



Supplier innovation management

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ISBN 978-951-38-8568-7 (URL: <http://www.vttresearch.com/impact/publications>)

VTT Technology 307

ISSN-L 2242-1211

ISSN 2242-122X (Online)

<http://urn.fi/URN:ISBN:978-951-38-8568-7>

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JULKAISIJA – UTGIVARE – PUBLISHER

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If you want to succeed you
should strike out on new paths,
rather than travel the worn
paths of accepted success.



John D Rockefeller
Founder of the Standard Oil Company

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Abstract

Tiivistelmä

1. SIM-projektin viestit yrityksille

Toimittajat ja muut yrityksen ulkoiset resurssit voivat tuottaa arvoa tuottamiensa varsinaisten tuotteiden ja palveluiden lisäksi. Ulkoisten resurssien tehokas käyttö mahdollistaa pääsyn uusiin ideoihin ja innovaatioihin sekä tietoon ja osaamiseen. SIM-projekti (Supplier Innovation Management) pureutui niihin haasteisiin, joita yrityksissä on toimittajainnovaatioiden johtamisessa, ja ratkaisuihin, joilla yritykset voivat edistää, hallita ja kehittää toimittajainnovaatioita ja hyödyntää niitä. SIM on Aalto-yliopiston Logistiikan tutkimusryhmän (LRG) ja VTT:n yhteishanke ja osa Tekesin Huippuostajat-ohjelmaa.

Projektin tuloksena syntyi uutta tieteellisin menetelmin tuotettua tietoa, joka mahdollistaa toimittajaverkoston kyvykkyyksien ja innovaatioiden hyödyntämisen suomalaisissa yrityksissä ja organisaatioissa. Lisäksi saatiin ymmärrystä menetelmistä, joilla voidaan kannustaa toimittajia innovoimaan. Projektin tulokset kasvattavat osaltaan strategisen hankinnan ja toimittajainnovaatioiden hallinnan osaamista. Tämän osaamisen kehittäminen parantaa yritysten kilpailukykyä, kun ulkoisia resursseja hyödynnetään entistä paremmin ja toimittajamarkkinoita kehitetään.

Alle on koottu SIM-projektin pääviestit yrityksille.

Viesti 1: Toimittajainnovaatiot ovat tärkeä ulkoisten resurssien muoto, jonka kaikkia mahdollisuuksia yritykset eivät vielä hyödynnä.

Toimittajien varhainen osallistaminen tuotekehitykseen (ESI, early supplier involvement) on yleistynyt yrityksissä, ja yritykset ovat suunnanneet toimittajainnovaatioihin käyttämiään resursseja juuri tuotekehitysyhteistyöhön. Myös tutkimuksessa aihe on herättänyt kiinnostusta, ja kansainvälisten tutkimustulosten mukaan on selkeästi hyödyllistä ottaa toimittajia mukaan tuotekehitykseen. SIM-projektissa kuitenkin havaittiin, että toimittajainnovaatioiden johtaminen sisältää tuotekehitysyhteistyön lisäksi muitakin tärkeitä osa-alueita. Hyödyntääkseen toimittajien innovaatiopotentiaalia kokonaisvaltaisesti yritysten on valittava oikeat johtamistavat ja mekanismit sen mukaan, mitä toimittajalta odotetaan. Erityisesti havaittiin, että sen lisäksi, että innovaatioita voidaan synnyttää yhdessä toimittajien kanssa, toimittajia voidaan kannustaa tuottamaan innovaatioita itsenäisesti. Toimittajainnovaatioiden johtaminen sisältää siis myös innovatiivisten toimittajien tunnistamisen ja valitsemisen sekä innovaatioiden stimuloimisen.

Viesti 2: Toimittajainnovaatioiden stimulointi on tärkeää, ja sen edistäminen vaatii monipuolisia lähestymistapoja.

Innovaatioiden edistämiseksi toimittajia täytyy toisaalta tukea ja toisaalta toimittajien suuntaan on keskeistä luoda painetta. Yritysten on tärkeää ohjata ja suunnata toimittajien kehityshankkeita sellaiseen suuntaan, että panostukset tuottavat juuri ostajayritykselle hyödyllisiä tuloksia. Eri konteksteissa seuraavia keinoja tulee painottaa eri tavoin:

- Luottamus: luottamuksen edistäminen ostaja-toimittajasuhteissa.
- Avoimuus: kommunikaation ja tiedonvälityksen edistäminen.
- Houkuttelevuus: suhteen odotettujen hyötyjen kasvattaminen.
- Tuki: toimittajien kykyjen ja resurssien tukeminen.
- Päämäärät: tavoitteiden ja päämäärien asettaminen, muun muassa innovaatiotavoitteiden määrittely sekä innovointiin kannustaminen.
- Kilpailupaine: paineen luominen esimerkiksi mittaamalla toimittajien innovatiivisuutta.

Viesti 3: Toimittajien innovaatiokyvykkyksiä hyödyntämällä on mahdollista korvata sisäisiä T&K-investointeja. Tämä edellyttää hyvää hankintaosaamista, mm. toimittajamarkkinatuntemusta, neuvottelu- ja sopimus-taitoja sekä kykyä tehdä yhteistyötä toimittajien kanssa.

Yritykset voivat rakentaa uutta liiketoimintaa tai kehittää nykyistä liiketoimintaa toimittajainnovaatioihin pohjautuen, vaikka yrityksellä itsellään ei ole merkittävää panostusta tutkimus- ja kehitystoimintaan. Tehdyn tapaustutkimuksen mukaan yrityksellä ei tarvitse olla omaa teknologiaosaamista, jotta se pystyy luomaan liiketoimintaa uuteen teknologiaan perustuen, vaan tuo osaaminen voi olla yksinomaan toimittajan vastuulla. Neljässä tutkitussa uuteen innovaatioon johtaneessa tapauksessa teknologian kehittäminen oli kokonaan toimittajan vastuulla. Toimittaja omisti myös immateriaalioikeudet, mikä varmistaa toimittajan mielenkiinnon teknologian jatkokehittämiseen. Ostajayrityksellä sen sijaan havaittiin olevan tärkeää olla muita kyvykkyksiä, esimerkiksi hankintaan ja kaupallistamiseen liittyen, jolloin yritysten osaamisalueet täydentävät toisiaan. Case-tulosten perusteella on tärkeää, että ostaja pystyy tunnistamaan uudet liiketoimintatarpeet, löytämään oikeat kumppanit toteuttamaan teknologiaratkaisut ja muodostamaan toimittajan kanssa yhteisen liiketoimintamallin. Tämä huomio ostajan osaamistarpeista voi sopia myös epäsuoriin hankintoihin liittyviin innovaatioihin.

Näillä löydöksillä on myös merkittävää tieteellistä arvoa. Nykyinen omaksumiskapasiteettia (absorptive capacity) käsittelevä kirjallisuus esittää, että osaaminen täytyy sisäistää (assimilate) yritykseen, jotta ulkoisten partnerien kyvykkyksiä voidaan hyödyntää innovaatiotoiminnassa. Tämä tutkimus täydentää ja tuo uuden näkökulman kirjallisuuteen, sillä esitämme, että muu osaaminen voi korvata teknologiaosaamisen puuttumisen toimittajainnovaatioihin perustuvissa kehityshankkeissa.

Viesti 4: Hankintojen johtamisen tulisi perustua vahvemmin tietoon toimittajamarkkinoista ja tämän tiedon älykkääseen analysointiin, jotta yritykselle pystytään luomaan kilpailuetua.

Monissa yrityksissä hankintojen johtaminen ei riittävästi perustu tiedon hyödyntämiseen. Toimittajamarkkinoiden tuntemus on keskeinen kilpailutekijä, jonka mahdollisuudet ovat monilta osin vielä tunnistamatta ja hyödyntämättä. Esimerkiksi riskien tunnistaminen ja hallinta ja uudet liiketoiminta-alueet ovat alueita, jotka hyötyisivät entistä laajemmasta ja kattavammasta toimittajamarkkinatietämyksestä. Analysoituun tietoon perustuvassa päätöksenteossa haettava tieto on tärkeää linkittää yrityksen tunnistettuihin tarpeisiin. Näkökulmana voivat olla esimerkiksi yrityksen, myynnin, hankinnan tai tuotekehityksen tarpeet.

Viesti 5. Yritykset tarvitsevat käyttöönsä monipuolisia keinoja ja mekanismeja, jotta ne pystyvät hyödyntämään toimittajamarkkinatietämyksen mahdollisuuksia.

Mitä kompleksisempi tietotarve on, sitä enemmän ja monimuotoisempia mekanismeja tarvitaan tiedon hankkimiseen ja hyödyntämiseen. Hankintojen johtamiseen käytettävät mekanismit voivat liittyä sisäisen ja ulkoisen integraation edistämiseen, houkuttelevuuteen, tiedon keräämiseen ja löytämiseen sekä organisointiin ja roolitukseen. Big data -analytiikka mahdollistaa suurten tietomassojen käsittelyn, mutta sen mahdollisuudet ovat vielä suurelta osin tunnistamatta ja hyödyntämättä.

2. Background

This is the final report of the SIM-project (SIM – Supplier Innovation Management). This report summarizes the project phases, highlights the core findings of the project, and thus presents the main contents of the project.

2.1 Purpose of the project

Today, innovation collaboration with existing suppliers, as well with new interfaces with various communities, have become an essential element for the success of companies. Consequently, suppliers and partners can be considered as external resources of a company, which may be used in addition to internal resources. One consequence of this development is that firms are more and more dependent on various types of suppliers, contractors and partners. Increasingly, the most qualified sources of relevant know-how are located outside company boundaries. Therefore, competitive advantage is dependent on the relationships and linkages a firm forges with external organizations. As a supply manager stated: “Accessing the knowledge in the heads of 10,000 people in the supply base to improve your product and come up with new ideas is surely an asset worth working for!” (Cousins et al. 2011)

The vast amount of relevant knowledge that lies outside the company makes supply markets and supplier relationships a key area of management interest. It is suggested that the actual configuration of the interface between a buyer and a seller (or service provider) determines to a large extent what buyer is able to capture from a supplier in addition to the actual product or service. This development has caused new managerial challenges for companies and a need for guidelines for managing suppliers in the context of innovation.

The main objective of the SIM project was to use scientific methods to provide new knowledge that may enable Finnish companies and other organisations to benefit from the innovation potential and capabilities of their supplier networks and to stimulate the creation of supplier innovations. Supplier innovation is defined as creating innovations together with suppliers, or accessing innovations created by suppliers. The main research questions of SIM were formulated as follows:

- How to manage supplier innovations?
- How to get more and better supplier innovations?

The project is connected to the theme ‘Managing Innovative Purchases’ in Tekes Smart Procurement program. It provides information about the impact of innovative purchases on the supplier’s competitive advantage, as well as the processes of innovative purchases.

The project emphasizes how supplier innovations can be connected to a company’s business processes. The project increases the capabilities to manage strategic purchases and supplier relationships in Finnish companies and public organizations to benefit from the suppliers’ innovation potential. This capability enables companies to better manage their external resource base and develop their supply market to increase its innovativeness.

2.2 Implementing the project

The project was conducted in collaboration between Aalto University, VTT and participating companies and organisations (Kone Oyj, Fortum Oyj, Posiva Oy, Orion Oyj and the Finnish Traffic Agency). The practical orientation of the supplier innovation management proposes a research approach that includes a strong collaboration between academics and practitioners, and thus, SIM project had a strong empirical focus. However, to create a strong basis for the study, relevant literature was identified and synthesized.

The main methods of SIM project were:

- Systematic literature review, final sample 158 articles
- In-depth single case studies (3 cases)
- 2 multiple case studies (4 cases + 8 cases).

The empirical data collection included

- Totally 105 interviews of company representatives in 30 companies
- 6 workshops in companies
- 7 presentations of results or validation events in case companies.

The project organized (described in detail in Chapter 1.3.)

- 3 open seminars, organized in collaboration with LOGY
- focus group discussions (world café method) with totally 80 participants
- 7 steering group meetings
- 6 round table discussions with steering group members

2.3 Dissemination activities

Dissemination to the companies

The SIM project put a lot of effort to disseminate the results to Finnish companies and public organizations. We actively communicated and enhanced exploitation of the results during the whole project. In order to disseminate the results to a broader audience in Finnish industry, we utilized our access to different networks, Finnish Association of Purchasing and Logistics (LOGY) in specific. As per the strong emphasis to empirical research, there were various joint activities with the partner companies, including interviews and workshops and events to validate emerging results. The results were presented in six result dissemination meetings and workshops where companies could invite their internal stakeholders to be present.

The main dissemination activities were:

- 3 open seminars with totally 115 participants from different companies
- 5 presentations in different events
- An article in 'Osto&Logistiikka Magazine' Big data vajakäytössä. Osto&Logistiikka, iss. 2, pp. 36-39
- An article in STO magazine: Vuori, Mervi; Pihlajamaa, Matti; Viitamo, Esa "Alihankkijoiden tuotekehityksosaaminen hyötykäyttöön", STO-lehti 2016 (3), pp. 12–13.
- Reports:
 - Opportunities of big data analytics in supply market intelligence to reinforce supply management, VTT report (to be published in June 2017)
 - Mallinnusinnovaatioiden edistäminen infra-alalla hankinnan keinoin (the report of Finnish Traffic Agency)
 - The end report of SIM project
- 2 blog posts

Dissemination to the academia

The results of SIM project were actively disseminated to academia. The active communication and discussion with global academic community in conferences confirmed that SIM project has succeeded to bring novel approaches to academic discussion. The publications indicate the novelty and academic contribution of the results.

The numbers of publications in SIM project are as follows:

- 15 conference papers
- 16 Journal articles (including both published (10) and articles that are in a review process (6))
- 1 Doctoral dissertation (Pihlajamaa, currently in official pre-examination), in addition 3 doctoral dissertations have been strongly affected by the ERM research in LRG, or partly funded by SIM (finalized: Aminoff (2015) Iloranta (2016), on-going: Vuori)
- 3 Master's Theses

The publications are listed in Appendix A.

Dissemination to students and society

The project results are used in Aalto University teaching. The most relevant one is the course “External Resource Management”, participated around 70 students annually. In addition, individual student work, such as Master’s thesis projects create remarkable understanding and capabilities on supplier innovations for individual students.

SIM-researchers are involved in many training programs and give lectures also outside their home university. The results achieved in research efforts form an important part of the content of the given lectures and training. This type of dissemination takes place in for example in Metropolia University of Applied Sciences, Aalto Executive Education, and in company-specific training.

Table 1. Criteria for evaluating supplier innovativeness

Characteristic	Description
Professionalism	Project management competencies, internal innovation activities
R&D expenditure	Expenditure on innovation can be used to assess innovation capability
Specialization	Buyers compensate their lack of internal knowledge by making use of supplier's area of specialization.
Collaborative attitude	Both parties need to have the capability to collaborate constructively
High own (supplier's) development capability	Supplier's research and development activities and technical activities, process and product know-how, and indicators for that such as quality certificates are likely to be more innovative.
Customer orientation	Supplier's orientation to customer's customer

Theme 2: Developing innovations with suppliers

This theme discusses, first, the nature of relationships with suppliers when engaging in joint innovation activities, second, practical management methods to implement these relationships, and third, how internal organization may influence the success of collaborative innovation.

- Choosing a suitable relationship type: Innovation has been found to benefit from tight relationships characterized by trust, loyalty, commitment, transparency, flexibility, mutual support, and reputation. In practice, supplier relationship management often requires balanced mixtures of trust and power and different organizational functions, such as R&D and purchasing, can adopt different approaches towards the same supplier to achieve this balance. Suppliers' responsibilities differ in the development projects, and have been categorized to vary from consulting, to joint problem solving, and to being mainly in charge of the development based on buyer specifications. The joint problem-solving type of involvement leads to the most innovative outcomes but is the most challenging because it requires high interaction with high costs associated.
- Methods for managing collaborative development: The methods include knowledge management practices, as well as contracts and governance, target setting, property rights, and timing of supplier involvement. An important aspect of successful supplier involvement is the coordination of goals, expectations and possibilities, and shaping property rights, and this should be taken care of right at the beginning of the development project. When to involve suppliers with respect to the development process, the results clearly favoring early supplier involvement.
- Managing internal organization: A buying firm's internal factors, such as organization design, may also influence the success of collaborative innovation. Strong evidence exists suggesting that in order to benefit from inter-organizational collaboration, absorptive capacity and associated internal coordination mechanisms are needed. Cross-functional collaboration facilitates supplier involvement in product development and the exploitation of new knowledge internally.

Theme 3: Stimulating innovations by suppliers

This theme is about how buying firms may utilize various methods to influence the intensity and direction of their suppliers' innovative efforts, and gain access to innovations developed by the suppliers. In contrast to the previous theme, here the supplier is the sole innovator and no internal development resources are required from the buyer. Stimulating innovations by suppliers can be used to substitute or complement collaborative development activities with suppliers. This theme is divided into three subthemes, which describe different dimensions of stimulating innovations; by suppliers enhancing suppliers' innovation creation, guiding suppliers' innovation processes, and encouraging suppliers to share their innovations. The methods identified in the previous literature are presented in the table below.

Table 2. Dimensions on stimulating supplier innovations

Enhancing suppliers' innovation creation	<ul style="list-style-type: none"> • Flexible specifications • Knowledge sharing • Revealing long-term plans • Production process and system compatibility
Guiding suppliers' innovation processes	<ul style="list-style-type: none"> • Sharing product ideas with suppliers • Revealing long-term plans • Personal networks • Attraction as a customer
Encouraging suppliers to share their innovations	<ul style="list-style-type: none"> • Shared vision of future • Attraction as a customer • Flexibility • Knowledge sharing • Trust

Suppliers are needed to complement internal innovation capabilities, e.g., by providing specialized knowledge or developing components for large innovation projects. Furthermore, importantly, and – we believe – increasingly, suppliers need to be treated as the main responsible actors for developing innovations. The synthesis of SIM project highlights the variety of approaches managers need to adopt with respect to supplier innovation, and maps managerial issues and proposed methods in leveraging suppliers for innovation.

The identified literature is dominated by studies of collaborative development projects led by the buyer companies where suppliers may be used to complement internal innovation capabilities by providing knowledge, capabilities, or resources. There is, however, an absence of studies on how to influence suppliers to innovate outside the context of collaborative development projects. Nevertheless, getting suppliers to put more emphasis on innovation, aligning their innovation processes with the buyer company's interests, and sharing their innovations are important managerial issues.

The results are published in two conference papers and one journal article (in a review process / September 2017).

3.2 Stimulating supplier innovations

Recent literature has acknowledged the importance of suppliers in new business development. Involving suppliers in the innovation process from early on (early supplier involvement, ESI) has been found to reduce time to market, improve product quality, and decrease development costs. Other ways of benefiting from suppliers' innovation capabilities have been largely neglected. This line of research focuses on settings where the buying company is in charge of the development of new products and the supplier contributes to this task by carrying out some of the development activities, taking a role in decision making, and providing consultation and ideas.

However, acquiring innovations from suppliers is not limited to joint new product development projects and companies should be able to “go beyond” ESI in their management of supplier innovation. Especially for companies with low innovation capabilities and resources, supplier innovations may substitute internal innovation activities in creating new business. This study investigates how companies influence the intensity and direction of suppliers' innovation development and the access to its outcomes: that is how companies *stimulate innovations by suppliers*.

The study includes four cases, and data was collected by interviewing key stakeholders.

The results propose that by guiding suppliers' innovation activities, providing access to knowledge and other resources to help them innovate, and attracting innovative suppliers, companies are able to increase

their access to suitable innovations which can then be purchased or further developed. Identification of such managerial methods adds to existing studies which have suggested supplier concept competitions and safeguards, such as long contracts, as ways to motivate suppliers to share their innovations.

The results from our empirical multiple case study suggest that stimulation is currently not conducted very systematically. While there are methods in use that do influence supplier innovation, they are associated with other tasks and are rarely considered from the innovation viewpoint. There seems to be demand for more understanding about which stimulation methods are the most effective. In any case, the findings indicate that stimulation is targeted for a limited number of key suppliers because a) stimulation is costly as it requires lots of time and effort from the buying company's part, and b) long and close ties provide a good setting for knowledge exchange which can promote and guide supplier innovation.

Based on the data, we identified methods to stimulate supplier innovations, as presented in the table below. The buyer company needs to utilize various methods to stimulate the supplier innovations, and the buyer company needs to find a good balance between supporting the suppliers and putting pressure on the suppliers to innovate.

Table 3. Management areas to enhance supplier innovations, results from an empirical case study

Management areas	Definition
Trust	Facilitating the creation of trust in a buyer-supplier relationship
Openness	Promoting communication and knowledge exchange with suppliers
Attractiveness	Increasing the expected value of the relationship for suppliers
Support	Enhancing suppliers' innovation potential by giving them responsibilities and supporting their resources and abilities
Goals	Setting goals for innovation and encouraging suppliers to innovate
(Competitive) pressure	Measuring for innovativeness and demanding policies that promote innovation

The results are published in a conference paper, and a scientific article will be submitted to a journal.

3.3 Supply market intelligence

A capability to develop and sustain superior knowledge of supply markets and supply chains is required to improve the performance of purchasing and supply management (PSM) in companies. Information and knowledge about supply markets are important enablers for successful sourcing activities. Changes in the operative environment of companies, for example technological development, supply market dynamics, macro-economic developments, and changes in tax regimes, and servitization of manufacturing industries, lead to a greater need to actively conduct supply market research. There is a need for companies for proactive practices and maintaining preparedness in this area in the form of ongoing supply market intelligence activities.

This capability is commonly called supply market intelligence (SMI). SMI is defined by the project group as: *'the pursuit of actionable intelligence about supply markets, involving the process of defining the intelligence need, as well as the gathering, interpreting, synthesis and dissemination of information, in order to enable external resource management related decision-making'*. Supply market encompasses all potential suppliers (also from other markets) of services, products, or solutions in a category, in contrast to a supply base, merely comprising of the suppliers currently used by a focal firm.

It is clear that a high level of knowledge and understanding of the capabilities and opportunities available in the supply market and in the buying organization is required, in order to achieve the "right combinations" of external and internal resources and for developing and maintaining a pool of "the best" external resources. Based on our analysis of the extant existing literature, there appears to be a knowledge-gap in terms of SMI in general.

SIM project addresses the following fundamental and exploratory research questions: What are the SMI mechanisms for increasing information processing capacity? (RQ1); and How do the identified SMI mechanisms relate to the uncertainty facing SMI? (RQ2). A multiple case study to understand supply market intelligence was conducted, including eight cases with altogether 13 interviews.

In approaching the research topic, we draw on the information processing view (Galbraith, 1974; Tushman and Nadler, 1978), which can be summarized to be based on the idea of achieving a fit between the information processing requirements and the information processing capacity in organizations. Requirements for information processing, which 'refers to the gathering, interpreting and synthesis of information in the context of organizational decision making' (Tushman and Nadler, 1978, 614), are determined chiefly by uncertainty facing the organization. This uncertainty is the difference between information possessed and information required to complete a task, and it is in turn driven by task characteristics, task environment and inter-unit task interdependence. In our research context, the task to be completed is the 'production' of the SMI product, which faces uncertainty due to the complexity of the task, characteristics of the supply market environment for a particular category and the dependence of the SMI task on other functions, units or individuals in the corporation (Figure 2 below). For example, the task of producing the SMI product could have many and diverse components, be vaguely defined, unstable and/or novel, as well as characterized by time pressure, making the task essentially difficult. Furthermore, the supply market environment might be characterized by rapid rate of change, lack of transparency and availability constraints, implying further complications to the task. Finally, the SMI task in an organizational context may require discrete contributions from several parties such as purchasing teams (i.e. task interdependency is pooled), process inputs from other parties such as product and technology roadmaps (sequential). It might also require mutual exchange and joint work for example with the R&D function (reciprocal), making it interdependent on other parties, and therefore more difficult and uncertain.

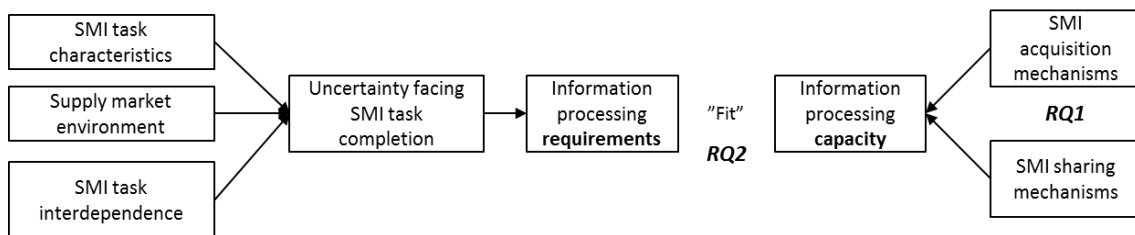


Figure 2. Information processing theory-based research framework (adapted from Tushman and Nadler, 1978; Trautmann et al., 2009)

Early in the research process, we formed an analytical framework, which suggests four different orientations for SMI, based on two dimensions. The vertical dimension incorporates the perpetuation aspect into the framework, i.e. on one hand SMI activity may be one-time or project-based, initiated by a specific need or purchasing requisition. On the other, SMI may be conducted continuously. The horizontal dimension incorporates the scope of the SMI, i.e. on one hand, intelligence collection is directed and the scope is defined in order to narrow down efforts on certain targets. This framework was used to structure the data collection, and to classify the field.

	Defined / directed	Undefined / open-ended
Project-based	A one-off effort to capture specific piece of knowledge, triggered by an event in the supply market, or reacting to an emerged new knowledge or information need. Non-recurring minor purchases or supplier selection cases may be based on focused ad-hoc knowledge capturing.	Capturing information from the supply market to create a comprehensive understanding on the supply environment for a specific purpose, such as a new product development project.
Continuous	A formal and continuous follow-up of a specific and narrowly defined environment factor of strategic importance, such as world market price follow-up of main raw material.	Maintaining understanding on the supply market and proactively preparing for possible changes. Open-ended follow-up of forces shaping the industry, such as technological changes, available alternative materials or solutions, and structural changes in the supply market.

Figure 3. Analytical framework on the orientations for SMI

The taxonomy of the SMI mechanisms is presented Table 4 below. This taxonomy identifies and classifies the knowledge gathering and usage mechanisms into six classes. This result is the first in the academic literature to create comprehensive understanding on the field. The companies need to understand the wide variety of the mechanisms they have, and that they need to select which one(s) to be used for each purpose. Here, the information processing approach can be used: companies need to identify the uncertainty connected to each task, and select the use of mechanisms according to the information needs to manage each task.

Table 4. Taxonomy of SMI mechanisms.

Acquisition mechanisms	
Attraction mechanisms	Purchasing marketing RFQ Open innovation platform Famous internal expert
Bridging mechanisms	Country sourcing subsidiaries IPOs Personnel at supplier's site
External and internal collection mechanisms	News feed Information brokers Internet search External databases (sourcing tools) Existing supplier information Industry association reports Supplier meetings
Density maximization mechanisms	Team diversity Personal contact network Exhibitions
Internal connector mechanisms	Centralised category director Process involving internal resource
External connector mechanisms	External expert External service
Culture-based mechanisms	Bottom-up Scouting mind-set

To clarify the principles for selecting and using the mechanisms, we developed the following propositions:

Proposition 1: SMI acquisition mechanisms generally fall into eight alternative categories, namely external/internal collection mechanisms, external/internal connector mechanisms, bridging mechanisms, attraction mechanisms, density maximization mechanisms and culture-based mechanisms.

Proposition 2: SMI sharing mechanisms generally fall into two alternative categories, namely vertical sharing mechanisms and lateral sharing mechanisms.

Proposition 3: The higher the level of ambiguity and open-endedness of the SMI production task, the higher the uncertainty facing the SMI task.

Proposition 4: The higher the level of uncertainty facing the SMI task, the higher the variety of SMI acquisition mechanisms used to meet the requirement.

Proposition 5: External collection mechanisms for SMI acquisition are used to high degree regardless of the uncertainty facing the SMI task; however, the use increases with increase in uncertainty.

Proposition 6: External connector, internal connector and internal collection mechanisms for SMI acquisition are used to a low degree regardless of the uncertainty facing the SMI task.

Proposition 7: The use of bridging, attraction, density maximization and culture-based mechanisms (i.e. mechanisms with information processing capacity) for SMI acquisition increases with the increase in uncertainty facing the SMI task.

Proposition 8: The use of SMI sharing mechanisms in general increase with the increase of uncertainty facing the SMI task.

Proposition 9: The higher the level of uncertainty facing the SMI task, the more prominent the role of lateral SMI sharing mechanisms in meeting the requirement.

This chapter reports the current state of the research. This research was conducted in collaboration with Professor Harri Lorenz, University of Turku. The results are published in a conference paper, a scientific article will be submitted.

3.4 Supplier innovations in a low R&D context

Prior literature suggests that significant internal R&D resources are needed to leverage suppliers for innovation and that external knowledge sources can be used to complement the internal knowledge base. Based on the analysis of inbound open innovation projects at Fortum, we argue that companies with low R&D intensity may adopt an alternative approach which aims at substituting – not merely complementing – internal R&D with external innovations.

The approach in this study challenges the current understanding on inbound open innovation which emphasizes that internal R&D investments are needed to leverage external innovation sources since the external knowledge needs to be assimilated within the receiving company before it can be exploited. Interestingly, a strong focus on external technology acquisition in place of internal R&D has been considered a weakness (Kim et al., 2016). So far, the question of whether (and how) companies with low internal R&D resources can successfully substitute internal R&D with open innovation has remained poorly understood.

Four cases were selected for the study based on three criteria: technological novelty, strategic importance, and supplier involvement, to fit the topic of substituting internal R&D with supplier innovation. Two of the cases aimed at the renewal of the company's core businesses and two, which aimed at the introduction of new business areas. In all cases new technology developed by a supplier, was applied.

We studied the contextual factors in the cases, and carefully studied how each of the absorptive capacity phases were realised in the cases. The results are collected in the table below.

Table 5. Case summaries

Case	Case Heat	Case Solar	Case Bio	Case Carbon
Innovation description	Intelligent home heating control system	Residential solar energy kit	Bio-oil production	CO ₂ emissions reduction in power plants
Business purpose	New product to consumer markets	New product to consumer markets	New product to B2B markets	To radically reduce CO ₂ emissions in Fortum's power plants
Innovation novelty	New-to-the-market product	New-to-the-market product	New-to-the-world application of an existing technology	New-to-the-world application of an emerging technology
Supplier size	Small	Small	Large	Large
Acquisition	Fortum scanned suppliers in home energy management technology market and ordered sample products for small scale testing.	The corporate technology team carried out internal pre-studies for technology search and created a technology roadmap for developing solar technology based new products.	Thorough global scanning of related technologies. Pre-study and a joint research project with the supplier a research centre and a potential customer.	Internal research about new technologies related to power production. The RFI process was used to gain supply market knowledge and identify potential suppliers of the technology.
Assimilation	No assimilation of the supplier's technology. The goal was to combine complementary capabilities while keeping them in separate organizations.	Fortum decided in the early phase to let the supplier own the intellectual property rights of the new technology and did not aim to assimilate it.	Fortum did not assimilate the supplier's technology. Fortum and the supplier had clearly complementary roles in the value chain for the new product.	Fortum did not assimilate the supplier's technology. Fortum and the supplier were aiming for different parts of the value chain, and thus they had clearly complementary roles.
Transformation	A joint business model was developed. The complementary capabilities were utilized for optimizing the customer value proposition. Risk sharing was a key issue in the negotiations.	Supply management function facilitated the collaboration between Fortum and the supplier for integrating the complementary capabilities in order to find the best joint business model.	A research project in a consortium provided a platform for building a collaborative business. A pilot project in the power plant scale was initiated.	A joint business model was developed and agreed in contract negotiations with the supplier providing the key technology.
Exploitation	The innovation was commercialized collaboratively through Fortum's sales channels. A six-month exclusive period was agreed.	A new-to-the-market product was commercialized successfully, and a category strategy was created for it.	No large-scale implementation after the pilot. An extension of collaboration to competitors has been considered.	CO ₂ transfer needed to be organised. The project was cancelled before commercialization, due to a change in Fortum's strategy. Still, the project was considered successful.
IPR ownership	Supplier	Supplier	Supplier	Supplier
Outcomes	New business model and product sales to residential customers. New revenues, business model, and reference product for Bravo.	Fortum: New revenues, business model, and technology competence. Supplier: new revenues, reference product, and business model	Successful pilot. Delivery project is delayed and still ongoing. Potential new revenues for Fortum; a reference product for Delta.	Not commercialized. A new business concept for the whole value chain. New competences for the buying company.

The study indicates that supplier innovations can substitute for internal R&D. Benefiting from supplier innovations in low R&D context, new requirements are set to acquisition, transformation, and exploitation capabilities.

The four propositions of the study are summarised in Figure 4 below. Based on the observations from the four cases of our study, we propose that in the low R&D context there are idiosyncrasies in all four sub-capabilities of the absorptive capacity that must be taken into account in the open innovation process. Since the firm has limited prior knowledge of the acquired technology, major efforts are required for gaining the sufficient knowledge about the new field before starting the open innovation process. It is also found that it is possible to manage without high assimilation capability making it possible for low R&D companies to benefit from new external technologies. In the low R&D context, transformation focuses on reaching an agreement on how the technologies should be commercialized. Exploitation, in turn, is more complicated in the low R&D context since it is a collaborative effort with the supplier.

The cases also demonstrate the importance of supplier management capabilities at several phases of the absorptive capacity process. Supplier management capabilities, such as the abilities to manage supplier relationships, supplier risks, and supplier development, are needed to establish and manage successful buyer-supplier relationships. According to our findings, supply market intelligence capability is needed at the acquisition phase, negotiating and contracting capabilities in the transformation phase, and supplier relationship management and collaboration capabilities in the exploitation phase. The study therefore takes a step in filling the gap in the current understanding of the processes and policies that firms can use to manage absorptive capacity in low R&D contexts (Lane et al., 2006).

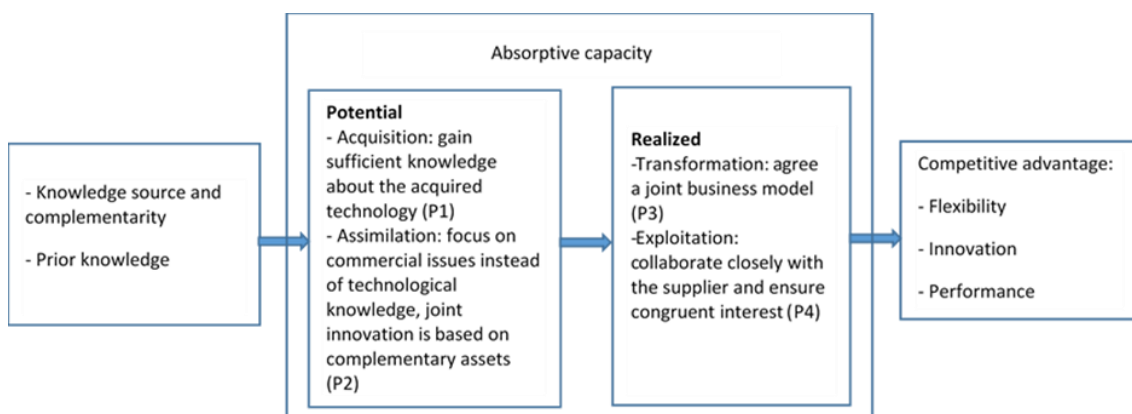


Figure 4. Absorptive capacity process in the low R&D intensity context (Cohen and Levinthal, 1990, Zahra and George, 2002, modified)

This study is reported in an article that is under review for publication in Journal of Purchasing and Supply Management (in September 2017).

4. Additional materials

SIM project included several studies that were reported as presentations or as conference papers. These results can be accessed through the links below (see also Appendix A for the list of publications).

Stimulating supplier innovation was studied in various context:

- Supplier innovations in alliances. [Link to conference paper](#)
- Supplier innovation in complex projects: [Link to conference paper](#)
- Stimulating BIM-related supplier innovations in infrastructure projects: [Link to conference paper](#)
[Link to the report](#)

Digitalization related applications enable novel solutions for information acquisition from supply markets. SIM project answered to this call by exploring the Opportunities of Big Data Analytics in Supply Market Intelligence ([a link](#)).

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Appendix A: Publications

Scientific articles

1. Kari Tanskanen, Tuomas Ahola, Anna Aminoff, Johanna Bragge, Riikka Kaipia and Katri Kauppi (2017): Towards evidence-based management of external resources: Developing design propositions and future research avenues through research synthesis, *Research Policy*, 46(6), pp. 1087–1105.
2. Kaipia Riikka, Homström Jan, Rajala Risto, Småros Johanna (2017) Information sharing for sales and operations planning: Contextualized solutions and mechanisms. *Journal of Operations Management*, 52, pp. 15–29.
3. Abrell, T., Pihlajamaa, M., Kanto, L., vom Brocke, J., Uebernickel, F. (2016) "The Role of Users and Customers in Digital Innovation: Insights from B2B Manufacturing Firms", *Information & Management*, Special issue on IT and Innovation, 53(3), pp. 324–335.
4. Tanskanen, K., 2015. Who wins in a complex buyer-supplier relationship? A social exchange theory based dyadic study. *International Journal of Operations & Production Management*, 35(4), pp. 577–603.
5. Tanskanen, K., Holmström, J. and Öhman, M., 2015. Generative Mechanisms of the Adoption of Logistics Innovation: The Case of On-site Shops in Construction Supply Chains. *Journal of Business Logistics*.
6. Tanskanen, K. and Aminoff, A., 2015. Buyer and supplier attractiveness in a strategic relationship—A dyadic multiple-case study. *Industrial Marketing Management*.
7. Kaipia, Turkulainen: Managing integration in outsourcing relationships – The influence of cost and quality priorities, *Industrial Marketing Management*.
8. Pihlajamaa, Matti (2017) "Absorbing radical ideas from unusual sources – the role of social integration mechanisms", *Technology Analysis & Strategic Management* (accepted for publication).
9. Pihlajamaa, Matti (2017) "Going the extra mile: Managing individual motivation in radical innovation development", *Journal of Engineering and Technology Management*, 43, pp. 48–66.
10. Heikkilä, Kaipia, Ojala: Purchasing Category Management: Proactive Integration between Purchasing and Other Business Functions, *International Journal of Procurement Management*, in press.
11. Makkonen, Aminoff, Valkokari Stimulating supplier innovation in a complex and regulated business environment – a dyadic case study: *International Journal of Innovation Management* (in press)

In a publication process

1. Pihlajamaa, Kaipia, Tanskanen, Säilä: Can supplier innovations substitute for internal R&D? A multiple-case study from an absorptive capacity perspective, *Journal of Purchasing & Supply Management*, in review.
2. Pihlajamaa, Kaipia, Aminoff: Managing supplier innovation - Synthesis of the literature, in review in *Industrial Marketing Management*.
3. Lorentz, Aminoff, Kaipia, Pihlajamaa, Ehtamo; Building a theory of supply market intelligence; *Journal of Supply Chain Management* (submit June 2017)
4. Pihlajamaa, Kaipia, Aminoff; Stimulating supplier innovations – a multiple case study *Journal of Supply Chain Management* (submit June 2017)
5. Abrell, Benker and Pihlajamaa. User knowledge utilisation in innovation of complex products and systems: an absorptive capacity perspective. *Creativity and Innovation Management* (in review).

Conference papers

1. Paajanen, Aminoff, Valkokari The Opportunities of Big Data Analytics in Supply Market Intelligence PRO-VE 2017 18th Working Conference on Virtual Enterprises, 18-20 Sep 2017 – Vicenza, Italy
2. Pihlajamaa, Kaipia, Tanskanen (2017): Absorptive Capacity and Supplier Involvement in NPD - Elaborating connections and identifying research opportunities, IPSERA 2017
3. Vuori, Kaipia (2017): REVIEW OF SUPPLIER INTEGRATION RESEARCH IN OPERATIONS MANAGEMENT AND PURCHASING & SUPPLY MANAGEMENT LITERATURE, Ipsera 2017
4. Säilä, Kaipia, Pihlajamaa, Tanskanen: Supply management capabilities in open innovation – Overcoming the lack of internal R&D resources , Ipsera 2016
5. Pihlajamaa, Kaipia, Aminoff: Stimulating Innovations by Suppliers – Insights from a Multiple Case Study, Ipsera 2016
6. Lorentz, Kaipia, Pihlajamaa, Aminoff: Supply market intelligence - understanding drivers and practices, Ipsera 2016
7. Aminoff, Niemi, Kiviniemi, Lahdenperä: Stimulating BIM related supplier innovations in infrastructure projects , CIB 2016
8. Aminoff, Pihlajamaa, Kaipia: Supplier innovation management –enhancing innovations by supplier evaluation and customer attraction dimensions , Production Economics 2016
9. Lorentz, Kaipia, Pihlajamaa, Aminoff, Tanskanen: Developing superior knowledge of supply markets, POM 2016, Conference paper.
10. Pihlajamaa, Kaipia, Aminoff: Stimulating Innovations in Alliances: Case Study of Infrastructure Construction, POM 2016, Conference paper
11. Makkonen, Aminoff, Valkokari: Stimulating supplier innovation in a complex and regulated business environment , ISPIM 2016, Conference paper
12. Aminoff, Kiviniemi: Stimulating BIM related supplier innovations in infrastructure projects - procurement perspective, ISPIM 2016, Conference paper
13. Aminoff, Niemi, Kiviniemi, Lahdenperä Stimulating BIM-related supplier innovations in infrastructure projects, CIB-WBC 2016
14. Aminoff, Kaipia, Pihlajamaa, Tanskanen, Kaipia: Managing supplier innovations – A systematic literature review, IPSERA 2015
15. Aminoff, Kaipia, Pihlajamaa, Mechanisms for stimulating supplier innovations, Euroma 2015

Master's Theses

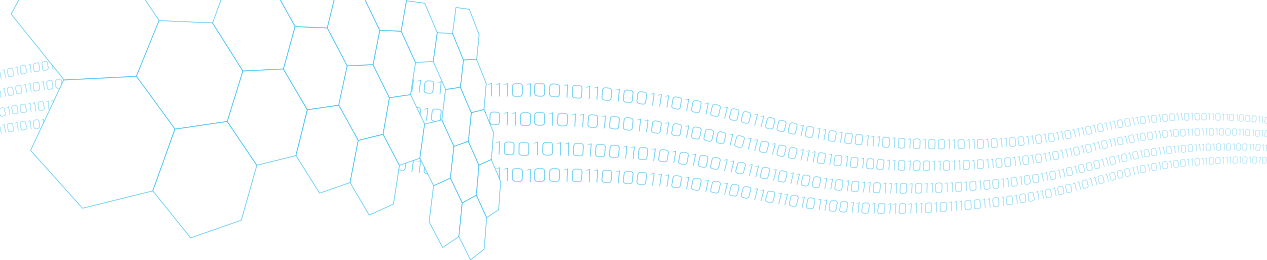
1. Säilä, Julius: Aalto-yliopisto, Inbound open innovation: an emerging role for supply management, Aalto-yliopisto, 2015
2. Niemi, M.: Mallinnusinnovaatioiden edistäminen infra-alalla hankinnan keinoin, TUT 2015
3. Paajanen, S.: Opportunities of Big Data Analytics in Supply Market Intelligence to Reinforce Supply Management, LUT 2017

Table A1. Doctoral dissertations

Author	Status	Topic	Link to SIM	Financing from SIM
Iloranta Kari	Dissertation 12/2016	Cognitive Barriers to External Resource Management – Top Management Perspective	Builds a base for SIM and external resource management, partner in SIM	-
Pihlajamaa Matti	In pre-examination, dissertation 09/2017	Innovation under high uncertainty and complexity: Managing radical innovation and open innovation	The results are based on SIM.	Whole project time
Vuori Mervi	Finalizing phase, dissertation late autumn 2017	Integrating suppliers	ESI and collaboration with suppliers	A small portion for finalizing phase.
Aminoff Anna	Dissertation 5/2015	The role of attraction and control boundaries in value creation – dyadic exploration of strategic buyer-supplier relationships	The dissertation build a base for SIM, it added our understanding of attraction concept.	SIM financed the finalising phase

Title	Supplier innovation management
Author(s)	Anna Aminoff & Riikka Kaipia
Abstract	<p>Today, innovation collaboration with existing suppliers, as well with new interfaces with external resources, has become an essential element for company success. One consequence of this development is that firms are more dependent on various types of suppliers, contractors and partners. Increasingly, the most qualified centers of excellence in the relevant know-how are located outside the boundaries of a company, and that competitive advantage can increasingly be gained rather with the relationships and linkages a firm can forge with external organizations. This means that the actual configuration of the interface between a buyer and a seller (or service provider) determines to a large extent what buyer is able to capture from a supplier in addition to the actual product or service.</p> <p>This report presents the main results of SIM project (Supplier Innovation Management). The project was conducted in collaboration with VTT and Aalto University, and was part of Tekes' 'Smart Procurement Program'. The project results offer the Finnish companies and public organizations systematic and purposeful means to stimulate and fasten supplier innovations, and ways to integrate supplier innovation activities to the company's business. The project emphasizes how supplier innovations can be connected to the company's processes, to different product development phases, capabilities and knowledge. The project increases the capabilities to manage strategic purchases and supplier innovation. This capability enables companies to better manage their external resource base and develop supply market.</p>
ISBN, ISSN, URN	ISBN 978-951-38-8568-7 (URL: http://www.vttresearch.com/impact/publications) ISSN-L 2242-1211 ISSN 2242-122X (Online) http://urn.fi/URN:ISBN:978-951-38-8568-7
Date	September 2017
Language	English, Finnish abstract
Pages	22 p. + app. 3 p.
Name of the project	Supplier Innovation Management (SIM)
Commissioned by	Tekes
Keywords	supplier innovation, supply management, supply market intelligence, information processing
Publisher	VTT Technical Research Centre of Finland Ltd P.O. Box 1000, FI-02044 VTT, Finland, Tel. 020 722 111

Nimeke	Toimittajainnovaatioiden johtaminen
Tekijä(t)	Anna Aminoff & Riikka Kaipia
Tiivistelmä	<p>Toimittajat ja muut yrityksen ulkoiset resurssit voivat tuottaa arvoa varsinaisten tuotteiden ja palveluiden lisäksi: ideoita ja innovaatioita, tietoa ja osaamista sekä prosessikehitystä. SIM-projekti (Supplier Innovation Management) pureutui niihin haasteisiin, joita yrityksissä on toimittajainnovaatioiden johtamisessa, ja ratkaisuihin, joilla yritykset voivat edistää, hallita ja kehittää toimittajainnovaatioita ja hyödyntää niitä. Toimittajainnovaatiot ovat tärkeä ulkoisten resurssien muoto, jonka kaikkia mahdollisuuksia yritykset eivät vielä hyödynnä.</p> <p>SIM on Aalto-yliopiston Logistiikan tutkimusryhmän (LRG) ja VTT:n yhteishanke ja osa Tekesin Huippuostajat-ohjelmaa. Projektin tuloksena syntyi uutta tieteellisin menetelmin tuotettua tietoa, joka mahdollistaa toimittajaverkoston kyvykkyyksien ja innovaatioiden hyödyntämisen suomalaisissa yrityksissä ja organisaatioissa ja jolla voidaan kannustaa toimittajia innovoimaan. Tähän raporttiin on tiivistetty SIM-projektin päätulokset.</p>
ISBN, ISSN, URN	ISBN 978-951-38-8568-7 (URL: http://www.vtt.fi/julkaisut) ISSN-L 2242-1211 ISSN 2242-122X (Verkkojulkaisu) http://urn.fi/URN:ISBN:978-951-38-8568-7
Julkaisuaika	Syyskuu 2017
Kieli	Englanti, suomenkielinen tiivistelmä
Sivumäärä	22 s. + liitt. 3 s.
Projektin nimi	Supplier Innovation Management (SIM)
Rahoittajat	Tekes
Avainsanat	toimittajainnovaatio, hankintojen johtaminen, toimittajamarkkinatietämys, tietomassojen käsittely
Julkaisija	Teknologian tutkimuskeskus VTT Oy PL 1000, 02044 VTT, puh. 020 722 111



Supplier innovation management

ISBN 978-951-38-8568-7 (URL: <http://www.vttresearch.com/impact/publications>)
ISSN-L 2242-1211
ISSN 2242-122X (Online)
<http://urn.fi/URN:ISBN:978-951-38-8568-7>

