Chapter 7

System Development in Information Systems Research

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Objectives

At the end of this topic you will be able to:

- recognise the place of system development within the information system research cycle;

- appreciate the role of system development as a way of theory testing/exploration;

- understand the difference between system development for practical application and as a tool for research;

Specifics of information systems research

The main aim of conducting information systems (IS) research is to ‘...study the effective design, delivery, use and impact of information technology [IT] in organisations and society’ (Keen 1987, p3). The study of IS can be regarded as a multi-disciplinary endeavour (Land 1993; Avison and Fitzgerald 1991).

A set of research methodologies has been explored for use in the general field of IS research; each being appropriate for different aspects of research study depending on the domain and philosophical position of the researcher. Consensus has not been reached on one framework classifying all research approaches suitable for IS. Attempts at such classifications are usually framed around different research contexts within the ‘Theory building - Theory testing - Theory refinement’ cycle. On the other hand, from the point of view of the analysis of data information systems, studies are following both of the major research traditions, i.e., positivist and interpretivist (Galliers, 1992; Land, 1993; Shanks, Rouse and Arnott, 1994). The range of IS research studies requires various approaches, each with their advantages and disadvantages depending on the research focus and application domain. Empirical approaches include case studies, surveys, laboratory and field experiments, various types of simulation and forecasting, on the positivist/scientific side of research, as well as action research and ethnographic studies. on the qualitative/interpretive side. These various research approaches allow the capture of a more or less open picture of changes in relation to information systems development and usage in the organisations.

Systems Development (SD), a particular research method, has been omitted from most taxonomies or classifications of IS research methods, mainly due to the assumption that system development does not lie within the IS research domain. The legitimacy of SD, as a valid research activity within the technical domain of IS, has been debated extensively
and justified by Nunamaker and Chen (1990), Nunamaker et al (1990-91) and Parker et al (1994). IS research has been perceived by some as purely a social science thus ignoring the technology side of it. However, this view is changing as more researchers recognise that information systems involve an unavoidable technical component (Cecez-Kecmanovic 1994). SD as a research method may bridge the gap between the technological and the social sides of IS research. This aim can only be achieved by building an application of the proposed theory as an illustration of the ‘technical’ side IS domain (Parker et al 1994).

**Systems development (SD) approach**

SD has also been referred to as engineering type research also known as social engineering (Cecez-Kecmanovic 1994; Vogel and Wetherbe 1984) or systems development (Nunamaker et al 1990-91; Nunamaker and Chen 1990). It is a developmental and engineering type of research, which falls under the category of applied science (Nunamaker et al 1990-91). It is grounded on the philosophical belief that development is always associated with exploration, advanced application and operationalisation of theory (Hitch and McKeen 1960).

The research approach may be classified as 'research and development' where scientific knowledge is used to produce ‘...useful materials, devices, systems, or methods, including design and development of prototypes and processes’ (Blake 1978; cited by Nunamaker and Chen 1990, p.631).

**Where systems development fits into the research cycle**

In the existing taxonomy of research methods (Newman 1994; Galliers 1991), a distinction is drawn between basic and applied research. The first is directed towards 'theory building' and contributes to the advancement of the general knowledge of the society. To a certain extent, this kind of research can only be conducted after a field of study has reached a certain level of maturity and has all the parameters clearly defined to be generalisable in a form of an appropriate theory: an established paradigm (Kuhn, 1970). Applied research, on the other hand, is targeting a specific problem relating to the introduction or functioning of an information system. In this respect applied research is closer to practice. The result of such research is intended to help practitioners to be better informed about their work environment and do their job better (Newman 1994).

Building a theory involves discovery of new knowledge in the field of study and can be seen as rarely contributing directly to practice. On the other hand, after the theory is proposed it needs to be tested in the real world to show its validity and to recognise its limitations, as well as to make appropriate refinements according to new facts and observations made during its application. Information systems still represents a relatively new discipline, resulting in a need and place for both types of research. It can be argued that, in any large research project, there are identifiable elements of basic and applied research, usually one followed closely by the other.

Testing can be conducted in more or less natural settings. For this purpose both interpretive and pseudo-scientific approaches can be applied. Interpretive studies represent a less controlled mechanism of applied exploration, whereas experimentation requires a certain level of control over some of the variables under consideration. At least
this approach assumes an ability to differentiate between independent, dependent and controlled variables.

In our context of IS research, the theory proposed may lead to the development of a prototype system that is intended to illustrate the theoretical framework. In some more organisation-, or society-oriented studies, the role of such a system can be played by the existing piece of technology or the process of technology transfer. Thus, systems development becomes a natural, intermediate step linking basic and applied research. In their seminal paper on the role of systems development in IS research, Nunamaker, Chen and Purdin (1990-91) argue that systems development represents a central part of a multi-methodological IS research cycle (see Figure 7.1).

![Figure 7.1 A multi-methodological approach to IS Research](adapted from Nunamaker, Chen and Purdin 1990-91, p.94).

This extended structure, with a systems development component integrated into the research cycle, presents a complete, comprehensive and dynamic research process. It allows multiple perspectives and flexible choices of methods to be considered in various stages of the research process.

We must note here, that time limitation is one of the factors to be considered before the decision is made whether systems development can be included in the project. However, if the scope of the prototype is closely monitored to conform to an absolute minimum necessary to illustrate the theory, it is possible to complete one cycle of system(s) development based on the given theory, followed by an evaluation-observation within the time limitations of a student project.

**Generalised research process model**

First proposed in the early 1990s, this systematic approach to information systems research, which includes some systems development, has now been revised and represents the generic research process. As a model, this approach is advocated by the Center for the Management of Information (CMI), Arizona University (see Figure 7.2). In this case, prototype building takes an equal third part as a mechanism for theory testing and refinement. The central part of the model, New Concept, evolves through the dynamic feedback loops between various testings of the prototype. The tests are
conducted in more or less natural settings, i.e., lab experiments and field tests and produce results, which are intended to be reflected in the new version of the prototype. On the other hand, the prototype reflects back to the concept under consideration.

The SD research procedure

Research methods generally address an existing problem from which a hypothesis is formed and analysed. Analysis may involve prototypical system(s) development to provide proof-of-concept. For fundamental research, this evidence or artifact is important as it becomes the focus for expanding or continuing research (Nunamaker et al 1990-91).

The SD approach denotes a way to perform research through exploration and integration of available technologies to produce an artefact, system or system prototype. Systems development focuses on the theory-testing, more than theory-building aspects of research, allowing a smooth progression from development to evaluation. It could be thought of as proof-by-demonstration (Nunamaker et al 1991). On the other hand, it can be useful to consider as part of the exploratory stage of IS study, when the aim is to observe and evaluate the implications or any other effects of introducing a particular new technology into the organisation. SD research process is of an iterative nature, as illustrated below, in Figure 7.3.
Step 1 – Concept Building
The construction of a meaningful research question, investigating the functionality and requirements of the system and studying other disciplines for other ideas and approaches.

Step 2 – System Building
The construction of the prototype system through the following steps

2a – Develop a system architecture
Developing an architectural design and defining system functionality, components and interrelationships.

2b – Analyse and design the system
Designing the database / knowledge base and processes to carry out system functions, developing alternative solutions and selecting one of them.

2c – Build the (prototype) system
Learning about concepts, framework and design through the building process and gaining insights about the problems and the complexity of the system.

Step 3 – System Evaluation
Observing the use of the system by case study or field experiment, evaluating the system through laboratory or field experiment, developing new theories / models based on the observation and evaluation of the system, and consolidating experiences learned.

Figure 7.3 The systems development method (based on Nunamaker et al 1990-1991)
Thus, a SD methodology comprises three major steps: concept development, system building, and system evaluation. As is described above, the concept building stage involves some theory building, where the theory can be illustrated by a system. The major difference between this approach as a research method and conventional systems development is that the major emphasis is on the concept that the system has to illustrate, and not so much on the quality of the system implementation. At the beginning of such a project the implementation has to be justified, in terms of whether there is another existing system that is capable of demonstrating the features of the concept under investigation. The evaluation stage of the SD method is also different from the testing of a commercial system. It has to be done from the perspective of the research questions set up during the concept-building stage, and the functionality of the system is very much a secondary issue.

This approach has been tested in a number of student projects (Sharma 1996; Maynard 1997; Wafula and Swatman 1995; Ngu 1996). Furthermore, following an SD research cycle, Fung (1997) performed an experimental evaluation in a laboratory experiment setting of the case-based organisational memory system that was developed by Sharma (1996) for her Masters project. The advantage of the approach is that it can be conducted as a sequence of related projects, where each complements the others in a full cycle of theory development and testing throughout the system development.

SD research framework is also relevant to information management research. For example, Schauder (1997) reports on a research in library-based electronic publishing. This study has been conducted with the aim of evaluating comparative advantages in using CD-ROM and Internet as a media for electronic publishing of Australian materials. This work can be viewed as an example of Step 3 in the SD methodology (see figure 7). The concept under consideration, electronic publishing, has been implemented using two proposed media, INFORMIT CD-ROM publications and VICNET as an example of internet-based publishing. The author reviews the results of the experiences gained from these two electronic publishing media. This study can be regarded as a kind of a field test conducted in order to justify the validity and usefulness of the concept. The results feed back into the initial concept development identifying the elements of the communicative transaction associated with this type of publishing (see Kaufer and Carley, 1993).

Conclusion: the role of system building in IS research

Research in IS has been criticised as being too conceptual (Hamilton and Ives 1992, Galliers 1992). However, the concepts under investigation in the IS study are usually not, by themselves, the main purpose of the research. They rather provide the opportunity to frame the findings in relation to the theories and contribute to the core body of knowledge of the field. Due to its rather applied nature, systems development is essential to prove underlying theories (Nunamaker et al 1990-91).

Information systems researchers have advocated that it is insufficient that ‘...a product of IS research be useful - it must also be used’ (Parker et al 1994, p. 198) for ‘...without development, research has no use; without research, development has no base.’ (Hitch and McKean 1960). The SD approach allows a link between theory building and applied IS research. It is also argued that SD research can be viewed as an example of action research, when the researcher is involved in the construction and testing of a method or

At the same time, Nunamaker et al (1990-91, p.103) suggest that ‘...building a system in and of itself does not constitute research’ and it is inapppropriate for the major contribution of an IS research project to be some software (Galliers 1993). Where systems are needed as proof of concept of an IS research investigation, development is a valid research activity (Parker, et al, 1994). Weber (1987) warns the reviewers of research papers to carefully evaluate the contents of papers describing systems development and design as the major focus. He argues that the design presented in such papers has to be justified by some preliminary basic research, and described in the context of some theory of information systems, or some theory should be used 'to predict the likely success or failure of a design' (Weber 1987, p.9). Otherwise, such papers cannot be classified as quality research papers.

Nunamaker and Chen (1990) state five criteria for use of systems development as a research methodology in information systems research:

1) An important phenomenon can only be studied in the process of system building.

2) The result of system(s) building will contribute to the advancement of the IS theory.

3) There are some hypotheses or propositions derived from the theory that require to be experimentally tested through the development process.

4) The new system design provides a better solution to the existing problem.

5) Some generalised results can be expected from the experiences gained with system building and design.

(Nunamaker and Chen 1990, p.637)

Systems development should derive results of practical value to the domain under study, while contributing to theoretical and practical knowledge in the field. The product of IS research and the lessons learned from development may lead to innovations in the field of IS as 'knowledge is learning by doing'.

**Key summary points**

- Building a system in and of itself does not constitute research.
- Development of a prototype is a part of IS research life cycle.
- Building a system is a part of evolutionary process of research (feasibility assessment).
- Software engineering - is a method of systems development research.

**Discussion questions**

1. What are the main advantages of following systems development model research?
2. Is it always important for the researcher to establish the most appropriate research approach before the beginning of the project? How will you determine which method is the best for a given situation?

3. When in your research project should you decide on whether to follow or not a systems development research approach? Give the reasons for your answer.

4. Is it always feasible and advisable to build a system in information systems research? Explain.

Further readings


References for Chapter 7


Fung, Soon Meen (1997) Experimental Evaluation of a Case-based Organisational


(3), pp. 89-106.


