8 CROSS-CASE ANALYSIS

8.1 Introduction

In this chapter, we analyze data across all of the cases in order to identify similarities and differences in the degree of formalization of the ordering process and the effects of formalization. By identifying similarities and differences, we seek to provide further insight into issues concerning the formalization of the ordering process by (analytically) generalizing the case study results. In Chapter 5, we argued that to be able to make meaningful sense of data generated by empirical research requires the use of a theoretical framework. The theoretical framework of this study consists of a model of the ordering process (as discussed in Chapter 2), operationalizations of formalization of the ordering process (as discussed in Chapter 3), and a conceptual model and proposed taxonomy of order-processing patterns (as discussed in Chapter 4). We use this framework as a template for comparing and generalizing the empirical results of the five cases. Studying multiple cases makes it possible to build a logical chain of evidence (Yin 1994; Miles and Huberman 1994). In other words, we use the cross-case analysis to seek a chain of evidence for the relationships studied on the basis of the framework.

We have thus far described variables related to the formalization of the ordering process by describing the cases in Chapter 6, and we have analyzed the relationships among the variables for each separate case in Chapter Seven. The next step is to conduct further analysis of consistencies identified across the cases in the various relationships, along with reasons why these relationships exist (e.g. Handfield and Melnyk 1998; Miles and Huberman 1994). The relevant issues concerning formalization of the ordering process relate to the research questions, as formulated in Chapter 1:

- What considerations underlie the degree of formalization of the ordering process?
- What are the positive and negative effects of formalization of the ordering process?

To answer these questions, we must understand why manufacturing companies formalize their ordering processes and know whether their reasons are consistent with the theoretical insights obtained in this study. We further seek to understand whether the degree to which the ordering process is formalized relates to the performance of the ordering process and to the performance of the company in balancing responsiveness and efficiency.

In answering these questions, we discuss the results of the cross-case comparison by comparing data for the various order-processing patterns, as characterized according to the taxonomy presented in Chapter 4. In discussing the conceptual model in Chapter 4, we argued that characteristics of demand (specifically uncertainty) and characteristics of the production system (specifically flexibility) influence both the complexity and the
degree of formalization of the ordering process. We therefore proposed a taxonomy of
four main types of order-processing patterns: the passing-on pattern, the rearranging
pattern, the puzzle-solving pattern, and the compromising pattern. We consequently
assume that the complexity and degree of formalization of the ordering process can be
ranked according to the taxonomy and are thus directly related to the order-processing
pattern. It is therefore logical to use the taxonomy as starting point for analyzing and
explaining formalization of the ordering process. Comparing the data for each order-
processing pattern thus means that we examine whether characterizing the ordering
process according to specific combinations of demand and production characteristics
makes it possible to explain formalization and its effects.

For each order-processing pattern, we discuss and explain the relationship between
the complexity and the degree of formalization of the ordering process. The relationship
between complexity and formalization of the ordering process is a central element of
our conceptual model. It is interesting to see whether complexity influences the degree
of formalization or whether the reverse is true. Both types of relationship are mentioned
in the literature; complexity is often associated with a low degree of formalization (e.g.
Daft 1998). It is also argued that formalization helps to avoid ambiguity (see Daugherty,
Stank, and Rogers 1992). It may therefore be helpful to understand the relationship
between complexity and formalization of the ordering process in the context of
structuring this process.

We discuss possible variations in the degree of formalization on the three
dimensions of the ordering process. In Chapter 3, we argued that it is possible to vary
the degree of formalization along the three dimensions of the ordering process in order
to cope with the complexity characteristics of the ordering process. We also argued that
varying the degree of formalization along the three dimensions is helpful for exploiting
the advantages of formalization (achieving efficiency) without having to suffer its
disadvantages (remaining flexible). For this reason, we therefore discuss possible
variations in formalization for each dimension of the ordering process in combination
with the effects of formalization on the performance of the ordering process and
performance in balancing responsiveness and efficiency.

This chapter proceeds as follows: we first discuss the classification of ordering
processes according to the taxonomy of order-processing patterns (Section 8.2). On the
basis of this classification, we proceed to analyze the three order-processing patterns
found in our study. We analyze the passing-on pattern (Section 8.3), the puzzle-solving
pattern (Section 8.4), and the compromising pattern (Section 8.5). The concluding
section of this chapter (8.6) summarizes and discusses the main findings of the cross-
case analysis and examines whether the research questions can be answered.
8.2 Classifying the ordering processes

In the within-case analyses, we characterized demand, production, and the order-processing pattern. Figure 8.1 shows the resulting classification of the various ordering processes according to the taxonomy of order-processing patterns. For three companies, we distinguished among different order streams, as these streams differed according to characteristics of demand or production. At Companies B and D, we distinguished two order streams that had different characteristics of demand (specifically related to the uncertainty of demand). At Company E, the flexibility of production differed for each order stream. Because orders from both streams are produced within the same production system, these differences may seem peculiar at first glance. The orders for shop products are much more dependent on purchased materials and parts, however, and this dependency on supplies influenced the flexibility of the production system greatly.

<table>
<thead>
<tr>
<th>High</th>
<th>Low</th>
</tr>
</thead>
<tbody>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Compromising</strong></td>
<td><strong>Puzzle-solving</strong></td>
</tr>
<tr>
<td>Company B, specials</td>
<td>Company A</td>
</tr>
<tr>
<td>Company D, non-stock orders</td>
<td>Company C</td>
</tr>
<tr>
<td>Company E, shop orders</td>
<td>Company E, office orders</td>
</tr>
<tr>
<td></td>
<td></td>
</tr>
<tr>
<td><strong>Passing-on</strong></td>
<td><strong>Rearranging</strong></td>
</tr>
<tr>
<td>Company B, standards</td>
<td>Low</td>
</tr>
<tr>
<td>Company D, stock orders</td>
<td>High</td>
</tr>
</tbody>
</table>

**Figure 8.1** Classification of ordering processes according to uncertainty of demand and flexibility of production

Separating the order streams for classification in the taxonomy allows us to discuss each order stream independently from other streams within the same company. We must bear in mind, however, that in the three companies with two order streams, the various order streams interfere in the ordering process and may therefore complicate the ordering process as a result of the dynamic relationship between the order streams within a single company. We address these dynamics in discussing the findings for each order-processing pattern and provide further discussion in Section 8.6.

The sections that follow treat each of the order-processing patterns separately. We have argued that order-processing patterns based on a predictable demand are less interesting for our study as formalization is relatively easy in those situations. Two companies have order streams based on relatively predictable and standard demand, reflecting the
passing-on pattern of order processing. In this cross-case analysis, we discuss the passing-on pattern briefly (Section 8.3), but focus on patterns characterized by uncertain demand - the puzzle-solving pattern (Section 8.4) and the compromising pattern (Section 8.5).

8.3 The passing-on pattern of order processing

In Chapter 4, we argued that the role of the ordering process in coordinating demand and production in the passing-on pattern is not complex and that formalization of the ordering process should be possible along all three dimensions. On the basis of theoretical insights concerning the three dimensions of the ordering process in the passing-on pattern, we expect logistical decision-making to be fairly routine, and that it may be formalized through structural coordination of Sales and Production. With regard to information processing, we assume that information requirements related to order processing are known as a result of the predictability of demand, and may therefore be formalized by using predefined information capabilities and a prescribed sequence of information-processing activities. With regard to the organizational setting, we assume that few actors are involved in order processing, that the actors are not highly interdependent, and that the organizational setting may be formalized by defining job descriptions and a formalized hierarchical structure. Formalized lateral consultative structures are probably not present.

The passing-on pattern of order processing is characterized by low uncertainty of demand and low flexibility of the production system. We observed this pattern in two companies: Company B for standard products and Company D for stock orders. For both order streams, demand is predictable and based on fixed agreements with regular customers. At Company B, products are standard and delivered to different customers. At Company D, products are standardized for each customer. Table 8.1 presents an overview of characteristics of the ordering processes within the passing-on pattern. The characteristics presented in the overview are based on the within-case analyses of Company B (Section 7.3) and Company D (Section 7.5).

Analysis of practices in the passing-on pattern of order processing reveals that both companies produce standard products according to make-to-stock production control structures. In MTS production situations, activities that are triggered by customer orders are related to the finished goods inventory (Bozarth and Chapman 1996). The logistical decisions to be made in such situations involve order acceptance and are only slightly interrelated with other decisions, as orders are accepted on the basis of the available stock of standard products. Both companies formalize the structural logistical coordination of order acceptance by specifying product range and minimum stock
levels. By formalizing structural coordination, companies set a framework for operational logistical coordination (see also the study of Konijnendijk 1992). The formalized structural coordination observed in these cases seems to make operational coordination redundant. Because decisions concerning which products to keep in stock and in what quantities are formalized on a structural level, order acceptance at the operational level requires no further coordination between demand and production.

Table 8.1  Characteristics of the passing-on pattern of order processing

<table>
<thead>
<tr>
<th></th>
<th>Company B standards</th>
<th>Company D stock orders</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Position CODP</strong></td>
<td>MTS</td>
<td>MTS</td>
</tr>
<tr>
<td><strong>Complexity OP</strong></td>
<td>Routine tasks for sales desk</td>
<td>Routine tasks for sales desk</td>
</tr>
<tr>
<td></td>
<td>Sequentially interdependent</td>
<td>Sequentially interdependent</td>
</tr>
<tr>
<td></td>
<td>Low ambiguity</td>
<td>Low ambiguity</td>
</tr>
<tr>
<td><strong>Formalization LD</strong></td>
<td>Structural coordination that formalizes order acceptance</td>
<td>Structural coordination that formalizes order acceptance</td>
</tr>
<tr>
<td><strong>Formalization IP</strong></td>
<td>Prescribed sequence + insight into material availability through ERP</td>
<td>Prescribed sequence + insight into material availability through ERP</td>
</tr>
<tr>
<td><strong>Formalization OS</strong></td>
<td>No formalized coordination</td>
<td>No formalized coordination for these specific orders</td>
</tr>
<tr>
<td><strong>Efficiency OP</strong></td>
<td>Short lead time for administrative order processing and low coordination costs</td>
<td>Short lead time for administrative order processing and low coordination costs</td>
</tr>
<tr>
<td><strong>Efficiency Production</strong></td>
<td>Optimization of batches</td>
<td>Optimization of batches</td>
</tr>
<tr>
<td></td>
<td>Relatively high inventory costs</td>
<td>Relatively high inventory costs</td>
</tr>
<tr>
<td><strong>Responsiveness</strong></td>
<td>Quick and reliable deliveries</td>
<td>Quick and reliable deliveries</td>
</tr>
</tbody>
</table>

Sales desks in both companies are able to handle orders routinely, using information concerning the availability of ordered items provided by the ERP system. There is no need to consult the planner. Sales and Production are sequentially interdependent for handling standard orders: the output of order acceptance of Sales is a production order that specifies the products to be delivered, and is thus the input for Production. When two parties are sequentially interdependent, coordination is likely to be based on planning, combined with rules and procedures (Thompson 1967). This expectation is applicable to the passing-on pattern of order processing; operational coordination of demand and production is not necessary.

We conclude that there are few uncertainties in the passing-on pattern of order processing and that order-processing activities are repetitive. It is therefore possible to define formal rules and procedures regarding logistical decision-making, information processing, and organizational setting to control and coordinate the ordering process, as
discussed in Chapter 3. The analysis shows that companies formalize the logistical decision-making involved in these order streams and information processing. In the passing-on pattern, the formalization of logistical decision-making and information processing influences the complexity of the ordering process in such a way that tasks are rather routine, few actors are involved and the interdependency and ambiguity is not very high. Orders must merely be passed on to the next department. In this respect, formalization of logistical decision-making and information processing apparently tends to routinize order processing (Shtub 1999) and to reduce the amount of information that must be processed between Sales and Production (Galbraith 1973). There is no further need for lateral coordination in the ordering process.

With regard to the effects of formalization in the passing-on pattern, this way of formalizing apparently results in an ordering process with a short lead time for administrative order processing in both companies, as orders are simply passed on to another party. In addition, coordination costs are low, as no operational coordination is needed. The degree of formalization in the ordering process thus influences the performance of the ordering process, at least indirectly.

To balance efficiency and responsiveness, both companies strive for costs and speed as order winning performance objectives. They are able to meet these performance objectives as their stock production allows them to optimize batches, thereby achieving efficient capacity utilization. Another advantage of stock production is that products can be delivered out-of-stock, resulting in quick and reliable deliveries, thereby guaranteeing responsiveness toward customers. At the same time, however, relatively high inventory costs affect efficiency negatively, due to the stock of end items.

We conclude that the role of the ordering process in the passing-on pattern is not complex, due mainly to the predictability of demand. It is therefore possible to formalize all three dimensions of the ordering process. Formalization is indeed used as a measure for structuring logistical decision-making and information processing, resulting in an efficient ordering process and a balance between efficiency and responsiveness. It is apparently both possible and desirable to formalize ordering processes reflecting the passing-on pattern.

### 8.4 The puzzle-solving pattern of order processing

In discussing the puzzle-solving pattern (Chapter 4), we argued that the role of the ordering process in coordinating demand and production is quite complex and that formalization may be necessary for decomposing the control problem in these situations. Formalization could be difficult, however, due to the uncertainty of demand.
On the basis of theoretical insights concerning the three dimensions of the ordering process, we assume that logistical decisions are interrelated and that they often involve trade-offs between customer-responsive and cost-conscious action in the puzzle-solving pattern. We therefore assume that formalizing these decisions may be difficult through the structural coordination of Sales and Production. With regard to information processing, we assume that the information required to process orders is known only partially prior to the arrival of orders. Information requirements concern order specifications, the materials and capacities needed, and the availability of materials and capacities. Because the specific information that is needed depends on particular customer orders, however, the necessary exchange of information may be difficult to formalize on a detailed level. We therefore assume that a prescribed sequence of information-processing activities is the primary means of formalization for information processing. Regarding the organizational setting, we assume that at least Sales, Planning and Production are involved in order processing. Because these parties are likely to be fairly interdependent, we assume that a lateral consultative structure may be necessary. A formalized lateral consultative structure is a means of formalizing the organizational setting.

In situations that combine uncertain demand with a flexible production system order processing is characterized as a puzzle-solving pattern. We observed this pattern in three different cases: Companies A and C, and Company E for office products. In all three cases, demand is hard to predict and is customized on the basis of customer-specific variations in a number of standard components. Table 8.2 presents an overview of characteristics of the puzzle-solving pattern of order processing. The characteristics are based on the within-case analyses of Company A (Section 7.2), Company C (Section 7.4), and Company E (Section 7.6).

We assume that demand that is customized by combining various standard modules is produced according to an ATO-structure (Hoekstra and Romme 1987). In two companies, the standard modules are produced on the basis of planning (ATO structure). Company C, however, produces primarily to order (MTO). The MTO structure is directly influenced by the fact that there is too little physical space in the production plant to keep stock. An important difference between the ATO and MTO structures is the influence of orders on production. In ATO structures, customer orders trigger assembly and other operations further downstream. In MTO structures, production of components is also triggered by customer orders (Bozarth and Chapman 1996). In the MTO structure, therefore, uncertainty of demand has more influence on production units than it does in the ATO structure, resulting in more complex production planning.
Table 8.2  Characteristics of the puzzle-solving pattern of order processing

<table>
<thead>
<tr>
<th></th>
<th>Company A</th>
<th>Company C</th>
<th>Company E-office</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CODP</strong></td>
<td>ATO</td>
<td>MTO</td>
<td>ATO</td>
</tr>
<tr>
<td><strong>Complexity OP</strong></td>
<td>Routine tasks for sales desk, but non-routine tasks for planners</td>
<td>Routine tasks for sales desk, but non-routine tasks for planner</td>
<td>Non-routine tasks for project leader</td>
</tr>
<tr>
<td></td>
<td>Reciprocal interdependency</td>
<td>Low interdependency</td>
<td>Reciprocal interdependency</td>
</tr>
<tr>
<td></td>
<td>Sales most powerful</td>
<td></td>
<td>Ambiguity between Sales and Production</td>
</tr>
<tr>
<td><strong>Formalization LD</strong></td>
<td>Structural coordination that formalizes order acceptance and delivery time promising to a certain degree. No production planning.</td>
<td>Structural coordination that formalizes operational decisions almost completely, with the exception of prioritization.</td>
<td>Structural coordination that formalizes order acceptance, delivery time promising, and allocation of materials and capacities.</td>
</tr>
<tr>
<td><strong>Formalization IP</strong></td>
<td>Prescribed sequence, but no automated production or stock control</td>
<td>Prescribed sequence and information requirements provided through ERP system</td>
<td>Prescribed sequence and DPR procedure for projects</td>
</tr>
<tr>
<td><strong>Formalization OS</strong></td>
<td>Formulated coordination of Sales, Planning, and Production</td>
<td>No formalized meetings</td>
<td>Project leader (responsible for sales and planning) and formalized meetings</td>
</tr>
<tr>
<td><strong>Efficiency OP</strong></td>
<td>Lead time OP realized</td>
<td>Lead time OP realized</td>
<td>Lead time OP acceptable</td>
</tr>
<tr>
<td></td>
<td>High coordination costs</td>
<td>Low coordination costs</td>
<td>High coordination costs</td>
</tr>
<tr>
<td><strong>Efficiency Production</strong></td>
<td>Optimized batches</td>
<td>Good capacity utilization</td>
<td>Batch production</td>
</tr>
<tr>
<td></td>
<td>High stock levels</td>
<td>Low stock levels</td>
<td>High stock levels of modules</td>
</tr>
<tr>
<td><strong>Responsiveness</strong></td>
<td>Mix flexibility/ Speed/ Reliability/ delivery flexibility</td>
<td>Speed/ delivery flexibility/ reliability/ mix flexibility</td>
<td>Mix flexibility/ delivery flexibility</td>
</tr>
</tbody>
</table>

Logistical decision-making

In an ATO production, the logistical decisions order acceptance and delivery time promising are both related to the allocation of materials and capacities for assembly. In an MTO production company, order acceptance and delivery time promising are both related to material and capacity allocation for all operations (Ruffini 1999; Bozarth and Chapman 1996; Bertrand, Wortmann, and Wijngaard 1990).

In all three companies, order acceptance and delivery time promising are formalized on a structural level by defining delivery times or delivery periods, at times combined with agreements concerning the use of slack in delivery time promising. Such
formalizing agreements apparently routinize the activities of the sales desk. The sales desk can accept customer orders within the margins of the formalized agreements for order acceptance and delivery time promising. For exceptions, however, the sales desk must consult the planner for delivery time promising, as non-standard decisions also depend on material and capacity allocation. The planner’s tasks are fairly complex in such situations. Because of the unpredictability and the degree of customization involved in demand, there may be many non-standard order requests, resulting in many non-routine orders for which planners must verify the availability of materials and capacity. In two of the three companies, operational decisions concerning allocation of materials and capacities are also formalized by rules defining stock control and planning. Although the structural coordination of logistical decisions concerning material and capacity allocation appear to reduce the time needed to plan non-routine orders, it does not appear to reduce the complexity of the planners’ tasks.

It is thus apparently possible for manufacturing companies to formalize logistical decision-making to a certain degree through the structural coordination of Sales and Production. This structural coordination does not formalize all operational logistical decisions, however. The formalized structural coordination does not coordinate requests for special orders, and extensive information exchange between Sales and Planning is therefore necessary to deal with these requests. The degree of formalization of logistical decision-making seems to decrease in response to increases in special customer requests related to incoming orders. The uncertainty and higher degree of customization required for special order requests influence the difficulties perceived in formalizing decision rules.

Although the characteristics of demand and production are comparable for the three order streams, the degree of formalization of logistical decision-making varies. Company C has a relatively high degree of formalization, which seems to be influenced by season-dependent demand and a lack of space to keep stock. In the high season, the company must process a large number of customer orders each day (50-75), about twice as many as the other two companies usually handle. This company is therefore forced to formalize its logistical decisions in order to control the ordering process by coordinating demand and production for the large number of high-season orders. The possibility of planning against infinite capacity accommodates the formalization of logistical decision-making. The relatively high degree of formalization of logistical decision-making reduces the level of interdependency between Sales and Planning in coordinating demand and production.

Information processing
The use of ERP systems seems to have particular influence on the formalization of information processing. All three companies use ERP systems that prescribe the sequence for the administrative information flow through the ordering process. In this way, the flow of information and its associated workflow are formalized.
The extents to which ERP systems are used and integrated seem to influence the degree of formalization regarding information requirements. Company A uses the ERP system to formalize only the flow of administrative orders. Information about material and capacity availability is not accessible through the automated system, and the information that is available is often not up to date. The planner therefore lacks current insights into actual production possibilities and, as a consequence, has fairly complex tasks. Further, the lack of adequate production and stock control results in high levels of interdependency among Sales, Planning, and Production. We conclude that a lack of adequate insight into material and capacity availability influences the complexity of coordinating demand and production.

The other two companies have integrated ERP systems that also support planning and stock control. At Company C, the system is completely customized according to user preferences, thereby providing adequate support for information requirements during order processing. The fully customized information systems also helps to reduce the level of interdependency involved in coordinating demand and production. This may be explained by the fact that information requirements are known on the basis of the well-defined logistical concept. The use of ERP systems and the extent to which they are integrated thus affect the degree of formalization of information processing as well as the complexity of the ordering process.

Organizational setting

Formalization of the organizational setting seems to be influenced primarily by the degree of interdependency among the parties involved. In cases of constant high (reciprocal) interdependency, formalized meetings are a means of coordinating demand and production. In all three companies, lateral relations serve as coordination mechanisms at the operational level. Two companies have formalized lateral relations that serve as devices for dealing with reciprocal interdependencies among the parties involved, as we would expect (Thompson 1967). In Company C, demand and production are coordinated by formal rules and procedures on a structural level, and lateral relations are used only for exceptional customer requests. We may conclude that the degree to which logistical decision-making is formalized indirectly influences the level of formalization of the organizational setting.

We conclude that the puzzle-solving pattern involves many uncertainties regarding non-routine orders. As a consequence, order-processing activities may vary, rendering formalization difficult, particularly with regard to logistical decisions related to non-routine orders. In the puzzle-solving pattern, the role of the ordering process in coordinating demand and production is complex. At least three parties are involved in order processing and these parties are frequently reciprocally interdependent in the search for optimal trade-offs between customer wishes and production possibilities. As shown in the analysis, the use of formalized logistical decision-making, supported by
formalized information processing, apparently reduces complexity. It is also clear that, when logistical decision-making cannot be formalized, the actors involved coordinate demand and production primarily by using lateral relations. When the coordination of demand and production frequently requires lateral relations for making decisions regarding customer-specific requests, manufacturing companies apparently choose to formalize the organizational setting using a formalized lateral consultative structures.

Analysis of the relationships between the degree of formalization of the ordering process and the performance of the ordering process shows that the lead time needed for administrative order processing is influenced by the use of ERP systems that prescribe information-processing sequences and make information easily accessible. The costs of coordination are influenced primarily by the necessity for operational coordination and the number of actors involved. At Companies A and E-office, a high degree of operational coordination is needed to process individual customer orders, thus raising the costs of coordination. At Company C, operational coordination is hardly necessary at all, due to a well-defined logistical concept combined with a customized information system. The costs of coordination are therefore relatively low.

The effects of formalization of the ordering process on balancing efficiency and responsiveness apparently relate to the position of the CODP and the formalization of logistical decision-making. The ATO structure allows the production of standard modules in efficient batches, but also results in a relatively high level of stock. Products at Company C are made to order, and batch production is therefore not easy. Because capacity is adjusted daily according to incoming orders, available capacity is planned and utilized in an optimal way, keeping stock levels low. All three companies are able to deliver rather broad ranges of products in relatively short periods of time. In all three companies, the delivery flexibility (i.e., the ability to handle rush orders) is influenced by both the flexibility of the production system and the use of lateral relations to coordinate demand and production. It apparently does not matter whether or not these lateral relations are formalized. Coordinating by means of lateral relations creates flexibility for responding to customer requests, as it allows for the immediate discussion of available options.

In summary, we conclude that the role of ordering process in coordinating demand and production is complex in the puzzle-solving pattern, due to the uncertainty and degree of customization of demand associated with this pattern. Complexity is addressed in part through the use of a prescribed sequence for information-processing activities and through some degree of formalization of logistical decision-making. The extent to which logistical decision-making is formalized seems to influence the number of special order requests. Special order requests that cannot be sufficiently controlled and coordinated by these defined rules and procedures are otherwise treated through coordination using formalized lateral relations. In general, the formalization measures
used seem to have a positive influence, particularly on responsiveness. More specifically, there are strong indications that formalization of logistical decision-making positively influences the balance between efficiency and responsiveness, and formalization of the organizational setting has beneficial effects for responsiveness. The formalization of lateral consultative structures, however, influences the efficiency of the ordering process negatively.

8.5 The compromising pattern of order processing

In discussing the compromising pattern (Chapter 4), we argued that the role of the ordering process in coordinating demand and production is very complex in this pattern, as the production system is not very flexible in responding to uncertain demand. We also argued that the interdependency between Sales and Production is likely to be high, and that ambiguity in goals and interests are particularly characteristic of this order-processing pattern. This situation is likely to necessitate the formalization of the ordering process in order to control both efficiency and responsiveness. Such formalization may be difficult to achieve, however, due to the characteristics of demand. We assume that formalizing the compromising pattern may be more difficult than formalizing the puzzle-solving pattern, as the ordering process is more complex. We assume that the differences between the compromising pattern and the puzzle-solving pattern of order processing are particularly evident in the degree to which logistical decisions are interrelated, the uncertainty concerning information requirements, and the degree of interdependency and ambiguity among the parties involved. Therefore, we expect that formalization is more difficult within the compromising pattern, and may even be impossible for logistical decision-making and information processing.

In situations that combine uncertain demand with not very flexible production systems, order processing reflects the compromising pattern. We observed this pattern in three different cases: Company B for specials, Company D for non-stock products, and Company E for shop products. In all three cases, demand is customized and difficult to predict. The degree of customization at Company E-shop is the highest, due to the customer-specific design involved in the first phase. Table 8.3 presents an overview of characteristics of the compromising pattern of ordering processes. The characteristics are based on the within-case analyses of Company B (Section 7.3), Company D (Section 7.5), and Company E (Section 7.6).
**Table 8.3** Characteristics of the compromising pattern of order processing

<table>
<thead>
<tr>
<th></th>
<th>B-specials</th>
<th>D-non-stock</th>
<th>E-shop</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>CODP</strong></td>
<td>MTO</td>
<td>MTO (specials)</td>
<td>ETO</td>
</tr>
<tr>
<td><strong>Formalization LD</strong></td>
<td>Structural coordination formalizes allocation of materials and capacity to a certain degree</td>
<td>Structural coordination formalizes allocation of materials and capacities to a certain degree</td>
<td>Structural coordination formalizes allocation of materials and capacities</td>
</tr>
<tr>
<td><strong>Formalization IP</strong></td>
<td>Prescribed sequence Use of ‘procals’</td>
<td>Prescribed sequence</td>
<td>Prescribed sequence and ‘DPR –procedure’</td>
</tr>
<tr>
<td><strong>Formalization OS</strong></td>
<td>Non-formalized direct contact Many formalized meetings</td>
<td>Many formalized meetings</td>
<td>Project leader (responsible for sales and planning and formalized meetings</td>
</tr>
<tr>
<td><strong>Efficiency OP</strong></td>
<td>Lead time OP exceeds norm High coordination costs</td>
<td>Long lead time OP High coordination costs</td>
<td>Long lead time for OP (design) High coordination costs</td>
</tr>
<tr>
<td><strong>Efficiency Production</strong></td>
<td>Small batches Stock levels exceed norm</td>
<td>Man-machine combination High stock levels for WIP</td>
<td>Outsourcing production</td>
</tr>
<tr>
<td><strong>Responsiveness</strong></td>
<td>Mix flexibility/delivery flexibility/low reliability</td>
<td>Mix flexibility/reliability/low delivery flexibility</td>
<td>Product flexibility/delivery flexibility (advance orders)</td>
</tr>
</tbody>
</table>

The position of the CODP differs among the three companies in the compromising pattern. An MTO structure is used for B-specials and also for specials within D-non-stock. In both cases, demand is uncertain and products are not modularized. Company E-shop can be characterized as an ETO situation, as products are completely customized and purchasing can take place only on the basis of customer orders. In an MTO structure, customer orders trigger all operations related to manufacturing. In an ETO structure, customer orders also trigger design and purchasing (Bozarth and Chapman 1996).

The complexity of the ordering process for each of these three order streams is comparable. Consistent with theoretical expectations, the tasks in all three companies are mostly non-routine, with high levels of interdependency and ambiguity among the parties involved.
Logistical decision-making

Logistical decisions are inter-related in production companies with MTO or ETO structures; order acceptance and delivery time promising relate to the allocation of materials and capacities for all operations (Ruffini 1999; Bozarth and Chapman 1996). In ETO structures, logistical decisions are also closely related to design and purchasing decisions. Analysis of the degree to which logistical decision-making is formalized in the three companies shows that all three companies have formalized the allocation of materials and capacities, primarily through the use of planning rules and agreements concerning the use of slack in planning. Order acceptance and delivery time promising are not formalized but depend on the allocation of capacity based on planning. This situation produces reciprocal interdependencies between Sales and Production in decisions concerning order acceptance and delivery time promising. In all three companies, planners serve as intermediaries between Sales and Production and have non-routine tasks. In planning customer orders, planners must cope with uncertain demand and a not flexible production system. Although planning rules and the use of slack guide planning to some extent, planners must also rely on experience when seeking the most suitable solution or compromise between customer requests and production possibilities. At Company E-shop, a project leader is responsible for all logistical decisions in order processing. Each project is unique, and the project leader is the intermediary between all other parties involved, resulting in non-routine tasks.

The degree to which logistical decision-making is formalized is comparable for the three compromising order patterns and is limited to structural coordination that formalizes the planning. Delivery time promising is not coordinated on a structural level, however. For these companies, the formalization of delivery time promising is impeded by difficulties involved in predicting the amount of time needed to produce customer-specific products. Because delivery time promising is dependent on other logistical decisions, the interdependency among parties is high and planning is a fairly complex task.

Information processing

In all three companies, information processing is formalized through the use of prescribed sequences for information-processing activities based on ERP systems. In two companies, separate procedures for specifying all relevant order information and processing customer-specific orders through the ordering process represent further formalization of information processing. These procedures are based primarily on documents that formalize information processing for customer-specific orders by specifying the information required. These procedures and documents are not supported by the information systems, however. The ERP systems in these companies do not support such customer-specific information processing. One possible explanation may be that the ERP systems used in these companies are based on standard models with
some company-specific adjustments that do not fit within the unique contexts of these companies (see for instance Swan, Newell, and Robertson 1999). Moreover, the companies with compromising order-processing patterns also have combinations of two different order streams that must be handled by a single information system. The information systems at both Company E and Company B are not well suited for handling the customized and complex order streams of the compromising pattern. Another explanation for why the ERP systems do not support information processing for customer-specific orders may be that the users are incapable of using the system correctly (see for instance El Louadi 1998). According to an ERP system expert in one company, users are not able to make adequate use of system functionality, thereby leaving important functionalities of the ERP system unused.

**Organizational setting**

Interdependencies among parties in the compromising pattern of order processing are reciprocal. Reciprocal interdependencies are often controlled by some sort of lateral relations (Galbraith 1973), as observed in all three companies. The difference among the three companies is that B-specials makes considerable use of direct contact to coordinate demand and production but has not formalized this coordination mechanism and has no formalized meetings of the parties involved. Informal direct contact is used to solve concrete problems with customer orders. The absence of meetings apparently influences the level of ambiguity between Sales and Production. This may be explained by the fact that the parties involved do not discuss problems in order processing at a more structural level, but focus on solving their own tasks in order to achieve their own objectives.

Ambiguity is fairly high in these three ordering processes. This ambiguity seems to be influenced, at least in part, by a lack of a clear operations strategy. More detailed examination of this relationship shows that all three companies are apparently struggling with the transition to more customer-oriented production systems. The production systems are equipped to produce large batches, while customer-specific demand must be produced in small batches. This conflict between demand requirements and production constraints results in a misfit between demand and production. The lack of a clear operations strategy and a high level of ambiguity are apparently influenced partially by the dynamics of combining two different order streams within a single ordering process.

With respect to ambiguity, the most important problem seems to be that the parties involved in the ordering process have different interests and are therefore unable to generate commitment for performance objectives. Sales-oriented parties prefer to focus on specials in order to be able to fulfill customer requests, thereby achieving responsiveness. In contrast, production-oriented parties prefer to focus on standards and efficient production utilization. Although the parties acknowledge their differences in focus, as well as the problems that arise from these differences, they appear either
unable to define order-winning performance objectives and agreements for coordinating demand and production or unable to commit to these objectives. The ambiguous interests of Sales and Production result in not clearly defined performance objectives. As a consequence, Sales and Production are unable to achieve commitment to rules regarding order processing. In the compromising pattern of order processing, therefore, conflicting interests between Sales and Production appear to play an important role in order processing, in particular by impeding the coordination of demand and production.

We conclude that the role of the ordering process in coordinating demand and production within the compromising pattern is very complex. Misfits between uncertain demand and not flexible production systems seem to affect the complexity. Such misfits influence both the complexity of the planner’s tasks and the interdependence among the parties involved. Lateral relations are used as coordinating devices for coping with these complexities. When structuring the ordering process, the emphasis seems to be on the organizational setting. Because logistical decision-making is difficult to formalize, demand and production are coordinated primarily at the operational level. This coordination necessarily involves some form of direct contact among actors. It is therefore logical for these companies to focus on the organizational setting.

Analysis of the performance of the ordering process in the compromising pattern shows that operational coordination takes time, resulting in long lead times for administratively processing orders. This may be explained by the fact that Sales and Planning cannot rely on formalized structural coordination of order acceptance and delivery time promising. In addition, information processing is time-consuming because of the non-automated procedures involved. The extensive operational coordination also influences the costs of coordination, which are evaluated as high for all three companies.

In the compromising pattern, balancing efficiency and responsiveness apparently focuses on responsiveness toward the customer. Realizing customer-specific requests and a broad range of products (product and mix flexibility) requires the production of small batches, which are not easily handled by the fairly inflexible production systems. At Company E-shop, customer-specific designs are often addressed by outsourcing production, leaving in-house production unfilled. This misfit between demand and production therefore has a negative influence on the efficiency of production. As discussed in the within-case analyses (Chapter 7), Company B-specials uses slack in planning and overtime to handle rush orders. Company E handles rush orders in the rollout phase of projects primarily by using creative solutions. Company D appears either incapable or unwilling to handle rush orders, despite its use of slack in planning. Planning and Production make decisions about accepting rush orders. They preserve the built-in slack for uncertainties in production in order to guarantee reliable delivery of already planned orders.
In summary, we conclude that the role of the ordering process in the compromising pattern is especially complex, due to the uncertainty of demand and the misfit between demand and production. This complexity produces a high level of ambiguity among the parties involved. Misfits between demand and production appear to have a negative influence on the possibility of formalizing logistical decision-making and the possibility of formalizing information processing for customer-specific orders. To cope with complexity and to coordinate demand and production in order to achieve responsiveness, manufacturing companies seem to rely heavily on lateral consultative structures. Formalizing these structures seems to have a positive influence on responsiveness toward customers.

8.6 Discussion of main findings and concluding remarks

In our analysis of data for each order-processing pattern, we have discussed consistencies and inconsistencies on the level of specific order-processing situations, as defined by the order-processing patterns. This section discusses the main findings of the cross-case analysis. This discussion aims to answer the research questions, as formulated in the introduction. The first question was “What considerations underlie the degree of formalization of the ordering process?” To answer this question, we discuss insights concerning variables that influence the complexity and degree of formalization of the ordering process, and the relationship between complexity and formalization of the ordering process. The second question was “What are the positive and negative effects of formalization of the ordering process?” To answer this question, we discuss insights concerning the effects of formalizing the ordering process on the balance between efficiency and responsiveness. We conclude the section by discussing insights we obtained with respect to varying the degree of formalization for each dimension of the ordering process.

Complexity and degree of formalization of the ordering process

The influences of demand and production on the complexity and degree of formalization of the ordering process have been the central focus of the proposed taxonomy of four order-processing patterns. Classifying the ordering processes according to this taxonomy allowed us to discuss such complexity and formalization with regard to how they are affected by demand and production.

We assumed complexity of the ordering process to be influenced primarily by the combination of demand and production. Analysis of the three different order-processing patterns reveals a ranking of complexity of the ordering process, corresponding to our theoretical expectations. The ordering process in the passing-on pattern is quite simple; tasks are routine, and interdependency and ambiguity are low. In the puzzle-solving
pattern, the ordering process is more complex; in particular, planning-related tasks are non-routine, the interdependency between Sales and Production is higher, and there may be some ambiguity among the parties involved. The ordering process is most complex in the compromising pattern, which involves primarily non-routine tasks, high interdependency, and high ambiguity among the parties involved.

Only one ordering process (the puzzle-solving pattern) appears to be less complex than expected. One possible explanation is that the company has been able to define a logistical concept for formalizing logistical decision-making within the ordering process to a relatively high degree, thereby reducing complexity of the ordering process.

We also assumed the degree of formalization of the ordering process to be related to the complexity of the process. Analysis of the order-processing patterns reveals a ranking of the degree of formalization of logistical decision-making that apparently relates to the complexity of the ordering process. In the passing-on pattern, logistical decision-making is formalized to the extent necessary for formalizing the operational decisions involved in this pattern. In the puzzle-solving pattern, logistical decision-making is formalized for order acceptance and delivery time promising, and in some cases for capacity and material allocation as well. Managerial agreements within this pattern do not adequately support logistical decisions concerning special order requests, however. Logistical decision-making appears to be least formalized in the compromising pattern; planning rules and rules on stock levels formalize allocation decisions, but order acceptance and delivery time promising is based primarily on operational coordination.

With regard to the degree of formalization of information processing, there is less variation among the three patterns of order processing. In all three order processing patterns, the sequence of information-processing activities is prescribed mainly by ERP systems. The use of such systems therefore influences the degree of formalization of information processing. When customer orders are highly customized, information systems are apparently unable to provide adequate information-processing support for the orders. Separate procedures based on formalized, but not automated, documents are used as alternatives.

Analysis of the degree of formalization of the organizational setting again reveals a ranking of formalization in the consultative structure. No such structure exist in the passing-on pattern, but the puzzle-solving and compromising patterns both use lateral consultative structures to cope with interdependencies in coordinating demand and production. Manufacturing companies apparently formalize the coordination of demand and production by using lateral consultative structures when management is unable to formalize logistical decision-making. In order to respond to customized demand, companies may formalize operational trade-offs by defining meetings or direct contact.

In general, therefore, the degree to which logistical decision-making is formalized within the ordering process is lower when the ordering processes are more complex,
while the degree of formalization of the organizational setting is higher in more complex ordering processes.

Another important issue regarding the formalization of the ordering process is the combination of two different order streams within a single ordering process. Manufacturing companies apparently do not make clear distinctions between different order streams, each of which has its own requirements for order processing. The ordering processes for both order streams are structured according to the same basic rules for the three separate dimensions. Logistical decision-making and information processing are formalized in accordance with requirements posed by the less complex orders. This way of formalizing logistical decision-making and information processing is less appropriate for processing complex orders, as evidenced by problems encountered in processing such orders.

*The effects of formalization of the ordering process on performance*

This study was particularly interested in the effects of formalization of the ordering process on the balance between efficiency and responsiveness. We assume that the positive effects of formalization are related to improving efficiency, but may also relate to clarifying priorities, avoiding ambiguity, and improving flexibility in handling customer-specific requests, as discussed in Chapter 3. We assume that the negative effects of formalization are related to the small amount of leeway allowed for the actors involved in order processing and less flexibility for handling unforeseen orders.

In general, we found indications that formalizing structural coordination of demand and production is easier when companies have a clear manufacturing strategy and defined performance objectives. Clarity about manufacturing strategy and objectives imply that companies have also defined the balance they wish to achieve between efficiency and responsiveness. The parties involved have fixed goals and plans within which to make operational decisions, as argued in Chapter 2. The formalization of logistical decision-making is therefore likely to have a positive effect on trade-off decisions between customer-responsive and cost-conscious action. In cases of formalized structural coordination, trade-off decisions are based on priorities in optimizing the balance between efficiency and responsiveness (specific to each company). Moreover, in the absence of a clear manufacturing strategy, companies experience difficulty in defining logistical concepts or other managerial agreements. As a result, ambiguity among the parties involved is high, and considerable operational coordination is necessary for trade-off decisions. We may therefore conclude that formalization of logistical decision-making helps to clarify priorities with respect to trade-offs and may also reduce ambiguity among the parties involved. In addition, difficulties involved in defining rules for logistical decision-making apparently result in more extensive use of slack in delivery time promising, in stock levels, and in planning.
The use of slack has a negative influence on efficiency, but a positive effect on responsiveness.

Regarding formalization of the information processing, we found strong indications that a prescribed sequence of information processing activities and adequate information accessibility affect both the speed and efficiency of order processing positively. With respect to the formalization of the organizational setting, our study suggested that formalized lateral consultative structures affect responsiveness positively, while their effects on efficiency are negative, due to the high costs of coordination.

The effects of formalization of the ordering process may be particularly negative with respect to flexibility in handling unforeseen orders in cases where the degree of formalization is appropriate for handling routine orders but cannot be adjusted for handling non-routine orders. This situation was observed in ordering processes that combined two different order streams.

Varying the degree of formalization for the three dimensions of the ordering process

While the formalization of the three separate dimensions of the ordering process appears to be important for explaining and understanding the role of the ordering process in balancing responsiveness and efficiency, interactions among these three dimensions are also important. We observed an interesting relationship between the degree of formalization of logistical decision-making and formalization of the organizational setting. With regard to operational decisions, manufacturing companies apparently compensate for the lack of structural coordination between demand and production with formalized lateral consultative structures for controlling and coordinating trade-off decisions, particularly with regard to achieving responsiveness. Moreover, when the degree of formalization of both logistical decision-making and the organizational setting is fairly low, companies tend to be both less responsive and less efficient. As previously discussed, it seems that formalization of logistical decision-making reduces interdependency between Sales and Production. When logistical decision-making is not formalized, therefore, Sales and Production may be more highly interdependent. When interdependency is high, coordination can be achieved by mutual agreement. Defining and formalizing lateral consultative structures enables companies to cope with such interdependency.
9 CONSOLIDATION AND CONCLUSIONS

9.1 Introduction

This study was inspired by two developments observed within manufacturing companies. The first is that manufacturing companies are increasingly forced to become more customer-oriented in order to fulfill higher market demands while remaining efficient. This situation results in a pronounced manifestation of the classical conflict between internal and external objectives. The ordering process plays an important role in balancing these objectives. The second development relates to the increasing capabilities of information technologies. We have argued that manufacturing companies frequently use IT applications to structure the ordering process in achieving the required level of both responsiveness and efficiency. Because the use of IT applications assumes that it is possible to model and formalize the ordering process to some extent, however, companies are frequently confronted with the formalization paradox. This paradox refers to a situation in which organizations use formalization as a means of increasing customer-orientation or responsiveness, even though formalization may also lead to inflexibility and rigidity. The literature recognizes the ordering process as important for achieving responsiveness, but little is known about the formalization of the ordering process. We have therefore conducted this study in order to obtain a better understanding of formalization of the ordering process.

This study addresses formalization of the ordering processes in manufacturing companies from three main perspectives: logistical decision-making, information processing, and organizational setting. We used this model to operationalize formalization of the ordering process. We further developed a conceptual model of relationships among variables related to formalization of the ordering process and a taxonomy of order-processing situations based on characteristics of demand and production. These elements together form the framework for describing and analyzing formalization of the ordering process. In this last chapter we look back at this study and the results of this study. Section 9.2 summarizes and consolidates the framework that we have developed. Section 9.3 describes the results of applying the framework, and Section 9.4 focuses on its diagnostic value. In Section 9.5, we present suggestions for further research.

9.2 Consolidation of the framework

The framework developed in this study consists of a model of the ordering process, an operationalization of formalization of the ordering process, a conceptual model of
related variables and relationships among these variables, and a taxonomy for classifying ordering processes. Table 9.1 presents a summary of the framework.

Table 9.1 Overview of the elements and description of the framework

<table>
<thead>
<tr>
<th>Elements</th>
<th>Description of the framework</th>
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| Model of the ordering process (Chapter 2)    | Coordination of demand and production plays a central role. The ordering process has three dimensions:  
- Logistical decision-making  
- Information processing  
- Organizational setting |
| Operationalization of formalization of the ordering process (Chapter 3) |  
**Logistical decision-making**  
Operational decisions within the ordering process may be formalized by managerial agreements between Sales and Production (Section 3.3).  
**Information processing**  
Information flow within the ordering process may be formalized by a prescribed sequence of information-processing activities, and information requirements may be formalized by the use of formalized ways of information processing (Section 3.4).  
**Organizational setting**  
The organizational setting may be formalized by defining tasks and responsibilities, a hierarchical structure, and a lateral consultative structure (Section 3.5). |
| Conceptual model and taxonomy (Chapter 4)    |  
**Influencing variables**  
Characteristics of demand (especially uncertainty) and characteristics of production system (especially flexibility) influence the structuring of the ordering process.  
On the basis of various combinations of characteristics of demand and production, four different patterns of order processing are classified.  
**Complexity and degree of formalization of the ordering process**  
The complexity of the ordering process (characterized by task routinization, interdependency, and ambiguity), and the degree of formalization of the ordering process vary for each order-processing pattern. The complexity of the ordering process is related to the degree of formalization of the ordering process.  
**Effects of formalization of the ordering process**  
The degree of formalization of the ordering process may influence the efficiency of order processing and may also contribute to balancing the responsiveness and efficiency of production. |
Model of the ordering process

The central role of the ordering process in coordinating demand and production forms a starting point for modeling the ordering process. Modeling the ordering process as a process in which coordination of demand and production plays a central role revealed three dimensions of the ordering process: logistical decision-making, information processing, and organizational setting (Chapter 2).

To model the ordering process, we used Actor Activity Diagramming as a tool for modeling information flow, actors involved, and moments of consultation (first element of the framework). The use of Actor Activity Diagramming was helpful in describing both the information flow and the organizational setting of the ordering process. With respect to logistical decision-making within the ordering process, the Actor Activity Diagramming was also helpful in identifying moments in which decisions were not formalized by decision rules (consultation moments).

Operationalization of formalization of the ordering process

We used the model of the ordering process to conceptualize and operationalize formalization of the ordering process. Formalization is defined as the degree to which decisions, activities, and working relationships are controlled and coordinated by formal explicit rules and procedures. On the basis of this definition and the model of the ordering process formalization is operationalized for each of the three dimensions of the ordering process.

Regarding formalization of logistical decision-making, managerial agreements between Sales and Production (structural coordination) formalize operational decisions within the ordering process. Identifying these managerial agreements for each operational decision that must be made within the ordering process can thus serve as an operationalization for formalization of logistical decision-making. With respect to the formalization of information processing, a prescribed sequence of information-processing activities formalizes the flow of information. In addition, the use of formalized ways of information processing formalizes information requirements. In this way, we can operationalize the formalization of information processing by identifying the flow of information and procedures for processing information for each information requirement within the ordering process. Regarding formalization of the organizational setting, a defined hierarchical structure, defined tasks and responsibilities, and a defined lateral consultative structure are all means of formalizing the coordination of Sales and Production.

Operationalizations of formalization for each dimension of the ordering process resulted in a detailed overview of ways of formalizing logistical decision-making (see Table 3.1), information processing (see Tables 3.2 and 3.3), and organizational setting (see Table 3.4). These detailed operationalizations contribute to the detailed, structured analysis of the degree of formalization of the ordering processes in manufacturing companies.
The conceptual model and the taxonomy

The conceptual model provides a basis for studying relationships among the influencing variables, the degree of formalization of the ordering process, and its effects. The central idea of the conceptual model is that characteristics of demand and of the production system influence both the complexity and the degree of formalization of the ordering process. In this study, complexity of the ordering process is characterized by task routinization, interdependencies among the actors involved in order processing, and ambiguity in the goals and interests of the parties involved in order processing. By defining order-processing patterns according to characteristics of demand (especially uncertainty) and production (especially flexibility), we introduced a taxonomy for classifying four different order-processing patterns. Using this taxonomy, we analyzed the relationship between complexity and the degree of formalization of the ordering process. Besides influences of demand and production, we identified two other influencing factors, the use of ERP and the presence of a clear operations strategy.

The framework facilitates the description and analysis of the degree of formalization of logistical decision-making, information processing, and the organizational setting of ordering processes within manufacturing companies. With respect to integrating the various perspectives, several studies integrate insights from operations management and organizational studies to examine the coordination between Sales and Production (see for instance Konijnendijk, 1992; Crittenden et al., 1993). Another example is the study by De Vries (1999) on the organizational embeddedness of logistical control. The present study is broader, as it makes use of insights from more perspectives. It is also more detailed because of its focus on a specific business process. In addition, this study contributes to developing a framework for studying a business process on a detailed level using insights from several perspectives. Results obtained from applying the framework are discussed in the next section.

9.3 The results of applying the framework

In our empirical research, we applied the framework for describing and analyzing formalization of the ordering process in five order-driven manufacturing companies. As shown in the description of the five cases (Chapter 6) and the within-case analyses (Chapter 7), the framework is useful in describing and analyzing the ordering process in general and the degree of formalization in particular.

Using the framework allowed us to capture the influence of characteristics of both demand and production on complexity and formalization of the ordering process. The application of the framework also showed the effects of formalization of the ordering process on the efficiency of order processing and on the balance between
responsiveness and efficiency of the production system. We have already discussed the main conclusions regarding the application of the framework in more detail in Section 8.6. One of the main conclusions is that characteristics of demand and production influence the complexity of the ordering process in coordinating demand and production. Complexity is fairly low in order-processing situations combining certain demand with not flexible production (the passing-on pattern). Complexity, particularly the interdependency between Sales and Production, is higher in order-processing situations combining uncertain demand with flexible production (the puzzle-solving pattern). The most complex order-processing situations are those combining uncertain demand with not flexible production systems (the compromising pattern). Complexity in compromising patterns is characterized not only by high interdependency but also by a high degree of ambiguity between Sales and Production.

We further provided a more precise analysis of the relationship between the complexity and the degree of formalization of the ordering process. Evidence strongly indicated that the degree to which logistical decision-making within ordering processes is formalized is lower when the ordering processes is complex, while the degree of formalization of the organizational setting is higher in complex ordering process. Moreover, we found strong indications that complex order-processing situations combine a fairly low degree of formalization of logistical decision-making with a fairly high degree of formalization of the lateral consultative structure.

With respect to the degree of formalization of information processing, we concluded that there is very little variation among the various order-processing patterns. In all order-processing patterns the formalization of the information processing seem to be influenced by the use of an ERP-system. The ERP-system prescribes the sequence of information-processing activities and supports the formalization of information processing concerning information requirements.

The results of this study concerning the effects of formalization of the ordering process suggest that the positive effects of formalizing logistical decision-making are related to the clarification of priorities in regard to trade-off decisions between customer-responsive and cost-conscious action, and to reducing ambiguities among the parties involved. The positive effects of formalizing information processing relate to both the speed and the efficiency of order processing. The positive effects of formalizing the organizational setting relate to achieving responsiveness, as they involve the ability to respond flexibly to customer requests. The negative effects of formalizing the organizational setting relate to the relatively high costs of coordination, using a formalized lateral consultative structure. Another important result of this study is that interactions among the three dimensions and the related degree of formalization of the ordering process are particularly useful for manufacturing companies seeking to achieve a balance between responsiveness and efficiency. The findings indicate that formalized lateral consultative structures for controlling and coordinating trade-off decisions can
compensate for the lack of structural coordination between demand and production. In other words, this study shows that varying the degree of formalization for each of the three dimensions of the ordering process affects the balance between responsiveness and efficiency positively.

9.4 Diagnostic value as perceived by the companies involved

To discuss the practical value of the framework, we rely on the diagnostic value perceived by the managers of the companies participating in the empirical research. As mentioned in Chapter 5, we presented case study reports to each of the five participating companies. The case study reports were written with a primary focus on diagnosing the ordering process and the degree of formalization of the ordering process, resulting in a report of the strengths and weaknesses of the ordering processes involved. We conducted a review session concerning the case study report in each company. During these review sessions, we explicitly asked managers to comment on the diagnostic value of the framework we used, based on the following issues:

- completeness of the description of the ordering process
- clarity of the three dimensions of the ordering process
- analysis of the ordering process using the Actor Activity Diagram
- analysis of the degree of formalization for each dimension
- utility of insight into the degree of formalization for each dimension
- adequacy of diagnosing the strengths and weaknesses of order processing
- ideas for improving the structuring of the ordering process

The companies agreed that the descriptions of the ordering process were complete and presented a correct overview of the ordering process. The Actor Activity Diagram was seen as a valuable instrument for modeling the ordering process. Although many of the problems that were diagnosed were already known within the management of the companies, each company stressed the relevance of having an overall picture of the ordering process and of the inter-relatedness of the problems.

Managers also considered the analysis of the degree of formalization of the ordering process according to the three dimensions to be helpful. The contribution was particularly relevant to several insights obtained through the analysis. First, the managers gained further insight into decisions concerning order processing, the flow of information, and the moments of consultation during order processing. Second, the managers became aware of superfluous activities within the ordering process. These superfluous activities included double checks in order processing and several consultations at different points during the ordering process regarding the same subject. Third, the managers became conscious of different ways of formalizing the ordering
process and the variety in the degree of formalization. According to the managers, the idea of varying the degree of formalization for each dimension gave them particularly valuable insight into how to cope with complexity of the ordering process. In this respect, the managers stressed the value of understanding the relationship between formalization of the ordering process and the reduction of ambiguity among the various parties involved, as well as the relationship between formalization and managing a balance between efficiency and responsiveness.

In all five companies, the case study reports were used as an initial step in improving the ordering process, and the management in three of the five companies adopted some of the proposed improvements.

On the basis of the results of the review sessions, we conclude that the framework has practical value for capturing relevant aspects of the ordering process. More importantly, the framework offers an instrument for diagnosing the degree of formalization of the ordering process related to performance in balancing responsiveness and efficiency.

9.5 Suggestions for further research

This study developed a framework for describing and analyzing formalization of the ordering process and applied it in five manufacturing companies. The companies selected for the study were characterized primarily by customer-specific demand and order-driven production systems, as discussed in detail in Chapter 5. Because three of the five companies, however, had two distinct order streams, each with different demand or production system characteristics, we applied the framework to eight different order streams (see Section 8.2). Analysis of the eight different order streams allowed us to discuss important relationships and issues associated with structuring the ordering process. Because of the limited number of cases, the analysis resulted primarily in the identification of strong indications of the relationships as discussed. Future research should therefore try to expand the analysis to a larger number of manufacturing companies in order to ensure more generalizable results. In addition, the framework should be refined through further exploration of the relationships found in this study. For purposes of generalization, a survey conducted in a large number of comparable manufacturing companies on the basis of the insights of this study and its elaborated framework, would probably be helpful.

In addition to refining the framework by applying it to a large number of comparable manufacturing companies, it could also be refined by studying relationships found in other types of manufacturing companies. As mentioned, this study has applied the framework to medium-sized, order-driven manufacturing companies with job shop environments. This raises the question of whether the framework can also be applied to other types of manufacturing companies in which the coordination of demand and
production plays an important role in order processing. Future research should therefore focus on applying the framework in a variety of settings, including larger companies, companies in the semi-process industry, and engineer-to-order environments.

The insights from various perspectives have proven particularly fruitful for studying the ordering process. By identifying three dimensions of the ordering process, we made a first step toward integrating insights from various fields. In order to gain a deeper understanding of the complex issues related to formalizing ordering processes, future research should focus on the deeper analysis of insights, models, and theories from other fields relating to the structuring of ordering processes in general, and to formalization in particular. In this respect, we refer to the importance of the interface function of the ordering process. The interface function could be studied further by integrating insights from the behavioral studies on related issues, including social interaction among actors involved in order processing and the effects of the distribution of power among the parties or actors involved. The study by Wijngaard, De Vries, and Nauta (2004) on operational networks can be seen as a first step toward integrating the insights from operations management and behavioral studies in studying relevant interface functions in manufacturing companies. More elaborate and in-depth case studies on the role of operational networks in manufacturing companies, and particularly the role of these operational networks in order processing, seems to be a logical step for further research.