

The effect of intra-organizational routines and inter-organizational routines on collaborative
innovation performance.

An experiment.

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Number of words (excl. title, abstract, references and appendices): 7.862

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Abstract

This study examines the effects of intra-organizational routines and inter-organizational routines on collaborative innovation and efficiency performance. Intra-organizational routines are the routines that exist within each partner firm and are brought into the collaboration. In this study they were operationalized as serial or parallel work routines. Inter-organizational routines are the routines that are developed in the collaboration itself and is operationalized as task variety within the collaboration. In an experimental design the effects of supplementary (similar intra-organizational routines that are used) vs. complementary (different intra-organizational routines that are used) alignment on collaborative innovation and efficiency performance was tested. Also the effects of inter-organizational routines on collaborative innovation and efficiency performance were studied. The results showed that a complementary intra-organizational routines alignment affected the collaborative performance (innovation and efficiency) more positively than a supplementary intra-organizational routines alignment. Inter-organizational routines were found to have an U-shaped effect on collaborative innovation performance. For inter-organizational routines, no effects were found on efficiency.

Acknowledgement

I hereby would like to thank Mark Jansen (University of Twente), Joost Klappe (Corus), Raymond Loohuis (University of Twente), Ariane von Raesfeld-Meijer (University of Twente), and all the participants (mainly students of the School of Management and Governance of the University of Twente) for their contribution to this study.

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Many organizations throughout the world are engaged in some form of collaboration with one or more partners. These collaborations are initiated for many different reasons, for instance from a strategy, costs, resources, or learning perspective (Chen, Wang, Chen & Lee, 2010); usually to achieve competitive advantage for the partners (Das & Teng, 2000). Collaborations come in diverse types, and are typically categorized in equity arrangements such as joint ventures or non-equity arrangements and labeled strategic alliances (Gulati, 1995). Despite many advantages of collaborating are recognized, many of these collaborations do not work out as well as they were supposed to do; Park and Ungson (2001) even indicate that more than half of the alliances fail. In search for understanding how and why some collaborations are successful and others are not, researchers have tried to identify the determinants of collaborative performance from different angles.

Two different research streams explaining alliance performance can be identified (Lui & Ngo, 2005). One focuses on initial factors or conditions that partner firms bring into the collaboration or that are formed before the collaboration begins. The other brings in the process and development of the collaboration as an variable explaining the alliance outcomes. Most research has been focused on the initial factors like firm size, equity control, and resources. Primarily resources that the partner firms bring into the collaboration, and the degree to which these resources are similar or complementary to each other, have been the focus of many studies (e.g. Bierly & Gallagher, 2007; Das & Teng, 2000; Das & Teng, 2003; Saxton, 1997). This notion is based on the resource-based theory of firms (see for an overview of the basic theory Barney, 1991) applied to collaborations (the different partners in a collaboration bring in various resources).

Doz (1996) acknowledges the importance of initial conditions, but adds the process aspect into the equation. His study shows that successful alliances are highly evolutionary and go through a sequence of interactive learning, reevaluation and readjustment cycles. Unsuccessful alliances are, in contrast, highly inertial and with little learning. Doz (1996) suggests that initial conditions may lead to fixed processes that make alliances highly inertial or they may lead to generative and evolutionary processes that make alliances highly adaptive. It all depends on how the initial conditions are set.

Also Kale and Singh (2009) admit the influence of initial conditions and process aspects on alliance performance. However, they depict different conditions and process aspects than Doz (1996) as being important. As Doz (1996) finds learning cycles having an effect on alliance outcomes, Kale and Singh (2009) believe that alliance governance, use of coordination mechanisms, development of trust etc. do have their effect on alliance performance. Initial conditions between the two are partly overlapping, however, presented in a different way. As Doz (1996) recognizes task definition, interface structure, expectations of performance, behavior and motives, and partners' routines as initial conditions; Kale and Singh (2009) define partner complementarity, compatibility, commitment, and different governance and design factors as initial conditions.

This study combines more or less the views of Doz (1996) and Kale and Singh (2009) and focuses on the effects of one initial condition (partners' routines or intra-organizational routines) and one process aspect (inter-organizational routines) on alliance innovation performance (as in new product development). Studies on measuring the success of collaborations, especially in innovation, are still relatively rare (Ojanen & Hallikas, 2009). Furthermore, the effects of routines (whether they are intra-organizational or inter-organizational) on collaborative innovation performance is not well studied nor understood. As routines are generally regarded as key elements of organizational structure (Espedal, 2006)

and are seen as the primary means by which organizations accomplish much of what they do (Feldman & Pentland, 2003), routines seem to be a very important aspect of collaboration. Therefore, the question in this study is to what extent do intra-organizational and inter-organizational routines affect collaborative innovation performance?

The effects are described in two different studies: one focusing on the effects of intra-organizational routines, the other focuses on the effects of inter-organizational routines on collaborative new product development.

STUDY 1

THEORY AND HYPOTHESES

As Doz (1996) pointed out, organizational routines are one of the initial conditions of a collaboration which affect the collaborative performance. In this study the term ‘intra-organizational routines’ is used, to better distinguish between these routines and the routines that are developed in the collaboration (inter-organizational routines) as is the subject in study 2.

Doz (1996) found that the initial conditions, hence organizational routines, facilitate or hamper learning in the collaboration. The amount of learning cycles in the collaboration (and the resulting right evaluations and readjustments) affects the success of the collaboration. In his study, the author found that when there existed discrepancies in routines between partners in a collaboration, there were conflicts, tension and members opting-out of the relationship. It also appeared that the intra-organizational routines that were brought into the collaboration became baffling, disconcerting and finally aggravating to members of the collaboration. From

Doz' study it can be concluded that discrepant intra-organizational routines that partner firms bring into the collaboration affect collaborative performance negatively.

However, there is much research that argues otherwise. For this, it is necessary to take a step away from organizational routines and dig into a field of research that is adjacent and partly overlapping with this study. As is already pointed out in the introduction, Kale and Singh (2009), among others, argue that partner complementarity and partner compatibility are important factors for collaborative success. Partner complementarity is the extent to which a partner contributes nonoverlapping resources to the relationship, while partner compatibility refers to the fit between partners' working styles and cultures (Kale & Singh, 2009). According to Kale and Singh (2009) do "resource-based theories suggest that the greater the complementarity between partners the greater the likelihood of alliance success" (p. 47). Let us take a closer look at this statement.

Dyer and Singh (1998) were the first authors who recognized resources as important determinants of collaborative performance. They argue that collaborating partners should combine and invest in resources in order to create competitive advantage. Das and Teng (2000) elaborate further and introduce 'resource alignment' as an important factor for collaborative performance. Resource alignment "refers broadly to the pattern, whereby the resources of partner firms are matched and integrated in an alliance" (Das & Teng, 2000, p. 48). Hence, it is not merely the input of different resources, however, it also takes into account whether these resources are similar and are utilized in the collaboration. Resource similarity will be high if two partners contribute comparable amounts of similar types of resources to a collaboration. Resource utilization is the degree to which the resources contributed by the partners are utilized for achieving the goals of the alliance (Das & Teng, 2000). In some way, this could be perceived as resources being compatible. If they were not compatible, the resources could not be utilized. The authors distinguish four types of resource

alignment: supplementary, surplus, complementary, and wasteful. In a supplementary resource alignment, the resources that the different partners bring into the collaboration are similar and are utilized in the collaboration. When similar resources are brought into the collaboration, but these are not utilized, Das and Teng (2000) denominate this as surplus. For resource alignment to be complementary, two conditions are necessary: the resources have to be dissimilar and also performing. Here, Das and Teng (2000) pass the notion, which is common in literature, that complementary resources mean dissimilar resources. Often complementarity is measured on a similarity scale, denoting dissimilarity as being complementarity. Das and Teng (2000) argue that “complementary alignment is not equivalent to resource diversity, as dissimilar resources may not be compatible” (p. 50). When partners bring in different resources and these resources are not fully used, this is called wasteful resource alignment (Das & Teng, 2000). See table 1 for an overview of the different resource alignments.

<i>Resource similarity</i>	<i>Resource utilization</i>	
	<i>Performing resources</i>	<i>Nonperforming resources</i>
<i>Similar resources</i>	Supplementary	Surplus
<i>Dissimilar resources</i>	Complementary	Wasteful

Table 1 - *Typology of Inter-Partner Resource Alignment (Das & Teng, 2000)*

Whether resource alignment should be supplementary or complementary is an issue researchers seem to disagree about. Cohen and Levinthal (1990), for example, argue that the more similar the firms’ technological knowledge is, the more quickly this knowledge can be commercially exploited. However, while Das and Teng (2000, 2003) acknowledge this advantage of similar resources, they argue that when partner firms provide the collaboration with dissimilar resources (and these resources are fully utilized) this could affect collaborative

success positively. Wittman, Hunt and Arnett (2009) found support for this argument in their empirical study. They sent out a questionnaire to managers in different organizations asking about their experiences in collaborations. One of the topics was to what extent the different partners contributed different resources to the collaboration that helped achieving mutual goals. They found that complementary resources ultimately affected alliance performance. Also Murray and Kotabe (2005) findings support this latter view and they argue (however not tested it) that in collaborations with a skill-sharing motive the collaborative performance will be positively affected by heterogeneous and complementary resources, while when efficiency or economies of scale are wanted to be realized, there is a need for more similarity. As Das and Teng (2000) argue for more research to clarify the effects of similarity and complementarity in resource alignment, Murray and Kotabe (2005) pointed out a seemingly important variable: the measure of the performance of the collaboration (innovation of economies of scale/efficiency). This is in line with Miotti and Sachwald (2003) who argue that if partners aim at reducing costs and risks through economies of scale they need to go for similar resources in the collaboration. If partners aim at innovation instead, they need to combine complementary resources. See table 2 for an overview of the literature concerning similar and dissimilar resources and their effect on collaborative performance.

	<i>Empirical / not empirical</i>	<i>Findings / statements</i>
Miotti and Sachwald (2003)	Empirical	Economies of scale: need for similar resources. Innovation: need for complementary resources.
Murray and Kotabe (2005)	Empirical	Complementary resources positively affect collaboration performance (efficiency, competitiveness).
Wittmann et al. (2009)	Empirical	Dissimilar resources positively affect

		collaborative performance (financial performance)
Cohen and Levinthal (1990)	Not empirical	Similar resources positively affect collaborative performance (technological knowledge).
Das and Teng (2000)	Not empirical	Similar and dissimilar resources could affect collaborative performance positively.

Table 2 - Overview of literature on similar/dissimilar resources and their effect on performance

As this short overview shows, there is little empirical evidence that these arguments are true. Just a few empirical studies exist on the topic (e.g. Miotti & Sachwald, 2003; Murray & Kotabe, 2005; Wittmann et al., 2009) of which the study of Wittmann et al. (2009) is closest to empirically studying the effect of (dis)similar resources on collaborative performance. However, in this study a slightly different focus is used. First of all, this study focuses on just one variable (intra-organizational routines). Second, Wittmann et al. (2009) used financial collaborative performance as the dependent variable. They asked for joint profits as well as profits for the focal firm. This financial focus is different than the new product development focus of this study and might give different results.

In this study it is not argued that intra-organizational routines are resources (although there might be some arguments that they are), however, the discussion about complementarity might also hold for routines and their effect on collaborative performance. The explanation is twofold. First, routines could be perceived as being some kind of skill. Therefore, routines, may act as skills. Skills are a knowledge-based resource according to Das and Teng (2000). “Others cannot easily copy or imitate knowledge-based resources, because they are vague and ambiguous.”(p. 42). Second, one could argue that when intra-organizational routines differ

among partners in a collaboration, there is room to learn from each other. According to Doz (1996) this might not be the case, however, the author pointed out that because of the discrepancies in the routines, conflicts emerged. Some amount of conflict is being recognized as positively affecting innovation performance (Gebert, Boerner & Kearney, 2006; Troyer and Youngreen, 2009). Or another reason might be that the discrepancies between the routines were so large that the routines were not compatible anymore. But mainly, researchers seem to agree to a great extent that some degree of differences between partners in a collaboration is beneficial for innovation performance. Therefore, hypothesis 1 states:

H1: Complementary intra-organizational routines affect the overall collaborative innovation performance more positively than supplementary intra-organizational routines.

Since literature suggests different effects for collaborative innovation and efficiency, this study also takes into account the efficiency with which the collaborating partners worked together. According to Miotti and Sachwald (2003) and Murray and Kotabe (2005) this would lead to the following hypothesis:

H2: Supplementary intra-organizational routines affect the collaborative efficiency performance more positively than complementary intra-organizational routines.

METHOD

Design and participants

To test the hypotheses, a one factor (intra-organizational routines alignment, two levels: supplementary vs. complementary) between-subjects experimental design was used. In this study the goal is to study causal relationships. The primary tool for studying these kinds of relationships are experiments (Babbie, 2007, p. 239). There is a body of literature on the topic

addressed in this study, however many propositions are not yet empirically tested, an experiment seems to be appropriate to confirm causal relationships. An experimental research method is commonly used in the social sciences, mainly in economical and social psychological studies. Nowadays, the experimental design has begun to be utilized in the field of strategic management (Agarwal, Croson & Mahoney, 2010). By using experiments, researchers are able to test the proposed theories by the implementation of different treatments corresponding to each while controlling for factors that may confound with these mechanisms in the real world (Agarwal, Croson & Mahoney, 2010). Furthermore, this experimental design enables the use of operationalizations of the dependent variables (efficiency and collaborative innovation performance) that are not possible in real-life situations. When studying real-life data, researchers must cope with high diversity (in markets, products, financial outcomes, firm size etc.). In this experimental setting, diversity is set to a minimum, allowing only the manipulations and collaborative performance to be different. This makes comparison less ambiguous.

Different than in psychological experiments, where the unit of analysis is an individual, in organizational research, the unit of analysis is an organization generally consisting of more than one individual. Some researchers succeeded to test hypotheses on organizational theory by experimenting with one or two individuals as the unit of analysis (e.g. Agarwal, Croson & Mahoney, 2010; Bidault & Castello, 2009; Seale, Arend & Phelan, 2006). In this study the unit of analysis is a collaboration of two organizations, each represented by three individuals, creating a collaboration of six individuals.

The experiment was constructed in such a manner that relational rent was generated through the combination of resources and capabilities which resulted in the joint creation of unique new products. According to Dyer and Singh (1998) relational rents could only fall in to four categories:

1. Combination of resources and capabilities;
2. Investments in relation-specific assets;
3. Substantial knowledge exchange, including the exchange of knowledge that results in joint learning;
4. Lower transaction costs than competitor alliances owing to more effective governance mechanisms. (p. 662)

192 college-students took part in the experiment. The participants were randomly assigned to a group of 3 for the treatment, after which groups of 6 (2 x a group of 3) were formed. A total of 32 groups were formed. Data of 190 participants (of which 95.8% had an age between 17 and 28) were included in the dataset, due to questionnaires that were not handed in. 132 of these participants were male, 58 were female. For analysis reasons, three groups were omitted from the analysis of effects, resulting in 29 groups. All the participants received an incentive for their participation (a lottery ticket which cost € 3.-).

Before the experiment was executed, a pre-test (or pilot) was done. This pre-test was intended to give insight in the adjustments needed in the procedure and manipulations, questionnaires etc. After analysis of the pre-test's results, some small adjustments in the questionnaire were made whereupon the actual experiment could be executed.

Procedure

The procedure consisted of three phases:

1. Learning of routine;
2. Collaboration;
3. Questionnaire.

Every phase took about 30 minutes, except for the collaboration phase, which took exactly 30 minutes.

Each participant was randomly assigned to one of the two conditions (supplementary or complementary collaboration). In every condition 6 participants collaborated. In order to obtain those two conditions, participants had to undergo a treatment procedure. This is the first phase of three in the experiment.

Before the manipulations can be tested, the participants need to be prepared for their conditions they are assigned to. Reason for this is that the participants do not yet have the intra-organizational routines needed. These need to be acquired in the first phase of the experiment; the treatment procedure. The intra-organizational routines differ in such a way that one is cost serial production, and the other is parallel production. In the serial routines condition, participants produce large series of models in a serial manner (the group works together to produce every model). They know in advance what model needs to be made in what quantity. For parallel routines condition, small series (of one model at a time) are made in a parallel manner (the group members work individually on one model). Participants do not know in advance which model is needed. The groups in both treatments made 3 different models of wings or fuselages. The tool used for acquiring skills, and which is also used in the collaboration, is Stickle Bricks. This is a construction toy with which many different shapes can be constructed. Both teams make different 'products' out of their assortment of Stickle Bricks; wings or fuselages, in order to assemble airplanes in the collaboration. This first phase took 30 minutes.

Then, in the second phase, the actual experiment started. The conditions were set and both teams could be brought together in the collaboration. The collaborations took place in different rooms than in which the individual teams learned their skills. In the collaboration, the organizations needed to address a number of customer's problems in an innovative way

(producing different kinds of planes). For a solution they needed to work together. The problems were stated somewhat vaguely (only the name of the plane model was given) in order to give the possibility to be creative and innovative, and to be able to compare the solutions to analyze the collaboration's performance. However, some boundaries were given, for instance to be sure that all participants took part in the collaboration. The collaborations themselves could decide the time they (wanted to) spend on one single problem. When they conclude that they have a solution, they can continue with the next problem. In doing so, the number of problems addressed could be measured. This second phase also took 30 minutes.

In the third phase of experiment, the collaboration is ended and all participants returned to the initial room. Here, they were asked to fill out a questionnaire (approximately 20-30 minutes). During the second phase of the experiment, in the rooms of all collaborations camera's were placed in order to record all activities of the participants. The recordings can be used in a later stadium (future research) to produce more objective data to which the results of this study can be compared to and to test other hypotheses.

Independent variable

Intra-organizational routines alignment. Intra-organizational routines alignment in the collaboration is the independent variable in this study. This is operationalized in supplementary and complementary intra-organizational routines. These routines are manipulated in the experiment and are induced by the procedure. Two different forms of intra-organizational routines are taken into account: serial and parallel work routines. Combinations of these routines construct supplementary or complementary intra-organizational routines alignment in the collaborating groups. Supplementary groups consist of either two groups that are used to work in a serial manner, or two groups that have

experience working in a parallel fashion. Complementary groups consist of one group that is accustomed to work serially, and the other group has been taught to work in a parallel way.

Dependent variables

The ultimate dependent variable is the collaboration's performance measured by innovation and efficiency. Innovation is very difficult to quantify and as such, there is no universally accepted measure. A number of studies have used patent counts as an appropriate proxy (Tomlinson, 200). This experiment, however, allows different measures of collaborative innovation performance than in real-life situations. Commonly used measures are (besides patents) the number of innovations brought onto the market, or more subjective measures like perceptions of people within the organization (see for an example Lai & Chang, 2010). In this experimental study, all the collaborations needed to produce the same kind of new products (airplanes), which are comparable among each other. The collaborative performance is divided into innovation and efficiency performance.

Collaborative innovation performance. The collaborate innovation performance can be calculated and will be done in two different ways. The first method to be used for this calculation is derived from the study of Troyer and Youngreen (2009); innovativeness is determined by calculating the frequency of each solution across all collaborations in all conditions of the experiment as a proportion of the total number of solutions generated (for each separate problem). The inverse of that proportion will be taken (for interpretability reasons), resulting in a higher value for a more innovative solution. In this way, every solution will be given an innovativeness score. In this study, the collaborations constructed (airplane) solutions. A total of 15 solutions could be made, however, many groups did not reach this amount. These 15 solutions were 15 different airplane models. For calculating an innovation score every one solution of a collaboration was rated against all other solutions within the

model made by the other collaborations. Since not all solutions may be exactly the same, two researchers scored every solution against every other solution within a model for similarity. An inter-rater reliability analysis using the Kappa statistic was performed to determine consistency among raters. This reliability statistic was calculated for three models, ranging from .73 to .81, which means substantial to almost perfect agreement (Landis & Koch, 1977). An index for the innovation score was created by the mean of innovativeness scores for the solutions given by the collaboration.

The second method for calculating the collaborative innovation performance is by using the average number of standard templates used. Standard templates are taught during the first part of the experiment. For each solution given in the collaboration the number of standard templates were counted by the researchers and were averaged for the total number of solutions given (as this might differ among collaborations).

Collaborative efficiency performance. Collaborate efficiency performance is measured by the number of solutions given by the collaborating group and can be counted easily. This is done by the researchers after the collaboration is ended.

RESULTS

A MANOVA analysis was used to test to what extent intra-organizational routines alignment had an effect on collaborative innovation performance (hypotheses 1 and 2). The multivariate main effect of the routines alignment on collaborative performance was significant ($F(3,24) = 5.41, p < .01, \text{partial } \eta^2 = .40$).

The univariate test for the effect of intra-organizational routines alignment on the number of templates that were used showed significance ($F(1,26) = 9.02, p < .01, \text{partial } \eta^2 =$

.26). The means showed that the supplementary groups ($M = 3.05$, $SD = 1.69$) used more standard templates than the complementary groups ($M = 1.37$, $SD = 1.27$), supporting the hypothesis that complementary groups are more innovative than supplementary groups (hypothesis 1).

Also the univariate effect of intra-organizational routines alignment on the innovation score, turned out to be significant ($F(1,26) = 12.32$, $p < .01$, partial $\eta^2 = .32$). Complementary groups ($M = .93$, $SD = .03$) showed a significantly higher innovation score than supplementary groups ($M = .90$, $SD = .03$). Also the result of this analysis supports hypothesis 1; complementary groups are more innovative than supplementary groups.

The univariate effect of intra-organizational routines alignment on the number of models made turned out to be significant ($F(1,26) = 4.96$, $p < .05$, partial $\eta^2 = .16$). The complementary groups ($M = 13.76$, $SD = 1.56$), made more models than the supplementary groups ($M = 11.73$, $SD = 3.26$). Consequently, hypothesis 2 is not supported by the results. In fact, the effect of intra-organizational routines alignment is contrary to what has been hypothesized; complementary groups are more efficient than supplementary groups. In the discussion paragraph this effect will be elaborated more carefully.

STUDY 2

THEORY AND HYPOTHESES

Partnering relationships produce a set of routines as organizations work together (Ojanen & Hallikas, 2009). These inter-organizational routines have been widely recognized as affecting collaborative performance (e.g. Ojanen & Hallikas, 2009; Zollo, Reuer & Singh, 2002). According to Zollo et al. (2002) inter-organizational routines contribute to this performance of the collaboration. Also Schilke (2007) acknowledges this positive relationship between routines and collaborative performance and argues that collaborative benefits may be improved. However, empirical studies or more theoretical contributions on the topic of inter-organizational routines and their effect on collaborative performance in its broadest sense is minimal, and focuses merely on interaction patterns for the governance of the collaboration (Zollo et al., 2002). Therefore, to get a better understanding of the impact of collaborative routines on collaborative performance (more specifically ‘collaborative innovation performance’), the more common, organizational routines should be explored. The focus here is different than in study 1: in study 1 the effect of the alignment of intra-organizational routines in a collaboration was studied; in this study the focus is on the routines that are formed in the collaboration itself and their effect on collaborative performance.

Many authors describe routines as being important for competitive advantage (e.g. Pentland, 2003; Peng, Schroeder, & Shah, 2008; Webster, 2004). According to Jones and Craven (2001) do outputs from organizational routines include innovation and performance. But what are routines? Peng et al. (2008) define routines:

as regular and predictable patterns of behaviors or the way work is done (Grant, 1991; Teece et al., 1997; Zollo and Winter, 2002). They encompass both standard operating

procedures and patterns of behaviors not explicitly guided by written rules and policies (Ketokivi and Schroeder, 2004a). (p. 733)

The authors also describe that routines are what firms can do as clusters of resources working together, emphasizing the relationship between resources and routines. Feldman and Pentland (2003) state that among researchers there is agreement that organizational routines are repetitive, recognizable patterns of independent actions carried out by multiple actors. In its basic sense, this definition is quite similar to the one Peng et al. (2008) describe.

Researchers seem to disagree on whether routines have a positive or a negative effect on innovation performance, in a broader context also perceived as creative performance. Feldman and Pentland (2003, p. 94) found in earlier work that routines may have a detrimental effect on innovation and creativity: “While recognized as an essential aspect of organized work, organizational routines are also a well-known source of inertia (Hannan and Freeman, 1983), inflexibility (Weiss and Ilgen, 1985; Gersick and Hackman, 1990), and even mindlessness (Ashforth and Fried, 1988)”. The authors recognize that routines are conceptualized as sources of stability, reenacting the past. Pentland (2003) agrees with this view and argues that variability (as opposite to routine) in organizational work processes is believed to influence productivity, quality, and flexibility and some other aspects of organizational design and management. The author states that an organization that can execute a wider variety of processes is more flexible and in competitive environments process variation is positively related to performance. Scott and Bruce (1994) also found similar results in their study in which managers rated employees with routine tasks as less innovative and less creative than employees whose jobs were comprised of less routines.

However, many researchers argue or even found evidence that routines could affect innovation in a positive way. Becker, Lazaric, Nelson and Winter (2005) simply state that this

is not surprising since in some cases routines are designed to produce innovation (e.g. new product development routines). Notwithstanding that Feldman and Pentland (2003) recognize the detrimental effects that routines could have on innovation, they argue that these could have positive effects as well. Feldman and Pentland (2003) state that routines could be important sources of flexibility and change since they could involve adapting to contexts that require either idiosyncratic or ongoing changes and reflecting the meaning of actions for future realities. Therefore, routines can generate variety. Ohly, Sonnentag and Pluntke (2006) agree with this view, however, they differ in their reasoning why routines could have a beneficial effect on innovation and creativity. These authors argue that mental resources are freed when a certain behavior is practiced often, as in a routine. This means that routinization enhances creativity by enabling employees to think more about their work. Consequently, problems might be discovered and new ways of solving these problems can be thought through. Employees have time available to think about the task and to develop new ideas, a precursor of creativity. Hence, routines are positively related to creativity (Ohly et al., 2006). The authors found support for this idea in their study testing the effect of routine on creative and proactive behaviors in a randomly selected sample of 278 employees of a German high-tech company. Beside these studies, also Espedal's (2006) study adds to the notion that routines could both be beneficial and detrimental to innovation. His argument is supported by a case study and includes that routines become a source of exploration and adaptiveness when heedful interaction is in place, and they lead to exploitation, inertia and carelessness when heedless interactions are present.

Besides these linear relationships between routine and performance, evidence can be found for a curvilinear effect. Gilson and Shalley (2004) found an inverted U-shaped function of routine on creative performance. Their rationale holds that employees need to have enough knowledge about their tasks to be able to contribute creative ideas. However, high levels of

this knowledge also may lead to the tendency to adhere to strict routines rather than seeking out new and creative ways of performing. Therefore, Gilson and Shalley (2004) state that a moderate amount of routine affects creative performance positively.

The preliminary discussion concerns organizational routines and their effects on (innovation) performance. However, in this study the focus is on inter-organizational routines and collaborative (innovation) performance. Therefore, the views of organizational routines are extended to inter-organizational routines. The discussion does not lead to one outstanding line of thought. Therefore, three (partially) contradicting hypotheses are formulated:

H3a: Inter-organizational routine has a negative effect on collaborative innovation performance.

H3b: Inter-organizational routine has a positive effect on collaborative innovation performance.

H3c: Collaborative innovation performance is an inverted U-shaped function of inter-organizational routine.

What about the effect of routine on efficiency? Feldman and Pentland (2003) indicate that routines have an enhancing effect on efficiency. Also Webster (2004) states that inertia in routines ensures that companies operate efficiently. Ojanen and Hallikas (2009) argue that certain routines are developed to reach efficiency (besides routines that are aimed at innovation). Ohly et al. (2006) give a more in-depth view why routines could have a positive effect on efficiency. They argue that this effect lies in the basic notion of what a routine is and how it is developed. Routines develop through the repeated execution of certain behavior, or through practice. During this process, the performance becomes faster leading to better efficiency. Hence, the following hypothesis can be stated:

H4: Inter-organizational routine has a positive effect on collaborative efficiency performance.

METHOD

Design, participants and procedure

To test the hypotheses, a one factor (routine, scale items) between-subjects experimental design was used. The procedure of the study was the same as in study 1. This means that a total of 192 individuals participated in this study. Of these 192 participants data was gathered for 190 participants (132 male, 58 female). All the participants received an incentive for their participation (a lottery ticket with a value of € 3-). The data was collected following the procedure in study 1.

Variables

Independent variable: Inter-organizational routine. Becker (2005) indicates four different methods for studying routines as in recurrent interaction patterns: identifying repeated sequences; identifying fixed condition-action rules; identifying task variety and analyzability; and identifying the content, process and sequence of recurrent interaction patterns. In this study, the focus is on the degree of routine in the work processes during the collaboration. This can be measured using the 'Type of Task' scale as was developed by Jehn (1995). The scale consisted of 19 items which are rated on a 5-points Likert scale. The scale measured the extent of routine in the form of task variety in the work participants accomplished in the collaboration. Examples of items are (see Appendix A for the questionnaire): 'I encountered a lot of variety in the work during collaboration' (strongly disagree / strongly agree), 'To what degree were there set patterns in your work?' (not at all /

to a great degree), and ‘To what extent did your work in the collaboration include being creative?’ (not at all / to a great degree). The scale was filled out by individuals within the collaborations. Since the unit of analysis is the collaboration itself and the collaborative performance, all data was aggregated to collaboration level. Some items were reversed-coded. The scale had a Cronbach’s α of .86.

Dependent variables: collaborative innovation performance and collaborative efficiency performance. Both dependent variables are measured as in study 1.

RESULTS

Hypotheses 3a and 3b predicted either a negative effect of inter-organizational routine on collaborative innovation performance (hypothesis 3a) or a positive effect of routine of collaborative innovation performance (hypothesis 3b). The regression analysis shows a non-significant result, however indicates a negative relationship between inter-organizational routine and the innovation score (see model 1 in table 3). Because of the small amount of cases ($N = 28$) it is assumed that when there is a larger N , the significance will increase. Therefore, this result is important and cannot be ignored. Model 1 in table 4 shows the results of the regression analysis for the other innovation measure, the number of templates used, which are non-significant to a greater extent.

Hypothesis 3c predicted a curvilinear, more specifically an inverted U-shaped, effect of inter-organizational routine on collaborative innovation performance. Accordingly, a quadratic model was tested (model 2 in table 3 and table 4). By including both a main effect for inter-organizational routine, which was negative and significant for the innovation score, and a squared term for this variable, which was positive and significant for the innovation score, a pattern was produced that showed an U-shaped relationship between inter-

Determinants of innovation performance: innovation score

	Model 1			Model 2		
	B	s.e.	p	B	s.e.	p
Routine	-,036	,025	,158	-,936 *	,423	,036
Routine ²				,149 *	,070	,043
R ²	,040			,155		

N = 28, * $p < ,05$

Table 3 - Results regression analysis for innovation score

Determinants of innovation performance: templates used

	Model 1			Model 2		
	B	s.e.	p	B	s.e.	p
Routine	,905	1,241	,472	19,079	22,675	,408
Routine ²				-3,000	3,737	,430
R ²	-,018			-,032		

N = 28, * $p < ,05$

Table 4 - Results regression analysis for number of templates used

organizational routine and collaborative innovation performance for the innovation score (the overall model was significant: [$F(2,27) = 4.11, p < .05$]). Inter-organizational routine explains 16% of the variance in the innovation score. This effect was found only for the innovation score, not for the number of templates used. Consequently, hypothesis 3c is also not supported by the results, since the effect is contrary to the hypothesis. This means that small amounts of inter-organizational routine and high amounts of inter-organizational routine are beneficial for collaborative innovation performance. Moderate amounts of routine contribute significantly less to this performance.

Hypothesis 4 assumed a positive relationship between routine and collaborative efficiency performance (model 1 in table 5). The results show a marginally significant

positive effect of routine on the efficiency, meaning that a the more routine there is in a collaboration, the more efficient the collaboration is. Probably with a larger N this result will be more significant. A curvilinear relationship between routine and collaborative efficiency performance (model 2 in table 5) is non-significant.

Determinants of efficiency performance: number of models made

	Model 1			Model 2		
	B	s.e.	p	B	s.e.	p
Routine	3,095 *	1,781	,094	17,974	34,044	,602
Routine ²				-2,452	5,603	,665
R ²	,067			,038		

N = 29, * $p < ,10$

Table 5 - Results regression analysis for number of models made

DISCUSSION

In this study six hypotheses were formulated and tested in an experimental research design (see table 6 for an overview of the hypotheses and their results). Of these six hypotheses, support for one hypothesis could be found. The results supported hypothesis 1 which predicted that complementary intra-organizational routines alignment alignment in a collaboration affected the collaborative innovation performance more positively than supplementary intra-organizational routines alignment. This means that when two organizations that collaborate for innovation bring in different intra-organizational routines which are utilized within the collaboration, more innovation is reached than when these organizations bring in similar intra-organizational routines (which are also utilized within the collaboration).

Hypotheses	Dependent variable	Result
H1: Complementary intra-organizational routines affect the overall collaborative innovation performance more positively than supplementary intra-organizational routines.	Innovation score	Significant
	Templates used	Significant
H2: Supplementary intra-organizational routines affect the collaborative efficiency performance more positively than complementary intra-organizational routines.	Number of models made	Significant contrary
H3a: Inter-organizational routine has a negative effect on collaborative innovation performance.	Innovation score	Non-significant
	Templates used	Non-significant
H3b: Inter-organizational routine has a positive effect on collaborative innovation performance.	Innovation score	Non-significant
	Templates used	Non-significant

H3c: Collaborative innovation performance is an inverted U-shaped function of inter-organizational routine.	Innovation score	Significant contrary
	Templates used	Non-significant
H4: Inter-organizational routine has a positive effect on collaborative efficiency performance.	Number of models made	Marginally significant

Table 6 – *Hypotheses and results*

The effect assumed in hypothesis 2 turned out to be contrary than expected. The prediction was that supplementary intra-organizational routines alignment would have a more positive effect on collaborative efficiency performance than complementary intra-organizational routines alignment. However, the results showed that there was a significant effect indicating that complementary intra-organizational routines alignment positively affected collaborative efficiency performance instead of supplementary intra-organizational routines alignment. So, how can this effect be explained? An alert reader might have noticed that the supplementary intra-organizational routines alignment groups were not all equal. These groups consisted of either two groups that were used to serial work routines, or two groups experienced in parallel work routines. Taking this into account and observing the results again, one can see that the standard deviation in the supplementary groups is far greater than that in the complementary groups (compare $SD = 1.56$ for the complementary groups and $SD = 3.26$ for the supplementary groups). In this study, unfortunately, we cannot dig into this any deeper, however, it seems that an explanation could be found in the composition of the supplementary intra-organizational routines alignment groups. One might assume, for example, that for the serial groups the collaborative efficiency performance might differ from that of the parallel groups. If the collaborative efficiency performance is high for one group and low for the other, the large standard deviation is explained. Naturally, this has an impact on the mean of the total supplementary group, and since the analysis tests for differences between the means

of groups, the effect might be different than expected. For future research it is interesting to test whether this high standard deviation is a result of the composition of the supplementary groups and to what extent serial or parallel groups affect collaborative efficiency performance differently.

Hypothesis 3a, 3b and 3c considered the effect of inter-organizational routine on collaborative innovation performance. The first two assumed a linear relationship between the variables, while the last one predicted a curvilinear relation. No linear effects were found, however, the results showed a curvilinear one. This effect was not the predicted inverted U-shaped function, yet an U-shaped effect of inter-organizational routine on collaborative innovation performance was found. This effect means that low amounts of inter-organizational routine and high amounts of this routine are beneficial for collaborative innovation performance, moderate amounts of inter-organizational routine are significantly less beneficial.

This was a not predicted result. Also in the literature review, no indication could be found initially. However, the result might be explainable. First, an explanation might be found within the concept of routine. As can be extracted from the literature, routines come in different forms. Since this study only focused on the degree of routinization in the collaborative work processes, one might argue that the nature or content of the routine should be taken into account. As discussed in study 2, some routines are developed for innovation, then a high degree of routinization in this case may lead to innovation (Feldman and Pentland, 2003), whereas a low degree of routinization, when these innovation routines are not in place, might also lead to innovation (Pentland, 2003). Or, highly routinized tasks make the mind free for creative thinking (Ohly et al., 2006) and low routinized tasks leave space for variety (Pentland, 2003). This view is (at least partially) supported by the diverse literature leading to

hypotheses 3a and 3b. Anyhow, it seems appropriate to study the nature of the inter-organizational routines more carefully in future research.

Second, in behavioral learning theory there might be found some evidence for this U-shaped function. For example, Haleblian and Finkelstein (1999) found an U-shaped experience-performance relationship in the acquisition context. Despite that Haleblian and Finkelstein (1999) do not mention routines as such, their perspective on learning and experience seems rather similar:

When an antecedent condition is similar to a previous condition, the behavior that has come to dominate in the previous situation will likely be generalized to the current situation (e.g., Pinder, 1984). Invoking the same behavior in response to a variety of similar antecedent conditions is referred to as generalization, which provides a ready-made response so that each new antecedent condition does not require new learning (Nye, 1979). When an antecedent condition is dissimilar to previous situations, however, generalizing past experience may lead to detrimental outcomes (Mazur, 1994). (p. 31)

Here, the 'same behavior' or experience might be perceived as being a routine. Also, similar antecedents might invoke this behavior, like routines are recurrent patterns for similar situations. To get a better understanding of how experience or routine affects performance Haleblian and Finkelstein (1999) distinguish between novices and experts making other decisions:

The research on differences between experts and novices shows that while novices primarily represent problems with obvious or surface-level information, the representations of experts include both surface and underlying features (Novick, 1988). The ability to perceive differences between dissimilar events decreases the

likelihood of making an inappropriate generalization error (...) and increases the likelihood of appropriate discrimination (...). (p. 38)

The authors conclude that the best performers are those who had a significant amount of experience and appropriately discriminated or those without experience who, therefore, could not make an inappropriate generalization error. In trying to match this view with routines, one might consider the experienced as the ones who are highly routinized. The less experienced show very little routinization. Both of them are beneficial to performance, making up an U-shaped function of experience on performance; and in this study of routinization on performance.

Finally, the analysis of hypothesis 4, predicting a linear relationship between inter-organizational routine and collaborative efficiency performance, showed no significance.

With these results, this study contributes to the field of innovation research, more specifically to the fields of the resource-based view, alliances and routines. This study gave especially better insight in the effect of resource alignment and inter-organizational routines on innovation, a field that has been researched rarely. Furthermore, the present study gives leads to future research opportunities.

FUTURE RESEARCH

The results of this study give rise to future studies. Two of them have already been mentioned: split the supplementary groups in serial and parallel groups to check for the effects on collaborative efficiency performance. Furthermore, the nature of the routines accounting for collaborative innovation performance might be explored more in-depth, in order to better explain the U-shaped relationship between inter-organizational routines and collaborative

innovation performance. Also, the interaction-effect of intra-organizational routines and inter-organizational routines might be interesting.

However, there is more. These two studies form part of a larger study for which the data had already been gathered to a great extent. In this experimental study the effects of resource alignment (supplementary and complementary, and the distinction between serial and parallel) and different process variables (routinization, trust, leadership, conflict, cooperation etc.) on collaborative innovation and collaborative efficiency performance are tested, according to the model represented in figure .

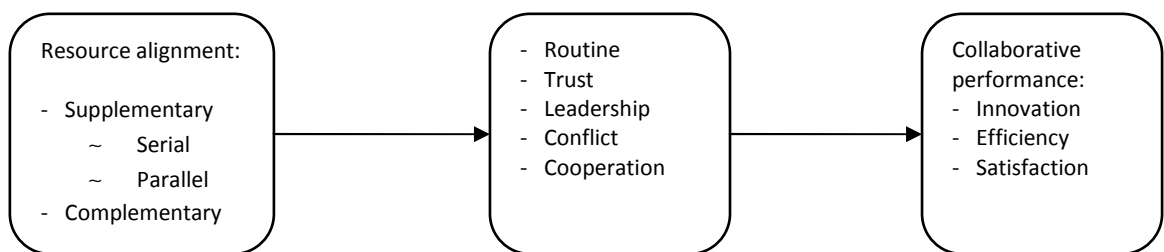


Figure 1 - Extensive Research Model

Also, many other variables are taken into account, for instance: education, gender, age, experience with working in teams (job, student groups, team sport), personality. At least four different studies result from this experiment. First, the effects of supplementary and complementary resource alignment on the collaborative performance will be explored. Here, the study will be more in-depth than the present one, taking into account the differences between serial and parallel work processes, resulting in not two levels for research alignment (as was the case in the present study), but three levels.

Second, the process variables and their effect on collaborative performance will be studied. This means a great extension of the present study, taking into account more process variables, such as trust and conflict. A more precise prediction model for collaborative performance can be calculated.

Third, the first and second study will be combined to test the total model, including mediation of the process variables between resource alignment and collaborative performance. The final research idea concerns a more in-depth study of the inter-organizational routines. Their nature, content and change during the collaboration will be explored.

LIMITATIONS

To every study a couple of limitations can be assigned. First, the operationalization of the variables leads to conservative generalization possibilities. For intra-organizational routines alignment, it was chosen to use serial and parallel work routines as the intra-organizational routines both organizations brought into the collaboration. The effects reported cannot be generalized to the many other intra-organizational routines without any caution. Also the operationalization for inter-organizational routine, which was task variety, gives reason to generalize carefully. However, for these operationalizations generalizations may be in place.

Second, this study consisted of an experimental design. These designs are rare in the research field, however, they become more used in the present day (Agarwal, Croson & Mahoney, 2010). Experiments have many benefits over other research methods (e.g. controllability, possibility to test for causal relationships), but they do have their limitations. The reverse side of controllability is that situations are manipulated that may be somewhat far from real-life situations. Of course this is done to enlarge effects and to make cases comparable. Due to the fact that, also in this experiment, the situation may differ from real-life, the effects found in this study may not be found in every situation comparable. This touches the generalizability of the results found. In the experiment, a specific situation was created. Combining groups with different or similar intra-organizational routines making new

products together. In the most narrow sense, effects could only be generalized to situations very much comparable to the situation created in the experiment.

Furthermore, this study is executed in the domain of organizational collaboration, in the form of alliances and joint ventures. However, in the experiment the tendency was to create 'organizations' by placing participants in groups. Of course, in real-life, an organization comprises of more than a certain combination of people. Therefore, we cannot claim that the groups created resemble organizations as such. However, it was tried to capture this problem by asking the group members to what extent they had the feeling they belonged to a group (which will be taken into account in future research).

Due to the fact that the experiment was executed over a time span of more than one year, participants might have been in touch with each other and exchanged information. This might have influenced the results. However, this could be tested by exploring whether results change over time.

Also the participants themselves might be a limitation. In this study all participants were students, with hardly any prior knowledge and experience of collaborations and innovation performance. Results might differ for people with more knowledge and experience with any of the variables.

PRACTICAL IMPLICATIONS

The most obvious practical implication of this study is that heterogeneous groups are more creative and innovative than homogeneous groups. This insight could be applied in different contexts; in organizations, on group level, team level and perhaps even in alliances etc. Concerning routines, it is believed that more research is necessary to describe practical

implications in better detail. For now, it is argued that routines have an impact on innovation. Results suggest that high and low amounts of routine are beneficial for innovation, however, this conclusion can only be drawn for routines in operational processes. More research needs to be done.

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Appendix A

Task variety questionnaire.

1. The type of work done in the collaboration was fairly consistent, so that people did the same job in the same way most of the time.
2. I encountered a lot of variety in the work during collaboration.*
3. The methods I followed in the collaboration were about the same for dealing with all types of work, regardless the activity.
4. To what extent was there a specific 'right way' to do things in the collaboration?
5. To what extent were there specific standards which you must meet in the collaboration?
6. How much variety was there in your work in the collaboration?*
7. How often was your work in the collaboration boring?
8. How often could you predict how long a task would take?
9. How much did your work in the collaboration include problem-solving?*
10. How much routine was there in your work in the collaboration?
11. To what degree were there set patterns in your work?
12. How often was your work simple?
13. To what extent was the work you did in the collaboration challenging?*
14. In general (thus not in this particular situation) how much actual 'thinking' time do you usually spend trying to solve such specific problems?*
15. To what degree did your work in the collaboration include improvised and unplanned performances (as opposed to planned performances)?*
16. To what degree did your work in the collaboration include being creative?*
17. To what extent was your work tiresome?
18. How often did your work in the collaboration give you a sense of accomplishment?*
19. To what extent did you feel like you were doing the same thing over and over again in the collaboration?

*reversed-scored items