizes the use of a reward mechanism incorporating sufficient monetary value to motivate subjects' performance and allowing the experimenter to induce pre-specified characteristics in subjects (Tung and Marsden, 2000; Adomavicius et al., 2013). Questionnaires to complete experimental results can be addressed to subjects at the end of the experiment (Sia et al., 2009).

  As detailed in the Appendix, controlled laboratory experiments include sub-categories of experiments such as: "neuro lab experiments", "behavioural experiments", "simulation game-based experiments", "scenario-based lab experiments", "think aloud procedure-based lab experiments" and "brainstorming-based experiments".

- **Field experiments:** Although several advantages of using the field rather than laboratory environment, such as higher external validity, have been identified, some weaknesses related to reduced internal validity remain. In this line, Zmud et al. (1989) stress two problematic elements of any experimental field design, i.e., randomization (the use of a randomised base assigning subjects or units to experimental or control groups) and experimental control.

[1] Standard laboratory experiments: Researchers study cause-effect relationships by imposing a high level of control to ensure that nothing other than treatment leads to behaviour change.

[2] Free simulations: during the experiment, participants are free to behave, and events are primarily shaped by their behaviour.

[3] Experimental simulations: the conditions are well defined by the researchers, and the independent variable remains under their control. As a result, experimental simulations are closer to standard laboratory experiments than free simulations.

On the other hand, these experiments present a higher degree of external validity than controlled laboratory experiments. They integrate more realistic contexts and differ from lab experiments in "their use of 'non-standard subject pool', actual goods rather than induced variations and/ or real contexts rather than abstract framing with an imposed set of rules" (Gupta et al., 2018, p. 597). They can involve "quasi-experiments" that present the strength of combining the control of a randomised experiment with the external validity of a natural experiment. Hence, the element of random assignment to treatment or control is missing (Cook and Campbell, 1979). As a result, internal validity issues generally arise.

As detailed in the Appendix, field experiments include sub-categories of experiments such as: "behavioural field experiments", "randomised field experiments", "simulation game-based field experiments", "scenario-based field experiments", and "quasi-experiments".

- **Online experiments:** These experiments could be controlled or field-based, but are conducted online. They are mainly used, on purpose, to investigate online environments and are usually based on real life virtual environment where participants make decisions (Facebook, Online auction markets, etc.). Web-based methods refer to methods traditionally used in the field and in the laboratory, adapted to the online context, to study new complex phenomena, such as the emergence of social media and virtual teams.

  Moreover, a lot of "standard experiments" are conducted online thanks to the development of platforms such as Mechanical Turk or Prolific. The main advantage is to reach a larger and more diverse population of participants.

  Besides a wide range of opportunities, these online research methods bring also new challenges in assessing control and reducing pollution compared to field and laboratory experiments. For instance, there is difficulty verifying the identity of participants. Moreover, it is merely impossible to verify that experimental instructions have not been ignored or read carelessly. The online setting may make a subject concerning that they are not interacting with real humans. As detailed in the Appendix, online experiments include sub-categories of experiments such as: "behavioural online field experiments", "online field experiments", "simulation game-based online field experiments", and "scenario-based online field experiments".

- **Natural experiments:** These experiments allow to compare the effects of a controlled treatment of human behaviour, on the one hand, and a condition that cannot be manipulated by the researcher, on the other hand. As a result, the assignment to pre-specified conditions cannot be introduced. The experiments might therefore be non-randomised but expect higher external validity than strictly controlled lab experiments.

It is worth going into further details and investigating the type of experiments published in each journal. One result concerns the significant weight of laboratory experiments, as it consists of 58.9 per cent of the overall experimental papers published in IS Journals. This predominance potentially outlines the preferred tendency followed by IS scholars to use experiments to control the source of variations of variables under study. This contrasts with the low rate of "natural experiments" oriented papers that represent less than 3.6 per cent of the overall experimental papers, on the period. Artificial simulations and field experiments are slightly more present, although less representative than laboratory experiments, since they respectively represent 13.2 per cent and 18.1 per cent of the overall experimental papers.

Table 2: Classification of settings of 392 collected articles in 8 top IS Journals using terms as "experiments" and similar terms (1999-2019)

	Art. Simulation	Lab	Field	Online	Natural	TOTAL
EJIS	1	24	1	1	0	27
ISJ	0	10	2	1	0	13
JIT	4	3	1	2	1	11
JMIS	6	63	12	7	4	92
JSIS	4	9	3	1	1	18
MISQ	19	53	21	4	5	102
ISR	17	39	30	7	2	95
JAIS	1	30	1	1	1	34
Total	**52**	**231**	**71**	**24**	**14**	**392**

We calculated trends by following the terminology used by the authors in the papers. In several papers, we find experiments conducted on online environments defined as "field experiments". However, the characteristics of the setting required web and IT application-based methods. This terminology typically contrasts with the typology proposed in this article, as it mainly relates to the technological dimension of the IS topics. Hence, we argue that there is a real need to emphasize the difference between the "classic" field setting used in management to analyse, for example, organisational dynamics, from these digital contexts. For this reason, we believe that these experiments should be called online field experiments, instead of merely field experiments. This is essentially resulting from the fact that, as highlighted before, the experimental online procedures offer new advantages and new challenges compared to those in the field.
In the next section discusses each of these five categories by highlighting some lessons, especially through the perspective of its degree of control and technological realism.

3 Lessons from the typology: Which experimental method for which IS settings?

The analysis of the 392 selected articles allowed us to provide a typology of the use of experiments in IS. Artificial simulation experiments are not the only unique and low-cost settings to test the effectiveness and virtues of models, IT systems, or designs (e.g., Wang et al., 2011). The practical and theoretical contributions of this typology cover a wide range of phenomena. We can explore potential or emerging environment, such as the design of online and digital environments (e.g., online auctions), and their related impacts on organizations, such as the digital competition (e.g., Chang et al., 2010). As a result, the findings also provide guidelines and approaches to deal with organisational issues (e.g., Hua and Bapna, 2013).
Laboratory experiments are costly compared to artificial simulations, and their range of treatment variables is restricted. However, laboratory settings provide the right context and conditions to investigate human decision processes and behaviour. The different types of lab experiments differ not only in terms of data collection methods and intensity of control, as shown in the previous section, but also in terms of the context of use.
Behavioural lab experiments mainly provide insights on individuals' behaviours by making subjects interact though the implementation of games from experimental economics (e.g., public good games, Hashim et al.,

2017), which incorporate salient phenomena features. These specific experiments refer to investigations on how individuals' behaviour varies in virtual worlds and online environments under different information regimes. The underlying dynamics of each specific information setting is on the other hand challenging to explore in natural settings.

Standard laboratory experiments - including scenario-based lab experiments - are mostly used, in a deterministic manner, to assess or test the impact of an IS on decision-making or human behaviour. The use of standard lab experiments covers a wide range of IT solutions and phenomena. We found papers that provide an analysis of virtual worlds dynamics, while others focus on the antecedents of acceptance and trust of different IT solutions (e.g., decision aid's user-systems, computer-mediated communication, and recommendation agents). Researchers also provide guidelines for optimization strategies (e.g. Ding et al., 2015), as well as analyse the effectiveness of strategic activities in enhancing consumers trust (e.g., Wang and Wang, 2019).

These laboratory experiments do not only validate and test previous results and theoretical models but can also open various avenues for future research.

In order to go beyond the technological determinism pervading the IS literature, methodological approaches from other disciplines could be particularly relevant to IS scholars. The Neuro-Information-Systems (NeuroIS) rely on neuroscience and neurophysiological principles and methods to bring new explanatory power to users' IT-related decisions and behaviour. Hence, individual-centric data collection allows studying individual traits, such as self-control (Hu et al., 2015), in order to understand online dynamics and users' decision process. For instance, tools from these domains enable scholars to study a variety of IT situations, such as human-computer interaction, attention, trust, and social networks. Moreover, findings reflect salient guidelines for improving designs by integrating physiological data into information technology artifacts.

Simulation game-based laboratory experiments define another type of laboratory experiment, where business games usually simulate realistic organisational situations. Accordingly, the lab setting provides a pertinent context to explore managerial decision making and virtual team dynamics in software project environments (e.g., Kanawattanachai and Yoo, 2002).

The last two types of laboratory experiments are characterized by an extensive use of qualitative methods for data collection and analysis. First, thinking aloud procedures primarily provide insights and indications on cognitive processes and knowledge acquisition in knowledge-based computer systems, as Van Someren et al. (1994) pointed out almost 25 years ago. Second, IS researchers have performed brainstorming lab sessions to investigate the effectiveness of Group Support Systems to improve creativity, knowledge acquisitions, and generating ideas (e.g., Kwok and Vogel, 2002).

Regarding field experiments, simulation games and scenarios also contribute to give subjects directives and contextualization but the experimental session is performed in more realistic contexts. As emphasized in section 2.2, the digital and online environments are the main targets of these type of experiments (including randomised field experiments). Hence, collaboration with IT providers allows IS scholar to analyse decision making and behaviour of a more generalized pool of subjects, especially real users. Field experiments also offer guidelines and insights on the design and effectiveness of IT products, platforms or policies (e.g. Kumar and Hosanagar, 2019).

In the same line, online experiments provide significant insights on adoption behaviour by using experimental economics techniques, simulation game, and scenarios. Moreover, insights for the design and personalisation of websites and IT products can be provided (e.g., Tam and Ho, 2005).

Natural experiments are usually used as a way to retrospectively analyse and understand changes at the individual or organizational level. IS scholars conduct natural experiments that, for instance, focus on the impact of policies, managerial activities or technological features on behaviour, decision-making processes,

and the quality of service. For instance, the empirical investigation of naturally occurring data can inform future managerial policy (see Liu et al., 2015) or digital strategy (Huang et al., 2016).

Several comments can complete the elaboration of these lessons and could be listed here as 5 main challenges.

- *Internal versus external validity in experiments:* Depending on the type of experiments, the researcher faces a trade-off between internal and external validity. The more controlled the experiment, the higher the internal validity. Many of the articles selected show that the laboratory settings are essentially a way to create a context that cannot be observed in a natural setting. The choice of a specific type of experiment could also result from the lack of existing observational data in the study of a specific technology – to a large extent. In a nutshell, controlled lab experiments allow the researcher to study users' effective behaviour rather than intentions to use a disruptive technology.

- *Technological realism in experiments:* In the IS field technological realism plays an important role in the contextualization of the experimental design. This is why IS researchers focus their research mainly on the perception or impact of well-defined prototypes or online environments. Similarly, in the case of behavioural experiments, they are mainly conducted to study user behaviour in particular in online environments such as online auctions (Adomavicius et al., 2013) or online commerce (Dimoka, 2010) that allow the use of experimental economics techniques and principles in typical games such as the Investment Game or the Ultimatum Game without jeopardizing the technological realism of the task. However, some research relies on describing a IT artefact without showing it and without having participants trying it out (Li et al., 2008).

- *Towards mixed methods based on experiments:* Articles show a rising tendency to combine qualitative and quantitative methodological approaches during the experiment (e.g. interviews conducted at the end of an experiment; content analysis; or a combination of field and lab experiments. According to Hong et al. (2017), "such a multi-method approach allows us to leverage the strength of lab experiments to achieve internal validity and randomised field experiments to demonstrate external validity".

- *Usefulness of experiments to study emerging technologies and behavioral traits:* behavioural experiments potentially provide a way to analyse the behavioural traits of potential users in order to explore prospective uses of emerging technologies and ensure high validity of results. Experiments allow to investigate individuals' attitudes as an explanatory variable of their behaviour in various decision-making contexts. Trust of emerging technologies can therefore be assessed through the experimental design.

- *Limits:* Methodological limits to experimental research are essentially concerned with the lack of statistical generalizability of the results because of the nature of the subjects (most of the time, chosen, among students). This issue of external validity has been qualified by some IS scholars who argued that "research in management decision making using student subjects is not necessarily questionable", since "both student and manager groups have common educational levels and no previous courses or experience on the specific theme of the experiment" (Lee and Truex, 2000, p. 354). In the same vein, Keil et al. (2007, p. 69) argue that "the choice between student and 'non-student' subjects is not as straightforward as one might at first think", since "non-student samples are often drawn from narrowly defined, homogeneous groups (Dipboye and Flanagan, 1979; Greenberg, 1987), which im-

pedes generalizability". To ensure replicability, the participants are usually students, and there is a performance-based incentive.

4 Concluding remarks

It is merely difficult or impossible to identify an experimental approach that is superior to others. The trade-off between external and internal validity always leads researchers to address the advantages and disadvantages of distant experimental environments and methodologies. For this reason, the experimental practices categorised in this paper are often considered as complementary. Multi-method approaches are recognised as suitable for robust and replicability of results. For example, the combination of results from two different experiments allows mitigating the disadvantages of one approach by using the advantages of the other (Hong et al., 2017). Different combinations have been defined, from the classical ones, such as the standard laboratory experiment combined with a randomised field experiment, to specific ones that matched methodologies traditionally presented as opposed. For example, results from a behavioural experiment with well-defined control conditions and mechanisms from experimental economics combined with natural occurrence data from natural experiments. In this sense, IS researchers usually extend previous findings by conducting other experiments. Alternatively, they suggest deepening the study of the phenomenon with other experimental methodologies to demonstrate the validity of the results, as well as, provide a greater understanding.

Moreover, even if a willingness to replicate methods used in previous experiments to draw on the same advantages is rather obvious, there is still a multitude of procedures and ways of bringing control and realism. One of the main challenges is to identify some methodological standards in order to improve replicability and robustness of the results. For instance, the use of monetary incentives in order to motivate participants and increase their involvement, though well established for years in the field of experimental economics - is far from being a generalised practice in the IS experimental literature we have analysed. Similarly, experimental economics research shows that the sensitivity of the performance of the model is related to the incentive mechanisms used in the experiment.

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APPENDIX A: Experimental Typology

ARTIFICIAL:

- **ARTIFICIAL SIMULATION EXPERIMENT**: Artificial simulation experiments serve various purposes. For example, they provide essential insights on the quality and effectiveness of methods, models, and policies. More precisely, simulations allow investigating scenarios that have proved difficult to analyse analytically, such as emerging IT phenomena. These artificial experiments provide significant theoretical and practical contributions.

LABORATORY:

- **BEHAVIOURAL LAB EXPERIMENTS**: This type of laboratory experiments - generally referred to as behavioural experiments in the IS literature - focuses primarily on Smith (1994)'s trajectory. In particular, control plays a crucial role. Of course, the results may lack external validity, but they provide significant insights that explain behavioural phenomena otherwise merely empirically unattainable. Students as a standard group of subjects and performance-based incentives are encouraged as good experimental practices. In general, these experimental economics techniques are used to investigate behaviours related to online privacy, trust, piracy, shopping, and auctions.
- **NEUROIS PROCEDURE-BASED LAB EXPERIMENTS**: Neuroeconomics and neuroscience methods are used, as well as pre- and post-session questionnaires to collect self-measured data. The main objective is to reveal mental processes "that are difficult or even impossible to measure with existing measurement methods and tools" (Dimoka et al., 2011).
- **STANDARD LAB EXPERIMENTS**: The prerequisite is that nothing other than treatment causes behaviour change in order to establish cause-effect relationships (Fromkin and Streufert, 1976). In general, participants are randomly assigned to control or treatment groups. In most cases, computer prototypes or web-based protocols are developed for study in order to provide technological realism. In most cases, this type is used to test models and theories. However, the results may provide the basis for theoretical works.
- **SCENARIO-BASED LAB EXPERIMENTS**: In this type of laboratory experiments, the experimental materials are designed to be as realistic as possible in order to simulate the real situation. Hypothetical scenarios (also called vignettes) are used to avoid the influence of external variables. Vignettes are generally stories that were created by researchers and evaluated by participants. The independent variable remains under control of researchers, as in experimental simulations (typology identified by Fromkin and Streufert (1976)).
- **SIMULATION GAME-BASED LAB EXPERIMENTS**: Simulation games allow players to take on different roles and play as a team or against another participant. Researchers create and control artificial conditions and contexts that simulate real environments (for example, organisational settings) in which participants are free to behave. As a result, they can create additional events that the experimenters cannot control. However, these types of experimental environments provide good technological and task realism. These simulation game experiments are also called free simulations (typology identified by Fromkin and Streufert (1976)).
- **THINK ALOUD PROCEDURE-BASED LAB EXPERIMENTS**: Participants can speak aloud during the session, and their statements are recorded Van Someren et al. (1994). Quantitative data can also be collected through questionnaires, etc. Scenario settings and role-plays and teamwork tasks provide technological realism.
- **BRAINSTORMING-BASED LAB EXPERIMENTS**: Participants are randomly assigned to a group and perform a brainstorming task. Therefore, the data comes mostly from brainstorming sessions, but quantitative methods can be used to obtain quantitative data (e.g., questionnaires). Experimenters usually create scenarios to contextualize the experiment.

FIELD:

- **CONJOINT EXPERIMENTS**: Researchers are experimentally manipulating independent computer variables with a view to using participant-analysed decision-making scenarios. «The strength of the conjoint approach is that it combines the control of a laboratory experiment with the external validity of a survey» (Tiwana and Bush, 2007). Sometimes, interviews can be used to help interpret the results.
- **RANDOMISED FIELD EXPERIMENTS**: Subjects are randomly assigned to one of the conditions/groups and instructed to explore and use IT solutions. This category refers to those experiments where scenarios, games, etc. have not been used in order to simulate the real event. This does not preclude other types of field experiments from being randomised.
- **BEHAVIOURAL FIELD EXPERIMENTS**: Techniques and principles of experimental economics in field environments.
- **SCENARIO-BASED FIELD EXPERIMENTS**: Randomised field experiments using scenarios as in laboratory settings. However, participants are generally real users, such as professionals. Post and pre-scenario surveys are usually used for data collection. In most cases, they are used to explore intentions to use and accept computer artifacts.
- **SIMULATION GAME-BASED FIELD EXPERIMENTS**: Randomised field experiments as in experiments based on simulation games in a laboratory environment. Sometimes the simulations are long-term.
- **QUASI-EXPERIMENTS**: The quasi-experiment shares resemblances with traditional randomised experiments, but in particular, the element of random assignment to treatment or control is missing (Cook and Campbell, 1979). Generally, this research experimentation encompasses a medium-long term period.

ONLINE:

- **BEHAVIOURAL ONLINE FIELD EXPERIMENTS**: An online context to bring the approach of the experimental economics into a highly generalizable real-life context.
- **ONLINE FIELD EXPERIMENTS**: Online field experiments are randomised field experiments whose setting is an online environment. This experimental design may be characterised by less control than the laboratory and field settings, as the experimenter is not physically present during the session. However, the researcher can analyse the decision-making process of a real user in its real environment.
- **SCENARIO-BASED ONLINE FIELD EXPERIMENTS**: Scenario-based experiments, similar to those in laboratory and field experiments, but performed online. Therefore, the control could be lower, as the internal validity of the results. Participants are usually users.
- **SIMULATION GAME-BASED ONLINE FIELD EXPERIMENTS**: Randomised experiments such as experiments based on simulation games in a laboratory or field environment but the setting is online or virtual.

NATURAL:

- **NATURAL EXPERIMENTS**: This empirical study investigates the effects of natural or unplanned comparison. Consequentially, conditions are manipulated by nature rather than by researchers. By being a natural setting, the experiment reflects real life, and ecological validity is one of its strengths.