

THE STRATEGIC IMPACT OF UNIVERSITIES NETWORKS TO THE GROWTH AND INNOVATIVENESS OF THE FIRMS

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Abstract

New Technology-based Firms (NTBFs) have been widely recognized for their prominent role in promoting economic growth and regional innovation. Due to their significance and strategic existence, many incubators have been established to support and ensure the survival and growth of these firms. Research have pointed out that much of the firms' success depends highly on their capability in building and developing networks. To carry out their mission to the fullest, incubators need to understand about firms' networks, especially their characteristics. Unfortunately, little is known about networks characteristics of those firms at incubators and more importantly, whether university or incubators have played an important role in the development of NTBFs. For that reason, we conducted this study to address the questions: Does support from university-incubator have any impact on the growth and innovativeness of NTBFs strategically? and then What is the role of support in influencing the relationship between networks and the growth and innovativeness of NTBFs? There were seven hypotheses tested for this study to three incubators in universities were selected as they present a similar objective in nurturing technology-based firms. In the analysis, a hierarchical moderated regression analysis was employed. The empirical findings drawn from our analysis confirmed that university and incubators have a mixed role in the growth of NTBFs. Apparently, support from incubator tends to influence growth in terms of job growth and location close to university tends to influence firms' level of innovativeness. Analyzing the influence of network characteristics, we found that NTBFs having loose networks are likely to be in a better position to grow compared to their counterparts that employ tight and strong relationships. Contrary to our expectation, the

findings failed to prove the importance of strong or weak ties on growth. The results on the moderating effect showed interesting findings that location and number of support play their important role differently. Location close to university was found to play a role in determining the relationship between network characteristics and level of innovation while support has influence on the relationship between network characteristics and job growth.

Keywords: universities, new technology-based firms, networks, support, growth, innovation.

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1. Introduction

Over the last two decades, attention for the contribution of universities and other public research institutions to the creation of new technology-based firms (NTBFs) has considerably increased, both among researchers and policymakers. It is through this type of firms that the transfer of scientific and technological knowledge from universities to the market place is effectively made (Chiesa and Piccaluga, 2000). NTBFs may appear small in terms of aggregate employment, but they significantly contribute to the creation of new jobs and of innovation through diffusion of new knowledge in the regional economy (Rothwell and Zegveld, 1985; Mansfield, 1991). Having new technology as the core of their business and provided that they are clustered in space, these firms increase the competitive edge of regions (e.g. Keeble and Wilkinson, 1999). NTBFs offer benefits such as promotion of technological entrepreneurship in regions and stimulate other business support and infrastructures that in turn provide benefits to other start ups (Lockett *et al.* 2003).

Bringing on such advantages, NTBFs have gained a wide recognition in such a way that fostering NTBFs has become part of most universities' policy to commercialize research today. From university perspective, supporting the growth of NTBFs will strengthen their relationships with business community, through which universities improve their image, fulfil commitment to society, and generate income from patents (e.g. Heydebreck *et al*, 2000). While there are many ways to support the growth of NTBFs, perhaps the most captivating one is establishing incubator organizations. The infrastructure of incubators was built gradually in industrial countries such as the United States and in Western Europe in the last two decades, and now appear to reach maturity (Lalkaka, 2003). The first generation of incubators in the 1980s essentially only offered affordable office facilities to potential new ventures, including shared services, and some kind of soft loans. As time progressed, it was realized that firms need more than just physical and financial support. Tenants of incubators which are mostly new technology-based firms experience more obstacles and face higher risk compared to non-technology-based firms. This situation has challenged various recent incubators to provide "value added support", like connecting entrepreneurs with various networks and utilize networks among tenants within incubator.

Looking on the relationship between university-incubator and NTBFs, some studies (e.g. Johansson *et al.*, 2005; Rothaermel and Thursby, 2005) find the presence of strong ties and a high degree of trust characterising this relationship due to history, reciprocity and location. This specific relationship including an exchange of knowledge and information becomes difficult to substitute. Knowledge produced in universities has been studied extensively, as it has its impact on industry. Yet, we know little about knowledge flows at the firms' level. The fact that access to diverse knowledge and resource are often acquired through networks, and since access to such resources may influence the growth (Stuart *et al.*, 1999; Burt, 2000, 2005), means that it is important from an academic and policy perspective to examine the role of networks in the growth of NTBFs (Gübeli and Doloreux, 2005). Moreover, the strong ties may lead to problems as firms are highly dependent on continued support (Johansson *et al.*, 2005). From firms' perspective, valuable support and knowledge extended by universities coupled with the difficulty to substitute the strong ties, make these ties have positive as well negative implication on firms' performance. In addition, firms receive too much support and become too dependent on support (Scholten, 2007). As a result, support and strong ties may hinder the performance of firms.

To date, there have been many studies conducted on new-technology based firms that provide a detailed understanding on the nature of linkages between university and NTBFs and whether these relationships have positive implications on growth and innovation. However, studies focusing on the role of universities in the development of networks of NTBFs are rather limited. To fill the gap in the literature, this study aims to investigate the relationship between NTBFs, especially during incubation process, and university. More specifically, we will address two questions; does support from university-incubator have any impact on the growth and innovativeness of NTBFs? What is the role of support in influencing the relationship between networks and the growth and innovativeness of NTBFs?

The structure of the paper is as follows. To begin, we construct a model of supporting NTBFs' growth and innovation through university-incubator model. We then outline the model to consider how external and internal factors may influence the NTBFs' performance. In the next section, hypotheses are discussed, followed by a section of research design. Thereafter, the findings of this study are discussed. Finally, discussion and conclusions are presented.

2. University-Incubator model: supporting the NTBFs' growth and innovation

Our approach to NTBFs' growth is inspired by the model of Reid and Garnsey (1998), focused to resources-based theory and first developed by Penrose (1959). Accordingly, firms may be conceptualized as heterogeneous bundles of assets or resources tied to the firms' management. Firms acquire or search for resources as an input and convert these into products or services for which revenue can be obtained. The resources-based theory deals with circumstances under which a resource will lead to high returns over longer periods of time. In order to progress through different phases of development, firms need to develop both resources and internal capabilities. Thus, they need access to specific resources such as new technology, investment capital, qualified employees, etc. and need to develop particular capabilities, of which networking seems to be the most important one. Networking enables firms to find new resources and generate stocks of network contacts that may be important for growth.

Based on Reid and Garnsey's model (1998), the development of firms can be divided into various stages (Figure 1), i.e. steady growth (or early failure), the former including moving from access to resources, mobilization of resources, and own generation of resources, followed by different outcomes, like growth reinforcement, stability (eventually with oscillation) and growth reversal. Today, many researchers and policymakers perceive incubation as a process in which different stages are followed (e.g. van Geenhuizen, 2003). The model of Reid and Garnsey particularly focuses on the different types of resources associated with the stages of access to resources and mobilization and generation of resources, i.e. financial, information, and relationships.

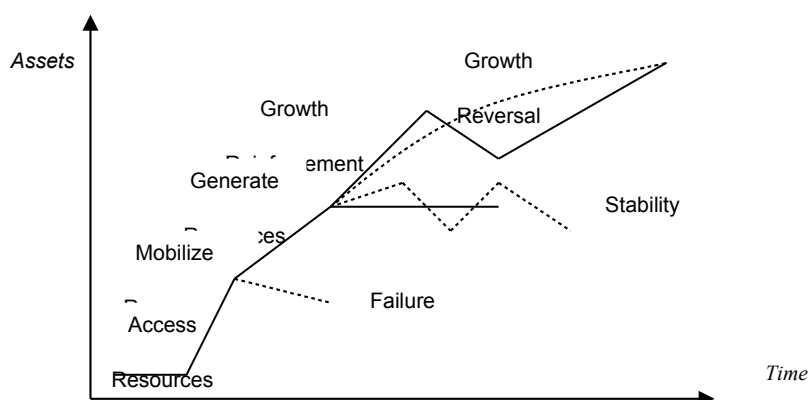


Figure 1 Growth paths of new high-technology firms (Reid and Garnsey, 1998)

Regarding the resources needed for new technology-based firms, many studies show that firms often experience similar lack of resources (Roberts, 1991; Kirwan et al., 2006). According to the above model, failing to find resources may harm firms' growth. The first obstacle encountered by firms is a lack of reputation. This is also known as the liability of newness. Scholars, e.g. Stinchcombe (1965), Choev and Anderson (2006), find that young firms have a greater propensity to fail than mature organizations because of this obstacle. As a new firm, NTBFs have not yet established relationships with customers and suppliers. Accordingly, NTBFs that are able to persuade potential customers and secure a stable supplier have more possibilities to succeed in a new market. Secondly, firms may lack an adequate supply of capital (Miller and Garnsey, 2000; Stuart and Sorenson, 2003). To develop an innovative product, NTBFs need relatively large investments for research and development activities. Thirdly, a later obstacle experienced by NTBFs is finding a source of knowledge, skills and expertise, often highly specialized, to deal with their difficulty in the development of products or services. Prahalad and Hamel (1990) argue that knowledge is one of the important sources of competitive advantages in technology-based firms. Using knowledge, firms are able to innovate continuously (Nonaka et al., 2000). The last obstacle faced by NTBFs is related to a lack of entrepreneurial knowledge (Soetanto and van Geenhuizen, 2006). As NTBFs intend to bring new

technology and innovation to market, practical knowledge such as understanding market conditions and how to manage a firm is important. The lack of knowledge is particularly true for the founders of NTBFs who mostly have a technical or engineering educational background.

Regardless the different obstacles faced by firms, NTBFs need to access resources in order to fulfil their strategy (e.g. Barney, 1991). At the same time, NTBFs need to acquire particular capabilities through learning, and one of these capabilities is to establish and maintain useful social networks through which external resources can be accessed. In general, organizations, whether established firms or start-ups, are part of a network and are dependent on external actors (Pfeffer and Salancik, 1978). Studies on growth of small firms indicate that developed networks of strong relationships with various partners may give advantages in gaining resources (Hoang and Antoncic, 2003). Networks provide entrepreneurs with avenues for negotiation and persuasion, enabling them to gather a variety of resources (e.g., market information, social support, venture funding and other financial resources) held by other actors (Nicolaou and Birley, 2003). Birley (1985) observes an extensive use of social networks in the early stages of the venture generation process, which in the case of NTBFs may include family, friends, previous colleagues and employers, and former professors. It is particular in these stages that social capital is needed to facilitate interactions, including the norms of reciprocity and trustworthiness that arise from them (Coleman, 1988; Putnam, 2000).

In our study, a limitation was made to study the determinant factors of NTBFs which is located at incubator. We define incubators as *organizations* that aim to accelerate the development of high-technology start-ups by providing an array of resources and services. Organization means that there is no strict boundary between university and incubator. Instead we see them as one entity of organization which shares a similar objective. Traditionally, incubators merge the concept of fostering new business development with technology transfer and commercialization of academic knowledge, by supplying mainly *physical* support such as accommodation and initial funding (Phillips, 2002). In a more modern version, they are entrepreneurial (non-profit) organizations that perform a bridging function between promising NTBFs and resources required by these firms while protecting them against potential failure (Hackett and Dilts, 2004). Accordingly, incubators act as a mechanism facilitating a wide range of networking as a link between firms and stakeholders that provide resources, such as governments, financial institutions, and business clubs.

According to the assumption that networks have play a significant role in supporting the performance of NTBFs, this study argue that the performance of NTBFs can be determined by two factors, external and internal factors. External factors mean that NTBFs receive support from external actors or condition such as support from university-incubator organization and relationship with university or other research institute. Internal factors means the networks among firms at incubators may be useful in the process of seeking resources. In addition, we also assume that supports from university-incubator as a part of incubator management may also influence the impact of internal factors to the NTBFs' performance. Accordingly, we propose the following model of the NTBFs' performance.

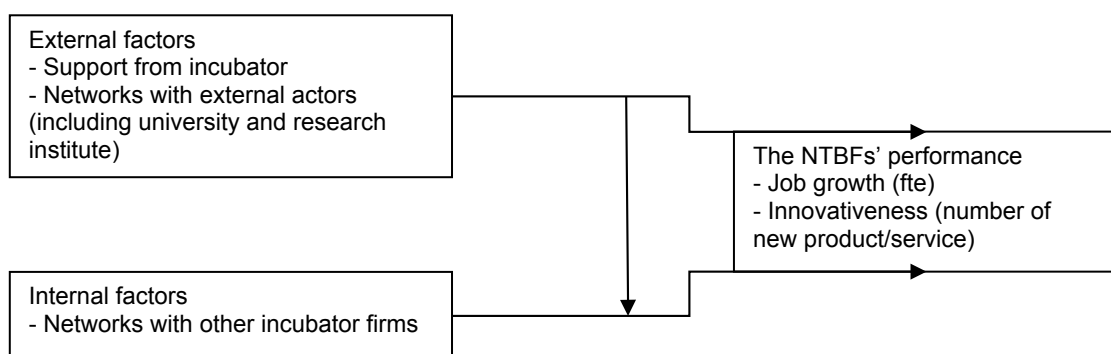


Figure 2. conceptual models of the determinant factors of NTBFs' performance

The above model is in line with previous works which argue that firms at incubators can utilize two kinds of networks, external and internal. Both networks are perceived to be equally important because they can both lead to access to appropriate resources. External, networks are defined as networks of important ‘external *partners*’ that potentially provide valuable resources for firms’ growth. As NTBFs frequently lack critical resources, especially market-related knowledge and skills (van Geenhuizen and Soetanto, 2004), they attempt to fill resource-deficiency in the development of technology by seeking a solution through ‘*partners*’ (e.g. professor at university, scientists at research institute etc). Relationships with ‘*partners*’ may be essential to gather relevant knowledge, to get external support and services, and to achieve access to those resources that are not available in-house (Birley, 1985). Thus, in the early years of NTBFs’ life, external networks with university and research institute are important and cannot be neglected.

Regarding the internal networks, Lyons (2002) argues that the most important support offered by incubators is the opportunity for internal networking among tenant companies. In practice, this relationship may involve formal or informal partnerships, joint ventures, or basic information exchanges among tenants. Moreover, Duff (1994) suggests that locating on the same site can generate a symbiotic environment where firms share resources and experience, learn from others, exchange business contacts and establish collaborative business relationships and practices. In addition, a positive effect of internal networking emerges through scale economies that arise when larger projects generate significantly more resources than smaller projects (Ahunja, 2000). Collaboration enables firms to take advantage of such scale economies. It also helps utilise existing expertise and/or technology, rather than having to create itself and therefore at an increased risk to the business.

3. Determinant factors of the NTBFs’ performance: Hypotheses development

In this section, we present hypotheses constructed for this study. In total there are seven hypotheses. The first two hypotheses are related to the external factors (location and support provided by university-incubators) and the other three are related to the internal factors (personal networks of NTBFs). The rest of the hypotheses are concerned with the moderating effect of those two external factors on the relationship between the internal factors and growth.

External factors

Location at university is one of the factors that may determine the performance of NTBFs. In the new understanding of knowledge, where parts of learning process emerges as a localised process (Asheim, 1999), the competitive advantage is created and sustained through a highly localised process (Porter, 1998). Therefore, we assume that NTBFs at incubators located within or spatially close to university will receive benefits that may support growth and innovativeness. Therefore, we propose the two following hypotheses: *The performance of NTBFs is positively influenced by being located in close proximity with university (hypothesis 1).*

Our next hypothesis refers to the nature of support provided by university-incubator. Conventional support is oriented towards the provision of tangible assets, e.g. flexible room, laboratory facilities and financial support. However, there has been an important evolution in the kind of support leading to additional added-value support, including connecting start-ups to various networks (e.g. Hannon and Chaplin, 2003). This type of support aims to strengthen the firm capability to grow independently. Based on the arguments about the influence of added-value support on the performance of NTBFs, we construct the second hypothesis: *There will be inverted U-shape of*

relationship between performance of NTBFs and the number of added-value support provided by university (hypothesis 2).

Internal factors

Our third hypothesis refers to the spatial orientation of networks. In studies of network creation, it is assumed that networks do not randomly link individuals (Sorenson, 2005). Rather, people interact most frequently with those in close spatial proximity, and with whom they share common backgrounds, interests and affiliations (Gertler, 2003). Close spatial proximity decreases direct costs associated with frequent and extended interactions necessary for maintaining social relationships (Zipf, 1949; Cooke et al., 2005), particularly personal networks. In contrast, in recent studies there is also an emphasis on the importance of partners located at a distance, i.e. external orientation of firms. Interactions between firms and their distant partners bring benefits in terms of receiving new information, opportunities and novel knowledge which is also necessary for growth (Bathelt et al., 2004). Based on these arguments, hypothesis eight was constructed in two parts: *The performance of NTBFs is positively influenced by internal orientation (hypothesis 3a); The performance of NTBFs is positively influenced by external orientation (hypothesis 3b).*

Our next hypothesis refers to the structural characteristics (tightness of networks) of networks. In studies on small business development, the importance of tight networks is stressed as being one of the factors that enhances the survival of new and small firms (Simsek et al., 2003). Tight networks are described as networks in which everyone is connected, because people know and interact with each other, they are more likely to convey and reinforce norms of exchange and are more able to enforce sanctions. In general, tight networks are beneficial for the transfer of complex and tacit knowledge, development of trust and comfort, legitimacy or reputation, and joint-problem solving (Coleman, 1990; Uzzi, 1996). In contrast with the above argument, Granovetter (1983) suggests that people who are connected in loose networks will benefit from the diversity of information available and the brokerage opportunities created by the lack of connection between separate clusters in the networks. The persons who occupy brokerage positions between separate clusters have better access to information (Hanaki et al., 2007). The above discussion shows that studies on the influence of structural characteristics of networks on growth are not yet conclusive (Gargiulo and Benassi, 2000). Taking it into consideration, we construct the following hypothesis: *The performance of NTBFs is positively influenced by tight networks (hypothesis 4a); The performance of NTBFs is positively influenced by loose networks (hypothesis 4b).*

The last hypothesis regarding internal factors refers to the relational characteristics (strength of ties) of networks. Strength of relationships is based on time and emotions invested in the relationships and reciprocity between partners (Granovetter, 1983). As people know each other more and become emotionally involved, they will develop strong ties that involve trust, commitment and willingness to support each other. In contrast, Granovetter (1983) argues that new information is obtained through casual acquaintances, i.e. weak ties, rather than through strong ties. Since strongly connected partners are likely to interact frequently, much of the information that circulates in this social system is redundant. Weak ties often include links with partners from other networks. In the case of NTBFs, it may be that either strong or weak ties have a positive influence on growth (Hite and Hesterly, 2001; Elfring and Hulsink, 2003). NTBFs need to access knowledge or get references of their product or service through strong ties with their partners while information and opportunity about new market can be obtained through weak ties. Based on these arguments, hypothesis was formulated: *The performance of NTBFs is positively influenced by strong ties (hypothesis 5a); The performance of NTBFs is positively influenced by weak ties (hypothesis 5b).*

Moderating effect

As stated in the beginning of the paper that the objective of this study is to understand whether university-incubators' support hinders the growth and innovativeness of NTBFs, the two following

hypotheses are constructed and tested in the model. Our assumption is that NTBFs endowed with a high number of support may develop networks that are more effective in supporting growth compared with NTBFs with a low number of support. Obtaining a high number of support, NTBFs will be empowered to develop certain network characteristics that positively influence growth (Reagans et al., 2004; Vissa and Chacar, 2009). Therefore, the following hypothesis is constructed with the objective to explore this relationship: *The number of support has a moderating effect on the relationship between the profile of social networks and the performance of NTBFs (hypothesis 6).*

Another variable that is expected to have a moderating effect on growth is the spatial proximity of university to NTBFs. Due to larger opportunities for networking, the growth of NTBFs located close to university seems to be influenced by certain characteristics of networks such as tight networks, loose ties and an internal orientation (orientation on local connections). In contrast, certain characteristics such as loose networks, weak ties and an external orientation may color the networks characteristics of NTBFs located in a distant proximity from university. Due to the large distance, NTBFs may have a limited chance to receive knowledge spillover and absorb tacit and complex knowledge from university. The idea that location may determine the characteristics of networks that have an impact on growth will be tested using the following hypothesis: *The spatial proximity between NTBFs and university has a moderating effect on the relationship between the profile of social networks and the performance of NTBFs (hypothesis 7).*

Table 1. Hypotheses summary

Hypothesis	Description
1	The performance of NTBFs is positively influenced by being located in close proximity with university
2a	There will be inverted U-shape of relationship between performance of NTBFs and the number of added-value support provided by university.
3a	The performance of NTBFs is positively influenced by internal orientation
3b	The performance of NTBFs is positively influenced by external orientation
4a	The performance of NTBFs is positively influenced by tight networks
4b	The performance of NTBFs is positively influenced by loose networks
5a	The performance of NTBFs is positively influenced by strong ties
5b	The performance of NTBFs is positively influenced by weak ties
6	The number of supports has a moderating effect on the relationship between the profile of social networks and the performance of NTBFs
7	The spatial proximity between NTBFs and university has a moderating effect on the relationship between the profile of social networks and the performance of NTBFs

Note: performance of NTBFs is measured by job growth and level of innovativeness; added-value supports include networking support, business coaching, etc, and exclude some basic supports such as initial investment and accommodation.

4. Research design

The study draws on a survey of NTBFs located at three incubators, namely TU Delft (Delft, the Netherlands), NTNU (Trondheim, Norway), and Daresbury SIC (Cheshire, UK). The three incubators were selected as they represent a similar objective in nurturing technology-based firms. The first incubator is incubator as a part of Technical University of Delft, the Netherlands. Technical University of Delft (TU Delft) represents a category of technical universities in Western Europe that became involved in supporting NTBFs relatively late. The first official program, named the Techno-starter program, was introduced in 1998, but similar support was provided a few years prior to 1998. The Techno-starter program was intended to support firms founded by graduates, students, and academic staff. At the time the data was collected, the program did not provide room in a special incubator building or in a Science Park. Rather, the NTBFs were located in faculty buildings, some old laboratories of the university (temporary) and in various business buildings in Delft. The Techno-starter program provided support in terms of initial investment, a small loan without interest, entrepreneurial courses, office space and use of equipment and laboratories at the faculties and some mentoring.

The second incubator aims to accommodate NTBFs which bringing knowledge and innovation from Norwegian University of Science and Technology (NTNU). Together with SINTEF (a government research institute), NTNU are the major stakeholders in knowledge commercialization from the university and research center. Together with Leiv Eirikson Nyfotek (LEN), a seed and venture capital company, NTNU established an incubator building at the university's premises in 2000. The incubator, called Innovasjonssenter Gloshaugen, offers office space, shared administration services, managerial support and network development support. In addition, LEN employs another incubator outside the university campus that provides a set of similar support facilities but with a focus more on IT and service industry companies as its tenants. Through these two incubators LEN has been involved in the establishment of 50 NTBFs in the period of 1995–2003.

The last incubator is the Daresbury Science and Innovation Center. Different from the previous two incubators which are mainly supported by university, the Daresbury SIC is part of government's effort to encourage increased commercial exploitation of scientific research and knowledge exchange in the Northwest region. Interestingly, three universities in the Northwest region of UK, Lancaster University, University of Liverpool, and University of Manchester are the main supporters of this incubator. Currently, the Daresbury SIC is home to over 90 innovative technology companies that typically form the biomedical, digital/ICT, advanced engineering and energy and environmental sectors. The facility is located in the heart of the technological based complex set in 30 hectares of Cheshire countryside between Liverpool and Manchester.

Using a semi-structured questionnaire in face-to-face interviews with the entrepreneurs in Delft and Trondheim, we collected data for this study. In Cheshire several means were employed to collect data as data used for this analysis was not directly available. Alternatively, we collected the data from the tenant survey, added with some interviews with the entrepreneurs. As a result, this approach led to 150 respondents from these three incubators. We measured social networks using the so-called *ego-centric* approach. The ego-centric approach focuses on individuals, rather than on networks as a whole. It starts with a selection of focal nodes or egos, and identifies the nodes to which they are connected. In this research, the focal nodes are the entrepreneurs and we identify the partners with whom they interact and discuss business affairs on a regular basis. This kind of approach can be quite effective for collecting relational data from large populations. To test the hypotheses, we used hierarchical moderated regression analysis. Hierarchical regression analysis allows for a comparison between alternative models with and without interaction terms, where an interaction effect only exist if the interaction contribute significantly to the variance explained in the dependent variable over the main effect of the independent variable (Jaccard and Turrisi, 2003). For all model, we used several regression diagnostics to assess whether modelling assumption were satisfied, except for testing hypothesis 2a and 2b where a non-linear transformation was used. The non-linearity of the variable is expressed in the square term. We checked for normality by conducting a Kolomogrov-Smirnov test, which supported the univariate normality assumption. In addition, we assessed the variance inflation factor (VIF) value and found no significant multicollinearity problems.

We used average annual job growth as an indicator for growth and number of new products as an indicator for innovativeness. The way in which we measured the various dependent and independent variables in the regression model can be found in table 2.

Table 2. Variables used for regression analysis

Variables	Measurement
<i>Dependent variables</i>	
Job growth	Average annual growth of jobs (in full-time equivalent).
Innovation level	Average number of new product or service
<i>Independent variables</i>	
Location	A dummy variable; 1 for firms with a close proximity with university and 0 for firms with a distant proximity with university.

Number of support	A value reflecting a number of the value added component in supports.
Spatial characteristic (close or distant proximity)	This variable is described as a quotient of the number of distant partners (> 60 minutes car driving) (d) and number of local partners ($n-d$) (shorter travel time) of a firm, given a maximum of five partners (Krackhardt and Stern, 1988). A high value indicates a relatively strong non-local network (more partners at a distance) (min: 0; max: 1). The formula is as follows: $(d - (n - d)) / n$
Structural characteristic (tight or loose network)	The variable, structural characteristic was measured as the quotient of the total number of ties of the network relations (t) and the total number of partners (n) per firm (Borgatti et al., 1998; Jensen and Greve, 2002). A high value indicates a relatively tight network, min: 0; max: 1. The formula is as follows: $2t / (n(n - 1))$
Relational characteristic (strong or weak ties)	According to Granovetter (1974), the relational characteristic is a linear combination of the amount of time, the emotional intensity, the intimacy, and the reciprocal service which characterizes the tie. In this study, the relational characteristic was constructed as a composite variable derived from three-rank variables: frequency of face-to-face interaction (i), duration of relationship (d), and entrepreneurs' assessment of closeness of the relationship (c) with partners (n) (Burt, 1992). A high value indicates a relatively strong ties, min: 0; max: 1. The formula is as follows: $(\frac{\sum_{p=1}^n i_p + \sum_{p=1}^n d_p + \sum_{p=1}^n c_p}{3n}) / 3$

In the regression analysis, we used age in years as a control variable as it is most likely correlated with growth. In our sample (table 3), the average age of firms is 5.09 years old, with more than 55% of firms have age between 4 and 6 years old. With regard to job growth, the average job growth is 1.08 fte. The number is relatively strong especially for small firms. Most of the firms (40.1%) have growth with 0.5 – 1 fte per year while only 25.8% of firms experience growth less than 0.5 fte per year and only 11.2% of firms experience growth more than 2 fte per year. Most of the firms in the sample are relatively small with 47.6% of firms have less than 5 fte. With the other 33.8% of the firms have employees of 5-10 fte, only 20.9% of the firms have size more than 10 fte. In terms of innovation, the firms in the sample have invested quite a lot of resources with average R&D investment of 45% from annual turnover and having at least 2 new products or services per year.

Table 3. Characteristics of the sample

Variables	Descriptive
<i>Average Age</i> (years)	5.09 years (SD: 7.1)
<i>Age of firms</i>	
- Less than 4 years old	26.4%
- 4-6 years	55.9%
- More than 6 years (to 10 years)	17.7%
<i>Average Growth</i> (jobs)	1.08 fte (SD: 0.91)
<i>Growth</i>	
- Less than 0.5 fte per year	25.8%
- 0.5 – 1 fte per year	40.1%
- 1 – 2 fte per year	22.9%
- More than 2 fte per year	11.2%
<i>Size (fte)</i>	
- Less than 5 fte	47.6%
- 5-10 fte	33.8%
- More than 10 fte	20.9%
<i>Average R&D</i> (% of annual turnover)	45%
<i>Average number of new products / services</i>	2 products/services per year

The following table (table 4) shows the network characteristics. Regarding the spatial characteristics, the table indicates a value of 0.32 meaning that NTBFs have a weak external orientation moderately dominated by local contacts. NTBFs in Trondheim interact with more local partners than those in Cheshire and Delft, witnessing

0.20 compared to 0.46 and 0.47 respectively. Apparently, the non-metropolitan character and geographical location of Trondheim, far from other European cities, may urge NTBFs to rely on contacts in close proximity. In contrast, located in a metropolitan area or close to metropolitan areas endowed with a dense transportation network, NTBFs in Delft and Cheshire have more opportunities to develop networks with non-local contacts.

The relational characteristic was measured using three variables, i.e. frequency of interaction, duration of relationship and perception of closeness. The total sample had an average score of strength of ties of 0.72. This score indicates that NTBFs in this sample have a relatively strong relationship with contacts. Concerning the different categories, NTBFs in Delft and Cheshire have a stronger relationship with their contacts compared to NTBFs in Trondheim. The strong relationship with partners found in Delft and Cheshire may be affected by the close proximity of Delft and Cheshire to other big cities in the region.

Regarding the structural characteristics, the average tightness of networks in the total sample was 0.59. This score means that NTBFs in the sample had a relatively modest value. With an average score of 0.52, NTBFs in Delft have relatively more loose networks compared to NTBFs in Trondheim with an average score of 0.69. NTBFs in Cheshire have a slightly similar average score to NTBFs in Trondheim. In other words, NTBFs in Delft employ networks of partners that are not well connected while in Trondheim and Cheshire, NTBFs have partners that mostly know each other. The loose networks of NTBFs in Delft may be set off by the fact that being located in a metropolitan area with a large reservoir of potential partners, NTBFs are able to develop networks with partners that are not connected.

Table 4. Characteristics of social networks

	Spatial characteristic (close or distant proximity)	Relational characteristic (strong or weak ties)	Structural characteristic (dense or sparse network)
Total sample	0.32 (0.5)	0.72 (0.1)	0.59 (0.3)
Delft	0.47 (0.6)	0.76 (0.1)	0.52 (0.3)
Trondheim	0.20(0.4)	0.64 (0.2)	0.69 (0.5)
Daresbury	0.46 (0.4)	0.75 (0.1)	0.68 (0.2)

5. Findings

In this section, we will examine to what extent the previously discussed university-incubators influence the growth of NTBFs, aside from the influence of internal factors, such as network characteristics. Overall, Table 5 shows that all the models passed the statistical F test and the R-square (the goodness of fit) of the models showed a relatively high value. In the second model concerning job growth as the dependent variable, four beta-coefficients were significant. The model failed to confirm the influence of location and external orientation on job growth. In the third model, the square transformation of support was introduced and found significant. Moreover, in the fourth and fifth model, the interactions were introduced. As a result, none of the beta-coefficients between location and network characteristics was significant. In the fifth model, the beta-coefficient of the interaction between the number of support and external orientation was significant as well as the beta-coefficient of the interaction between number of support and strength of ties.

In the model explaining level of innovation, the second model confirmed that location and network characteristics including external orientation and strength of ties were significant for growth. This result is quite interesting as in the previous model using job growth as the dependent variable, it was found that the location was not significant while number of support was proven to be important. The third model showed that the square transformation of added value support was not significant. In the fourth model, the beta-coefficient of the interaction between location and external orientation was significant while the beta-coefficient of the interaction between location and strength of ties was also found significant. In contrast, none of the beta-coefficients of the interaction between number of support and network characteristics was significant.

Table 5. Results of the linear regression model estimation

	Job growth				
	1	2	3	4	5
	β (s.e.)	β (s.e.)		β (s.e.)	β (s.e.)
<i>Control variable</i>					
Age of firms	0.11(0.01)	0.12(0.03)*	0.13(0.01)*	0.09(0.05)	0.07(0.00)
<i>Main effect – external factors</i>					
Location	0.09(0.07)	0.14(0.10)	0.11(0.07)	0.10(0.07)	0.14(0.17)
Number of added-value supports	0.38 (0.13)*	0.34(0.21)*	0.26(0.11)*	0.27(0.11)*	0.33(0.12)**
Number of added-value supports ²			-0.38 (0.23)*		
<i>Main effect – internal factors</i>					
External orientation		0.17(0.03)	0.15(0.07)	0.17(0.14)	0.19(0.37)
Tightness of network		-0.39 (0.15)*	-0.39 (0.11)**	-0.33 (0.14)*	-0.42 (0.01)*
Strength of ties		-0.25(0.34)*	-0.21(0.29)*	-0.10(0.19)	-0.23(0.23)*
<i>Two way interaction - location</i>					
Location x external orientation				-0.15(0.19)	
Location x Tightness of network				0.10(0.05)	
Location x Strength of ties				0.02(0.10)	
<i>Two way interaction – number of supports</i>					
Number of supports x external orientation					0.31(0.14)*
Number of supports x Tightness of network					0.12(0.07)
Number of supports x Strength of ties					-0.19(0.12)*
N	150	150	150	150	150
F	39.08**	38.65**	39.87**	41.08**	42.01**
R ²	.31	.40	.43	.55	.49
Root MSE	.65	.57	.58	.61	.64

* $p < 0.05$; ** $p < 0.01$

Table 6. Results of the linear regression model estimation

	Level of innovation				
	1	2	3	4	5
	β (s.e.)	β (s.e.)	β (s.e.)	β (s.e.)	β (s.e.)
<i>Control variable</i>					
Age of firms	-0.15 (0.01)	0.12 (0.04)	0.19 (0.02)	0.16 (0.00)	0.11 (0.00)
<i>Main effect – external factors</i>					
Location	0.09 (0.07)*	0.24 (0.12)**	0.18 (0.12)*	0.19 (0.07)*	0.22 (0.11)*
Number of added-value supports	0.10 (0.11)	0.08 (0.11)	0.13 (0.16)	0.10 (0.11)	0.08 (0.21)
Number of added-value supports ²		0.02 (0.01)	0.02 (0.02)		
<i>Main effect – internal factors</i>					
External orientation		-0.14 (0.09)*	-0.10 (0.02)*	-0.13 (0.22)*	-0.12 (0.12)*
Tightness of network		-0.39 (0.26)**	-0.31 (0.18)**	-0.38 (0.21)*	-0.32 (0.19)**
Strength of ties		-0.10 (0.10)	-0.12 (0.09)	-0.12 (0.03)	-0.12 (0.02)
<i>Two way interaction - location</i>					
Location x external orientation				-0.32(0.18)*	
Location x Tightness of network				0.19(0.03)	
Location x Strength of ties				0.21(0.29)*	
<i>Two way interaction – number of</i>					

<i>supports</i>					
Number of supports x external orientation					-0.08(0.11)
Number of supports x Tightness of network					0.12(0.07)
Number of supports x Strength of ties					-0.17(0.18)
N	150	150	150	150	150
F	43.08**	42.65**	41.43**	45.12**	40.77**
R ²	.35	.39	.41	.50	.43
Root MSE	.42	.70	.75	.65	.59

* $p < 0.05$; ** $p < 0.01$

6. Discussion and Analysis

Previous research on the relationship of university-incubators and the growth of their tenants has produced a mixed result, highlighting the importance of different elements during the incubation process. Addressing recent calls for more research on understanding this relationship, this study was undertaken by the belief that in order to more fully understand how firms benefit from support provided by university – incubators, it is necessary to consider the relationship between firms, networks and performance, and how support may influence the relationship. We provided initial empirical evidence to prove that the extent of firms’ indulgence on benefits of having networks on their growth and innovativeness is contingent on the location and support received from university-incubators. Specifically, the result lends support for the notion that too much support may have negative influence on growth. Another interesting finding was location of university does still matter for NTBFs especially in terms of support to their innovation.

In the following section, we will discuss the results of the analysis on each hypothesis. In the first hypothesis, it was tested whether being located in close proximity with university offers benefits to NTBFs. The result indicates that being located in close proximity to university has a significant implication on the firms’ level of innovation. Being located close to university, NTBFs may enjoy knowledge spillover and monitor research activities within university that may increase firms’ level of innovativeness. In terms of job growth, it seems that the presence of university in a close distance does not have any significant impact.

The role of support on the growth and innovation of NTBFs in the next hypothesis was tested. As we hypothesized, the findings confirmed that the number of support is beneficial for the growth of NTBFs. The support provided by university-incubator such as initial investment, networking workshop and business coaching may improve firms’ capability to solve their obstacles and experience growth. However, the influence becomes negative if firms receive too much support or obtain support for a long time. Apparently, the support that was supposed to save firms from the difficulty of starting a new venture did not effectively improve firms’ learning capability. In addition, the influence of support was not significant either for the innovativeness of NTBFs.

In the hypothesis dealing with spatial orientation of NTBFs, two types of orientation, internal and external were distinguished. NTBFs with dominated by an internal orientation employ partners in close proximity. Some studies find that, in terms of knowledge utilization, partners in close proximity bring positive benefits for growth, while other studies find that an external orientation stimulates growth by introducing more novel information and knowledge (Bathelt et al., 2004). These two arguments are covered in hypotheses 3. Using job growth as a dependent variable, the result of the hypotheses testing showed that the hypotheses on the influence of internal and external orientation (hypotheses 3a and 3b) were rejected in all the models. Apparently, both external and internal orientation is not likely to promote growth for NTBFs. In contrast, when level of innovation was used as a dependent variable, the internal orientation is likely to be important. In other words,

local contacts may play an important role in increasing level of innovativeness of NTBFs such as participated in problem solving or development of innovation. These contrasting findings may raise some interesting implications especially for the effort in supporting the growth or innovativeness of NTBFs. In the early years, when firms may depend on the development of technology and innovation from university, the importance of being located close to university is essential. However, in the long run, the close proximity may no longer support growth. Apparently, the findings revealed a complex and dynamic nature of the relationship between NTBFs and source of knowledge.

Regarding the structural characteristics, the literature shows two different arguments, namely the closure and the structural hole argument. The closure argument stresses that a tight network of partners can easily transfer tacit knowledge, reputational effects and provides continuous access to resources. The structural hole argument claims that a loose network provides access to a wider circle of information about resources and opportunities, and referrals on a wider potential of partners. Given the ambiguity in the literature, the impact of these characteristics of networks was tested using hypotheses 4a and 4b. Hypothesis 4a refers to a tight network with a high level of connection among all partners. The results from the hypothesis testing showed that all the models (job growth and level of innovativeness) rejected this hypothesis. Thus, closure (tightness) does not show any significant impact on growth. The alternative hypothesis concerning loose networks which emphasizes the structural holes argument was supported. Overall, this finding is consistent with previous studies (e.g. Burt, 2000, 2005) that stress the important role of structural holes. For university incubators, the findings highlight the importance of bringing different parties to engage with NTBFs. With regard to structural holes construction, the networking support can be created with an aim to widen the network of NTBFs as NTBFs need to develop a network with people from different backgrounds and clusters, However, a careful selection of potential partners needs to be examined as different firms may target different new contacts which can bring benefits to firms.

Next, the hypotheses on the relational characteristics of networks (strength of ties) were tested. In the literature, the role of strength of ties in growth is still under debate. Several studies stress that strong ties are more beneficial while others argue the importance of weak ties (Gulati, 1995; Larson 1992). Strong ties may contribute to the transfer of complex knowledge whereas weak ties may benefit from the introduction of novel information (Hansen 1999; Elfring and Hulsink, 2003) and the facilitation of explorative activities (Rowley et al., 2000). In this study, these arguments were tested using hypotheses 5a and 5b. The result showed that most of the models rejected both hypotheses, except for model with job growth as a dependent variable which confirmed the positive influence of weak ties on job growth. The failure to confirm the hypotheses on strong ties is intriguing as many studies argue the importance of strong ties especially in the early years of firms establishment. Firms lack initial resources and they can normally acquire them through personal and close ties such as friends, family and colleagues. However, the finding supports what has been indicated in several studies as the benefits gained from various, simultaneously occurring, combinations of strong and weak ties (Elfring and Hulsink, 2003; Burt, 2000; Jack, 2005).

In addition to the above hypotheses, two hypotheses were formulated on the assumption that several variables played a role in moderating the relationship between network characteristics and growth. The first factor was location of university. It has often been argued, but with limited empirical evidence, that the presence of university has influence on the relationship between university and NTBFs. It was assumed in this study that the closer proximity with university is, the stronger the relationship between network characteristics and growth is. However, the results showed no significant influence on location when job growth was measured as an indicator of growth. Moreover, the results revealed an interesting result when using level of innovativeness as a dependent variable. The result confirmed the influence of location in moderating the relationship between external orientation and strength of ties. The results suggested that the strong growth of NTBFs located close to university tends to come from more local and strong ties.

The next factor tested was support provided by university-incubators. Based on advantages of receiving support, we hypothesized that the relationship between networks and growth would be stronger for NTBFs which receive support. The results showed that this hypothesis was partially supported. The support moderates the relationship between spatial orientation with growth and strength of ties. Strong growth of NTBFs with a high level of support tends to be influenced by weak ties and external orientation while strongly growing NTBFs with a low level of support tend to have strong ties and an internal orientation. Overall, the finding shows the importance of networking support in bringing new potential contacts for firms.

Table 7. The result of hypotheses testing

Hypothesis	Description	Job growth	Level of innovativeness
1	The performance of NTBFs is positively influenced by being located in close proximity with university	Rejected	Confirmed
2	There will be inverted U-shape of relationship between performance of NTBFs and the number of added-value support provided by university.	Confirmed	Rejected
3a	The performance of NTBFs is positively influenced by internal orientation	Rejected	Confirmed
3b	The performance of NTBFs is positively influenced by external orientation	Rejected	Rejected
4a	The performance of NTBFs is positively influenced by tight networks	Rejected	Rejected
4b	The performance of NTBFs is positively influenced by loose networks	Confirmed	Confirmed
5a	The performance of NTBFs is positively influenced by strong ties	Rejected	Rejected
5b	The performance of NTBFs is positively influenced by weak ties	Confirmed	Rejected
6	The number of supports has a moderating effect on the relationship between the profile of social networks and the performance of NTBFs	Partly confirmed	
7	The spatial proximity between NTBFs and university has a moderating effect on the relationship between the profile of social networks and the performance of NTBFs	Partly confirmed	

7. Conclusion

Our research questions were does support from university-incubator have any impact on the growth and innovativeness of NTBFs? and What is the role of support in influencing the relationship between networks and the growth and innovativeness of NTBFs? The empirical findings drawn from our analysis confirmed that university-incubator have a positive role in the growth of NTBFs and support tends to influence growth in terms of job growth and location with university tend to influence level of innovation. This study revealed interesting findings regarding the different influence of location and support on growth and innovativeness. In addition, the findings also found the appearance of reverse u-curve relationship between support and growth. The findings are interesting and may intrigue further investigation as it is barely known how support has any impact in a long term. In terms of network characteristics, NTBFs having loose and weak relationships tend to be in a better position to grow compared to NTBFs that employ tight and strong relationships. The previous results all pointed into the same direction that is, relatively open information (knowledge) sources and flow have a positive influence on growth of innovative companies. Contrary to our expectation, the findings failed to prove the importance of strong or weak ties on growth. However, in terms of innovation, having more close contacts have a positive influence on the level of innovativeness of NTBFs. The results on moderating effect showed interesting findings as location

and number of support have played their important role differently. Location of university plays a role in determining the relationship between network characteristics and level of innovation while support has influence on the relationship network characteristics and job growth.

The overall contribution of this study can be employed in two folds, research on networks and policy practise in supporting the performance of NTBFs. In terms of research on networks, the findings show that network is a multidimensional phenomenon in which each characteristic may offer different benefits to the growth and innovativeness of NTBFs. Focusing on one characteristic may hinder the understanding on the impact of networks on the performance. Another interesting finding is the role of factors in moderating the networks characteristics and performance of NTBFs. As the study shown the influence of location and support in determining the relation of networks characteristics on performance, this finding imply that network have developed based on certain condition and mechanism. Interestingly, there are still few studies on networks literature which emphasize on the antecedent and condition of network development. Moreover, this study has contributed in improving policy of supporting NTBFs. The first implication is on designing an improved networking support for NTBFs. Network support provided for NTBFs need to be designed according to the need or stage growth of NTBFs. In designing support, the selection criteria of firms who enter incubator need to define whether focus on growth or innovation.

We believe that our study can be generalized to some extent, namely to NTBFs and universities different countries, such as Indonesia and other various countries. Therefore, replications of the study are the best effort to enrich the findings and generalizations as well. Despite the interesting results, we acknowledge that there are some limitations in our study. The first limitation is the issue of measurement. Measuring level of innovativeness as done in this study may not be able to catch the real innovation process faced by NTBFs although we made it as general as possible by including product and process innovation. The measurement of strength of ties also has a limitation. As suggested by Granovetter (1983), strength of ties can be measured as an aggregation of three different indicators. This measurement may just roughly describe the characteristics of ties. In business networks, firms might meet each other quite often but the level of emotion between entrepreneurs and their partners are still low as their discussion is restricted to business matters only. A better indicator for presenting those measurements needs to be identified for future researches. The second limitation is related to the heterogeneity of firms participated in the studies. As the study included firms which have quite similar characteristics, such as technology-based firms or knowledge-based firms, it did not take into account the different strategies of NTBFs for instance in penetrating market or developing networks with university. In addition, founders' capability in developing networks should be considered. Another limitation is the lack of attention paid to capture the dynamic relationship between networks and growth (Slotte-Kock and Coviello, 2009). In this study the assumption was made that networks influence the growth of NTBFs, but causality may also run into the opposite direction. Fast growing NTBFs may be perceived as an attractive partner, and therefore their network characteristics may be different from those of slow growing NTBFs. In the future, a longitudinal perspective should be adopted that can be used to track the interactions between networks and performance over time.

This study intended to make contribution to the theory of NTBFs' growth and policy of supporting them. The theoretical contribution was to deepen the knowledge on the role of social networks in growth and performance of NTBFs given different types of support and location. The result of this study can be used as a recommendation to improve support from university-incubator organizations, especially networking support. Studies to date have primarily discussed the incubation process in terms of organization, process and financial aspects and only a limited number of studies have examined the aspect of value-added support such as improving the quality of social networks.

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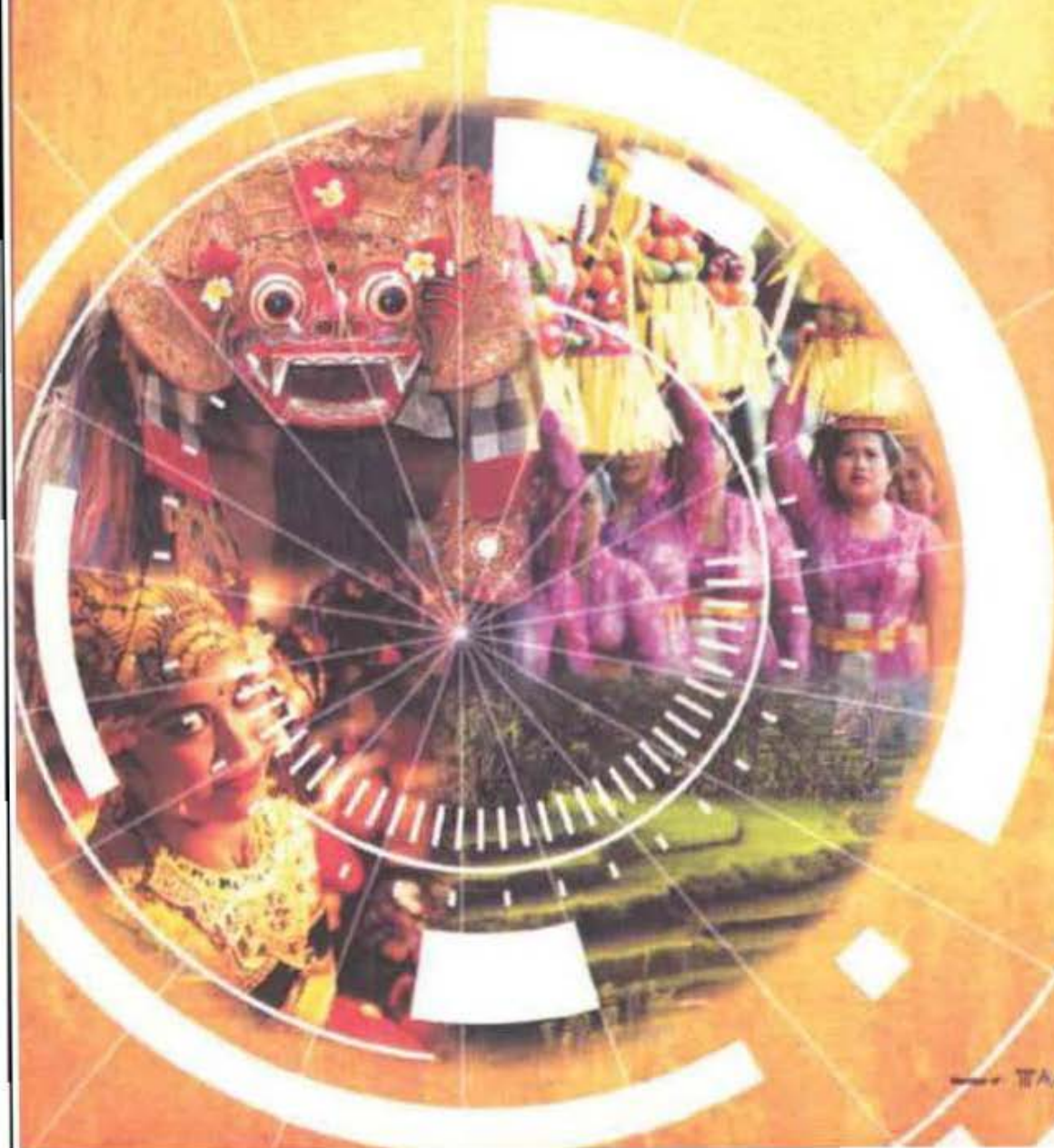
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Department of Management Faculty Of Business and Economics Universitas Surabaya

CHALLENGES AND OPPORTUNITIES OF THE LEADING EDGE IN WORLD CLASS SUPPLY CHAIN MANAGEMENT



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THE 10th INTERNATIONAL ANNUAL SYMPOSIUM
ON MANAGEMENT

**CHALLENGES AND
OPPORTUNITIES OF THE
LEADING EDGE IN WORLD CLASS
SUPPLY CHAIN MANAGEMENT**

Bali, March 16th, 2013

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Faculty of Business and Economics
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FOREWORD

This proceeding is a compilation of papers submitted for **The 10th International Annual Symposium on Management** (Insyma) conducted by the Department of Management, Faculty of Business and Economics, Universitas Surabaya. This year's theme of the symposium is **Challenges and Opportunities of the Leading Edge in World Class Supply Chain Management**.

In this opportunity, we would like to share our grateful to the institutions (National and abroad) who send their lecturer or researcher to our symposium. This symposium is to provide a sharing forum for researcher, academics, and practitioners engaged in basic and applied research in Supply Chain Management. This theme represents an emerging and highly challenging and opportunities area of research and practice. One of the most significant paradigm shifts of modern business management is that individual business no longer compete as solely autonomous entities, but rather as supply chains. Business management has entered the era of internetwork competition. In this emerging competitive environment, the ultimate success of the single business will depend on management's ability to integrate the company's intricate network of business relationships. The supply chain is not a chain of businesses with one-to-one, business-to-business relationships, but a network of multiple business and relationships. SCM deals with total business process excellence and represents a new way of managing the business and relationships with other members of the supply chain. Successful supply chain Management requires cross-functional integration must play a critical role. The challenge is to determine how to successfully accomplish this integration.

This symposium aims to bring together different points of view from academics, business practitioners, government agencies, and international institutions with the ultimate goal to share and disseminate various ideas and practices in Supply Chain Management.

Finally, we hope that this compilation of papers, ranging from a conceptual work to an empirical research, can enrich our perspective in supply chain management and its application in creating higher level of competitiveness.

Bali, March 16th, 2013

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