Scenarios for system development: matching context and strategy

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Abstract. A comparison of seventeen contingency models for system development (SD) led to the conclusion that no model supports all requested activities: diagnosing the context, describing alternative approaches, matching context and approach, looking at social organizational issues, and supporting a dynamic fit between context and approach. This study paid special attention to the social and organizational aspects of system development. Our contingency model specifies five possible types of risk (functional uncertainty, conflict potential, technical uncertainty and resistance potential) in system development that should be controlled. For each type, a corresponding proposition about its control was derived from this model and analysed in seven system development processes. We succeeded in explaining the outcome of the development process through the fit between context and situation, thereby gaining some preliminary support for the model. Still, the limitations of such a contingency model are to be taken seriously.

1. Introduction

The objective of this article is to present a contingency model for the control of the social and organizational aspects of the development of information systems for work-organizations and to report the preliminary evidence supporting this model.

While in the seventies attention was focused on the construction of the one ideal method for system development, during the eighties people became aware of the impossibility of this task. As information systems can be developed in different ways, the outcome of the development process depends on the 'fit' between context and development approach. Therefore universalist models have been replaced by contextual or contingency models, in which the system development (SD) method or approach taken, is matched with relevant contextual or contingency factors.

After giving an overview of existing contingency models for SD, this paper will discuss the framework and assumptions of our model and will introduce the propositions following from it. Subsequently, we will present our research method and the results of our exploratory study of seven SD processes, analysed with our model.

The model is based on the assumption that system development can be seen as an organizational change process, that is, an intervening process in a social system. From a practical point of view the model has the following purposes. First, it offers managers and system developers or any other dominant actors in charge of SD processes an overview of the possible strategies the team can pursue in accomplishing their task. Second, the model is meant to support the dominant actors to continuously diagnose the nature of their task in its context. Diagnosing contextual characteristics should help the dominant actors in choosing an effective strategy.

2. Theory

According to structural contingency theory, the social structure of an organization should fit its context in order to be effective (e.g. Galbraith 1973). Transferring this logic to system development, the approach to SD should fit the particular context in which the development takes place (e.g. Ciborra *et al.* 1980, Iivary 1986, Floyd 1986, Olle *et al.* 1988). Structural contingency theory gives an overall perspective of managerial adaptation to external constraints, but the specific structural dimensions to be adapted to, as well as the specific elements of context that affect structural choices are left unspecified (Pfeffer 1982: 148). Although it has high face validity, the substance of the theory is not clear (Schoonhoven 1981: 350).

Similarly, while the necessity of matching context and

0144-929X/96 $12.00

Table 1. Summary of seventeen frameworks for choosing an SD approach.

Reference	Contextual factors	Approach factors (or types)	Concept of fit
1. Ahituv *et al.* (1984)	Project and environment: scope/ importance/level/organization of MIS function/structuredness/ technical environment Type of SD	Vertical: fill in the phasing Horizontal: SD activities/control/time/human and non human resources	Risk and qualitative relations
2. Andersen INSP (1988)	Problem system: participants/problem location/ culture/stability/intensity of information Desired change: technical and organizational innovation, time	Managment commitment/ Resources/Clarity of problem/ Proficient and committed people/ Business characteristics Project: goals, demarcation, culture, organization, method and approach	Communication Proficiency Ambition (too high/low)
3. Blackler and Brown (1987)	Type of SD Type of goals	Two approach types (ideal types): task-technology or organization-user oriented	Commitment of personnel with innovation Certainty on its direction
4. Burns and Dennis (1985)	Complexity: size/number of users/data volume/ processing complexity Uncertainty: structuredness knowledge users experience developers	Three approach types: Life cycle Prototyping (intermediate types)	Risk: integration and/or requirements specifications
5. Cap Gemini (in Nijhof 1990)	Demarcation, Crew Project procedures, organization and characteristics Methods and standards of control and report, Technical infrastructure	Joint formulation and reporting of measures	Joint risk assessment by factor and for the total risk
6. Episkopou and Wood-Harper (1986)	Problem owner and problem solver: style/experience/knowledge Problem system: culture/level/size/background/ interests/resources/uncertainty	Problem-solution system: (not specified yet)	Perception versus cognition Required effort Tools Ideology
7. De Haas and Wubbels (1990)	Environment: external requirements relationship with user organization/level of automation Project: size/organization result	Phasing: magnitude of steps Decision making: frequency/intensity Control: amount of detail	Project risk
8. Heemstra (1990)	Product: clarity of needs/stability of needs Process: possibilities to adjust, measure and verify effects Resources: availability of people	Way of coordinating Leadership style Developmental strategy Meaning and method of budgeting	Controllability: uncertainty nature of control issues goal of development
9. Hirschheim and Klein (1989)	Implicit: Type of keyactors Assumptions Raison d'ȇtre Role of the developer	Technology architecture Kind of information flows Control of users Control of SD Access to information Training Error handling	Assumptions about epistemology and ontology

Table 1. Continued

Reference	Contextual factors	Approach factors (or type)	Concept of fit
10. McFarlan (1981)	Project: degree of structure, size Technology	External integration Internal integration Formal planning Formal control	Risk determined by size and uncertainty
11. Naumann *et al*. (1980)	Project size Degree of structuredness User task comprehension Developer task proficiency	Four information requirements assurance strategies	Degree of uncertainty about requirements
12. Van Reeken (1990)	Experience of supply side Experience of demand side	Four types of approach: version by version, traditional-linear, iterative and prototyping Buy it/Do it yourself	Optimal risk as determined by uncertainty and magnitude of steps
13. SBA Project (SARB-RDF)	Project size and scope Organization's data processing experience Technology Project organization Project's operating conditions	Not specified corrective measures, e.g. Changing size, project organisation technological requirements etc. Pilot studies Cancelling or redefinition of project	Quantitative risk measurement per factor and total
14. Schonberger (1980)	Level of decision making Structuredness	Participation: who, intensity Leadership: who	Acquaintedness with solution Sophistication Political weight
15. Shomenta *et al*. (1983)	19 solution characteristics, e.g. number of workstations, output dynamics, processing dynamics audit requirements, system applicability, data volume system complexity	Three types of approach: users-mainframe traditional-mainframe users-PC, package (intermediate types)	Quantitative formalized choice based on 18 types of application
16. Weitzel and Kerschberg (1989)	Three types of systems: Transaction processing systems Decision support systems Expert systems	Three approach types: –TPSLC –DSS-prototyping –KBSLC	Degree of uncertainty; observability and structuredness
17. Wissema *et al*. (1988)	Speed Complexity Willingness to change	Level of planning Formalization	Balance necessity and possibility to lay down plans

SD approach seems obvious, adoption and translation of this principle into specific models offering prescriptions for ways to realize the matching of context and SD approach taken, have remained quite troublesome (e.g. Lyytinen 1987, Nielsen 1990). Table 1 summarizes 17 models developed for this purpose in the last decade. These models are meant to support three important activities in choosing an SD approach:

(1) *Diagnosing the context*. The model defines which contextual factors should be taken into consideration.
(2) *Describing alternative approaches*. The model offers either alternative approaches or dimensions on which the approach can vary.
(3) *Matching context and approach*. The model enables a motivated choice of approach by specifying fits between context and approach.

A direct comparison of the models displayed in table 1 is difficult because of different or lacking definitions and varying levels of analysis. Furthermore, the *a priori* distinction between context and approach variables in a contingency model will always, to a certain extent, be arbitrary. Contextual factors are by definition exogenous to the development process, that is, they are given and cannot be influenced. However, many factors, such as the quality and quantity of human resources that can be appointed to the project, will be exogenous in some instances and endogenous in others. This explains why, for example, the expertise of the engineers is seen as a contextual factor in model 11, while in model 1 it is labelled a dimension of the SD approach.

For these reasons we will not evaluate the content of these models. We will only evaluate the extent to which these models support all three aforementioned activities. Furthermore, we want to assess whether two other issues are addressed in the models.

(4) *Looking at social and organizational issues*. As has been explained in the introduction we regard SD as an organizational change process. Therefore, we are primarily interested in knowing whether social and organizational issues are taken into consideration in the models.

(5) *Supporting a dynamic fit between context and approach*. During the development process contextual factors and/or approach can change. Therefore, it is important that the fit between context and approach is assessed not only at the start, but also during the SD process.

Diagnosing the context—In models 6 and 9 the amount of contextual factors to be taken into consideration is unlimited, making it difficult to test the models empirically. Most models (1, 2, 3, 4, 5, 7, 10, 11, 12, 13) do not only take the characteristics of the context of SD into consideration, but also the kind of system that has to be developed. Models 15 and 16 only diagnose the context in terms of the solution chosen, and as a consequence, they can only be applied in later stages of the development process. From our point of view of SD being an organizational change process, we find the last two models less relevant.

Describing alternative approaches—In order to describe the choice of an SD approach, six models (3, 4, 11, 12, 15, 16) offer a typology of SD approaches. Others (1, 2, 8, 10, 14) can best be characterized as describing one or more dimensions on which an SD approach can vary. Three models (7, 9, 17) give a typology based on variations on a few underlying dimensions. A small minority of the models (5, 13) do not, or not yet (6) support this activity.

Matching context and approach—In model 6, Episkopou and Wood-Harper (1986) argue for a fit between context and approach, but the only guidelines they offer are those of Naumann *et al* (1980). Models 5 and 13 do not address the fit between context and approach at all. Thus, they are not really contingency models. They have been included in table 1 as they are well known and have the explicit goal to support the control of the risks of SD processes, a feature they have in common with most of the other models cited here. Model 9 is descriptive in nature and consequently lacks guidelines for the matching of context and approach.

The other models do offer support for the matching of context and approach. Some models, for instance those of Shomenta *et al*. (1983) and Wissema *et al*. (1988) are based on empirical data. However, for most of the models it is not clear whether and with which results they have been tested empirically. In addition, the guidelines offered are rarely based on explicit theoretical considerations. In connection to this, outcome criteria for matching context and approach are seldom put forward explicitly. Thus, it remains unclear what is meant by successful or effective SD.

Looking at social and organizational issues—Social and political factors often determine the outcome of SD processes (e.g. Riesewijk and Warmerdam 1988, Van Offenbeek 1993). However, as many models have their origin in system engineering, most of them do not cover these issues (1, 4, 5, 7, 8, 10, 11, 13, 15, 16) or only to a limited extent (2, 14, 17). This means that these models are based on the assumption that organizational reality is known and stable, and that all actors in SD have the same known goals and interests. Only four models (3, 6, 9, 12) take into account that organizational reality often cannot be understood in an objective way and is political in nature.

Supporting a dynamic fit between context and approach—Only three models (1, 3, 13) explicitly discuss the subject of changes during the SD process. To summarize, no model fulfils all five requirements, and, in general, more empirical testing is needed. This state of affairs induced our empirical study in which the following question was examined: *How can a match between contextual characteristics on the one hand and system development (SD) approach on the other hand be realized in order to obtain successful development?* As the models developed thus far do not emphasize the perspective of SD as a special kind of organizational change, we tried to formulate a model that can complement several of the models that regard SD from a technical system engineering point of view, by incorporating social and organizational contextual factors. This was our primary objective. We used the insights offered by existing models, where this did not contradict this objective. A review of organizational as well as cognitive-social psychological literature, preceded the formulation of the contingency model. In the next section this model will be outlined.

3. A contingency model

The model is composed of three groups of variables:

(a) contingency or contextual factors, leading to five types of risks;
(b) approach characteristics and
(c) outcome factors, indicating the effectiveness of the SD process.

In this article we limit ourselves to an outline of the risk profile (section 3.1) and approach characteristics (section 3.2). In section 3.3 propositions are formulated on how the occurrence of different types of risks can be controlled by matching the approach characteristics on the basis of existing literature. Subsequently, in section 3.4 we consider the way in which such a contingency model should be used.

3.1. *Contextual diagnosis: establishing a risk-profile*

In our framework we limit ourselves to those contextual factors that cause a risk in terms of the effectiveness of SD (see table 2). We distinguish four types of substantial risks. These have been derived from the four interdependent domains of the organization as defined by Leavitt (1965): tasks, structure, technology, and people. According to his model, a change in one of the domains will to a greater or lesser extent cause changes in the other domains. Furthermore, attention should be given to the material preconditions, a fifth type of risk of another origin. This last type of risk defines the degrees of freedom the dominant actors have in matching the other four risk types with their SD approach.

Table 2. Contextual factors determining the five risk types.

Risk 1 functional uncertainty:
Existing situation (problem system)
Complexity of tasks
Stability of tasks
Acquaintance with tasks
Change situation
Acquaintance with problem(s)
Acquaintance with goal(s)/needs/criteria
Amount of change in business process
User experience with SD
Risk 2 conflict potential:
Pluriformity of problem system
Amount of groups involved
Heterogeneity of interests, ideas, semantics
Extensiveness of SD (people, time)
Desired homogeneity
Needed integration among groups
Dependency on third parties, other projects
Risk 3 technical uncertainty:
Existing situation (problem system)
Complexity of technology
Newness of technology
Change situation
Acquaintance with software-environment
Complexity of technological innovation
Quality and commitment of technical experts
Risk 4 resistance potential:
Changeability of problem system
Change potential of workers (-management)
Willingness to change by workers (-management)
Desired change
Quantitative impact on work organization
Qualitative impact on work organization
Risk 5 material preconditions:
Importance for organization,
Time pressure, budget,
Human and computer resources

Functional uncertainty refers to the risk that the actors choose a wrong solution or solve the wrong problem. The magnitude of this risk is determined by characteristics of the task system in the existing situation and of the (expected) changes in the task system. High complexity, low stability of the tasks, and having no acquaintance with the tasks at which the system development is directed will heighten the functional uncertainty with which the system developers are confronted. So will obscurity of the problem(s), unknown goal(s) or needs, and the absence of criteria against which the solution will be judged. Two other potential factors are the anticipated extensiveness of the changes in the task system and lack of experience of the organizational members with SD.

Conflict potential refers to the risk that incompatible needs and interests will hamper problem solving. It is determined by the degree of pluralism in the existing structure compared with its desired uniformity. This type of risk is increased when more parties are involved whose ideas, language and/or interests are heterogeneous and when the scope of the SD process (in terms of people and finance) is large. This risk is also increased when the required integration among the parties is high and when the development is dependent on third parties or on the results or progress of other projects.

Technical uncertainty refers to the risk that the conceptualized solution cannot be realized. The magnitude of this risk is determined by characteristics of the technological aspect system in the existing situation and by the technological aspects of the change. In system development this risk increases when the existing technological system is complex and relatively new; when technical experts are unacquainted with the software environment, the complexity of the realization of the system is high, and the quality and commitment of the technical experts is low.

Resistance potential refers to the risk that members of the organization will be dissatisfied with the realized solution, because they feel its implementation would decrease the quality of their working life. The magnitude of this risk is determined by the changeability of the organizational members concerned, compared with characteristics of the wanted change. The risk is increased when the workers (management) have a low change potential, a low willingness to change, and when the qualitative and quantitative impact on the work organization is high.

Material preconditions refers to the risk that the SD process will not pay for itself or will be aborted prematurely due to lack of resources. This risk is defined as the amount of energy needed, compared with the amount available, that is, budget, capacity in terms of human, machine and computer resources, time pressure, and importance of the SD process. Material preconditions define the extent to which an approach needs to be efficient.

3.2. *A three level model of the SD approach*

We distinguish three levels of SD (approach): the strategic, the tactical and the operational level (see table 3). These are three perspectives from which the functioning of an SD process can be described and analysed. The levels provide insight into the nature of the SD process, the structuring of the process and the interaction within the process, respectively. Table 3 specifies the relevant dimensions on which the approach can vary.

At the strategic level the dominant actors establish at which parts of the organization the development is directed: the definition of the problem system. Furthermore, when considering system development as organizing, the SD process itself can be seen as a collaboration of a number of people which should be given implicit or explicit direction: the orientation of the problem-solving system. Whether the emphasis is on a problem or a solution orientation is an important strategic choice. That is the extent to which the SD process is directed towards diagnosing and analysing the problems and needs, or towards the development of a system for given goals and needs. Often the approach will alternate between a problem and a solution orientation. Moreover, the orientation defines the extent to which the problem-solving system is related to social organizational as opposed to technical administrative issues within the problem system. This choice concerns the issues that will receive most weight and attention in the SD process.

Secondly, the SD process is structured at the tactical level. The structure of the process encompasses the differentiation of the necessary SD activities and the coordination among these activities. Differentiation means breaking down or decomposing the problem-solving system into activities, which can be distinguished in terms of time and/or people performing the separate activities. Mintzberg (1979) describes five coordinating mechanisms within organizations: mutual adjustment, direct supervision, and three forms of standardization, of skills, work processes and output. These coordinating mechanisms can also be found in SD (e.g Heemstra 1990).

The third level of strategy is concerned with the operational activities within the SD process. From a psychological point of view, this process consists of social

Table 3. Three levels of SD approach.

Level	Decision	Dimensions
Strategic	definition of problem system	function domain social domain
	orientation of problem-solving system	problem orientedness solution orientedness technical-adminstrative versus social-organizational
Tactical	differentiation of development process	linearity of activities, magnitude of (development) steps, parallellisation of activities
	coordination of development process	formality of coordination mechanisms
Operational	interaction during development process	who: number, parties how: timing, form function: exchanging information, motivating, collective learning and negotiating

activities, of the interactions among the participants. Four important functions of interaction in SD processes can be distinguished in SD literature: exchanging information (Ashmos *et al.* 1990, Markus 1983, Ives and Olson 1984), collective learning (Markus 1983, Ciborra and Lanzara 1989), motivating (Kotter and Schlesinger 1979, Markus 1983, Ives and Olson 1984), and negotiating (Vaas 1988, Blackler 1990). Interactions can be aimed at different functions at the same time, or the functions may involve activities that are clearly separated in time and place.

3.3. *Propositions*

Existing theory led to propositions concerning the matching of context and SD. The starting point of our framework was that the choice of approach should be geared to the faced or expected risks. These risks can be political or cognitive in nature (Episkopou and Wood-Harper 1986, Hirschheim and Klein 1989). Organizational reality is not simple, it is not ordered through known principles, nor is it stable and unambiguous. Moreover, not everyone has the same objectives, interests and views. Therefore, dominant actors will often find themselves in situations that are characterized by uncertainty and/or heterogeneity of goals and organizational conservatism. If, as a result of this the actors perceive high risks, measures to control these risks should be taken. For each type of risk a proposition specifying the required measures was formulated. Within the scope of this paper we restrict ourselves to the propositions that relate to the four substantial risks.

When *functional uncertainty* is high, information relevant to the system to be developed is missing and consequently exchange of information between problem system and problem–solution system is needed at the operational level (Vroom and Jago 1988, Van Oostrum and Rabbie 1988). This interaction should be initiated in an early stage, when the information processing capacity of the problem–solution system is highest (Ashmos *et al.* 1990, McFarlan 1981, Davis and Olson 1985, Cressey 1989). Moreover, collective learning processes will also have to take place (Argyris and Schön 1978, Swieringa and Wierdsma 1992). At the tactical level, learning processes should be stimulated by an iterative process model (Naumann *et al.* 1980), thereby providing the necessary feedback loops. Models, prototypes and pilot sites can be part of such an interactive approach.

Proposition 1: ***High functional uncertainty*** *requires (a) an early interaction between knowledgeable users and system developers, and, (b) an iterative process model aimed at the exchange of information and learning.*

When *conflict potential* is high, more interdependent parties are involved, and, therefore, more information will have to be processed (Davis and Olson 1985). Ironically, it is not only more important, but also more difficult to realize effective interactions under conditions of high conflict potential. Interactions will unfold most easily when conflict potential is low (Algera and Koopman 1986, Vroom and Yetton 1973). Rational exchange of information will not be sufficient, as different interests and definitions of reality are involved. The goals of SD process will have to be negotiated. Therefore, interactions should take place in early stages of the process. According to Vroom and Jago (1988), Heller *et al.* (1988), and Van Oostrum and Rabbie (1988) the creation of constructive conflicts leads to better decision making and will not enlarge the differences in opinion. Representational forms of interaction among groups will prohibit chaos. Apart from negotiation, collective learning will also be necessary, especially in the case of simultaneous high functional uncertainty. As groups are not acquainted with each other's language, assets and images, interactions lead to higher intersubjectivity. Values and norms will be questioned (Hirschheim and Klein 1989). Under such circumstances Bouwen and Fry (1991) found a learning-confrontation strategy to be more successful. At the tactical level formal coordination is necessary to make and record decisions and communicate them. If closely supervised by a higher, neutral power centre, negotiation will be more successful (Vroom and Yetton 1973, Mastenbroek 1982).

Proposition 2: A ***high conflict potential*** *requires (a) early and representational interaction* among *the user groups involved, aimed at negotiating and learning, and (b) formal coordination of these interactions.*

When *technical uncertainty* is high, at an operational level, information exchange and learning will be the most important functions of interaction. Learning will occur whenever developers have little experience with the technology, methods or orientation to be used, or lack the necessary skills. At the tactical level, the necessary feedback loops can be provided by iterations between realization activities. Technical experiments, prototypes and tests can be part of such an iterative strategy. Coordination among different technical specialisms and/or workgroups will be important. This coordination should be intensive and consist of formal as well as informal mechanisms, for instance, supervision by experienced specialists, teambuilding activities, arranging teams of people who have worked together before, frequent meetings and sound documenting (McFarlan 1981).

Proposition 3: ***High technical uncertainty*** *requires (a) a blueprint of the functional design, followed by (b) iterative realization activities, during which (c) intensive coordination takes place through both formal and informal mechanisms.*

In processes with a high *resistance potential* at the operational level, information will have to be exchanged with all future users (direct and indirect). In part resistance has a cognitive base in the sense that uncertainty increases resistance. The availability of sufficient information about what is going to happen, what will be the consequences for the quality of working life and how to be able to function effectively in the changing and new work situation, will lower uncertainty. Besides, user management has an important motivational function in communication. Personal attention for people can generate willingness to cooperate even when the solution chosen is less ideal for them. One should create explicit avenues to discuss fears, canalise dissatisfaction and mourn possible personal losses (Korteweg 1988). At the tactical level a step-by-step approach provides for the necessary points of recovery for the problem system and makes sure the development process does not surpass the comprehension of organizational members (Wissema *et al*. 1988). At the strategic level concern for both the social and the organizational change requirements and implications is necessary, because the existing conditions in this domain are insufficient and/or the development is expected to have a profound impact on organizational members.

Proposition 4: A ***high resistance potential*** *requires (a) a 'step -by-step'-approach with (b) some interaction of the responsible management and/or system developers with all users, aimed at motivating and information exchange and (c) a social-organizational orientation.*

Sometimes situations will occur that are relatively simple, and in which principles of linearity, objectivity and technical rationality can be successfully applied. Then the dominant actors can choose the most efficient approach, as they do not have to take measures for low risks. We called proposition 5 the 'efficiency proposition' and it is central to our model:

Proposition 5: In so far as the context is characterized by low substantial risks, the corresponding control measures as specified in propositions 1 to 4 are not needed for system development to be successful.

The 'efficiency proposition; has the following consequence for situations in which the material preconditions are insufficient. There it would be required to redefine at the strategic approach level the SD process in such a way that substantial risks are lowered in order to enable the use of a more efficient approach. This pertains to our conception of a dynamic fit between context and approach characteristics.

3.4. *A dynamic fit in SD processes*

In our model the following assumptions were made about the establishment of a fit between context and approach.

The possibility of contextual changes during an SD process has been mentioned in section 2. It has consequences for both the empirical testing (see section 4) and the practical application of a contingency model. Determining a fit between context and approach at the start of the SD process is insufficient. Substantive changes during a process, impede charting the variables for the process as a whole. The scenario should be rediagnosed and readjusted at regular intervals during the process or in the case of critical changes (figure 1).

The choice and evaluation of the scenario for SD can be seen as an interpretation process. The model is focused on those contextual factors constituting a risk to successful development of information systems, that is to factors that endanger the development and subsequent use of a system. Given a certain magnitude of these risks, the dominant actors have to choose a fitting approach.

However, material preconditions may be insufficient, so that actors cannot sustain the necessary approach requirements, that is, realize a match between context and strategy. They can, for instance, be short on personnel or time. Then a successful fit will not be possible, unless the context is redefined in order to make the process less risky. This could be accomplished by limiting the target groups and/or the functional purposes of the system.

It follows that the dominant actors should interpret the context in an active way: how can I define, influence, give meaning to a part of reality in such a way that it becomes manageable? To a certain extent the dominant actors cannot only choose their approach but also their context, whether by definition or by intervention, that is by deliberately changing the context. This has to do with the fact, mentioned in section 2, that the theoretical distinction between context and strategy is an arbitrary one in the first place. Only in a specific process can we tell which factors are endogenic and which are exogenic.

Next, the extent to which context factors constitute risks is partly dependent on the local perceptions. It seems simple to define beforehand that building a system for 10 people constitutes a low risk and building a system for 150 people a high risk. In reality, many contingency factors have to be taken into account, meaning that the interaction of the

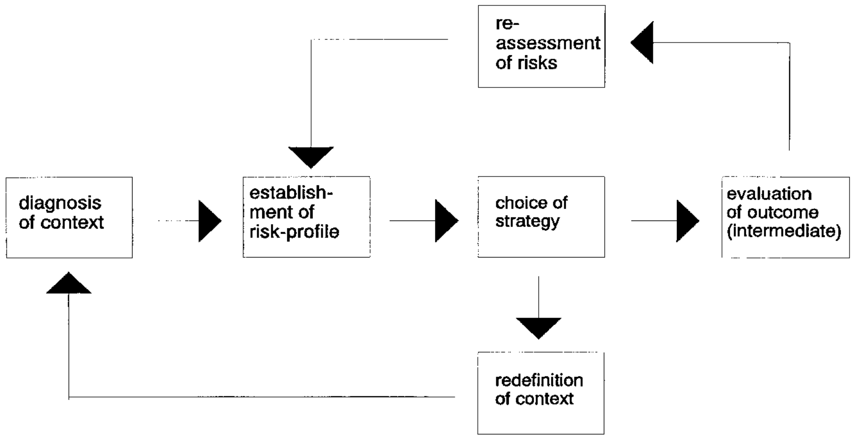

Figure 1. Realizing a dynamic fit between context and SD approach.

relevant factors has to be assessed for each process, and to determine to what extent this will constitute a risk. In a model we are able to state which contextual factors will give rise to which risks, but the assessment of these risks cannot be quantified in advance by giving objective, absolute scales to compute a risk profile (see also Nijhof 1990). As we take the position that risks can only be estimated within the local context, our risk concept is relative and based on intersubjectivity.

4. Case studies

A multiple case study was undertaken to further develop and conduct a first preliminary test of the model (Van Offenbeek 1993). Case material consisted of retrospective analyses of seven system development processes. In each case a data processing, operational, and/or tactical management information system was developed. In other words the research domain was limited to administrative in contrast to technical automation and encompassed the profit as well as the non-profit sector. The cases were selected on the basis of the following two criteria: (1) the SD process should at least involve several social and/or organizational issues, and (2) the cases should vary on the context variables.

The development of an information system cannot be approached as a single research unit, because substantive changes may occur in the variables examined during development (see section 3.4). In our study, we divided some of the seven cases in different episodes, studied separately, due to such changes. This resulted in ten episodes, five of which could be considered failures and five episodes that were considered successes. We defined a successful outcome of SD as: 'the development of a system that is implemented and used on a regular basis'. The propositions were tentatively tested in each of these episodes.

4.1. *Data collection and analysis*

Data collection took place during the last phase(s) of SD in each site, and consisted of elaborate semi-structured interviews with five to eleven stakeholders (e.g. developers, users, management) and of the analysis of documents. Furthermore, six months after implementation of the system, questionnaires were filled out by direct users and managers. In one non-successful case the system was not implemented and, subsequently, no questionnaires were filled out.

The data from the semi-structured interviews and documents were used to determine the characteristics of context and approach. This resulted in a rich case description as well as a qualitative description of each context and approach variable. The case description was fed back to the organization.

Next, three researchers who were familiar with the cases rated the risks on a three-point scale: low–moderate–high risk. For this purpose each of the substantial types of risk was divided into four measures. The amount of inter-rater agreement, corrected for coincidence ($0 =$ no agreement, $1 =$ perfect agreement; see Tinsly and Weiss 1975), was satisfactory (for functional uncertainty and conflict potential 1.00, for technical uncertainty 0.65 and for resistance potential 0.82). Differences were discussed among the three researchers and a final conclusion was reached. The descriptions of the approach variables were used to rate on a five-point Likert-type scale (– – , – , 0, + , + +) whether each approach requirement that was mentioned in the propositions had been fulfilled in the SD process. This rating asked for less subjective judgement and was done by one

Table 4. Functional uncertainty and whether requirements were fulfilled.

		Approach characteristics	
	Risk	Early interaction user-developer	Iterative process model
Successful cases			
A	low	+	–
B	moderate	+	–
C2	moderate	+	+
D2	moderate	+	–
E2	low	+	+
Failure cases			
C1	moderate	+	–
D1	high	+	–
E1	moderate	+	+
F	moderate	+	–
G	moderate	–	+

researcher and checked by two others. To determine whether the propositions were supported a two-point scale: 'not fulfilled' (– – , – 0) or 'fulfilled' (+ , ++) was used.

The indicator for success of SD, a dichotomous measure, was whether the resulting system was actually implemented, and used on a regular basis (that is adopted by the users). This measure was chosen because it is a rather unambiguous and robust measure. In addition we used questionnaires to measure the experienced usability of the system, the perceived changes in the quality of work, the user satisfaction, and the perceived efficiency of the SD. However, these data were not used to analyse the propositions presented in this article, because these measures are less robust, do not fit within our narrow definition of success, and some of the measures cannot be considered in the case of failure, when no system is implemented or is not used on a regular basis.

4.2. *Results*

Proposition 1: ***High functional uncertainty*** *requires (a) an early interaction between knowledgeable users and system developers, and, (b) an iterative process model aimed at the exchange of information and learning.*

A high functional uncertainty was found in only one episode (D1). As can be seen in table 4, here, the requirements for controlling functional uncertainty were not met. A classic linear strategy was followed and only one of the three user organizations was involved in the information analysis, while the others did not get involved until the design phase. During the design, it turned out that processes in the three organizations were not fully interchangeable. Because of this the information analysis presented problems for the design team and the resulting design was even rejected and had to be redone.

In most other episodes (B, C1 and 2, D2, E1, F and G) we found a moderate amount of functional uncertainty. Explorations of these data suggest that moderate functional uncertainty asks for the same approach as high functional uncertainty, but here an iterative process model is not necessary unless users have little experience with system development and/or little comprehension of their own tasks. The efficiency proposition can be applied to the two cases with a low functional uncertainty. So these cases will be discussed under proposition 5.

Proposition 2: A ***high conflict potential*** *requires (a) early and representational interaction among the user groups involved, aimed at negotiating and collective learning, and (b) formal coordination of the interaction.*

The episodes with a low conflict potential are discussed under proposition 5. As table 5 shows a high conflict potential had to be controlled in four episodes.

In two of them, D1 and E1, the approach did not meet the hypothesized requirements and both episodes failed. In E1, for example, the different interests and views were not openly discussed in the first phases: central management was not represented in the project. Whereas the central and decentral users participated, they did this separately from each other, without interaction between them. Coordination was largely based on mutual adjustment. Formal supervision and standardization of output were insufficient, for example, a feasibility report was quickly written at the start, which the responsible manager decided not to sign. Nevertheless he did not openly intervene and the project team just went on with the system analysis. The report resulting from that phase could be read in different ways. Next, a prototype was built and implemented. Some months later central management cancelled the project in line with the wishes of the central users.

The other two episodes with a high conflict potential, B and D2, were successful. In both cases the approach was in line with our proposition.

In the three other episodes (F, G, E2) we found a moderate amount of conflict potential. Exploration of these data suggests that moderate conflict potential calls for the same approach as high conflict potential. For example, in case F which failed, representatives of the groups involved interacted early, but nobody was appointed the formal responsibility for the SD process and there were no clear agreements about the interaction (a lack of formal coordination).

Table 5. Conflict potential and whether approach requirements were fulfilled.

	Risk	Approach characteristics: Early, representational interaction among user groups	Approach characteristics: Formal coordination
Successful cases			
A	low	–	–
B	high	+	+
C2	low	–	–
D2	high	+	+
E2	moderate	+	+
Failure cases			
C1	low	–	–
D1	high	–	–
E1	high	–	–
F	moderate	+	–
G	moderate	–	–

The data supported the proposition, but we still wonder whether in the case of an extremely high conflict potential as in D1, the dominant actors should not try to reduce the risk beforehand. Reduction can be achieved by either limiting the definition of the problem system, or by actively changing the contextual factors giving rise to the risk. In episode D2 the requirements were met, but also the conflict potential was not as high as in the first episode of case D: in episode D2 the system was developed for one user organization instead of three as in episode D1. Moreover, further analysis of the data led us to believe that in the case of a high or moderate conflict potential, early, representational interaction is needed not only among user groups, but among all groups in the problem system who hold a stake in the SD process.

Proposition 3: ***High technical uncertainty*** *requires (a) a blueprint of the functional design, followed by (b) iterative realization activities, during which (c) intensive coordination takes place through both formal and informal mechanisms.*

The cases with a low technical uncertainty will be discussed under proposition 5. Technical uncertainty was high in case D. The realization process passed off considerably more successfully after the coordination (formal as well as informal) became more intensive in episode D2. In episode D1 formal procedures prohibited interactions between builders and testers. Serious tensions arose between the two groups because they were not allowed to talk directly with each other, e.g. explain to each

Table 6. Technical uncertainty and whether approach requirements were fulfilled.

	Risk	Approach characteristics: Blueprint of design	Approach characteristics: Iterations during realization	Approach characteristics: Intensive coordination (formal and informal)
Successful cases				
A	low	–	+	–
B	moderate	+	+	+
C2	low	–	+	–
D2	high	+	+	+
E2	moderate	–	+	+
Failure cases				
C1	low	–	–	–
D1	high	+	+	–
E1	low	–	–	–
F	low	–	+	–
G	moderate	–	+	+

Table 7. Resistance potential and whether approach requirements were fulfilled.

		Approach characteristics		
	Risk	Step-by-step	Interaction of management with all users	Social-organizational orientation
Successful cases				
A	low	+	–	–
B	high	+	+	+
C2	low	+	+	–
D2	moderate	–	+	+
E2	moderate	+	–	–
Failure cases				
C1	low	–	–	–
D1	moderate	–	–	– (later +)
E1	high	+	–	–
F	moderate	+	–	–
G	moderate	+	–	–

other why something was seen as a mistake or how a previous problem had been solved. However, while formal coordination alone may not be sufficient, it is still necessary. For instance, in the same case sometimes there was no way of knowing which version of the design was the correct one. Whereas in the successful cases B and D2, it was perceived as very important that the developers followed a standard procedure for modifications of the design, that was strictly supervised by the project leader.

In all cases the realization activities were, to a certain extent, characterized by iterations. Apparently, it is not necessarily more efficient to separate technical design steps, programming and testing in clearly separated phases. In episode A design, realization and testing phases were not separated, while this case had relatively the highest efficiency score. Furthermore, our data were not detailed enough to determine whether high technical uncertainty requires significantly more iterations than low technical uncertainty.

In the other cases, mentioned in table 6, the technical uncertainty was moderate. Exploration of these data led us to hypothesize that *a moderate technical uncertainty can be controlled by a blueprint of the logical design or a well documented functional prototype, followed by iterative realization activities, during which coordination intensively makes use of formal as well as informal mechanisms.*

*Proposition 4: A **high resistance potential** requires (a) a 'step -by-step'-approach with (b) some interaction of the responsible management and/or system developers with all users, aimed at motivating and information exchange and (c) a social-organizational orientation.*

The three cases (A, C1, C2) with a low resistance potential will be discussed under proposition 5. Case B was successful, despite the high resistance potential. This outcome can be explained by the approach taken (table 7) and it thereby supports our proposition. In E1 after an informal start, the resistance potential had become high, as the goals of the development at the strategic approach level had been expanded. As a consequence, the impact on the work organization was much greater. However, as table 7 shows, the other approach characteristics did not meet the accompanying requirements as specified in proposition 4. Therefore, the subsequent cancelling of the process for political reasons supports the proposition.

After the resistance potential in case E decreased due to factors external to the development process (changes in the organizational structure and three stakeholders moving to other jobs), the development was resumed. This time the project (E2) was successful, while the resistance potential was moderate. It resulted in a system that was implemented and used on a regular basis in the central planning department and a few other departments. Still, because system use was voluntary the majority of the decentral departments had not yet adopted it. The approach was a 'step-by-step' one, but the other requirements specified in proposition 4 were not met.

In case D2 the resistance potential was also moderate. In this episode user management interacted with all users and at the strategic level the orientation was social organizational, but a 'step-by-step' approach was not found. Still, this process was successful. We should add that D2 was a large-scale project under time pressure. Because of these two characteristics a 'step-by-step' approach could not be realized. However, from three alternative ways of implementing the user management chose the way that would least harm the direct users. This may have compensated for the fact that they did not use a 'step-by-step' approach.

In three other episodes (D1, F, G) mentioned in table 7, the resistance potential was moderate. The approach did not fulfil the requirements and the development was not successful. Qualitative analysis of these data suggests that the cause of failure should be (partly) attributed to not controlling the resistance potential. The explorative data from these cases led to the following proposition: *A moderate resistance potential requires (a) interaction (of the management and/or system developers) with all future users (direct and indirect) aimed at exchange of information and motivating the users (b) and a social-organizational orientation.*

Proposition 5: When the context is characterized by low risks, the requirements as specified in propositions 1 to 4 are not needed for system development to be successful (efficiency proposition).

Four of the episodes did not have any low risk scores at all (B, D1, D2 and G). Subsequently, in these episodes nothing can be learned about proposition 5. The same is true for case E2, but for a different reason. Case E2 did score low on functional uncertainty, but the approach requirements as specified in proposition 1 were fulfilled. We do not know if case E2 would also have been successful when these requirements would not have been met.

We can learn more from case A, which scored low on functional uncertainty (table 4), on conflict potential (table 5), on technical uncertainty (table 6), and on resistance potential (table 7). In line with our efficiency proposition, case A was successful while most of the requirements stated in propositions 1 to 4 were not fulfilled. No iterative process model was used to specify the user needs, nor formally coordinated and early representational interaction among user groups, nor a social-organizational orientation. No blueprint of the design was made before the start of the realization activities and we also found no intensive use of formal coordination mechanisms during the realization activities.

The episodes C1, E1 and F failed, while scoring low on some risks and moderate or high on others. Can we explain that their failure was due to not controlling the moderate and/or high risks?

C1 scored low on technical uncertainty and conflict as well as resistance potential. The functional uncertainty was moderate: the users really wanted a system, but were inexperienced and awareness of their problems, goals and needs was low. The user department had only talked a few times with the Information Systems department about their needs, on the basis of which the IS department wrote a feasibility study. During the next half year there was no contact between the IS department and the users. Then the users received an application that did not meet their demands, so they hired a student to locally develop a better application for them (episode C2). Episode C1 is in line with proposition 5, because the causes of the failure are not technical in nature, nor are they caused by resistance or conflicts. A likewise explanation can be given for the failure of case F, in which technical uncertainty was low. In fact, the software was implemented in this case and was for some time used on a temporary basis and the technical quality was clearly not the reason the project failed. The lack of control of the other risks (all moderate, see tables 4, 5 and 7) in this case explains the failure satisfactorily. In episode E1 the technical uncertainty was also low. The failure of episode E1 was caused, as has been explained (see tables 5 and 7), by not controlling the conflict and resistance potential. The problems were not technical in nature as the pilot department was actually already using the developed software when the central management stopped the project.

The other two episodes E2 and C2 were characterized by a low resistance potential. In line with proposition 5, the requirements for controlling a high resistance potential were not met, while the cases were successful (table 7).

In summary, we can conclude that our data are in line with proposition 5: no control measures have to be taken for low risks. Still, because of another finding in episode C2, we think the efficiency proposition should be slightly amended. In episode C2 the developer, the student, was inexperienced. His inexperience being the only technical uncertainty, this risk was rated low. However, the realization process was iterative and this approach characteristic appeared to be essential, because the developer was inexperienced and needed to learn. A more efficient linear approach would not have been feasible. So we added proposition 5a to the efficiency proposition.

Proposition 5a: Independent of any other technical uncertainty inexperienced system developers should be given room for iterations among stages during the realization activities in order for system development to be successful.

5. Conclusions

Based on these results, we conclude that there is a substantive need for a more flexible choice of SD scenarios, especially with respect to the social and organizational aspects of the management of these processes. The use of a contingency model was supported by the data. Only those system development processes with matching approach and contingency factors were successful. The results of the ten episodes of system development were in line with our propositions. Several alternative explanations of the outcomes of the processes were also considered, but all failed:

neither the five risk scores (taken together or separately) nor the approach factors (taken together or separately) could explain the outcome of the ten episodes, whereas most of our propositions were able to explain the outcomes as has been shown in section 5. In so far as our model specifies fits between risk and approach it can, when sufficiently tested, be used in a prescriptive way. The model can also be used to describe the risks and the approach of an SD process. For such a descriptive purpose, the model was shown to be applicable to a wide variety of system development processes (as our cases contained ample variance on the characteristics of the context).

However, some limitations of our largely explorative study have to be taken into account. First, the seven processes that were analysed constitute a very small subset of the vast amount of SD scenarios (combinations of context and approach) that are theoretically possible. Obviously, the propositions need to be tested on far more cases.

Second, the fits between risks factors of a moderate magnitude and approach characteristics have thus far not been tested at all. We have only formulated propositions about the control of moderate risks on the basis of the explorative findings reported in this article. Moreover, a systematic comparison of low, high, and moderate risks could generate more clarity about the nature of the interaction effect of risk factors and approach characteristics on successful system development, for example on its linearity (Schoonhoven 1981).

Third, propositions only specified simple relations between context factors and one or more approach variables. More attention should be given to more complex interactions, for example, among various approach variables as these will not all be independent (see Van Offenbeek 1993).

Fourth, when we look at our framework from the viewpoint of the practitioner, it can be said that the propositions are rather general in nature. We discussed our framework with practitioners and tried to evaluate other cases with it. Each time we were left with the feeling that the propositions do indeed apply, but that their translation into more detailed requirements for a specific SD approach is the real proof of the pudding. In terms of Thorngate's postulate of commensurate complexity (Weick 1979: 35) our model seems to be quite simple and possibly generally applicable, but in the inevitable trade-off we have lost some accuracy.

We described a small and heterogeneous sample of SD processes with the model. Not only should more cases be studied, a sensible next step would be to draw a sample which is quite homogeneous and to study those cases longitudinally from the start. Such a design can provide greater accuracy, although generalization will be (more) limited. Also, this design would enable further investigation of the way in which, and the conditions under which, decisions about the SD strategy are made. This would shed more light on the demands that a contingency framework will have to meet in order to be useful in SD practices.

The strength of a contingency model like the one presented here lies in the description of fits made possible by analytical restriction and distinction of the variables to be taken into account. This implies a certain amount of simplification, but such an analytical approach can help practitioners to understand a complex reality and it provides reference points for determining their interventions.

In our model we have integrated organizational and cognitive social psychological knowledge. Time and again organizational settings appear to have a strong influence on human behaviour (Davis-Blake and Pfeffer 1989). People are bound to their context (both literally and metaphorically) and are both active participants and passive victims (Goedvolk and Smeets 1991). A contingency model can help make the context eligible and debatable and specify alternative SD approaches. Organization studies contribute to our understanding of the strategic and tactical level of the SD approach, cognitive social psychological notions can help in understanding the interaction in SD processes, the operational level. To summarize, models like ours can be tools that assist practitioners to step back and consider the context they are in, and subsequently determine their approach. A contingency model helps them to see alternatives, while they remain responsible for the rationality of their choice.

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