Research Report

How can leaders trigger bottom-up innovation?

An empirical research into knowledge-intensive services

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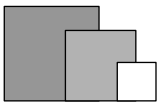

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1 Introduction

1.1 Motivation

In today's marketplace it is pivotal for leaders to pay attention to innovation. Firms need to continuously renew and improve their product offerings, services and work processes to secure long-term survival, profitability and growth (Geroski & Machin, 1992; Freel, 2000). Of course, leaders can initiate change themselves, trying to ensure that their organization will be able to cope with future environmental demands. Such top-down innovations can sometimes be quite radical. On the other hand, organizations can also profit from bottom-up innovations which are initiated by individual employees. To trigger bottom-up innovation, individual employees need to be both willing and able to show innovative behaviour (Van de Ven, 1986). Katz (1964) was among the first to notice that 'an organization which depends solely upon its blueprints of prescribed behaviour is a very fragile social system' (p. 132). They are the ones who have to put 'beneficial novelty' into practice and who can come up with the creative ideas that may become pillars of future performance (Van de Ven, 1986; Kanter, 1988). This emphasis on innovative behaviour is a key element of many principles of management today, such as total quality management and continuous improvement schemes (e.g. McLoughlin & Harris, 1997), Kaizen (e.g. Imai, 1986), reflexivity (e.g. Schippers, 2003) and organizational citizenship behaviour (e.g. Organ & Konovsky, 1997).

Leadership is widely recognized as a critical success factor for firms' innovative ability. Leaders can help the development and implementation of sensitive and fragile ideas at various stages of the innovation process (e.g., Waldman & Bass, 1991; Manz et al., 1989). Despite agreement on the importance of leadership in the innovation process, research in this area is relatively scarce. Neither the innovation nor the leadership field provides a detailed overview or inventory of specific behaviour that leaders might use to enhance their subordinates' innovative behaviour. Leadership research usually focuses on the leader's role in enhancing firm or employee performance and effectiveness rather than their role in fostering renewal and innovation. Conversely, innovation research is generally concerned with exploring a broad range of factors related to successful new product development. Leadership is often mentioned as one such factor amongst many others, without providing more detailed insight in how or why specific leader behaviour may impact on different parts of the innovation process.

1.2 Objective

The current study explores what particular leader behaviour enhances the innovative behaviour of employees[1]. Last year we made an extensive literature review. We also performed a number of in-depth interviews with managers and entrepreneurs to explore if and how they stimulate innovative behaviour (see De Jong & Den Hartog, 2003). This resulted in an inventory of thirteen types of leader behaviour that may affect employees' suggestions and implementation efforts. We also identified some control variables that are likely to affect whether employees generate and implement ideas, including an

[1] In this paper we will use the terms 'employees' and 'subordinates' alternately.

innovative work climate and having frequent external contacts. The current study aims to:

– Collect quantitative data among a sample of firms,
– Perform a first empirical test on innovation-enhancing leader behaviour that goes beyond the influence of control variables like an innovative work climate and the extent to which employees have external contacts,
– Provide guidelines for leaders.

Another extension from previous research is our focus on knowledge-intensive services, a sector that current researchers tend to overlook. It is striking that most current research focuses on manufacturing firms (e.g., Axtell et al., 2000) or on the effectiveness of R&D-workers in multinational firms (e.g., Scott & Bruce, 1994; 1998). Knowledge-intensive services have boomed in the past 15 years and their importance for economic development is significant (Anxo & Storrie, 2001). This sector includes engineering, architecture, IT, consultancy and market research firms. Compared to other sectors, knowledge-intensive services have an intangible, heterogeneous and perishable nature (Den Hertog, 2000). Such firms feel a strong need for continuous minor improvements and additions to their current product offerings, which makes employees' innovative behaviour very important.

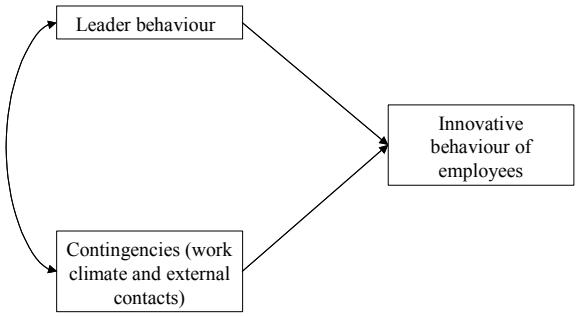
Outline of this report

Below, we first review the most important findings from our previous research and develop hypotheses. The third section presents the methodology we have used to collect quantitative data among a sample of knowledge-intensive service firms. We also describe the construction of scales and measurement issues. The fourth section covers the results of a causal analysis to explore which types of leader behaviour matter most. The final section deals with the implications for leaders in knowledge-intensive services and directions for future research.

2 Theory

The previous research consisted of an extensive literature review and twelve in-depth interviews with managers and entrepreneurs from knowledge-intensive service firms. For a detailed discussion we refer to De Jong & Den Hartog (2003). In figure 1 we reveal the framework that we use to guide our discussion of relevant concepts. The remainder of this chapter summarizes all subjects within the framework.

figure 1 Framework for this study



2.1 Innovative behaviour

What is innovative behaviour?

Innovative behaviour can be defined as 'all individual actions directed at the generation, introduction and application of beneficial novelty at any organizational level' (West & Farr, 1989). Innovative behaviour of employees is a necessary condition for incremental, bottom-up innovations to occur. People can have tremendous ideas, but most organisations do not understand the process of capturing, nurturing, and transforming ideas into usable and profitable commodities. In this context, Getz & Robinson (2003) discuss some previous research by the Swedish Institute for Suggestions Systems (p. 134). Those organisations that manage to listen to and act on employees' ideas have participation rates of at least 90 percent (making contributions by coming up with ideas, etc), and more than € 8.000 in net cost-savings or new revenue is generated per employee each year. This beats the results of any centralised suggestion system (e.g., an idea box).

Dimensions of subordinate innovative behaviour

Some previous researchers assessed innovative behaviour as being a one-dimensional construct (e.g., Scott & Bruce, 1994; Spreitzer, 1995). Yet others took a more detailed look by distinguishing numerous dimensions of innovative behaviour, e.g., Axtell et al. (2000) explored that different work factors may be associated with the different stages of innovation, while Janssen (2000) discerned three dimensions: idea generation, idea promotion and idea implementation.

Because theorists disagree on how to operationalize innovative behaviour, we decided to cover this issue as part of the current research. Based on the theoretical foundations

laid by Kanter (1988), our literature review suggested four dimensions that are frequently mentioned as being related to the innovative behaviour of subordinates:

– Opportunity exploration
– Idea generation
– Championing
– Application.

Innovation begins with employees identifying new opportunities (e.g., Krueger, 2000). Opportunity exploration is a necessary condition to initiate a process of departing from the organization's established routines or systems. Opportunities lie in incongruities and discontinuities - things that do not fit expected patterns, problems in existing working methods, unfulfilled needs of customers, or indications that trends may be changing (Drucker, 1985; Mumford et al., 1996). One can think of employees looking for ways to improve current services or delivery processes, or trying to solve problems by themselves (Kleysen & Street, 2001).

Having ideas is a necessary condition for innovation. Mumford (2000) states that, ultimately, the individual is the source of any new idea. Idea generation is about subordinate behaviour directed at 'generating concepts for the purpose of improvement' (Kleysen & Street, 2001). It includes generating ideas for new or renewed services, distribution or supporting technologies and generating solutions to problems aiming to improve the service delivery process, making it more efficient (e.g., Mumford, 2000; Janssen & Buil, 1998). The key to idea generation appears to be the combination and reorganization of information and existing concepts to solve problems and/or to improve performance. Rothenberg (1996), in his study of Nobel laureates, found that these new combinations often provide a basis for advances in science. Along similar lines, Mumford et al. (1997) found that skill in combining and reorganizing concepts is one of the best predictors of creative achievement.

Employees who take prime responsibility for the introduction of innovations are often not formally appointed by the entrepreneur, but rather people who feel a strong personal commitment to a particular idea and are able to 'sell' it to others. A champion is someone who emerges to put efforts into creative ideas (which he may not have generated by himself) and bring them to life (Kleysen & Street, 2001). It is someone in an informal role that pushes a new service beyond roadblocks within the organization (Shane, 1994). Research in manufacturing firms has shown that successful firms are more likely to use and keep champions. This is often not the case in service firms (Martin & Horne, 1993). Championing includes persuading and influencing other employees as well as pushing and negotiating (Kleysen & Street, 2001). To implement an innovation there often is a need for coalition building, acquiring power by selling an idea to potential allies. For instance, a front-line employee who is responsible for customer service might identify a particular piece of technology which he believes would significantly improve firm performance if adopted. The success of his idea will depend on his ability to persuade powerful and influential people of the value of the innovation, and on his ability to access and utilize personal networks (Dougherty & Hardy, 1996).

Application is related to behaviour aimed at developing, testing and commercializing a new service. It deals with making innovations a regular part of work processes (Kleysen & Street, 2001). It includes developing new services or working methods and modifying them. Because of services' simultaneous nature, front-line employees play an essential role. During the implementation stage their knowledge of customers and of competitive offerings can help in defining the appropriate level of service customization and user

friendliness (De Brentani, 2001). Besides, during market launch, it is the ability of front-line staff to 'educate' and persuade clients about the benefits of a (totally) new way of solving a problem that can bring about the adoption of the new service (Atuahene-Gima, 1996; Johne & Storey, 1998).

2.2 Inventory of leader behaviour

The nature of leadership

Most definitions of leadership stress that leadership involves a process whereby intentional and goal directed influence is exerted by one person over other people in order to guide, structure and facilitate activities and relationships in a group or organization. Bryman (1992) states that definitions of leadership usually emphasize three elements: 'group', 'influence' and 'goal'. In our study, leadership refers to the process through which managers influence employees with the intermediate goal of enhancing their innovative behaviour, and the ultimate goal of realising a continuous flow of innovations in the organization.

Leadership research has assessed leader traits (e.g., physics, abilities, personality), behaviour (e.g., task-oriented, relationship-oriented, transformational and participative behaviours) and the influence of situational characteristics (e.g., market conditions) (Den Hartog & Koopman, 2001). In this study, we take a behavioural approach and limit ourselves the way in which behavioural styles of leaders affect subordinates' innovate behaviour. We focus on providing an inventory of leader behaviour that may enhance employees' innovative behaviour.

Behaviour that may affect subordinate innovative behaviour

Although the impact of leaders on their subordinates' innovative behaviour seems intuitively appealing, most behavioural leadership studies stress leaders' impact on performance or affective outcomes rather than innovation-related outcomes. Past research is highly fragmented and does not provide a detailed overview of leader behaviour relevant to stimulating innovative employee behaviour. By means of qualitative techniques (literature review, in-depth interviews) De Jong & Den Hartog (2003) have made an inventory of leader behaviour that may affect the innovative behaviour of employees. Their inventory includes thirteen behaviours:

A) Innovative role-modelling
B) Intellectual stimulation
C) Stimulating knowledge diffusion
D) Providing vision
E) Consulting
F) Delegating
G) Support for innovation
H) Organizing feedback
I) Recognizing
J) Rewarding
K) Providing resources
L) Monitoring
M) Task assignment

Ad A). Innovative role-modelling. A leader may enhance innovation by providing an example of innovative behaviour. For instance, Tierney et al. (1999) obtained direct assessments of leaders' creative skills and found these were related to the creative performance of subordinates. Mouly and Sankaran (1999) performed a qualitative study

formance of subordinates. Mouly and Sankaran (1999) performed a qualitative study of the factors shaping innovation in an R&D-laboratory. They concluded that a leader's creative capacity was a key determinant of subordinates' creative performance. Another example includes the work of Sundbo (1996). Based on case studies in Danish service firms, he concluded that working with a manager of the 'entrepreneurial type' strengthens entrepreneurial activities of employees. Extraordinary levels of innovative activity were found when such a leader was present.

Ad B). Intellectual stimulation. Intellectual stimulation involves increasing employees' awareness of problems and stimulating them to rethink old ways of doing things (e.g. Bass, 1985). It may directly tempt an employee to be innovative. The thought behind this is that people could make more suggestions when their leader challenges them to do so. For example, Mumford et al. (2002) stresses that intellectual stimulation serves as a direct trigger to generate ideas. Besides, this behaviour also seems to stimulate reflection among employees. Research by De Dreu (2002) shows that reflection moderates the relationship between minority dissent and innovativeness. High levels of minority dissent lead to more innovations, but only when there is a high level of reflection among employees. Thus, intellectual stimulation may create opportunities for employees to voice ideas that may otherwise be overlooked. Eventually, this could result in increased bottom-up innovations.

Ad C). Stimulating knowledge diffusion. Some entrepreneurs stimulate informal meetings with employees solely for the sake of knowledge diffusion. Stimulating knowledge diffusion could trigger innovative behaviour of employees. Whenever one hears about others' problems in current work, he/she may come up with suggestions or ideas for solutions how to solve these problems. Anomalies or things that do not fit expected patterns often serve as the basis for new ideas. Such discontinuities are best captured when information is widely available. In the context of this leader behaviour, Mumford et al. (2002) conclude that employees must be aware of the needs, trends and problems that their colleagues face. It provides them with a resource for new ideas. Scott and Bruce (1998) discuss how 'highly developed relations' between leaders and employees may impact on innovative behaviour. Such relations, in their view, include expanded information exchange. In their empirical research among R&D professionals, the availability of knowledge proved to be a predictor of enhanced individual innovation.

Ad D). Providing vision. Some theorists stress that entrepreneurs should try to integrate the innovative activities in their firms by providing their employees with a sense of direction and overarching goals as well as some general guidelines. Providing such an overarching vision could enhance subordinate innovative behaviour because it may provide a frame of reference that indicates what kind of ideas will be appreciated. Also, if an innovative idea fits within a vision known to and shared by employees, convincing them of its value and guiding implementation could be much easier. Empirical evidence demonstrating the effects of vision on idea generation is found in a study by Sosik et al. (1998). They showed that providing a vision resulted in enhanced creativity on a computer-based brainstorming task. Besides, Hounsell (1992) showed that having a vision resulted in better R&D-outcomes, while Shin (1997) found that those leaders in service firms expressing a clear vision, realized better innovation results than those who did not.

Ad E). Consulting. Participation in decision-making can be another trigger for subordinate innovative behaviour. The argument is that whenever something is implemented, those who have to work with it should be able to influence decision-making. Consulting employees in decision-making could make employees more committed to the out-

come of a decision. It motivates them to make suggestions for improvement of the decision and leads to more involvement (Kanter, 1988). Janssen et al. (1997) provided some empirical evidence. In a survey in a medium-sized IT firm, a critical role of the leader was to allow employees as much say in decisions as is practicable. Also, Ruigrok et al. (2000) present a case study showing that a 'shared leadership' style enhances innovativeness.

Ad F). Delegating. Delegating occurs when a leader gives a subordinate the responsibility and autonomy to determine independently how to do a job or certain task (Yukl, 2002). Current literature states that delegating results in perceived autonomy, and this could improve subordinate innovative behaviour. For example, Spreitzer (1995) shows that when employees experience empowerment they feel less constrained to explore opportunities and to generate ideas. A positive association between autonomy and the implementation of bottom-up innovations has been found in several other studies, such as those by Nijhof et al. (2002) in a Canadian transport firm, Axtell et al. (2000) in a manufacturing context, and De Jong & Kemp (2001) in service firms.

Ad G). Support for innovation. Support can be a motivator for those who are involved in any innovation process. Experiencing support may help employees to feel free to act creatively and generate ideas. Studies by Cummings and Oldham (1997) and Carson and Carson (1993) found that leader support had a positive impact on dependent variables like creativity. Such support promotes employees' feelings of self-determination and personal initiative at work. Creative people generally explore first and ask permission later. The consequence is that they will withdraw an innovative idea when confronted with premature criticism - when ideas are still in an early stage. An empirical study by Basu and Green (1997) showed that employees are far more likely to deviate from the ordinary, engage in unconventional behaviour, and implement innovative ideas when they are sure that they will not be penalized for it.

Ad H). Organizing feedback. Concepts for new services or processes could be improved considerably by making sure that those who are developing and implementing them receive feedback on an initial version. It can serve as a trigger to boost innovative behaviour of employees, and leaders can take action to organize feedback. They can stimulate and arrange that feedback will be provided, for instance by themselves, but they may also ask others (e.g. subordinates) to take on this role. Another way in which respondents can obtain feedback is to present an initial concept or idea to a group of customers to get their reaction. In the innovation literature, service firms are recommended not to refrain from testing new services. New services should be evaluated with clients and their feedback used to further refine a new service concept (e.g., Burpitt & Bigoness, 1997).

Ad I). Recognizing. Recognition includes giving praise (compliments), awards (for instance, certificates of achievement, private budgets, increased autonomy) and ceremonies (for instance, public speeches and celebrations) (Yukl, 2002). Janssen (2002) presented a survey among 170 employees of an energy supplier and shows leaders should be responsive by paying attention to innovative ideas and judge these in a fair and open manner. People will feel more secure about providing suggestions when they are met with positive rather than negative responses and will tend to expend more effort both in coming up with ideas and implementing them when they feel their work is appreciated. Redmond et al. (1993) also provided some evidence for the beneficial impact of recognition. In an experimental study, they asked undergraduates to work on a marketing task, developing advertising campaigns for a new product, under conditions where

confederate leaders either did or did not recognize innovative practices by stressing an undergraduate's competence. They found that giving recognition resulted in higher-quality campaigns and a more effective application of problem-solving skills.

Ad J). Rewarding. In some studies support is found for a positive contribution of concrete tangible rewards on employees' motivation to innovate. This research indicates that material rewards can be helpful, but they should be in line with other leader behaviour like providing support and recognition (Baer, 1997; Eisenberger & Cameron, 1996). Yet, theorists disagree on the contribution of financial rewards. They may not be the best incentive to stimulate idea generation. Amabile (1997) demonstrated that so-called intrinsic motivation is more important than extrinsic rewards. Such research suggests one should avoid using money to 'bribe' people to come up with innovative ideas.

Ad K). Providing resources. Providing resources is believed to be necessary for innovation. Ekvall and Ryhammer (1999) examined a variety of organizational variables that might influence innovation among scholars working at a Swedish university, and found that of these, the availability of resources was most strongly related to innovative results. Based on a case study in a Canadian transport firm, Nijhof et al. (2002) even recommend exempting employees from their usual tasks to help them concentrate all their efforts on the development and implementation of their ideas. When employees are assigned to work on innovations only part-time, they experience working on such a project as work that is additional to their (more important) daily activities. They will also tend to place higher priority on their regular work than on additional duties, resulting in longer development times.

Ad L). Monitoring. Monitoring includes leader practices like gathering information about work activities and checking on the progress of the work and the quality of output (Yukl, 2002). Previous research indicates that monitoring could impede subordinate innovative behaviour because it makes them feel insecure and unsafe at work - their jobs may be threatened if they make mistakes (Stahl & Koser, 1978). Focusing too strongly on error prevention (through monitoring) is likely to lead to low levels of risk taking, exploration and innovation (Kirkman & Den Hartog, 2003).

Ad M). Task assignment. Task assignment involves leader behaviour aimed at clarifying work roles, responsibilities and requirements (Yukl, 2002). Assigning employees with challenging tasks may have a positive impact, since intrinsically motivating tasks serve as a trigger for creativity and innovation (Amabile, 1997). Tasks defined in a broad and overlapping way improve innovative behaviour. Also, gaining work experience in different job or functional areas enhances employees' creative potential, since this broader experience will enable employees to more often or more easily come up with ideas for improvement in services, delivery processes, etc. (Axtell et al., 2000).

2.3 Control variables

Leadership aside, our preceding research highlighted some contextual factors that may affect the ability of employees be innovative (see De Jong & Den Hartog, 2003):

– An innovative work climate and
– The extent to which employees maintain external contacts.

These variables we will treat as control variables in our analysis. We seek to explore which leader behaviour has an impact on subordinate innovative behaviour that goes beyond the effect of control variables.

Work climate. Work climate is at the heart of an organization's informal structure. It implies a system of informal rules that spells out how people are to behave (Anderson & West, 1993). Knowing what is expected of them, employees will waste little time deciding how to act in a given situation. People generally tend to conform to norms and values, and comply with the socially desired group behaviour (*e.g.,* Asch, 1956).

Studies at the organisational and team level have offered empirical support for the work climate's effects on innovation (e.g, Abbey & Dickson, 1983; Burningham & West, 1995; Siegel & Kaemmerer, 1978; Nijhof *et al.,* 2002; Ahmed, 1998). However, empirical study of climate's effects on individual innovative behaviour has been limited. In a literature review Martins & Terblache (2003) assert that an employee's perception of climate affects the extent to which creative solutions are encouraged, supported and implemented. They believe it encourages innovative ways of representing problems and finding solutions, but no empirical support is provided. Scott & Bruce (1994) hypothesized that climate perceptions may positively affect individual innovative behaviour. In their survey among R&D-professionals of a multinational firm, they did indeed find a positive but rather weak relationship. De Jong & Kemp (2003) also expected a positive impact of climate on innovative behaviour, but in their research among knowledge-intensive service workers they concluded that such a relationship is entirely lacking. On the other hand, Axtell et al. (2000) conclude that an innovative climate is important in the latter stages of the innovation process. As soon as promising ideas are approved and have to be implemented, it makes a difference if employees find their colleagues to be supportive.

Although current literature does not provide hard empirical evidence, we have reasons to expect a positive relationship between climate perceptions and innovative work behaviour. Rogers (1954) was among the first to suggest that the cohesiveness of a work group determines the degree to which individuals believe that they can introduce ideas without personal censure. Albrecht & Hall (1991; 1992) observed that suggesting new ideas is perceived to be risky because it represents change to an established order. New ideas invite evaluation by other organizational members, and it is difficult to separate new ideas from the person offering them. To propose innovative ideas is to put oneself at risk. Since idea generation is part of innovative work behaviour we expect that climate may fortify innovative behaviour. Since innovation is a social process, the implementation of ideas relies more heavily on the involvement of others. For example, while a subordinate can be creative and generate ideas on his own, implementation typically depends upon the approval, support and resources of others. We expect this also applies to many bottom-up, incremental innovations. Unless an innovative person is essentially independent, incremental changes will usually affect others, and will therefore be subject to others' approval.

External contacts. Most knowledge-intensive service firms maintain frequent contacts with the 'outside world'. Due to simultaneity knowledge-intensive services are often produced in interaction with customers (Johne & Storey, 1998). Examples of external contacts include:

- Contacts with customers
- Contacts with parties like suppliers and competitors
- Attending conferences and fairs
- Training and education
- Being involved in external co-operation projects.

For instance, in consultancy firms the service (an advice or recommendation) is often produced in co-operation with a client. Direct interaction with customers is also found

in sectors like accountancy, R&D-services, engineering and advertising agencies. The nature of working in knowledge-intensive services implies that some subordinates have more frequent contacts with the 'outside world' than others. This applies particularly to sales people and those who actually deliver a service. In other functions (such a administrative jobs) having external contacts is less common.

We expect that subordinates with frequent external contacts will have better opportunities to be innovative than those who do not. Making employees stay more closely in touch with customers, suppliers, partners and competitors is believed to be beneficial because their input is the key to the company's success (Getz & Robinson, 2003). A lack of external contacts may have the opposite effect. It implies fewer natural occasions for opportunity exploration (*e.g.,* Pelz & Andrews, 1966; De Brentani, 2001; Martin & Horne, 1995). Subordinates who maintain intensive contacts with customers can pick up information about customers' experiences with their services, using this to improve themselves. Such contacts can directly cause a person to make adjustments in a current service offering. For instance, a client may tempt a representative from a training firm to offer a particular workshop. Another example includes contacts with competitors. They have been identified as an important source of ideas for innovations as well (*e.g.,* Easingwood, 1986; Hooley & Mann, 1988; Scheuing & Johnson, 1989).

2.4 Hypotheses

In the current research we aim to do a quantitative test on which type of leader behaviour has an impact on subordinate innovative behaviour. We will explore the effect of the thirteen types of leader behaviour while controlling for innovative climate perceptions and the extent to which employees have external contacts. Our hypotheses are presented in table 1. Except for testing these hypotheses, our research will provide insights into the effects of innovative climate perceptions and having external contacts as well.

table 1 Hypotheses

Hypothesis	*Leader behaviour*	*Hypothesized effect**
A	Innovative role-modelling	Positive
B	Intellectual stimulation	Positive
C	Stimulating knowledge diffusion	Positive
D	Providing vision	Positive
E	Consulting	Positive
F	Delegating	Positive
G	Support for innovation	Positive
H	Organizing feedback	Positive
I	Recognizing	Positive
J	Rewarding	Positive
K	Providing resources	Positive
L	Monitoring	Negative
M	Task assignment	Positive

** Beyond the impact of innovative climate and external contacts.*

3 Methodology

To explore what kind of leadership affects subordinate innovative behaviour we first created an item database and draft questionnaires based on current literature (section 3.1). Next, a pilot study was performed among 81 employees from ten business units of a Dutch research institute (section 3.2). This step aimed to develop scales with sufficient reliability and content validity. It resulted in shortened, significantly improved questionnaires. In the third step we collected data among employees of 104 knowledge-intensive services firms. We used this main survey to further refine scale reliability and to assess various types of validity (section 3.3).

3.1 Item generation

3.1.1 *Construction of item pool*

We composed multi-item scales to measure our constructs. First an item pool was created to compose scales for employees' innovative behaviour, the thirteen leader behaviour constructs, employees' climate perceptions and external contacts. Items were formulated as statements (propositions), and respondents were invited to complete these on five-point Likert-type scales. Most scales used the following answer categories: totally agree (score 5) - agree (score 4) - no agree, nor disagree (3) - disagree (2) - totally disagree (1).

To better secure scale validity, items were picked and/or adapted from current scales that focus on measuring particular aspects of leadership, innovative behaviour, work climate or external contacts. This best ensures that a construct's domain is fully captured. It is in fact a necessary condition for a scale's validity (Churchill, 1999, p. 454-458)[1]. In cases where we had no existing scales at our disposal, we developed items ourselves.

Our pilot and main survey aimed to collect data from multiple sources. This prevents common method bias from affecting the estimates of any effect parameters. Therefore, we have developed *two questionnaires*: one for the leader and the other for a sample of his/her subordinates. The subjects within each questionnaire are listed in table 2. Below we will elaborate on the sources for our scales and indicators of both questionnaires.

[1] The adequacy with which a scale captures the domain of a characteristic is also known as *content validity*.

table 2 Contents of leader and subordinate questionnaire

Leader Questionnaire	*Subordinate Questionnaire*
Subordinate innovative behaviour (rated for each of a sample of subordinates)	Self-rated innovative behaviour
- Opportunity exploration, idea generation, championing, application	Leadership (A) Innovative role-modelling (B) Intellectual stimulation (C) Stimulating knowledge diffusion (D) Providing vision
Innovative output (at firm level)[b] - Product innovation - Process innovation	(E) Consulting (F) Delegating (G) Support for innovation (H) Organizing feedback (I) Recognizing (J) Rewarding (K) Providing resources (L) Monitoring (M) Task assignment
	Innovative climate – Participative safety, reflexivity, support for innovation
	External contacts Recent experiences[a]

a = pilot survey only, b = main survey only.

3.1.2 *Leader questionnaire*

In our pilot survey we asked a sample of leaders (mostly entrepreneurs for knowledge-intensive firms and otherwise general managers) to provide information on each of their subordinates' innovative behaviour.

Subordinate innovative behaviour. To measure subordinate innovative behaviour, we initially constructed an extensive multiple-item scale. Subordinate innovative behaviour is meant to be our dependent variable, and this makes it important to have a measure with high reliability and validity at our disposal. The initial version of our measurement consisted of no less than 17 items. Five items related to subordinate opportunity exploration and four to idea generation. Another four items were about championing behaviour and four covered application behaviour. Because current literature does not provide a decisive answer on the construct's number of dimensions, we wanted to explore this using a relatively large set of items. To measure opportunity exploration, we included some items based on a recent study by Kleysen & Street (2001) who, after an extended literature research and quantitative survey among 225 employees, came up with an unidimensional scale for innovative behaviour. We also included an item that was used by Tierney et al. (1999) in a study on leadership and employee creativity (among 191 R&D-employees from a large chemical company). For the other items, we drew heavily on the work of Onno Janssen (2000; 2001; 2002). Based on the theoretical framework of Rosabeth Moss Kanter (1988) he constructed a measure for innovative behaviour to capture idea generation, championing and application behaviour.

3.1.3 *Subordinate questionnaire*

This questionnaire first asked subordinates to rate their own innovative behaviour (for validation purposes, using a multiple-item scale). Next, it inquired about perceptions of the thirteen types of leader behaviour and our control variables (innovative work climate and external contacts).

Self-rated innovative behaviour. It must be remembered that our dependent measure of subordinate innovative behaviour (part of the leader questionnaire) is extremely important. To validate this measure the subordinate questionnaire included a self-report of innovative behaviour. This measure did not focus on behaviour such as opportunity exploration. Instead, it was quite different to ensure a truly different and independent measure of the same construct. We examined the results of both stages of the innovation process as described by Zaltman et al. (1973). They postulate the innovation process as consisting of two stages: initiation and implementation. The initiation stage centers around exploring opportunities and gathering ideas for innovations. Applied to the contribution of subordinates, the initiation stage is expected to result in suggestions. The implementation stage deals with developing, testing and commercialising a promising idea. This implies that employees should contribute by implementation efforts. We asked respondents to indicate how often they came up with suggestions to improve current products/services, develop new products/services, improve current work practices, acquire new customers, change the work organisation, and acquire new knowledge. They also indicated how often they contributed to implementing such changes. Thus this scale contained 12 a priori items. Axtell et al. (2000) applied a similar measure and came up with a two-dimensional measure with sufficient reliability and discriminant validity.

Leader behaviour

(A) Innovative role-modelling. This scale contained seven a priori items. Most of them we picked from a scale developed by Janssen & Buil (1998) measuring executive innovative work behaviour. As with subordinate innovative behaviour these items relate to opportunity exploration, idea generation, championing and application behaviour. Two more items were selected from Basu & Green's (1997) innovative attitude scale that was developed in a study among 225 leader-member dyads in a Fortune 500 manufacturing plant.

(B) Intellectual stimulation. This scale consisted of seven a priori items. We leaned heavily on the intellectual stimulation scale that is part of the Value Based Leadership Questionnaire (VBLQ) (House et al., 1997). This scale has been further developed and adapted to the Dutch situation by Den Hartog (1997). We also added a single new item: 'My executive expects me to be concerned with more than just my own tasks'.

(C) Stimulating knowledge diffusion. For this scale we used six items. Two of them were inspired by Jaworski & Kohli's (1993) intelligence dissemination scale. This one focuses on subordinates' climate perceptions instead of leader behaviour, therefore we adjusted the items. Because our construct's domain is slightly different, we added four self-constructed items measuring whether leaders are perceived to stimulate knowledge diffusion with colleagues.

(D) Providing vision. For this six-item scale we were able to use various insights from leadership research. Providing vision is part of the Multifactor Leadership Questionnaire (MLQ) that measures transformational and transactional leadership (Bass & Aviolo, 1989). The above-mentioned VBLQ also pays attention to providing vision. In the Inspi-

rational Leadership in Organisations (ILO) questionnaire Den Hartog (1997) further modified and adapted the corresponding items. We picked four of them and added two more items from De Jong & Kemp's (2003) scale measuring a manager's strategic attention for innovation.

(E) Consulting. Consulting items are usually part of participative leadership scales (e.g., Koopman, 1980). However, our focus is more narrow; we aim to measure whether leaders encourage and facilitate employees to join in decision-making. Den Hartog (1997) and Koopman (1980) provided a multiple-item scale for participative leadership that contained four items on consulting. Parker et al. (1997; in Axtell et al., 2000) developed a participation scale that contained another useful item. We also picked an item from House & Dessler's (1974) scale of supportive leadership. Altogether, we had six a priori items at our disposal.

(F) Delegating. Using six a priori items, we aimed to measure whether leaders give their subordinates autonomy to determine independently how to do a job. As with consulting, delegating items are sometimes part of participative leadership scales. The already mentioned measure of Koopman (1980) and Den Hartog (1997) provided us with two items. We derived some more items from current autonomy scales, e.g. Spreitzer's subscale of formalisation (1995) and Jackson et al.'s (1993, in Axtell et al., 2000) scale for individual method control.

(G) Support for innovation. Providing support is a leader behaviour that is basically well-covered in state-of-the-art measures (e.g., Yukl et al., 1990), but unfortunately its focus is never on support for innovation in particular. Therefore we developed six items ourselves, taking Yukl's (2002) description of providing support as a guideline, and adjusting the items to account for employees' innovative efforts. A sample item includes 'My executive provides me with support to improve things'.

(H) Organizing feedback. As with support for innovation, we found no current measures that matched our definition here. We developed an a priori scale of seven items. Following the results of our qualitative survey (see chapter 5) some items account for providing feedback directly ('My executive provides hints on how to effectively implement something new') while others relate to those who organize feedback in a indirect manner ('My executive lets employees discuss new ideas').

(I) Recognizing. Using six a priori items, we aimed to measure if leaders praise and show appreciation to employees for innovative behaviour. Three of them were taken from Kohli's (1985) measure of contingent approving supervisory behaviour. The overview of managerial practices presented by Yukl (2002), containing a recognizing construct, inspired us to formulate some more items.

(J) Rewarding. Following the results of our qualitative investigation (chapter 5), this five-item scale intends to measure pretty directly the extent to which financial rewards are given for innovative behaviour. We developed three items ourselves (e.g., 'My executive offers bonuses for innovative contributions') and added two items that were adapted from Jaworski & Kohli's (1993) scale for reward system orientation.

(K) Providing resources. This scale consisted of five a priori items. It aimed to measure to what extent leaders provide employees with sufficient time and money to work out ideas. In some of our earlier research we already developed three items for the availabil-

ity of resources with a cronbach's α of 0.74 (see De Jong & Kemp, 2001, page 20). To further enhance scale reliability we decided to add two more, self-developed items.

(L) Monitoring. Monitoring is the leader behaviour that is probably best covered in state-of-the-art leadership measures. We were able to use seven items from various sources. Most were proposed by House et al. (1997), Bass & Aviolo (1989) and Den Hartog (1997), to measure active management by exception or direct supervision.

(M) Task assignment. In one of our earlier studies we developed a measure for perceived job challenge that contained relevant items (De Jong & Kemp, 2003, p. 198). We reformulated these items to account for leader behaviour (e.g., 'My executive assigns a wide range of tasks to me'). Because Cronbach's α was only just sufficient ($\alpha = 0.71$) we formulated some new items and added one from Jackson et al.'s (1993, in Axtell et al., 2000) scale for problem solving demand. Altogether, this scale contained six a priori items.

Control variables

Innovative climate. Our climate measure was intended to be multidimensional. Following Anderson & West (1998) we accounted for three dimensions of an innovative climate:

- participative safety (implying an interpersonally non-threatening atmosphere),
- task orientation (the extent to which group members reflect upon their objectives, strategies and processes, and adapt them to current circumstances, also known as reflexivity) and
- group support for innovation.

Items were based on Anderson & West's (1998) team climate inventory (TCI) which directly measures employees' innovative climate perceptions. The TCI captures many existing measures of innovative work climate, e.g. the subscale 'support for creativity' is partly based on its corresponding measure that was developed by Siegel & Kaemmerer (1978). In the task orientation subscale we went even further by including some items developed by Swift & West (1998) that have recently been applied in the Dutch context by Schippers (2003). In total, we used 17 a priori items to measure innovative climate.

External contacts. For this measure, we were inspired by the overview of Afuah (2003) on functional sources of innovation. This overview stresses the role of competitors, customers and universities. We constructed an a priori scale with eight statements on having frequent contacts with customers, suppliers, subcontractors, competitors, knowledge institutions and universities. We also acquired external contacts by means of visiting conferences, trade fairs and expositions. In current innovation surveys (that aim to measure innovation at the firm level) having such contacts is regarded as a key item for knowledge acquisition and contacting external sources (see also OECD, 1997). We expect that these external contacts are certainly relevant in knowledge-intensive service firms.

Recent experiences

In the pilot survey we added some open questions on how leaders provide feedback on the employee's suggestions and implementation efforts. Respondents were asked if they had any recent experiences with suggesting and/or implementing ideas. If yes, they were asked how their executive had reacted to this. Our purpose was twofold here. First these questions served as a check on the completeness of our overview of leader behaviour. Second, we aimed to test if adding such open questions would provide use-

ful information on any mechanisms between leader behaviour, control variables and subordinate innovative behaviour.

3.2 Pilot survey

We performed a pilot study that aimed to test our measures, improve our scale's reliability and validity, and significantly reduce the length of both questionnaires. First, we asked four experts in the field psychological measurement to provide feedback on preliminary versions of our questionnaires and a priori scales. This led to some minor changes in the wording of items. A few items were deleted and others completely reformulated.

Sample and data collection

The pilot study itself was performed among 81 employees of a Dutch research institute. This organization is mainly occupied in applied economic research. Its customer base consists of policy makers from Dutch ministries, provinces and cites, representatives of intermediate organisations (such as sectoral organisations, Chambers of Commerce and the antitrust authority), large financial institutions, various services of the European Commission, and large enterprises. In addition to research, the target firm provides consultancy and IT services.

Our sample consisted of 102 employees who performed knowledge-intensive work. They all received an introductory letter describing the purpose of the survey. One week later we issued the questionnaire itself along with a covering letter that assured data confidentiality and details of a contact person in case of any questions. In leadership research confidentiality is of major importance because subordinates' career opportunities at least partly depend on their executive's judgement. We also provided a stamped addressed envelope in which respondents could return the completed questionnaire. Eventually, 81 subordinates participated in the pilot survey, a response rate of 79%. For a pen-and-paper survey this is a very good response.

In the following step, we requested all executives to provide information on each respondent's innovative behaviour. The procedure was that we visited each manager and gave verbal instructions for the completion of the leader questionnaire. Each manager then filled out the questionnaire and handed it to the researcher.

All responses were processed in the statistical package SPSS for Windows. Responses were paired by means of unique user IDS that had been printed on the questionnaires. In all, our dataset consisted of 81 leader-subordinate dyads.

Procedure for the construction of scales

For the construction of one-dimensional scales we used the criteria of unidimensionality, internal consistency and parsimony. Rules of thumb to construct scales included:

– To assess unidimensionality we required that a factor analysis should account for at least 50% of the variance within the items (Hair et al., 1998).
– To assess internal consistency we applied the same procedure as Den Hartog (1997) by looking at three measures. We regarded 0.70 to be the critical value for Cronbach's α, 0.40 for the mean inter-item correlation, and 0.30 for any item-rest correlation.

– Initial responses from respondents revealed that our draft questionnaires were still far too long. To diminish respondent burden we constructed scales with an average of four items.

For the construction of multi-dimensional scales we used a slightly different procedure. We first performed exploratory factor analysis to investigate what number of dimensions might be feasible, and to check if our theory-based factor structures worked out. Factor loadings were used to judge an item's contribution to its overall scale. Following Hair et al. (1998), we considered factor loadings of 0.30 to be the minimal level for significance (p. 111). For each dimension we assessed the above-discussed criteria for internal consistency (α and mean inter-item correlations) and parsimony. Parsimony implied that we would like to maintain an average of four items within each dimension.

Results

With the above-mentioned procedures we produced various scales with limited numbers of items. In table 3 we present descriptive statistics and measures for the internal consistency and unidimensionality. Below we elaborate on our findings.

table 3 Results of scale construction for pilot survey scales (n=81)

Scale (subscale)	*# items (a priori)*	*# items* (selected)*	*variance explained*	α	*mean r*
Innovative behaviour:					
Subordinate innovative behaviour	17	10	72%	-	-
– (Opportunity exploration)	5	2	-	0.88	0.78
– (Idea generation)	4	3	-	0.90	0.74
– (Championing)	4	2	-	0.95	0.90
– (Application)	4	3	-	0.93	0.82
Self-rated innovative behaviour	12	6	54%	0.82	0.44
Leadership:					
(A) Innovative role-modelling	7	4	71%	0.87	0.62
(B) Intellectual stimulation	7	4	56%	0.74	0.42
(C) Stimulating knowledge diffusion	6	4	61%	0.79	0.48
(D) Providing vision	6	4	77%	0.90	0.70
(E) Consulting	6	4	80%	0.92	0.74
(F) Delegating	6	4	74%	0.88	0.64
(G) Support for innovation	6	4	70%	0.85	0.58
(H) Organizing feedback	7	4	64%	0.80	0.49
(I) Recognizing	6	4	72%	0.87	0.63
(J) Rewarding	5	3	79%	0.87	0.68
(K) Providing resources	5	3	81%	0.89	0.72
(L) Monitoring	7	4	62%	0.79	0.48
(M) Task assignment	6	4	80%	0.91	0.72
Contingencies:					
Innovative climate	17	11	75%	-	-
– (Participative safety)	5	4	-	0.80	0.50
– (Task orientation)	6	3	-	0.89	0.72
– (Support for innovation)	6	4	-	0.91	0.72
External contacts	8	5	63%	0.85	0.52

** All remaining items have item-rest correlations or factor loadings > 0.30.*

Innovative behaviour

Subordinate innovative behaviour. A priori we constructed a 17-item scale to assess subordinate innovative behaviour. These were supposed to constitute a four-dimensional scale. We performed a principal factor analysis with oblique rotation and forced SPSS to extract four factors. After removing items with ambigious loadings, we found a solution with ten items that matched with our expectations, each of them loaded highest on their specific factor. All subscales had an excellent internal consistency with α values exceeding 0.88 (table 3).

Instead of a theory-based approach one could also let the data decide what number of dimensions are feasible (Hair et al., 1998). Application of the latent root criterion on an initial solution with no constraints (eigenvalue > 1) indicated that a single factor solution might also be feasible. Besides, application of the screen test suggested that a two-factor solution could be better. Therefore we decided to postpone taking a final stand. After the main survey, a confirmatory data analysis would provide a definite answer on the dimensionality of subordinate innovative behaviour.

Self-rated innovative behaviour. To explore the external validity of the subordinate innovative behaviour scale, we asked each subordinate to self-report a similar but independent construct. We asked if they made suggestions and put any efforts into the implementation of six innovative objects: improve current products/services, develop new products/services, improve current work practices, acquire new customers, change the work organisation, and acquire new knowledge. Contrary to Axtell et al. (2000), we could not derive a two-dimensional scale from these items. This may be due to the context of our study. Axtell et al. (2000) derived their two-dimensional measure in a study among operators in a large manufacturing plant. Such firms usually have standardised production processes, and whenever one generates ideas he/she must probably first consult an executive and gain others' support (executive, colleagues) before the idea can be implemented. In the context of our pilot survey's research firm, generating ideas and directly implementing them may be easier.

The analysis revealed that a simple, one-dimensional measure for self-rated innovative behaviour would be best. We followed the item-selection criteria discussed above. As a result, we selected six items with sufficient internal consistency (α = 0.82, main correlation = 0.44).

Leader behaviour scales

For each pre-defined construct, we managed to select a limited number of items with sufficient internal consistency and unidimensionality. As shown in table 3, for each construct we dropped a number of items to meet our goal of sufficient parsimony.

Contingencies

Innovative climate. After the item-selection process we maintained an 11-item scale with items covering participative safety (4 items), task orientation/reflexivity (3 items) and support for innovation (4 items). An exploratory factor analysis with oblique rotation showed that each item loaded on its a priori subscale. Internal consistency measures for each subscale were very acceptable (table 3).

External contacts. Our a priori scale consisted of eight items, and we selected five of them to construct a one-dimensional scale. The reduced scale covers contacts with customers, other firms and knowledge sources (like universities, trade shows and fairs).

These are all of major importance to knowledge-intensive service firms (Den Hertog, 2000). Internal consistency was good (α = 0.85, mean correlation = 0.52).

Recent experiences

In the pilot survey we added some open questions on how leaders provide feedback on the employee's suggestions and implementation efforts. When asked for any recent ideas or implementation efforts, about half (45%) of the respondents indicated that they had made recent suggestions and 53% did some recent implementation efforts. Most idea generators had communicated their idea to an executive (85%) and most idea implementers perceived their efforts to have been noticed by their executive (85% as well). These findings indicated that in the pilot survey's organisation, subordinate innovative behaviour is a topic that is relevant in daily work.

By asking open-ended questions, we intended to collect information on any mechanisms between leader behaviour, contigencies and subordinate innovative behaviour. Unfortunately, this experiment did not prove to be very useful. The open questions did not result in detailed answers on leader behaviour. However, the open-ended questions did provide a check on any missing leader behaviour. We concluded that no additions were necessary. Examples of how executives replied to employees' suggestions or implementation efforts included

- Providing support ('he was enthusiastic and thought it was worth a try'),
- Providing resources ('he made the investments that were needed to implement the idea' and 'time and money were reserved for a feasibility study'),
- Organizing feedback ('my executive brought in some other experts to provide feedback on my idea'),
- Recognizing ('he paid me compliments and saw a lot of opportunities when we would implement it' and 'it is appreciated that I come up with ideas in the current recession'),
- Innovative role-modelling ('it seemed my executive 'ran away' with my idea, by being so enthusiastic I felt really motivated to put effort into its implementation').

Since all types of behaviour were already part of our behaviour taxonomy, we feel pretty confident that our preceding research has provided an exhaustive overview of relevant leader behaviour.

3.3 Main survey

The main survey aimed to collect data among a sample of employees from various knowledge-intensive service firms. This section presents the adjustment of both questionnaires, the sample and procedure, and the construction of the final scales.

Adjustment of questionnaires

All remaining items were processed and adjusted, much more parsimonious versions of the questionnaires. We added some indicators for the organisation's innovative outputs to the leader questionnaire. Such indicators are usable to assess sample representativity, as will be discussed below.

Innovative output (at firm level). Both theoretists and statisticians stress that innovative output may be related to the introduction of new products or services (product innovation) and/or the implementation of new processes (process innovation) (e.g., Tidd et al., 2001; OECD, 1997).

Our main survey questionnaire contained three indicators for product innovation. We first asked the respondents if any new products/services had been introduced in the past three years (e.g., De Jong & Ten Kroode, 2003; OECD, 1997). New product/service introduction is the goal of every product innovation process. Second, we asked for an estimate of the percentage of turnover due to new product introductions (e.g., Kleinknecht, 2000; Brouwer, 1997; Van Ark et al., 1999; OECD, 1997). To reduce the respondent burden, we decided to be satisfied with an estimate by the leader using five categories of turnover (0-<10%, 10-<20%, 20-<30%, 30-<50% or >50%). This provides some idea of the magnitude of new product introductions and its consequences. Third, we checked up new products' radicalness by asking if new products/services were also new to the sector. This is also a contemporary indicator for innovative output (e.g, Tether & Miles, 2001; De Jong & Ten Kroode, 2003).

To measure process innovation we added five indicators to the questionnaire. Following the CIS guideline[1], we asked for renewal in strategy, marketing concepts and organisational structures (OECD, 1997). To these we added the introduction of new or improved work methods, management techniques and serving new markets.

Sample and data collection

Sectors and firm size. Our main survey covered legal and accounting services (lawyers, legal advisors, accountants), economic services (management consultancy, economic and social research, public relations, advertising agencies), engineering (including architecture and technical design) and IT services. We focused on employees of small firms only. In both innovation and leadership research small firms are not paid much attention. In accordance with the Dutch definition of SMEs, we targeted firms with at the most a hundred employees, and we only invited firms with more than ten employees. This is generally where an entrepreneur meets the boundaries of his 'span of control' and where additional organizational arrangements come into practice (Risseeuw, 2003).

Two-stage sampling procedure. Of course, we did not have a database with all Dutch knowledge workers at our disposal. Whenever an inventory of population elements is lacking, two-stage procedures are most feasible to obtain a sound probability sample (Churchill, 1999). We first made a selection of knowledge-intensive firms who were willing to participate. Next, we used these firms (entrepreneurs) as sampling units for the second layer of knowledge workers.

We drew a random, initial sample of 550 firms from an exhaustive database called DMCD that is managed by Marktselect (www.marktselect.nl). It claims to include all Dutch firms. To ensure that each employee had an equal chance of selection, we used firm size (size class of number of employees) to determine the probability of selection. Not correcting for firm size would leave employees in smaller firms with a larger probability to be selected. Eventually this could have led to bias in the estimates of effect parameters (see Churchill, 1999, p. 537-538).

Selection of firms. Entrepreneurs/executives were issued with information about the objectives of the survey and the necessary activities to be carried out. To encourage participation, we promised to send along a benchmark report that presented the firm's scores in comparison with sector scores. One could volunteer by sending in an e-mail, fax back form or answer sheet. Since the survey would impose quite a burden, partici-

[1] The Community Innovation Survey is held every four years within all European Union countries.

pation rates were low. To obtain enough participants we had to draw another sample of 650 firms. Eventually we found 104 firms that were willing to participate, a response rate of 9%.

Representativity of firms. To check for deviations among non-respondents, we compared our respondents with population figures on some firm-level indicators for innovative output. As discussed earlier, our leader questionnaire contained a number of firm-level output indicators. The following indicators were formulated identical to those of Dutch statistical offices and could thus be compared with population figures[1]:

– Introduction of new or significantly improved products/services in the past three years
– Estimated percentage of turnover due to such products/services
– New or significantly improved strategies in the past three years
– New or significantly improved organisational structures in the past three years
– New or significantly improved marketing concepts in the past three years.

The results of the comparison are presented in table 4. Looking at the introduction of new or improved products, a binomial test revealed no significant difference between our response and population figures ($p = 0.11$). On the other hand, the estimated percentage of turnover from new products was somewhat lower than might be expected (20% vs. 25%). A one-sample t-test showed this difference was significant at the 1%-level ($p = 0.002$). The indicators of process innovation provide a different view. Our respondents seemed to score somewhat lower than estimated population figures. After binomial tests, we found significant differences for the presence of new or improved strategies ($p = 0.001$) and organisational structures ($p = 0.011$). For new or improved marketing concepts no deviations were found.

table 4 Comparison of population firms and respondents on five innovative output indicators (n = 104)

Output indicator	*Population*	*Respondents*
Product innovation:		
- Introduction of new or significantly improved products/services in the past three years (% of firms)	92[2]	88
- Estimated percentage of turnover due to such products/services	25[1]	20**
Process innovation:		
- New or significantly improved strategies in the past three years (% of firms)	51[2]	64**
- New or significantly improved organisational structures in the past three years (% of firms)	36[2]	48*
- New or significantly improved marketing concepts in the past three years (% of firms)	38[2]	47

[1] Provided by Statistics Netherlands based on CIS data, [2] Computed from the EIM/BLISS Innovation database (www.eim.net).

*** p < 0.01, * p < 0.05.*

In all, our responding firms scored slightly lower than average on product innovation indicators but somewhat better on the indicators for process innovation. After compar-

[1] Dutch statistical offices like Statistics Netherlands and EIM tend to follow the OECD (1997) guidelines.

ing absolute figures, we concluded that no major differences with the Dutch population of knowledge-intensive service firms could be found, thus, we concluded that non-respondents would not have scored very differently on innovative output indicators.

Although comparing our participating firms with population figures provides some evidence of representativity, we stress that innovative output at firm level can be quite different from bottom-up innovations due to subordinate innovative behaviour. Common indicators for innovative output (like the ones we have used) not only capture incremental innovations, but also radical ones. Thus, although the innovativeness of participating firms roughly matches with all knowledge-intensive services, our results should always be interpreted carefully.

Data collection among leaders and subordinates. In the second step of our sampling procedure, we asked each leader/ entrepreneur to draw a random sample from his subordinates. To ensure an acceptable respondent burden, each leader was invited to draw a random sample of ten persons. Since we were interested in leader-subordinate dyads, leaders were allowed to select their direct subordinates only. Subordinates were sampled based on their date of birth. If the number of subordinates only slightly exceeded the number 10, leaders were allowed to select from all of their employees. In table 5 it is shown that the participating firms employed 2822 persons altogether. A sample of 1007 employees was invited to join the main survey.

table 5 Number of employees, sample and response among participating firms

	Total
Total number of employees	2822
Sample	1007
Response leader questionnaire (response rate)	960 (95%)
Response subordinate questionnaire (response rate)	784 (78%)
Available dyads (% of sampled dyads)	774 (77%)

Next we collected data among leaders and subordinates. Both received a mail survey with a stamped envelope to return the completed questionnaire. Not surprisingly, high response rates emerged. The response of the leaders covered 960 subordinate assessments. Thus, in terms of the number of employees, our response rate was 95% (table 5). Besides, 784 subordinates participated, a response rate of 78%.

All responses were processed in the statistical package SPSS for Windows. Both questionnaires contained a unique user ID that served to pair responses. Of course, for scale construction purposes we used all available responses, but to establish any causal relationships it was the leader-subordinate dyads we were interested in. After merging both files, our dataset consisted of 774 leader-subordinate dyads (77% of all sampled dyads) (table 5).

Confirmatory check on the quality of scales

A confirmatory check was performed on the methodological quality of each scale before we ran any causal analyses. This check was partly based on the previously mentioned criteria of unidimensionality and internal consistency. For the multidimensional scales we also ran some confirmatory factor analyses (CFA) to assess validity. Researchers usually assess various types of validity. We have already discussed face validity, implying that a selection of items must cover a construct's domain. Two other types that are often investigated are convergent and discriminant validity. Convergent validity of a

scale is indicated if each factor loading is significant and a model with an adequate fit emerges. This confirms that various subscales do indeed measure parts of a similar construct (Hair et al., 1998). Discriminant validity is tested by calculating fit measures for a CFA model with correlations among subscales that are fixed on 1. Discriminant validity is indicated when the constrained model has deteriorated fit indices compared to unconstrained model (Bollen, 1989).

Results

In table 6 we again present relevant scale statistics. Below we elaborate on our findings.

table 6 Results of scale construction for main survey scales

Scale (subscale)	*# items***	*variance explained*	α	*mean r*
Innovative behaviour:				
Subordinate innovative behaviour	10	85%	-	-
- Opportunity exploration)	2	-	0.77	0.62
- (Idea generation)	3	-	0.89	0.74
- Championing)	2	-	0.90	0.82
- (Application)	3	-	0.90	0.76
Self-rated innovative behaviour	6	53%	0.82	0.43
Leadership:				
(A) Innovative role-modelling	4	62%	0.79	0.49
(B) Intellectual stimulation	4	63%	0.81	0.51
(C) Stimulating knowledge diffusion	4	63%	0.80	0.50
(D) Providing vision	4	71%	0.87	0.62
(E) Consulting	4	72%	0.87	0.63
(F) Delegating	3*	77%	0.85	0.65
(G) Support for innovation	4	66%	0.82	0.54
(H) Organizing feedback	3*	73%	0.82	0.60
(I) Recognizing	4	72%	0.87	0.63
(J) Rewarding	3	73%	0.82	0.60
(K) Providing resources	3	74%	0.82	0.61
(L) Monitoring	4	62%	0.80	0.50
(M) Task assignment	4	71%	0.86	0.60
Other:				
Innovative climate	11	69%	-	-
- (Participative safety)	4	-	0.80	0.50
- (Task orientation)	3	-	0.78	0.55
- (Support for innovation)	4	-	0.87	0.63
External contacts	5	57%	0.81	0.46

** After removing one item to enhance internal consistency.*
*** All item-rest correlations/factor loadings > 0.30.*

Innovative behaviours

Subordinate innovative behaviour. To construct this scale we had ten items at our disposal, related to opportunity exploration, idea generation, championing and application behaviour. Our literature review suggested a four-dimensional solution, but fitting

just this model to the main survey data would not assure that the best model was found. Hair et al. (1998) recommend a 'competing models' strategy, suggesting that the strongest test of a proposed model is to identify and test competing models that represent different hypothetical relationships.

To generate a set of competing models, one should first look for alternative theoretical foundations. In their studies among R&D professionals Scott & Bruce (1994; 1998) regard innovative behaviour as being one-dimensional. Some other researchers claim that subordinate innovative behaviour is multi-dimensional. For example, Janssen (2000; 2002) maintains a three-dimensional measure that covers idea generation, idea promotion and idea implementation. Both latter dimensions are similar to championing and application behaviour. Opportunity exploration is no part of his measurement scale. De Boer (1996) and Janssen et al. (1997) do take account of this dimension and report a reliable and valid four-dimensional scale. Axtell et al. (2000) provide an alternative model. Based on the two-stage model of innovation, they focus on the results of innovative behaviour. The initiation stage is expected to result in employees' suggestions, while the implementation stage should lead to the implementation of innovations.

Another source of competing models is exploratory factor analysis (e.g., Anderson & West, 1998). Our data set consists of 960 leader ratings of subordinate innovative behaviour. Since confirming factor models based on the same data would result in 're-fitting', we have drawn a random sample of 760 cases for the exploratory analysis. An initial principal factor analysis without iteration was computed. The first factor accounted for 66% of the variance. Application of the latent root criterion suggested a one-dimensional solution. Application of the screen criterion (Cattell, 1966) now suggested a three-dimensional measure. After oblique rotation, a structure emerged with the five items related to opportunity exploration and idea generation loading on the first factor. We labelled the first factor as 'idea production'. The second factor consisted of the items covering application, while the third factor accounted for the championing items.

In all, based on theoretical foundations and our exploratory investigation, we acquired four competing models using confirmatory factor analysis. We used the 200 remaining cases for this purpose. This number is usually regarded to be optimal for structural equation modelling using maximum likelihood estimates (Hair et al., 1998, p. 605). The following procedure was adopted:

- Firstly, a one-factor model was run with all items loading on a single factor.
- Secondly, a two-factor model was run. Its first factor was labelled 'divergent behaviour'. It covered opportunity exploration and idea generation, which are relevant to the initiation stage of the NSD process. The second factor was called 'convergent behaviour'. It entailed our championing and application items. These are relevant to the implementation stage of the NSD process.
- The third model specified three factors: idea production (as discussed above), championing and application.
- The fourth model consisted of four factors: opportunity exploration, idea generation, championing and application.

CFA models have no single statistical test that best describes the 'strength' of a model's predictions. Instead, various fit measures are available. Researchers should always assess results from three perspectives, namely those of absolute, incremental and parsimonious fit (see also Hair et al., 1998, p. 653-659). In table 7 we display the CFA results and report various fit measures.

table 7 Overall fit indices for the subordinate innovative behaviour scales (n=200)

	Absolute indices		*Incremental indices*		*Parsimony index*
Model	*GFI*	*RMSEA*	*TLI*	*NFI*	χ^2/df
(1) One factor	0.77	0.19	0.76	0.83	8.22
(2) Two factors	0.78	0.18	0.79	0.86	7.28
(3) Three factors	0.92	0.10	0.95	0.94	2.82
(4) Four factors	0.95	0.07	0.97	0.97	1.93
Critical range of fit measure	> 0.90	< 0.08	> 0.90	> 0.90	< 2.0

The changes in fit measures indicate an improvement for each successive model computed, strongly suggesting that subordinate innovative behaviour is a multi-dimensional construct. The results indicate that the four-factor model provides the best fit. Values of all fit indices are within acceptable ranges (GFI > 0.90, RMSEA < 0.08, TLI > 0.90, NFI > 0.90, $\chi^2/df < 2.0$). Besides, each factor loading was statistically significant at $p < 0.001$ (output not shown here). These results clearly support convergent validity (Jöreskog & Sörbom, 1996). Also, table 6 shows that internal consistency measures for each subscale were acceptable, well above 0.70 (Cronbach's α) and 0.40 (mean inter-item correlation).

Finally, we ran some alternative four-factor models to assess discriminant validity. We subsequently fixed the correlations between the four subscales on unity (see also Bollen, 1989; Jöreskog & Sörbom, 1996). In each case a model with unacceptable fit measures emerged.

Self-rated innovative behaviour. This one-dimensional scale consisted of six items. Unidimensionality was again supported by the fact that a one-factor principal factor analysis extracted 53% of the variance among items. And internal consistency was sufficient with $\alpha = 0.82$ and the mean inter-item correlation = 0.43 (table 6).

As mentioned before, the subordinate innovative behaviour scale is meant to be the dependent variable in our analysis. We also assessed its *external validity* by relating it to the self-rated innovative behaviour scale. After computing summary scores for both scales by averaging their items, the Pearson correlation coefficient was 0.36 and significant ($p < 0.001$). This result is almost identical to the correlations reported in previous innovative behaviour studies that used independent measures for validation purposes (e.g., Scott & Bruce, 1994; Janssen, 2000).

Leader behaviour scales

Following the criteria for unidimensionality and internal consistency we again assessed whether the 13 pre-defined scales satisfied our standards. Based on our calculations we decided to skip two more items. The delegating scale contained an item 'My executive allows me to set my own goals'. The item-rest correlation for this item was remarkably low, only just exceeding the critical value of 0.30. In knowledge-intensive services, it may be less common for employees to formulate and pursue their own goals. The internal consistency of the delegating scale was significantly improved by removing this item. In the organizing feedback scale we had an item 'My executive provides hints on how to effectively implement something new'. Again, this item had a low IRC and by skipping it, internal consistency became much better.

From table 6 it becomes evident that all final scales have a good internal consistency (α > 0.70 and the mean inter-item correlation > 0.40), while unidimensionality is supported by the fact that one-dimensional factor solutions explain at least 50% of the variance.

Contingencies

Innovative climate. We again investigated if the innovative climate could form a three-dimensional scale with participative safety, reflexivity and support for innovation as its dimensions. Our data set contained 784 subordinate ratings of climate. We drew a random sample of 584 cases to repeat the exploratory factor analysis. It again supported a three-factor solution. Factor loadings exceeded 0.50, while no cross-loading was above 0.20 (no output shown here). This solution explained 69% of the variance, while internal consistency measures for each subscale were good (table 6)[1].

The challenge now was to confirm that this model would accurately reproduce the correlations between its items. To assess convergent validity, we used to 200 remaining cases to estimate a three-factor CFA model that specified each item to load on its specific factor only. All fit measures were acceptable (GFI = 0.93, RMSEA = 0.07, TLI = 0.93, NFI = 0.92 and χ^2/df = 2.04), while factor loadings exceeded 0.50 and were statistically significant. On the contrary, a competing model that specified all items to load on a single factor contained unacceptable fit measures. These results clearly indicated a fair convergent validity of the innovative climate scale.

To prove discriminant validity we fixed the correlations among our subscales on unity. In each case a model with unacceptable fit measures emerged.

External contacts. After the pilot we made this scale more parsimonious. In the main survey the items still satisfied our criteria of unidimensionality (variance explained = 57%) and internal consistency (α = 0.81, mean inter-item correlation = 0.46).

[1] We also explored alternative solutions using the latent root and screen criterion. This would result in two- and five-factor solutions. Both solutions were non-interpretable in terms of item content.

4 Empirical findings

Our goal was to investigate which leader behaviours affect subordinate innovative behaviour beyond the influence of the control variables. Hierarchical regression analyses were conducted to detect the main effects of the thirteen leader behaviours while controlling for innovative climate perceptions and the extent to which employees have external contacts. In section 4.1 we present the descriptive statistics of all variables. Section 4.2 continues with the results of the regression analyses. In section 4.3 we discuss our findings and draw conclusions on our hypotheses.

4.1 Descriptive statistics

Correlations and means of all variables are shown in table 8. It is evident that most constructs are positively related with significant bivariate correlations at the .001 level. In leadership research this is not an unusual phenomenon. It also becomes clear that some leadership behaviours have positive correlations with subordinate innovative behaviour (e.g., consulting, delegating, support for innovation) while others are unrelated (e.g., innovative role-modelling, intellectual stimulation, providing vision).

table 8 Descriptive statistics and correlations (n = [774, 960])

		mean	SD	(1)	(2)	(3)	(4)	(5)	(6)	(7)
Dependent variable										
(1)	Subordinate innovative behaviour	3.07	0.83							
Predictor variable (hypothesis)										
(2)	Innovative role-modelling (A)	3.51	0.70	0.02						
(3)	Intellectual stimulation (B)	3.36	0.72	0.03	0.58**					
(4)	Stimulating knowledge diffusion (C)	3.87	0.64	0.06	0.39**	0.44**				
(5)	Providing vision (D)	3.16	0.88	0.07	0.65**	0.52**	0.37**			
(6)	Consulting (E)	3.31	0.83	0.24**	0.45**	0.41**	0.42**	0.39**		
(7)	Delegating (F)	4.08	0.69	0.19**	0.15**	0.04	0.34**	0.08^	0.35**	
(8)	Support for innovation (G)	3.76	0.65	0.16**	0.47**	0.46**	0.41**	0.43**	0.57**	0.36**
(9)	Organizing feedback (H)	3.37	0.81	0.05	0.49**	0.45**	0.45**	0.53**	0.52**	0.21**
(10)	Recognizing (I)	3.53	0.72	0.20**	0.45**	0.41**	0.44**	0.46**	0.56**	0.32**
(11)	Rewarding (J)	2.54	0.85	0.08^	0.29**	0.32**	0.25**	0.32**	0.38**	0.15**
(12)	Providing resources (K)	3.19	0.75	0.14**	0.40**	0.34**	0.33**	0.40**	0.49**	0.30**
(13)	Monitoring (L)	3.28	0.70	-0.05	0.29**	0.44**	0.32**	0.29**	0.24**	-0.03
(14)	Task assignment (M)	3.67	0.71	0.20**	0.34**	0.37**	0.36**	0.32**	0.45**	0.31**
Control variable										
(15)	Innovative climate	3.53	0.55	-0.01	0.33**	0.34**	0.35**	0.39**	0.25**	0.11*
(16)	External contacts	2.81	0.89	0.27**	0.10*	0.16**	0.21**	0.08^	0.23**	0.13**
(17)	Firm size (no. of employees)	29.9	20.4	-0.07^	0.02	0.04	-0.03	0.11*	-0.13**	-0.04
(18)	Gender (0 = female, 1 = male)	0.67	0.47	0.08^	-0.09^	-0.02	0.06	-0.02	0.02	-0.02

table 8 Descriptive statistics and correlations (continued)

		(8)	(9)	(10)	(11)	(12)	(13)	(14)	(15)	(16)	(17)
Predictor variable (hypothesis)											
(9)	Organizing feedback (H)	0.51**									
(10)	Recognizing (I)	0.71**	0.54**								
(11)	Rewarding (J)	0.34**	0.27**	0.40**							
(12)	Providing resources (K)	0.55**	0.47**	0.54**	0.37**						
(13)	Monitoring (L)	0.24**	0.23**	0.24**	0.19**	0.17**					
(14)	Task assignment (M)	0.46**	0.34**	0.43**	0.27**	0.34**	0.32**				
Control variable											
(15)	Innovative climate	0.28**	0.37**	0.28**	0.18**	0.30**	0.26**	0.30**			
(16)	External contacts	0.11*	0.09^	0.15*	0.14**	0.09*	0.12**	0.31**	0.09^		
(17)	Firm size (no. of employees)	-0.04	-0.02	-0.09^	0.04	-0.05	-0.01	-0.02	0.05	0.02	
(18)	Gender	-0.01	0.05	-0.01	0.00	-0.02	-0.03	0.04	-0.02	0.31**	0.17**

*** p < 0.001, * p < 0.01, ^ p < 0.05.*

To control the possibility that socio-demographic factors might lead to spurious relationships, gender (0 = female, 1 = male) and firm size (number of employees) were also entered into the analysis as covariates. Although emancipation has made some giant leaps, in Dutch small firms male employees may still have better job positions and may be in a better position to be innovative. As far as firm size is concerned, researchers have pointed many times to the fact that large firms are more bureaucratic (e.g., Bodewes & De Jong, 2003). This might impede subordinate innovative behaviour.

As far as the control variables are concerned, innovative climate is surprisingly unrelated to subordinate innovative behaviour ($r = -0.01$). On the contrary we do find a positive relationship ($r = 0.27$, $p < 0.001$) for external contacts. For firm size and gender we also find the expected relationships although their significance is rather weak ($0.01 < p < 0.05$).

4.2 Regression analysis

Assessment of multicollinearity

From table 8 we can establish that most variables have moderate correlations. Although there many significant correlations between pairs, the variables are sufficiently distinct to enable them to be used separately in the regression. More share much less than 25% of the variance with any other. Multicollinearity is not considered problematic until correlations reach about 0.75 (Hair et al., 1998). To check for multicollinearity, we first ran an exploratory factor analysis with oblimin rotation that was forced to extract 13 factors. It appeared that all items loaded on their a priori defined factor with loadings exceeding a 0.30 value, while by far most of the items had cross-loadings smaller than 0.10 but no cross-loading was higher than 0.30. The 13-factor solution explained 71% percent of the variance between the items. This provides some initial evidence on the distinctiveness of the leader behaviour scales.

Another check on multicollinearity consisted of the examination of variance inflation factors (VIFs) associated with each independent variable in the regression equation. The

VIFs ranged from 1.1 to 2.5. These fall far short of the 10 cut-off recommended in the literature (e.g. Hair *et al.*, 1998), indicating that multicollinearity is not a major problem.

Assessment of dependence

In our main survey respondents within a knowledge-intensive service firm rate their perception of the same leader. One should recognize that group membership can affect how employees perceive their executive's leadership style. The nested structure of our data (due to the two-stage sampling procedure) makes group membership play a role in the interrelationships among variables. The term *dependence* is relevant here. Dependence refers to the degree to which responses from individuals in the same group are influenced by group membership (Kenny & Judd, 1986; 1996). To test for dependence, intraclass correlation coefficients (ICC) and F-tests were computed for each multiple-item measure (table 9).

table 9 Dependence tests for multiple-item measures: ICC- and F-values

Scale (subscale)	*ICC*	*F-value*
Innovative behaviour:		
Subordinate innovative behaviour	0,24	3.93**
Leadership:		
(A) Innovative role-modelling	0,21	3.06**
(B) Intellectual stimulation	0,16	2.48**
(C) Stimulating knowledge diffusion	0,11	1.96**
(D) Providing vision	0,31	4.32**
(E) Consulting	0,12	2.00**
(F) Delegating	0,11	1.64**
(G) Support for innovation	0,13	2.14**
(H) Organizing feedback	0,13	2.30**
(I) Recognizing	0,12	2.04**
(J) Rewarding	0,15	2.29**
(K) Providing resources	0,16	2.48**
(L) Monitoring	0,14	2.26**
(M) Task assignment	0,06	1.50*
Other:		
Innovative climate	0,22	3.24**
External contacts	0,13	2.17**

*^ p < 0.05, * p < 0,01, ** p < 0,001.*

The ICC-values provide an estimate of the amount of individual-level variance that can be accounted for by being employed at a particular firm (Bliese, 2000). Positive values indicate that some of the variance in our scales is due to variation among leaders. Dependence can also be examined by performing oneway F-tests with group membership (firm) as the independent variable. If these tests reveal significant differences, variation among leaders will cause variance between the firms in our sample (Snijders & Bosker, 1999). Both tests reveal that dependence is present in our data.

Not adjusting for dependence would result in biased estimates of effect parameters (Kenny & Judd, 1986; Kreft & De Leeuw, 1998). To check for dependence we have used multilevel random-coefficient models to perform the hierarchical regression analysis.

Such models provide tests of causal relationships that correct for dependence (Diez-Roux, 2002).

Multilevel analysis

Multilevel random-coefficient models are very similar to classical multiple regression models. They both provide estimates of effect parameters and intercepts, which can be tested on significance by means of a t-test. For a detailed discussion we refer to Snijders & Bosker (1999) and Diez-Roux (2002). Major differences with classical multiple regression include

- The simultaneous examination of the effects of group level and individual level variables while accounting for the dependence of observations within groups. The equation defining a multilevel model contains more than one error term: one (or more) for each level.
- As a consequence, two types of explained variance (R^2) can be defined: at the individual level (R_1^2) and also at the group level (R_2^2). Formulas for their calculation are provided by Snijders & Bosker (1999, p. 102-103). Since we aim to study the determinants of individual innovative behaviour we will only report R_1^2.
- The use of maximum-likelihood estimates instead of ordinary least squares. This implies that a deviance measure is calculated to assess model fit (instead of the traditional F-test). The deviance measure can be regarded as a measure of lack of fit between model and data. To assess model fit a comparison is made with some baseline model, usually an empty model that estimates the intercept only. Differences in deviance values can be used as a test statistic having a χ^2-distribution.

Our analysis consisted of five steps:

- First, a baseline model was computed with no predictor variables. This model serves as a baseline to compute the initial value of the deviance measure, enabling us to assess if any of the next models will be significantly better (step 1).
- Next, we ran a model that contained firm size and gender as a control for relationships with the predictor and outcome variables (step 2).
- Third, we added innovative climate perceptions and external contacts as predictors to the equation (step 3).
- In the fourth step, we ran a number of multilevel models to explore which of the thirteen types of leader behaviour have an impact on subordinate innovative behaviour beyond the influence of the control variables (steps 4a - 4m).
- Finally, we ran an integral model that contained all control and predictor variables at the same time. We wanted to see if the significant type of leader behaviour would still have an impact when the other types of leader behaviour are held constant (step 5).

Results

Results of these analyses are shown in table 10 and will be elaborated on below.

table 10 Hierarchical multiple regression of subordinate innovative behaviour on leadership behaviours and contingencies (n = 774)[a]

	Step								
	1	*2*	*3*	*4a*	*4b*	*4c*	*4d*	*4e*	*4f*
Control variables:									
Firm size (no. of employees)		-0.08	-0.05	-0.05	-0.05	-0.05	-0.05	-0.03	-0.05
Gender		0.08^	-0.01	-0.01	-0.01	-0.01	0.00	-0.01	0.00
Innovative climate			-0.06	-0.05	-0.05	-0.07	-0.06	-0.10*	-0.09^
External contacts			0.29**	0.29**	0.29**	0.29**	0.29**	0.25**	0.27**
Predictor variables:									
(A) Innovative role-modelling				-0.02					
(B) Intellectual stimulation					-0.02				
(C) Stimulating knowledge diffusion						0.03			
(D) Providing vision							0.03		
(E) Consulting								0.19**	
(F) Delegating									0.17**
(G) Support for innovation									
(H) Organizing feedback									
(I) Recognizing									
(J) Rewarding									
(K) Providing resources									
(L) Monitoring									
(M) Task assignment									
Model fit:									
Deviance	2591.64	2367.12	1810.37	1811.29	1812.64	1805.69	1805.03	1786.68	1786.97
Δ Deviance		224.52**	556.75**	-0.92	-2.27	4.68	5.34	23.69**	23.40**
R_1^2		0.04	0.14	0.17	0.16	0.16	0.17	0.18	0.16

table 10 Hierarchical multiple regression (continued)

	Step							
	4g	*4h*	*4i*	*4j*	*4k*	*4l*	*4m*	*5*
Control variables:								
Firm size (no. of employees)	-0.05	-0.05	-0.03	-0.06	-0.04	-0.05	-0.05	-0.02
Gender	-0.01	-0.01	-0.01	-0.01	-0.01	-0.01	0.00	-0.02
Innovative climate	-0.11*	-0.07	-0.14*	-0.07	-0.10^	-0.03	-0.12*	-0.10^
External contacts	0.28**	0.29**	0.27**	0.28**	0.28**	0.31**	0.24**	0.24**
Predictor variables:								
(A) Innovative role-modelling								-0.11^
(B) Intellectual stimulation								-0.01
(C) Stimulating knowledge diffusion								-0.04
(D) Providing vision								-0.02
(E) Consulting								0.12^
(F) Delegating								0.08^
(G) Support for innovation	0.18**							0.02
(H) Organizing feedback		0.03						-0.10^
(I) Recognizing			0.22**					0.21**
(J) Rewarding				0.06				-0.04
(K) Providing resources					0.13*			0.03
(L) Monitoring						-0.09^		-0.08^
(M) Task assignment							0.18**	0.12*
Model fit:								
Deviance	1786.00	1812.45	1769.39	1795.38	1788.34	1805.38	1792.27	1746.81
Δ Deviance	24.37**	-2.08	40.98**	14.99**	22.03**	4.99	18.10**	63.56**
R_1^2	0.19	0.14	0.20	0.15	0.17	0.16	0.17	0.27

*** p < 0.001, * p < 0.01, ^ p < 0.05.*

[a] standardised regression coefficients are shown.

The first step reveals the baseline model with an initial deviance of 2591.64. The deviance measure must be interpreted as 'smaller is better'. Differences in deviance values can be used as a test statistic having a χ^2-distribution. After adding predictors, testing the significance of Δ deviance could indicate a better fit compared to the previous step.

In the second step, entering the control variables of firm size and gender into the regression yielded a significantly better equation compared to the baseline model (Δ deviance = 224.52, $p < 0.001$). Although both firm size and gender had the expected sign, it was just gender making a significant contribution to the explanation of subordinate innovative behaviour.

The third step added the other control variables, namely innovative climate and the extent to which employees maintain external contacts. Again, model fit was improved significantly (Δ deviance = 556.75, $p < 0.001$). With the four predictors, 14% of the variance between individual employees could be explained ($R_1^2 = 0.14$). A remarkable result was that innovative climate perceptions do not appear to contribute to subordi-

nate innovative behaviour (b = -0.06, p > 0.05). In the next section we will elaborate on this. Another striking result was that the effect of gender became insignificant after external contacts and climate perceptions were included into the regression equation (b = -0.01).

In the steps 4a to 4m inc. we tested our hypotheses by subsequently adding each leader behaviour to the regression equation. Controlling for firm size, gender, innovative climate and external contacts, step 4a shows that innovative role-modelling is not related to subordinate innovative behaviour. The same applies to intellectual stimulation (step 4b), stimulating knowledge diffusion (4c) and providing vision (4d). On the contrary, step 4e reveals that consulting is a leader behaviour that makes a significant contribution to subordinate innovative behaviour. Adding this construct yielded a regression equation with better fit (Δ deviance = 23.69, $p < 0.001$) and a significant and positive standardised regression coefficient (b = 0.19, $p < 0.001$).
Steps 4f and 4g indicated that the effects of delegating behaviour and support for innovation are also positive. By including these constructs we can explain 19 and 16 percent of the individual level variance (R_1^2), respectively. On the other hand, stimulating knowledge diffusion does not seem to help much to trigger bottom-up innovation. Step 4h produced a model with an unprofitable equation (higher deviance value compared to step 3) and an insignificant effect parameter (b = 0.03, $p > 0.05$).
Step 4i showed that recognizing employees' innovative contributions is an important leader behaviour to trigger bottom-up innovation. This model had a much better deviance and a significant standardised regression coefficient (b = 0.22, $p < 0.001$). The model explained 20 percent of the individual level variance between the employees in our sample. In contradiction, rewarding subordinates (step 4j) for being innovative does not seem to help much. This model produced an insignificant effect parameter.
Providing resources appeared to be a leader behaviour that is more significant to enhance subordinate innovative behaviour (step 4k). This equation had favourable fit measures and a significant standardised regression coefficient (b = 0.13, $p < 0.01$).
For the impact of monitoring behaviour we found a regression coefficient with the expected negative sign (b = -0.09, $p < 0.05$). Yet, Δ deviance was not significant at the 0.05 level (step 4l). Finally, task assignment (step 4m) provided a sensible contribution to the explanation of individual innovative behaviour. The effect parameter b indicated a significant and positive contribution.

The fifth and final step treated all types of leader behaviour as equal by adding them to the regression equation simultaneously. It provides a test on the significance of leader behaviours while holding the impact of the other leader behaviours constant. As could be expected, this model had a much better fit compared to step 3 (Δ deviance = 63.56, $p < 0.001$). With the variables in the equation, 27 percent of the variance in subordinate innovative behaviour could be explained ($R_1^2 = 0.27$).
The final model revealed that most types of leader behaviour maintained their significance (e.g., consulting, delegating, recognizing, monitoring, task assignment). There were also two differences. First, the impact of support for innovation and providing resources now became insignificant. The second deviation was that two types of leader behaviour now seemed to have a negative relation with subordinate innovative behaviour. While the other behaviours are held constant, innovative role-modelling (step 4a) and organizing feedback (step 4h) are estimated to contribute negatively. Below we will elaborate on these results.

4.3 Discussion

Confirmed hypotheses

Our analyses revealed some types of leader behaviour that enhance subordinate innovative behaviour, while others will not make much difference when one wants to trigger bottom-up innovation. In the context of knowledge-intensive service firms, leader behaviour that appeared to fortify the innovative behaviour of employees is consulting, delegating, recognizing and a challenging task assignment. We also found the hypothesized negative relationship with monitoring behaviour, which appeared to impede subordinate innovative behaviour.

As we expected, providing support for innovation and providing resources to implement ideas made positive contributions, however, their significant effects vanished in a regression equation that contained all types of leader behaviour. This is probably due to some significant correlations with other predictors. For instance, support for innovation related to the recognizing construct (r = 0.71, see table 8). After controlling for recognizing behaviour, not enough variance is left for a significant estimate of support for innovation. A similar explanation is feasible for providing resources. This construct is significantly related to various other constructs, including recognizing and support for innovation (table 8). In all, our analyses confirmed hypotheses E, F, G, I, K, L and M.

Rejected hypotheses

Leader practices that appeared not to trigger innovative behaviour were intellectual stimulation, stimulating knowledge diffusion, providing vision, and rewarding employees with financial incentives.

Contrary to our hypotheses, when we estimated a regression equation with all behaviour constructs, innovative role-modelling and organising feedback seemed to make a negative contribution. We could conclude that both constructs have a negative impact on subordinate innovative behaviour. For instance, innovative role-modelling relates to leaders being an example of innovative behaviour themselves. However, in the context of knowledge-intensive service firms innovative role-modellers may be very dominant leaders who claim a monopoly on innovative actions. The following attitude might be characteristic: 'I am the one in charge, so I will do all the thinking' or 'As an entrepreneur it is my task to create new things, I will let my employees just assist me realising them'. A similar reasoning can be followed for organising feedback. Leaders that ensure feedback on innovative actions might enhance successful implementation, but could simultaneously demoralise their employees from being innovative. Feedback might be explained as criticism and prevent future innovative attempts by employees.

On the other hand, empirical evidence for a truly negative impact of innovative role-modelling and organising feedback was not very convincing. In steps 4a and 4h we did not find significant effects (table 10) as the bivariate correlations with subordinate innovative behaviour are insignificant (r = 0.02 and 0.05, see table 8). In fact, the lack of significant correlations with innovative behaviour and the positive correlations with many other constructs (see table 8) suggest that in the final regression model suppression does occur (cf. Cohen & Cohen, 1983; Lord & Novick, 1968). It is likely that leader behaviour with a significant impact suppresses some of the variance in innovative role-modelling and organising feedback that was irrelevant to innovative behaviour. When this error variance is partialed out, or suppressed, the remaining variance is more strongly related to innovative behaviour.

Our interpretation of the pattern found is that innovative role-modelling and organising feedback are unrelated to subordinate innovative behaviour. In conclusion, our analysis did not support hypotheses A, B, C, D, H and J.

Impact of control variables

Our analyses also provided us with insights on the effect of our control variables (firm size, gender, innovative climate and external contacts). For firm size we did find negative regression coefficients in all equations (table 10), unfortunately, none of them was significant. We conclude that the effect of firm size on subordinate innovative behaviour should not be exaggerated. Although firm size is frequently mentioned as an important driver of the innovative ability of firms, at the dyadic level of employees and their direct executives it does not seem to make a large difference.

For gender we found the expected significant impact in the first equation, indicating that male workers are perceived to be more innovative compared to their female counterparts. It is striking that this effect vanishes as soon as innovative climate and external contacts are entered into the analysis (see table 10, step 2). A visual inspection of the correlation matrix (table 8) showed us that external contacts and gender are positively related. Our interpretation is that in knowledge-intensive services male workers are in better positions for opportunity exploration and innovative behaviour, probably because they are more frequently involved in primary work processes such as sales, customer service and delivery. On the contrary, female subordinates will more frequently do jobs like secretarial work and bookkeeping, not having external contacts that serve as a trigger for innovation.

A non-intuitive result was that innovative climate appeared to be unrelated to subordinate innovative behaviour. Our innovative climate measure consisted of participative safety, reflection and (group) support for innovation. Inspection of table 10 reveals no significant regression coefficients in most models, while some models even indicate a negative contribution (table 10). Negative regression coefficients are again likely to be caused by suppression. Looking at table 8 shows a lack of correlation between innovative behaviour and innovative climate, while both constructs are significantly related to many types of leader behaviour. Leader behaviour with a significant impact on innovative behaviour seems to suppress some irrelevant variance in climate perceptions, leaving its remaining variance negatively related to innovative behaviour. Indeed, in each step with a significant negative b-value for climate, a leader behaviour with a significant positive b-value was included (see table 10).
In all, we conclude that innovative climate is unrelated to subordinate innovative behaviour. This is still a non-intuitive result, since we would expect a positive relationship (see our discussion in section 2.4). We repeat that although studies at the organisational and team level have shown a positive effect of climate on innovation (e.g, Abbey & Dickson, 1983; Burningham & West, 1995; Siegel & Kaemmerer, 1978; Nijhof *et al.,* 2002; Ahmed, 1998), empirical support for an effect on innovative behaviour at *the individual level* is very limited. This is certainly an issue that is worth investigating in future research. A possible explanation is that an innovative climate has no direct impact on innovative behaviour, but instead it could be a conditional variable that enhances the impact of other variables (like leadership) (Scott & Bruce, 1994). This would call for an investigation of interaction effects. Of course, we cannot exclude that climate definitely has no impact on subordinate innovative behaviour. Particularly in the small knowledge-intensive services firms it may be just the leader/entrepreneur who has to approve and support the innovative actions of employees, no matter what other people (colleagues) think of them.

Finally, having external contacts proved to be a control variable with a consistent and significant impact. Our analysis revealed that subordinates with frequent external contacts are more often perceived to be innovative. Making employees stay more closely in touch with customers, suppliers, partners and competitors seemed to be beneficial for those leaders that wanted to trigger bottom-up innovation.

5 Implications and future research

Today, leaders in businesses face the challenge of innovating continuously in order to stay competitive. Leaders who think they can initiate all necessary changes by themselves will probably find themselves deceived. They will also need a continuous stream of bottom-up innovations to maintain profitability and high customer satisfaction. For this purpose, individual employees need to be both willing and able to show innovative behaviour.

This study investigated which types of leader behaviour have an impact on subordinate innovative behaviour. The research was carried out among a sample of knowledge-intensive service firms (such as research, consultancy, engineering and advertising), a group of firms that had grown rapidly in the past fifteen years, but is still under-researched. In this chapter we present the implications of our research for leaders in knowledge-intensive services (section 5.1). Section 5.2 discusses limitations and suggestions for future research.

5.1 Implications

We examined the impact of thirteen types of leader behaviour based on the qualitative research of De Jong & Den Hartog (2003). Based on a large-scale quantitative survey, we explored what types of leader behaviour affect subordinate innovative behaviour beyond the influence of control variables like an innovative work climate and the extent to which employees maintain external contacts. With these variables we managed to explain 27 percent of the variance in subordinate innovative behaviour. This result is fairly important, since it indicates that leaders in knowledge-intensive service firms who want to trigger bottom-up innovation control their own destiny. With their own behaviour they can strengthen and encourage their subordinate's innovative behaviour.

How to trigger bottom-up innovation

Although only seven of our 13 hypotheses were confirmed, the range of innovation-enhancing leader behaviour is still wide. Actually, it seems impossible for leaders NOT to affect their employees' innovative efforts. Among the types of relevant leader behaviour we found four practices that leaders display as a part of their daily work, no matter whether they wish to do so or not. These include:

- Consulting (checking with people before initiating changes that may affect them, incorporating their ideas and suggestions in decisions)
- Delegating (giving subordinates autonomy to determine independently how to do a job)
- Monitoring (checking on effectiveness and efficiency, stressing tried and tested routines; excessive monitoring have a negative impact on subordinate innovative behaviour)
- Challenging task assignments (providing employees with challenging tasks, accounting for employees' commitment when assigning tasks).

Such behaviour is typically exhibited for other reasons (like increasing financial performance, commitment or job satisfaction), but leaders should be aware of its impact on innovative behaviour as well. For example, delegation means that employees are sure of having sufficient autonomy in deciding how to go about their task. This may sound

rather obvious, but a true test is performed as soon as an employee dares to deviate from his executive's opinion. Japanese firms provide an excellent example of how far one can go with involving employees. During any innovation's design and planning process, Japanese businesses involve as many people as possible. They study every aspect of a new product or service, incorporating important features. Once the innovation has been implemented, it has reached a high level of thoroughness. Although this is a laborious process, the final innovation is more likely to be enthusiastically implemented, supported, and carried out with fewer errors and delays (Smith, 2002).
It also appeared that a challenging task experience can boost employees' innovative behaviour. This conclusion is very much in line with important theoretical work by Theresa Amabile on intrinsic task motivation (Amabile, 1983; 1988; 1997). People gain the greatest amount of motivation from challenging job opportunities and the ability to contribute to the business. To assign employees with challenging tasks, a leader should first become aware of the current perceived challenge in one's work. Leaders could inform themselves by frequently consulting their subordinates as to what kind of work they would like to do, or through investigations of employee satisfaction. It can help to define tasks in a broad and overlapping way. A specific way to increase challenging task assignment is job rotation. As employees they take their previous experiences with them to a new workplace, ideas and improvements are likely to occur. Southwest Airlines provides a nice example of how job rotation can be beneficial. Typically, this company starts with managers setting the right example. All managers at Southwest work at a job other than their primary jobs one day a quarter. They may work as a luggage handler, gate agent, flight attendant, or any other position, as long as it is a front-line position. This helps them learn more about the company, resulting in enhanced innovative behaviour.

In addition to the 'general' leader behaviour, we found three practices by which leaders can directly trigger bottom-up innovation:
– Providing support for innovation (acting in a friendly way to innovative employees, being patient and helpful, listening, looking after for someone's interests if problems arise)
– Recognizing (showing appreciation for innovative performances)
– Providing resources (providing time and money to implement ideas).

Experiencing support helps employees to feel free to act creatively and generate ideas. Thus, how leaders deal with mistakes is very significant. Preferably, mistakes should not be used to punish subordinates, but instead should be considered a learning opportunity.
Personal recognition appeared to be another leader practice leading to high innovative behaviour. It plays a vital role when realising that recognition reinforces and encourages the same behaviour. If positive behaviour is reinforced, it will repeat itself. People recognized for using their brains add a significant energy boost to the company. Providing pats on the back, ice cream parties, and other simple celebrations can create a feeling of pride that makes everyone a winner.
Next we looked at the provision of resources. Simply this means: it takes time and money to implement beneficial novelty. When suggestions are never implemented people become de-motivated. It takes resources to fortify their motivation and ability to strive for successful implementation, thus, leaders should trigger bottom-up innovation not only by words, but also by reserving time and money to work out ideas.

Another option for leaders that might be cheap and effective is to increase the extent to which employees have external contacts. Although our research treated this con-

struct as a control variable, it appeared that those respondents who were perceived to have frequent contacts with clients, suppliers, competitors and representatives from knowledge institutions, were being rated as better innovators. This is not surprising. By being in touch with external stakeholders employees have better opportunities to generate ideas, to assess their potential and to convince the people in their own firm of their value.

Where to save energy

Our research also revealed some leader practices that did NOT trigger innovative behaviour:

- Innovative role-modelling (being an example of innovative behaviour, exploring opportunities, generating ideas, championing and putting efforts in development)
- Intellectual stimulation (teasing subordinates directly to come up with ideas and to evaluate current practices)
- Stimulating knowledge diffusion (stimulating open and transparent communication, introducing supportive communication structures like informal work meetings)
- Providing vision (communicating an explicit vision on the role and preferred types of innovation, providing directions for future activities)
- Organising feedback (ensuring feedback on concepts and first trials, providing feedback to employees, asking customers for their opinion)
- Rewarding employees (providing financial/material rewards for innovative performances).

Although their impact on subordinate innovative behaviour might be intuitively appealing, leaders in knowledge-intensive services who try to boost bottom-up innovation through such types of behaviour will probably find themselves deceived. We do not claim that the above-mentioned leader behaviour is completely unrelated to subordinate innovative behaviour. Yet, we found no direct effects, indicating that leaders in knowledge-intensive services can save their energy and be more effective in stimulating innovative behaviour when they commit themselves to the previously discussed practices.

5.2 Limitations and future research

Of course the current study has limitations and raises several questions that should be addressed in future research. First and most important is that our results are incomplete in the sense that we have explored only the direct, additive effects of leadership. Future research should also explore how contingencies like innovative climate and having external contacts moderate the leadership - innovative behaviour relationship. One can guess why we found no direct relationship for some particular leader behaviour. For example, for intellectual stimulation to have an impact on subordinate innovative behaviour, it might be necessary for employees to have positive climate perceptions. Also, we can think of particular leader behaviour that should go together to boost bottom-up innovation. Maybe providing an innovative vision will, after all, have an impact when employees face challenging tasks. In all, future research should seek for interaction effects to see if (combinations of) particular constructs serve as enabling, neutralising or substituting factors (cf. Podsakoff *et al.,* 1993; 1996).

Second, future studies should test the robustness of our findings by doing research in other sectors. We focused exclusively on leaders of knowledge-intensive services. Perhaps some different leader behaviour might surface in other sectors. Knowledge-

intensive services should probably be distinguished from firms with other ways of organising the innovation process, such as supplier-dominated firms (e.g., Pavitt, 1984; Evangelista, 2000). These include sectors like personal services, hotels and retail stores. Such firms are generally adopters of innovations developed by other firms, and innovative behaviour of employees is likely to be less crucial to firm innovativeness in that context. Work practices tend to be more standardised, and there may be other innovation-enhancing leader behaviour in this context.

Third, we found a wide range of leadership practices that play a role, but it is not yet clear how they are exactly interrelated. The correlation matrix (table 8) indicated some significant correlations among the behaviour constructs. Although a factor analysis and calculation of VIF-values indicated that the constructs were sufficiently distinct, future quantitative research may condense the list of innovation-enhancing leader behaviour into a limited number of dimensions (maybe even a single dimension). One should attempt to produce a concise multiple-item measure for leadership to trigger subordinate innovative behaviour. In current research such a measure is still lacking.

A final recommendation for future research is to explore the impact of an innovative work climate in detail. It is striking that empirical evidence for its effect on individual innovative behaviour is still lacking. Contrary to our expectations, we found no effect of a supportive climate. Although we could argue that climate truly has no impact on subordinate innovative behaviour, before drawing such a non-intuitive conclusion other options should be investigated. For example, climate may indeed be relevant for the development of radical innovations while it is less important for incremental improvements due to subordinate innovative behaviour. Alternatively, climate may be a variable that mediates the leadership - innovative behaviour relationship.

Annex I Literature

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