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A MULTIPLE CASE STUDY OF SMALL BUSINESS UPSTREAM SUPPLY CHAIN UNCERTAINTIES IN RAPID PRODUCTIZATION

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ABSTRACT

This study aims at highlighting the use of upstream supply chain in Rapid Productization (RP) by analyzing upstream supply chain practices in small firms. RP is a process of quickly supplementing a company's product or service offering to meet unexpected customer needs.

A well-managed upstream supply chain network is a critical facilitator of RP for a small business. Selection of an upstream supplier during an RP process escalates the level of risk in fulfilling customer's needs. To avoid the mistakes resulting from the selection of the supplier, the company should use a smaller variety of suppliers and choose products that the suppliers know they can fulfill. Due to the nature of RP use, established supplier network resources are recommended. We also find evidence that a company's performance is positively associated with the use of RP.

This study contributes to the research domain of professional supply chain and product/service development by applying the development-as-practice approach to the study of practices that are resorted to by the company's management as well as sales, supply chain and R&D managers.

Keywords: rapid productization, small business, decision making, portfolio management, product life cycle management

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1 INTRODUCTION

Suominen et al., (2009, p.9) have defined productization as "*a standardized process which aims to produce a high quality commercial good or service viable in the market from produced information*". It is important to evaluate the needed resources and services correctly; i.e., in a way that is cost efficient and time-saving but still fulfills customer needs (Simula et al., 2008). According to Jaakkola (2011), firms may apply productization to secure more time for customized expert work and the accumulation of the tacit knowledge developed in their organization. Instead of denying standardization, firms attempt to find an optimal balance between customization and standardization. It seems that productization is applied because of professional characteristics, not in spite of them (Jaakkola, 2011).

The pressure for the continuous supply of new products, coupled with the increasing speed to market, has not changed. However, the nature of a product is changing in a traditional manufacturing industry where services and other intangible products are yielding significant profits (Gebauer at al., 2005; Oliva and Kallenberg, 2003). Current product and service deliverables are increasingly mixtures of tangible and intangible parts (e.g., Tuli et al., 2007). They cause new challenges in modeling and managing a product, and product related information, especially when trying to understand the differentiated nature of deliverables (Kropsu-Vehkapera et al., 2011).

Developing an agile supply chain, which allows such organizations to meet the variations in demand at an acceptable level of cost and response time, is now a major focus in many leading organizations (Christopher and Towill, 2002; Fisher, 1997; Mason-Jones et al., 2000). Agile manufacturing means that the production process must be able to respond quickly to changes in information from the market (Goldman et al., 1994). Agility, for a company, is the capability of operating profitably in a competitive environment of continual and unpredictable changing customer opportunities (Golman at al., 1995). It is the ability to make low-cost, high-quality products with short lead times and in varying volumes, providing enhanced value to customers through customization (Fliedner and Vokurka, 1997). For example, rapid responses to market demands have been shown to facilitate the capture of a greater share of demand (Fisher et al., 1994). Based on van Hoek et al. (2001), customer responsiveness is crucial in yielding success in today's markets. Agility is all about creating that responsiveness and mastering the uncertainty. In that respect, the agile mind-set varies with the lean production model, which is commonly embraced in supply chain management. The elements of an agile supply chain are customer sensitivity, virtual integration, process integration and network integration (van Hoek et al., 2001). Supply chain management is the purposeful integration of these organizations and activities in order to achieve greater customer responsiveness and lower overall costs (see also Handfield and Nichols, 1999; Poirier and Bauer, 2000; Simchi-Levi et al., 2000).

Many managers and practitioners in SMEs have indicated that this kind of "rapid productisation" is a common but informal and disorganized process in practice (Hänninen et al., 2013a, b and c). In addition, better management of the RP process would be beneficial (Hänninen et al., 2013b). In general, during RP, a company quickly evaluates a conception over a gap product; i.e., whether providing such a gap product is viable for the company and at what cost. Also, decisions are made on whether the company is prepared to provide the gap product. The need of an upstream supply chain should also be analyzed. Rapid productization does not take a position on the concrete realization of the product; it purely aims at forming a conception over the requested gap product, within a rational timeframe, so as to provide solution to customers. The final decision to select a particular upstream supply chain supplier for the gap product is perhaps the most critical stage in rapid productization. Obviously, such a decision is influenced by many aspects, the specifics of which are not known a priori during an analysis stage. If the sales organization identifies a gap between an offering and the customer need, the company needs to react to get a sales contract. The case companies have used upstream supply chain resources to support rapid productization (RP). A rapid productization process (RPP) is a framework for quickly supplementing a customer need, in a sales situation, to a rapid offering to the customer.

The goal of this study is to outline uncertainties caused by using an upstream supply chain in RP. Also of interest is: what are the upstream supply chains characteristics in RP? To achieve the goal, the paper attempts to answer the following Research Questions (RQs):

RQ1) *what are the uncertainties in using an upstream supply chain in small businesses?*

RQ2) *what are the characteristics of an upstream supply chain in RP?*

2 METHOD

This retrospective, multi-case study uses a holistic research strategy (Saunders et al., 2007; Yin, 2003). The research process was divided into three phases: *case study design*, *single-case data collection and analysis* and *cross-case analysis*. The research process of this study is presented in Figure 1.

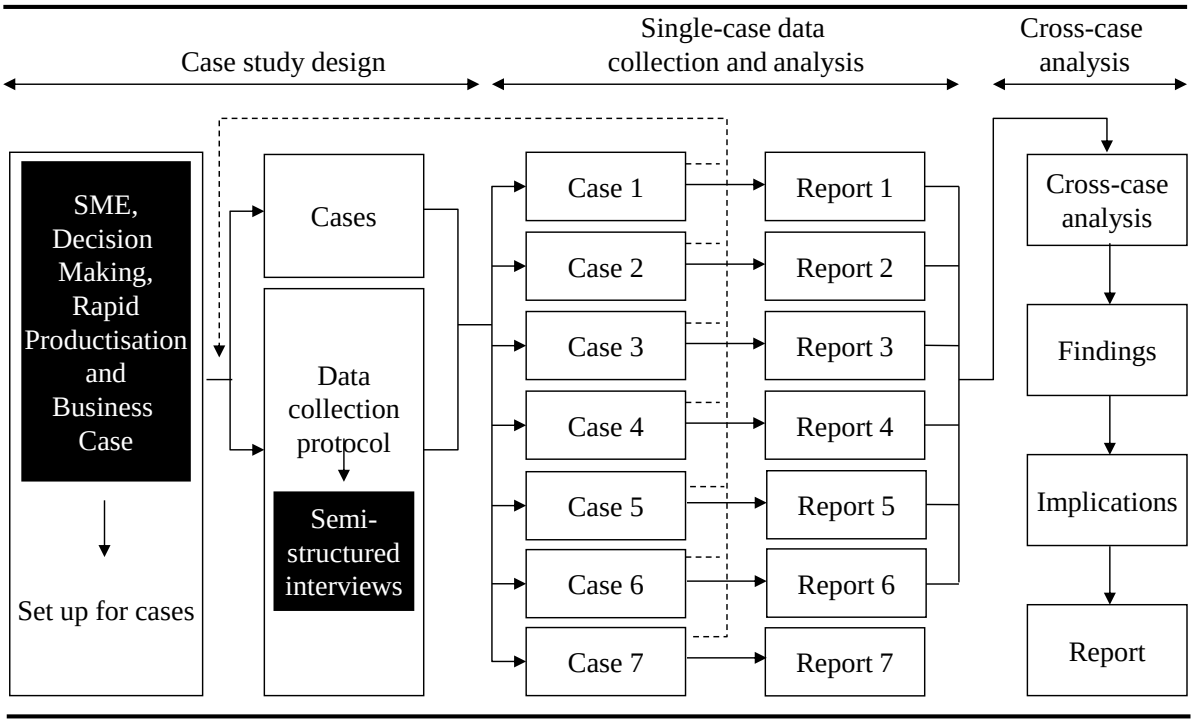

Figure 1. Research Process

Qualitative research refers to any type of research that produces findings which are not results of statistical or other means of quantification (Corbin and Strauss, 2007). However, multiple data collection techniques can be employed in case studies, and are likely to be used in combination with one another (Saunders et al., (2007), p.139). Moreover, both qualitative and quantitative evidence can be shown in a case study (Yin, 2003); in fact, Yin (2003) encourages using both techniques. In line with Yin's (2003) guidelines, a combination of qualitative and quantitative evidence was collected in this study. However, the main focus is on qualitative analysis.

At the data collection phase, qualitative techniques may include focus groups, individual depth interviews and case studies (Cooper and Schindler, 2010). During analyses, the qualitative researcher often uses the content analysis of written or recorded materials. Qualitative research aims at providing an in-depth understanding about the situation in hand (Cooper and Schindler, 2010).

The data was drawn from semi-structured interviews designed to gather information about the upstream supply chain in rapid productization in US industries. Interviews were keenly constructed to allow the interviewees to explain and clarify the case and topics as entities. Interviews were conducted in seven heterogeneous companies to obtain a wider view on the subject studied. The main themes of the interview questionnaire are presented in Table 1.

Table 1. Main themes of the questionnaire

What is a structure of an upstream supply chain network in RP?
What is the company's approach to choosing a supplier?
What risks can be instigated by selecting an upstream supplier in RP?

The interviews were conducted with seven companies (see Table 2). The number of cases was limited to seven in order to achieve an in-depth understanding of the phenomenon studied. These companies are able to offer a comprehensive study material, the extent of the phenomenon. The companies' advanced practice and advanced product development processes can be used as a comparison with other participating companies. The topics that were merely company specific are not reported.

Altogether, the study included 11 interviews (see Table 2). The interviewed industry experts were selected carefully, based on their professional background and expertise. The selected participants hold positions related to productization. Their experience and current interest ensured high motivation and up-to-date knowledge about the topics discussed. The questionnaire was sent early enough to enable the interviewees go through it well in advance. The interviews were recorded and transcribed. The interviews lasted up to two hours each.

NVivo® software application was used in organizing and analyzing the interview content and for the criteria categorization. For each company, we conducted a within-case analysis and classified the cases according to the following categories:

- A supplier selection in rapid productization
- Case companies' supply chain characteristics
    - upstream supply chain layer in case companies
    - the role and responsibility of an upstream supply chain supplier and
    - the supply chain's ability to fast response.

Case companies' characteristics are presented in Table 2.

Table 2. Case companies' characteristics

Case	Founded	# of empl.	# of interviews	Role of the interviewee	Area of business
A	2003	15	2	CEO and Manager of Product Development	Software solutions
B	1995	30	1	CEO	Software solutions and equipment manufacturing
C	1971	37	1	CEO	Electronics manufacturing
D	2009	11	2	CEO and President of Sales/Marketing	Software solutions
E	2009	18	2	CEO and Director of Marketing	Software solutions and consumer goods
F	1999	25	1	CEO	Telecommunication
G	2009	7	2	CEO and Bio tech. consultant	Bio technology

3 MULTIPLE CASE STUDY

3.1 A supplier selection in rapid productization

In *company **A,*** there is no real need for a supplier selection; it is more of choosing different cloud service suppliers. The main point, from the customer's point of view, is that there is no latency when going on the cloud. From the customer view point they just want everything to work across all the continents.

C*ompany **B*** mainly uses a preferred vendor network. A query will be sent to those vendors when the company has a need for rapid productization. The supply vendor should then be integrated immediately. The selection criteria are typically flexible in terms of delivery times and quality, more than just a price tag.

In *company **C,*** supplier involvement happens in an early pre-sales discussion to make sure that all the relevant information will be in place. A supplier can be integrated into a rapid productization process during a normal process time.

When *company **D*** works with another technology, vendors of the company act like a client where the vendors are trying to accommodate the client's needs. The vendor has to be somewhat flexible to accommodate the needs and requests of the client. Timing how early supplier involvement is needed is based on when a supplier is found. The main risk when dealing with upstream suppliers is that they necessarily do not adhere to industry standards.

In *company **E,*** supplier involvement will be needed as soon as possible. It is not a simple task to change suppliers without compromising quality. The company wants to maintain its quality while changing suppliers. If a new item needed is an inline product, something the supplier already has,

obviously there is no big problem to get it in. Selecting a new vendor is always a challenging task. The most vital issue is money. A company can lose a lot of money by choosing the wrong vendor. Therefore, a company has to really have the right folks.
In *company **F**,* the attempts to choose a new supplier involve a fairly formal procurement process following ISO 9000 procedures. The most crucial concern when adding a new vendor is whether the process increases the risk level (a new vendor does not reduce it).
In *company **G**,* usually, there are no many choices available in a market place. There are fewer choices available when selecting a supplier because suppliers try to differentiate themselves. Meaning that one supplier is targeted to produce a ligand for human beings and another supplier is targeted to produce it for mice. As a result, there is generally one choice available in the market place. From a management point of view, it makes the supply chain quite easy to manage.

3.2 Case companies supply chain characteristics

The next definitions have been used in this study to categorize a supplier's roles and responsibilities (Table 3).

Table 3. Definitions for a supplier's roles and responsibilities

Role of a supplier	Responsibility of supplier
Component manufacturer	*None* - No need for supplier involvement. The supplier "makes to print".
Distributor	*White Box* – Informal supplier integration. A company "consults" with the supplier on its design.
Contract manufacture	*Grey Box* – A formal supplier integration. Joint development activity
OEM	*Black Box* – A design is primarily supplier driven but it is based on a company's specifications.
Other	Described by the interviewee.

3.2.1 Upstream supply chain layers

*Company **A*** uses one upstream layer, which is a cloud service provider.
In *company **B**,* most of layers represent component manufacturers and a few contract manufacturers. In some cases, the company also uses OEM's. Primarily, the upstream supply chain has up to two layers.
*Company **C*** uses two levels of an upstream supply chain because of the diverse and varied sets of the upstream supply chain requirements. The levels are: 1) a mechanical milling house for bigger orders and 2) a local small vendor for rapid customization.
In company ***D**,* there is only one layer, provided by a cloud service provider, which covers two suppliers providing what the company needs.
*Company **E*** uses two upstream layers: 1) an embellisher is a supplier who decorates a garment and 2) a supplier who manufactures the product. This is the case when the company manufactures physical goods.
*Company **F*** uses two layers: 1) a vendor as a contract manufacturer for circuit card assemblies and a vendor for all sheet metal and machine parts, including painting chasses and 2) a collection of specialty vendors; mostly small technology companies from where to buy major components such as amplifiers, filters, lasers and detectors.
*Company **G*** uses only one supply chain layer from where they buy a particular ligand. This can be an antibody or a small molecule.

3.2.2 The role and responsibility of an upstream supply chain supplier

In *company **A**,* the company used service providers, which means that only a license and training is needed from the company A. In the *OEM* case, the supplier builds a product, they sell it and they service it and company *A* does not get involved in it at all. There is still some collaboration between the suppliers and company *A*, similar to a white box.
In *company **B**,* most of the suppliers used are component manufacturers. The company does very little with contract manufacturers. In some cases, *OEM*'s are used and they are typically engaged closely with the company *B* during the customization of their products. A supplier's responsibility goes as far as a white box.

In *company **C,*** used component manufacturers typically buy what they have got to offer. Components mostly come through distributors. Everything else is bought by the company, which means that mechanical parts, shelves, cases and hardware come from vendors because all those parts are custom made to company *C*. They use contract manufacturers to build printed circuit boards. The supplier's responsibilities vary from a *white* to a *grey box*, depending on what the company is offering to a customer.
In *company **D,*** the role of a supplier is "*Other*". The company *D* uses service providers for a creation of server capability. A supplier's responsibility is either a *white* or a *grey box*.
*Company **E*** relies on *component manufacturers* in the garments. They do not use *distributors* because they distribute the products themselves. They use multiple *contract manufacturers*. They have an *OEM* that does garment printing, embroidery or add whatever needs to go on the garment. Some of the supplier's responsibilities are in a *grey box* level, but most of responsibilities are in a *black box* level.
In *company **F,** component manufacturers* are amplifier and filter suppliers. They get inexpensive parts from *distributors*, and they have two major *contract manufacturers*.
*Company **G*** uses *distributors* to buy what is needed.
There is no need for a supplier responsibility in the cases of *company **F** and **G***.

3.2.3 The supply chain's ability to rapid response

*Company **A*** uses cloud upstream vendors and they are able to respond quite well. Unexpected rapid productization needs are coming from a customer.
In *case **B,*** suppliers are typically less able to respond, than the company is, and they are normally less motivated to respond. A reason for that kind of behavior might be linked to a small versus a large company question. Normally, the case company *B* is sourcing from larger companies than they are.
In *case **C,*** an upstream supplier's involvement is needed in an early pre-sales discussion to make a selection next questions to be made: who are in general possible vendors, who vendor can offer a product/service and who can do needed modifications of standard products.
Vendors have to accommodate *case **D***'s needs and requests. This will require some changes in the upstream supply chain as well as the ability to fulfill a need set by a customer. This affects how vendors might response.
*In case **E,*** the question is not how well but how willingly will suppliers respond? The case company's upstream supply chain is a big multiple group and suppliers are big vendors. Their willingness to response depends on the size of the opportunity and what they think they would lose by not doing it. Generally, a supplier response will be needed almost instantly.
In *case **F,*** a supplier's ability to response is very situational. In this company, it has begun to dawn that the company needs to get the suppliers' involvement for large orders. A large order means they will carefully go to the suppliers and ask them to give their current pricing and updated lead times.
Supplier involvement is what is needed is buying in *case **G***, and it does not have to be integrated into their system. A summary of the companies' upstream supply chain characteristics are presented in Table 4.

Table 4. Summary of the companies' supply chain characteristics

Case	Level(s)	Role(s)	Responsibility
A	1	Other	White box
B	2	Component manufacturer, Contract manufacture and OEM	White box
C	2	Component manufacturer, Distributor and Contract manufacture	White box and Grey box
D	1	Other	White box and Grey box
E	2	Component manufacturer, Contract manufacture and OEM	Grey box and Black box
F	2	Component manufacturer, Distributor and Contract manufacture	None
G	1	Distributor	None

4 FINDINGS

To outline the use of an upstream supply chain in rapid productisation (RP), this study seeks to clarify *the uncertainties of using an upstream supply chain in small business* (RQ1) and *the main characteristics of an upstream supply chain in rapid productization* (RQ2).

The new business demands are often tackled by configuring products, but it is not usually possible or advisable to develop all the possible configurations through traditional product development due to the wide variety, and even the uncertainty, of specific customer needs or low marginal utility. In a solution-centric business, new demands occur every now and then and, thus, new methods for fast and controllable product development are required. One possible solution to overcome this is rapid productization (where productization is conceptualizing the product and fulfilling the data needs to be able to manage the product through a lifecycle). The motivations for rapid productization vary. One of the different motivators can be sellers selling product(s) that are not in the portfolio or a customer wanting tailor-made services or products.

4.1 Supplier selection

An upstream supplier selection is not a routine business in case of RP and that is why the selection criteria need to be very clear and easy to use. Suppliers have to meet the criteria's. They have to be of a certain size and be able to produce the product in the manner in which a company needs it. Basically, what that means is that a supplier ability to produce needs to match the company's ability to offer a new product or service. There are many different kinds of suppliers available and the company needs to look at everything, from relationships and referrals to the ability to produce. Even a check list is in use it will cause uncertainty to implement a new vendor at the beginning of rapid productization. Mainly because there is no history on how the supplier operates as a business, the selected supplier should be immediately integrated into a business process. A check-list for an upstream supplier selection is presented in Table 5.

Table 5. Upstream supply chain selection check-list

Reliability (who are they)	Quality of the product and speed of delivery
Fitness for use of the product not a cost	Do they have the right people that can do what is needed?
The required technology to make the product	Credibility (previous references)
Financial references (are they well-funded)	Company's operating time
The kind of clients they have, and their saturation on a market perspective	Do their markets match their client's markets?
Availability (who has the best inventory)	Which supplier is producing the best product?
A supplier's metrics tracking show green light	A supplier can be integrated into a RP process

4.2 Upstream supply chain uncertainties in rapid productization

As an answer to RQ1, when looking to move fast using rapid productization, it is necessary to find resources outside from the company's own walls. That is when an upstream supply chain comes into the picture. The *selection of an upstream supplier* during the rapid productization process instigates some risks; it will take time to verify and evaluate an upstream supplier candidate. The main challenge is that, in rapid productization, there is no extra time available. To reduce the risks caused by the selection of a supplier, it is necessary to demand that they do things within the industry standards.

It is challenging to get *appropriate supplier involvement* when it is needed immediately. The ability to respond to a customer's request for a new product will often require *customization capabilities from a supplier*.

The bigger risk is that a company may have suppliers who are unwilling to be as responsive as they should be. To avoid mistakes caused by vendor selection, the company must use a smaller variety of vendors and pick up products that the vendors know they can get. This means that does not only mean good vendor relationship, but it also requires keeping a range of products, which the company buys from the vendor, standardized. That is how both the vendor and the company can grow together. If the company cannot find a third party vendor to match what is needed, the business might not take place.

When a company has a stable core product with a very long product lifetime, all modification decisions need to be carefully justified. At the same time, it will set borders on the kind of upstream

supply chain cooperation that the company is able work with. The main uncertainty in this case is how well *the core product/service and the upstream supplier can be integrated*.
Upstream supply chains and rapid productization are even more complicated when *foreign vendors* need to be involved. Using the vendor network, especially from abroad, requires many things what have to be coordinated.
The situation becomes more complicated and challenging when a new and updated purchase forecast (typically not a big order) needs to be sent to a supplier base on a case of rapid productization. In order to react fast to a request made by a customer, a *fast and timely response* is required from a supply chain. If suppliers are not taking their responsibilities seriously, it means the supplier's response takes too long. This might lead to a situation where rapid productization is hampered and the company might end up losing money. Lack of response can be a challenge when trying source from larger suppliers than the company itself. It is quite challenging to deal with a situation whereby a company is interested in meeting the needs of a customer but, at same time, the upstream suppliers are not. As a result *conflicting interests*, the company cannot be able to benefit from the business. An outstanding motivator on how to solve an upstream supply chain mismatch is competition. A small business, in most cases, may not be able to make a product by itself. In that situation, the company may have almost zero leverage concerning the supplier.
Following this, how can rapid productization be integrated better into a supplier's own business process? It is essential to get an upstream supply chain to match with rapid productization needs. To achieve this, the upstream supply chain and the amount of layers should be in a manageable level. The point is how to balance a position of a win-win situation.
The most unwanted uncertainty is related to unacceptable vendor behavior. The business is at stake when the company *cannot trust the supplier*. In other words, the suppliers promise to do something but at the end they do not do anything. The outcome of not having an item will directly affect the company not the vendor. The customer is not interested on who the supplier/vendor is. They only see the company they deal with, and that is where they report their problems.
Severe uncertainties, which will link to the upstream supply chain, are related to: 1) *technical malfunctions* and 2) *supplier's capability to keep a schedule.* When buying on a firm fixed-price basis, there is no price uncertainty; however, there is a technical performance on the other hand. That is not supposed to be an issue at all. Uncertainty is mostly linked to a schedule commitment because the company has quoted to the customer a schedule. Therefore, the company has to have the right suppliers.
The key issue set for a supply chain network is delivery capability and product quality. Those are the key attributes and key risk-makers for the company. A summary of the upstream supply chain uncertainties is presented in Table 6.

Table 6. Summary of the upstream supply chain uncertainties in rapid productization

Upstream supplier selection	Suppliers' ability to respond rapidly
Supplier's involvement is fast enough	Suppliers' lack of interest to do business
Ability to offer customization	Suppliers' reliability
Support of a core product	Suppliers' product performance and quality
Use of foreign suppliers	Suppliers' schedule performance

4.3 Characteristics of an upstream supply chain in rapid productization

As an answer to RQ2, the main characteristics of an upstream supply chain in rapid productization are defined. In rapid productization, the *using a preferred vendor network* is recommended. It is a way of saving time as the vendors' capabilities are well known. A query should be sent to those vendors when the company is in need of rapid productization. Before sending the query to the preferred vendor network, the following information should be known: 1) who are the potential vendors, 2) who can offer a product or service, 3) what is the vendor's capability to respond in time, 4) how reliable is the vendor and 3) what modifications need to be made on a product in order to meet the customer's needs.
In small businesses, *having a common interest* between a company and a vendor/supplier is essential. This is more important when an upstream supplier is bigger than its customer. If there are any conflicting interests, the company cannot be able to take the business.

Important issues from rapid productization's point of view are upstream supply chain's *flexibility and a product customization capability*. Both features are needed because, quite often than not, products are unique and depend on what a customer wants (new requirement). It can be good if a supply chain network can support customization as well.
The key issues set in an upstream supply chain are the *ability to respond quickly, with proven delivery capability and product quality*. Rapid productization as a process requires that the upstream supply chain be able to deliver very fast, with an excellent product quality right from the start. In rapid productization, timing is crucial and, in most cases, a second opportunity is not available.
A company must have faith in the promises and the professional skills of the upstream supply chain vendors. To achieve this, it requires *confidence in business relationships*. A summary of upstream supply chain characteristics in rapid productization is presented in Table 7.

Table 7. Summary of upstream supply chain characteristics

Use of preferred vendor network	Fast ability to response to a request
Common interest to make business	Proven delivery capability and a product quality
Flexibility and customization support	Mutual trust and confidence in business relationships

5 CONCLUSION

This paper aimed at outlining the use of an upstream supply chain in RP by analyzing upstream supply chain practices in small business firms. The findings of the study suggest that a well-managed upstream supply chain network is an important facilitator of RP in small businesses. This is due to lack of resources; however, using third party vendors or suppliers can be a good resolution.
A starting point for a rapid productization process is an unexpected product or service gap in a portfolio requested by a customer. To be able to make good business, companies should constantly look for new supplier opportunities. Before selecting any vendor, they need to have proven track records which show vendors be able to improve products at reasonable cost level. Equally vendor's ability to keep high quality need to be remains when a distribution of that product starts. By being reliable, the company can serve more customers.
Rapid productization can be used against to the growth of a product variety. Even if its aim is to respond faster and better to customers' preferences, RP's key objective is to control product variety and operational performance. This is possible because RP can influence organizations to use the available technologies, platforms and product data in order to maximize the usage of limited resources. Fast and successful PR requires close and smooth collaboration between a customer, sellers, R&D and an upstream supply chain. Using an upstream supply chain is not the only resolution in RP. The bottom line is what are the unexpected customer demands in practice, and how can the situation be resolved without compromising other companies' on-going activities?
Offering fast responses to customers' needs requires better information processing and tools and systems which support sales negotiations. From sales point of view, this is challenging since, in RP, a sales configuration tool cannot be used. From a managerial point of view, the use of an upstream supply chain is not making analyzing work easier or faster. Having a supplier's metrics tracking system is one way of making decisions faster. The set of supplier metrics need to be in place and in use in order to be able to find out which supplier the company should choose.
This study has focused on small businesses' use of an upstream supply chain in rapid productization. Some limitations of this study should stimulate further research. First, the number of interviewed companies is limited yet a deeper analysis is needed to broadly cover the studied topic.
Secondly, our study focuses on small companies. The next step would be to study what might be upstream supply chain uncertainties and their characteristics in rapid productization related to large companies.
Third, it can be interesting to examine how new companies can utilize and take advantage of the upstream supply chain and rapid productization to boost the companies' early growth.

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