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## Improving product development in different type of ICT companies

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**Abstract:** The information and communications technology sector (ICT) is facing continuous change in its new product development as products are getting increasingly complicated, and customer segments more fragmented. Price erosion is also an escalating challenge for the management in the ICT sector. The automotive sector was chosen as benchmark as it has been for decades a large volume and competitive business sector, and has streamlined its processes to meet severe price targets. This study utilises Toyota's product development model as a learning platform and presents improvement ideas for three different type ICT companies: large, small, and suppliers.

**Keywords:** benchmarking; NPD; ICT; product development; innovation; Toyota; learning.

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## 1 Introduction

The ICT industry has expanded rapidly during the past decades and has evolved into a high clock-speed industry. The pace of new product introductions has increased drastically and devices, such as mobile phones have become commodities. In order to survive in severe competition companies must be innovative, and also learn from past experience of their own, but also from others. Companies are forced to reduce costs, shorten development times and production lead-times (e.g. Seetharaman et al., 2007). Efficient new product development (NPD) is thus essential. Products being more complicated than ever, and customer segments more fragmented, addressing the needs of both internal and external customers has become a challenge for product development and production. Technical superiority of products is, however, not enough for companies to succeed, but one must also invest in developing processes and people. (e.g. Pisano and Wheelwright 1995; Cooper et al., 2004; Drejer, 2008; Nonaka and Takeuchi, 1995; Gupta et al., 2007).

Despite of being the bellwether in technological development in many respects, the ICT industry has a lot to learn, and benchmarking with other sectors, such as the automotive industry, can be beneficial. The car industry has been a competitive sector for decades with large business volumes, and their NPD has been rationalised to a very high level of productivity. Toyota is a potential learning platform, due to ICT and automotive sectors having common elements, including global competition, consumer orientation increasingly complex products, growing importance of NPD process, and such. Toyota creates quality cars, faster and with a greater profit than its competitors, and is known for its systematic management practices (e.g. Chin et al., 2008).

This study utilises Toyota's NPD model (TNPD) as a benchmarking tool for finding potential improvement ideas. The main benefits of TNPD are its impact on issues, such as time-to-market, productivity, quality, the number of changes at the end of development, product cost, R&D capacity, rapid learning, among others (see e.g. Radeka and Sutton, 2007). Another motivation for using Toyota as a source for ideas is their procedures being well documented in the literature (e.g. Morgan and Liker, 2006; Ford and Sobek, 2005; Ward, 2007). Toyota was selected as a benchmark, even though following TNPD blindly is not an optimal approach as automotive and ICT sectors are different in terms of profit margins, timeframes and even though TNPD has also received critical analysis (e.g. Rosemann, 2006; Radeka 2007; Oliver et al., 2004).

This study analyses how ICT companies could benefit from TNPD learnings, providing development ideas. The research covers three different company types: large, small, and suppliers.

The above mentioned can be condensed into the following research questions:

**RQ 1** How does the company type, and size, influence the feasibility of utilising structured product development models, such as TNPD?

**RQ 2** What development ideas can be derived from TNPD practices for different type of ICT companies?

This study addresses the research questions in a qualitative manner both, through literature and analysis of industry interviews.

## **2 Improving NPD process**

The efficiency and effectiveness of new product development activities are seen as key factors determining a firm's competitive advantage, and its very survival (e.g. Godener and Soderquist, 2004; Khan et al., 2007; Loch et al., 1996; Caputo and Pelagagge, 2008; Meyer et al., 1997). Efficiency in product development can be seen as the cost control aspect, while effectiveness determines the actual impact. Typical impacts that are striven for include time-to-market and quality. Productivity, on the other hand, can be seen as the sum of efficiency and effectiveness (Sumanth, 1998).

It is seen imperative for product innovation to link customer needs, technological competence, engineering and process know-how (e.g. Lee, 2008; Su et al., 2007). Requirements for products, derived from customer needs, usually evolve during product development process, causing a challenge for management (e.g. Zeidler et al., 2008; Engelbrektsson and Soderman, 2004; Ojiako et al., 2008; Dawidson and Karlsson, 2005). In addition, the speed of product development is generally seen as an important target, however, entering markets too early includes risks (e.g. Meyer and Utterback 1995; Griffin, 1993; Ford and Sobek, 2005). The improvement of NDP processes typically starts with creating an efficient flow (e.g. Blog, 2007), after which the emphasis is on shortening development times, and on timing of different actions.

### *2.1 Product development in different type of companies*

Company size is seen to have influence on the way product development is organised. The larger the organisation, the more formal control is required, potentially hindering innovation, (e.g. Grimpe, 2007; Arvidsson et al., 2003). Generally, company size is seen to associate especially with innovation, supplier involvement, and also with managing development (e.g. Laforet, 2008; Wynstra et al., 2001).

Large companies have typically enough resources to divide NPD activities into smaller tasks, based on either time or specialisation. Bureaucracy, inertia, and communication needs may cause challenges. However, Leenders and Wierenga (2008) state that when all other things are equal, large companies may generate more new products than small companies.

Small companies have smaller resources in their disposal, compared to large companies, forcing them to focus their NPD activities, and thus utilise simpler methods. Small companies may also have difficulties in developing parallel alternatives, and do not have specialised personnel for all the activities. Coordination of activities is easier in small companies with less need for formal methods (e.g. Anderson and Tushman, 1991; Haapasalo and Ekholm, 2004). Senior management involvement occurs earlier in the small firms (Ledwith et al., 2006).

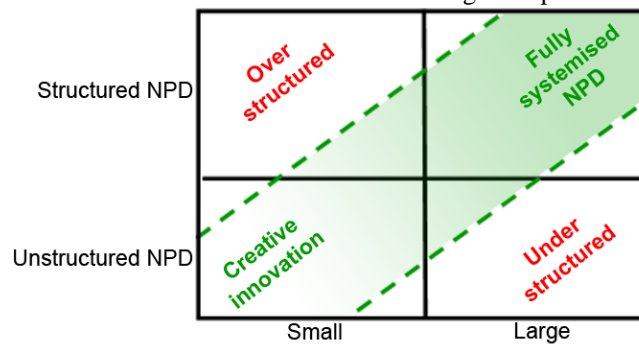
Different NPD frameworks (e.g. McGrath, 1995; McGrath, 2001) are typically more appropriate for large companies, as they are large enough to consider issues, such as product platforms, and involve the full enterprise. However, in small companies, product lines are more limited, and it is not suitable for them to strictly follow same frameworks as the large ones. Instead, it is seen to better suit them to base NPD on derivatives of a

core technology (e.g. Ledwith et al., 2006). Figure 1 gives a simplified illustration of the level of structured NPD practices in small and large companies.

Approaching supply chain from the perspective of NPD provides new viewpoints. Early, and extensive, involvement of suppliers in product development is seen to be one way to enhance product development performance relating to productivity, speed, and quality (van Echtelt et al., 2008). However, increased supplier involvement can be challenging, requiring adjustments and unlearning old behaviour in order to successfully integrate and benefit from new resource configurations (van Echtelt et al., 2008). The company size is seen to influence the company-supplier relationships (e.g. Redondo and Fierro, 2007). Moller et al., (2003) emphasise a resource based (competence) view on guiding companies in developing and handling relationships with technology suppliers, instead of a traditional product oriented view.

This study, however does not view suppliers from the supply chain perspective, but approaches them as independent companies.

**Figure 1.** Relative level of NPD structures in small and large companies



## 2.2 Toyota new product development

Toyota has gained reputation through its quality and efficient production system. Nevertheless, successful product development has significantly contributed to their success. Numerous authors have studied Toyota's new product development (Morgan and Liker, 2006; Kamath and Liker, 1994; Ward et al., 1995; Vassilakis, 1998; Sobek et al., 1999; Liker, 2004; Hong et al., 2004; Hines et al., 2006), making Toyota's new product development (TNPD) well documented. Toyota's product development is among the fastest in the automotive industry, even though is said to look inefficient, clumsy and expensive (e.g. Radeka, 2007; Vassilakis, 1998; Oakley, 1997; Ward et al., 1995). Strong emphasis on real customer needs, process efficiency and cross-functional integration have been identified among the success factors of Toyota's NPD (Im et al., 2003; Brown and Maylor, 2003; Ibusuki and Kaminski, 2007).

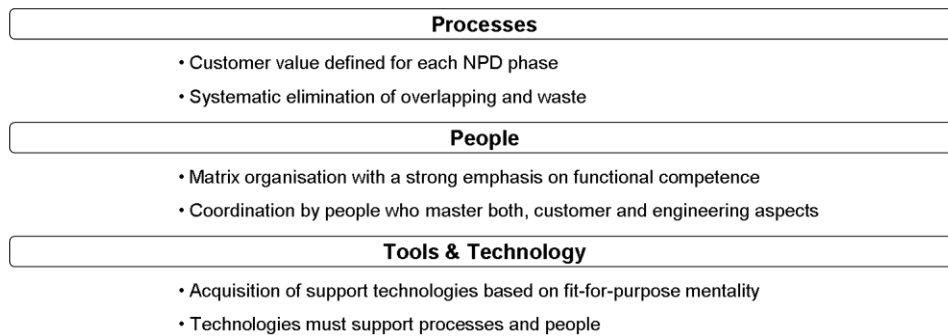
The key aspects of TNPD are seen to include the harmony of different mechanisms, and effective knowledge sharing across projects (Haque and James-Moore, 2004; Dyer and Nobeoka, 2000; Chow et al., 2007). Other factors identified as keys include, knowledge management, set-based concurrent engineering and delayed decision-making (see, e.g. Appleton and Short, 2008; Hines et al., 2006; Morgan and Liker, 2006; Liker, 2004; Ward et al., 1995; Sobek et al., 1999; Kamath and Liker, 1994). Continuous improvement and learning from previous projects is also a vital part of innovation and learning process at Toyota (Fuchs, 2007; Chang and Cho, 2008).

The set-based approach means developing several parallel technical alternatives, and thus deliberately delaying decision-making on technologies to be utilised in final

products (Ford and Sobek, 2005; Yang et al., 2004). The approach utilised by Toyota includes different actors working on rough-cut designs within defined, reasonable frames. This type of approach supports the acknowledgement of internal customers, and aids in avoiding over-the-wall designs (Hines et al., 2006).

Morgan and Liker (2006) have presented the TNPD model to include: 1) processes, 2) people, and 3) tools & technology, which are seen to interrelate, and to be interdependent. This model is the basis utilised for further analyses in this study (see Figure 2).

**Figure 2.** The key aspects of TNPD



Processes sub-system of TNPD includes the definition of factors creating customer value. All factors that do not add customer value are eliminated as waste (Faisal et al., 2006). All the functions are synchronised, and the use of resources is built flexible. In addition, early NPD activities are emphasised resulting in front-loading the process (e.g. Binder et al., 2008; Veryzer and de Mozota, 2005). A number of parallel alternatives are developed, thus postponing final technological decision-making. Variation is attempted to reduce through standardisation, which also eases common understanding.

Functional dimension of the matrix organisation is emphasised in the people sub-system. Co-ordination of functions is carried out by chief engineers (CE), experienced people with both thorough customer understanding and strong engineering background (e.g. Haque and James-Moore, 2004). The technical competence of personnel is strongly appreciated at Toyota, and is developed in company driven manner. Additionally, the suppliers and their employees are seamlessly integrated into product development projects, by utilising a three-tier system.

Tools & technology sub-system is dominated by a fit-for-purpose attitude for acquiring supporting technologies. Technology is not admired as such, rather utilised technologies must fully support processes and people. All vital information is processed, simplified and visualised at Toyota, tailoring it into a most suitable format for different purposes and users.

For detailed description of TNPD, please see (e.g. Morgan and Liker, 2006; Ward, 2007).

### 3 Empirical study

#### 3.1 The research process

The research process is described in Figure 3. The Toyota new product development process was analysed by using existing literature as the key source as summarised in the chapter 2.2. Industrial interviews were carried out in the ICT sector, in order to clarify the current state in ICT companies. Results were analysed by comparing them against Toyota practices. This was the base for improvement ideas for different company types: large, small and suppliers. The results of the analysis are presented in the section 3.2 results and analysis.

**Figure 3.** The research process



The study consisted of fifty three interviews, and eleven companies, in which at least three people were interviewed. The interviews comprised a representation from different phases of the new product development process. The interviews were conducted informally, in a qualitative manner, allowing the interviewees to explain and clarify the cases and topics as entities.

All the individual interviews were analysed separately by using TNPD as a tool, covering Toyota's principles for processes, people and tools & technology as described in Figure 2.

The companies that participated in the interviews represent different players in ICT supply chain. All the interviewed companies are analysed separately rather than as a part of a common supply chain. The first company type is large companies all of which are manufacturers that sell their own products globally. These companies provide products for both business-to-customer (B2C) and for business-to-business (B2B) markets. The second type of companies is small companies who have products of their own. The third category is suppliers, who serve companies in the first and second category. Therefore, these interviews represent the NPD activities in a versatile manner and provide understanding over managing diverse issues.

The participants interviewed were selected carefully on the basis of their professional background and expertise. Selected participants hold responsible positions related to new product development.

#### 3.2 Results

The interview material was analysed by using TNPD (see also Figure 2). The interviewee comments were examined against the three sub-categories of processes, people, and tools & technology. Each sub-category is divided into three company categories of large, small, and suppliers. Examples of interviewee comments for each category are presented in table format. The comments are classified into those supporting TNPD principles (+), partial realisation (0), and those against (-). All the interview material is analysed against the Toyota model and the analyses for each company category are presented.

### 3.2.1 Processes

Examples of interviewee comments relating to processes in large companies are presented in Table 1. The studied large companies clearly indicate that they do address customer needs. Engineers do not, however, typically participate in collecting and analysing customer requirements as deeply as in TNPD. Customer requirements are seen by R&D engineers to enter the NPD process “automatically” and are often assessed only after the project termination. Personnel of the studied large companies seem to think that it is a task only for top managers to analyse customer-value.

Product development in large companies is strongly platform-based, with a goal of generic solutions. A great challenge is, however, finding platforms that can serve the needs of later NPD phases. Analysing and addressing the needs of internal customers is generally weak in large companies. However, there is evidence of practices, such as *design for excellence* starting to realise, and become beneficial for addressing internal needs. Tackling technological uncertainties through analysing several parallel alternatives is utilised to a lesser degree in most of the interviewed large companies, than at Toyota. Large companies manufacturing consumer products seem to utilise more parallel development and delayed decision-making than large B2B companies with system products. B2C companies tend to follow Toyota by trying to solve technical challenges in the early phases of NPD, thus attempting to emphasise early NPD. System providers, however, tend to solve technical issues also in the later phases of NPD.

The interviewed large companies seem to have insufficient practices for optimally removing overlapping work. Most of the interviewees seem to, however, understand the need for coordinators, in order to link different NPD phases.

There are objectives for standardising technologies, and technical solutions, in the studied large companies. However, there is not undisputable evidence on standardisation of product development processes to the same degree as in TNPD. Also, standardisation of people skill-set is not as strong in the studied companies as in Toyota. The large companies seem to value personnel competences, but standardised career paths are not systematically planned.

**Table 1** Examples of interviewee comments relating to processes in large companies

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<b>Large</b>	
+	“Customer needs are taken into account when defining requirements, but tend to be keen-eared for changes later. All activities must be in sync, including marketing, sales, logistics and suppliers.”
+	“Product oriented operations means that in practice we aim at minimising all the activities not directly leading to productisation.”
+	“Platforms are developed to be generic, and are configured on product basis when required.”
+	“Developing platforms and modules serves the company’s own R&D, in the form of not having to dissect and test the same subjects multiple times.”
+	“Our capacity management is utilised to level the product development flow.”
+	“The information on test results and repair actions is utilised to improve the process.”
+	“By developing standard interfaces for tools and software, same tests could be universal.”
+	“I believe that the efforts on DfX practices have started to realise during the past years”
+	“We aim to standardise especially hardware interfaces. Software interfaces are standardised so that everyone would use the same.”
0	“Ideally, early product development provides the correct components that have already been sufficiently tested and are ready to be used.”
0	“It is important to consider appropriately already in the early phases of product development what the requirements are, and what should be tested and how.”
0	“The work is easier to complete, if it is possible to circulate the same personnel between early and late product development.”
-	“The employees focus more in finding technological solutions, than aiding the later development activities and productisation.”
-	“Sometimes incomplete platforms are taken further, and they are finished in productisation.”
-	“We operate in a system business, and our problem solving tends to concentrate on the later phases of NPD”
-	“Cost pressures prevent the use of proven technologies; our products have an annual price erosion of 20-30%.”
-	“Tight schedules cause prioritisation, and the internal wishes are often secondary.”
-	“Checklists have a tendency to get overly complicated, something should also be removed.”
-	“It is a serious challenge, when the software intended for a product is still under development and a product cannot be taken to a desired state e.g. for testing.”

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Examples of interviewee comments relating to processes in small companies are presented in Table 2. Small companies seem to recognise the importance of customer requirements, in a similar way as in TNPD. Especially, small B2B companies have intimate relationships with their customers, and even their product development is strongly driven by customer needs. However, small companies do not normally analyse which actions add customer value, nor eliminate non-value-adding activities to the same extent as Toyota. Neither do small companies emphasise the early parts of the NPD process. For example, parallel alternatives are typically not developed, mainly because they feel that they would not have sufficient resources available. These companies rather have a tendency to freeze their solutions as early as possible. Consequently, small companies have great challenges during the latter phases of NPD process, and are forced to costly and time-consuming iterations. Standardisation of processes, in small companies, has not developed, resulting in some tasks being ignored, and for example documentation is typically insufficient. The studied companies have also difficulties in addressing the requirements of internal customers.



**Table 2** Examples of interviewee comments relating to processes in small companies

<b>Small</b>	
+	“Early product development provides a correct platform and mature enough technologies for different uses.”
+	“Evolutionary platform development enables rapid product development, and is similar to connecting Lego blocks.”
+	“Classifying errors based on their severity is of significant importance. This helps to understand how to develop test environments, and how to manage requirements better.”
+	“Our products are modular, for which defining the interfaces precisely are of critical importance.”
+	“We try not to end up in a situation where someone is irreplaceable, we purposely build overlapping know-how. However, an individual employee leaving the company usually causes some temporary hassle.”
-	“We do not consider, separately in different stages, whether something adds value to the customer, or not, as this has been considered in the beginning.”
-	“Often technology is too immature for production, and issues, such as the component variation <u>ought</u> to be considered more, already during the product development.”
-	“We aim to freeze the technologies that are utilised in our products, as early as possible.”
-	“In early product development, there is usually deficient documentation on verification and validation and e.g. no guide lines for required equipment.”
-	“We are not learning enough from the previous examples as the projects tend to be unique, and we are lacking of systematic processes for verification and validation.”
-	“Other functions do not always understand our requirements well enough, so that they could accommodate for our real needs.”

Examples of interviewee comments relating to suppliers’ processes are presented in Table 3. Suppliers’ are fundamentally dependent on their clients, resulting in tight monitoring on the realisation of clients’ requirements and satisfaction. This dependence also covers suppliers’ own product development. There are ambitions for removing waste and creating a balanced product development flow. However, key personnel are often overburdened by several simultaneous roles weakening the possibilities to truly balance development activities. Front-loading the NPD process is practically non-existent. On the other hand, one must understand that the studied suppliers are only involved in NPD practices to a variable degree.

**Table 3** Examples of interviewee comments relating to suppliers’ processes

<b>Suppliers</b>	
+	“The key clients’ will define the direction of developing products, and for the required tests.”
+	“Customer satisfaction is monitored constantly, and it does have a direct effect to individual salaries.”
+	“The workload of our employees is monitored frequently.”
+	“Steering group follows the project statuses and resource needs. Resources are moved between projects based on the competences of our employees. The key people have back up persons.”
0	“Product development should be as close to the customer as possible, with minimum documentation.”
-	“Key personnel often end up in a double role, and under an unnecessary work burden, when they transfer to a new position in our organisation.”

### 3.2.2 People

Examples of interviewee comments relating to people in large companies are presented in Table 4. Roles precisely equivalent to Toyota's chief engineer are not found among the studied large companies. At Toyota, CE is responsible over managing customer requirements, cross-functional integration, and acts as a system integrator. In the studied large companies, cross-functional integration is typically managed by programme/product managers responsible for product development. These managers are typically not responsible over system integration, nor customer requirements during the entire NPD process. Interviewed companies tend to split these responsibilities among several people. CEs at Toyota are experienced people with a strong technical background and their role is highly ranked, while product managers in the studied large companies are typically much younger.

The interviews indicate balancing the development of functional expertise and cross-functional integration being a challenge for large companies. In matrix organisations of the studied large companies, programme processes dominate, in contrast to Toyota where the functional dimension is stronger.

Technical competences are considered vital for business success in the interviewed large companies, and attention is paid for their development. In the studied companies, the employees themselves are, in contrast to Toyota, seen as the engines of their own career development. At Toyota the competence development, and career paths, of personnel are managed by the company. There is, however, some evidence of isolated cases in large companies, where individuals identified potential are offered mentoring to develop their competences, and given possibilities for advancing towards more demanding positions.

Integration of outsourced activities into company processes seem to be shallower in the studied large companies than at Toyota. In some cases, subcontractors' employees are in close cooperation with the client company, especially during product development. Communication between the companies is, however, considered challenging. The study also revealed how the larger client sometimes uses its bargaining power to push subcontractors for lower prices, making long-term cooperation difficult, unless the development is strongly supported by the client.

The interviewees highlight how there are practices in the large companies for continuous learning and improvement. As an example, after project completions, meetings and reviews are arranged to identify areas for development. However, a thorough culture for systematic, continuous improvement cannot be found in the large companies, in the same manner as at Toyota. Even though, learning is usually based on previous experiences, deep root-cause analyses are typically not carried out. Transfer and utilisation of tacit knowledge is attempted, through mentoring, and face-to-face contacts. Systematic practices for transferring this type of knowledge, however, cannot be identified.

**Table 4** Examples of interviewee comments relating to people in large companies

<b>Large</b>	
+	“It is easy to build project groups on top of the line organisation, and to re-organise competences to different purposes in this way.”
+	“The leaders of the project groups are active and arrange weekly meetings on critical matters, and on meeting the requirements. Technical knowledge from different areas is dispersed in meetings and seminars.”
+	“The experts have a functional home-base, of which we do not divide them into different projects. Our experts stay in the same team, which aims to maximise their functional knowledge.”
+	“We aim to define the required know-how and directions for individual development, and to support the personal growth”
+	“The development of the core know-how is assured through internal and external training, and through learning on the job.”
+	“Internal circulation between different positions, gives new readiness, so that when you change roles, you learn new things.”
+	“Informing between us and our suppliers is typically arranged via web-based applications. We have <u>shared databases</u> , where one can report feature wishes, indicate faults, etc.”
+	“Suppliers team leader is transferred to our site for training, when new projects are started. Occasionally, we send someone to suppliers’ location, even up to six months.”
+	“We have a meeting after the project closure, to understand what have we learned that can be exploited in the future.”
0	“Co-operation with measuring equipment manufacturers and with test software houses is important. This is to assure detailed fulfilment of the requirements set by the new products.”
-	“Customer requirements are provided by product management. Product development’s task is to realise these requirements, not to come up with their own.”
-	“Receiving information from the suppliers is especially tricky as the feedback loop is not always effective enough.”
-	“We are now able to go to any vendor and tell them that we want XXXXX A, B, and C, and for what cost.”
-	“The bottom line is that the team members are the best experts in their field, and therefore we do not tell them how to do things. The only limitations are for finding the solutions, the set schedules, set resources, and realisation with particular components.”

Examples of interviewee comments relating to people in small companies are presented in Table 5. In the interviewed small companies, the success of product development projects is seen to overrun the development of functional expertise. These companies utilise multi-functional teams for cross-functional integration. The integration is less organised than at Toyota, and no roles similar to CE can be identified.

Low ranking managers are typically promoted from the operational level according to urgent needs, especially in rapidly growing small companies, and career changes are frequent. Among the interviewed small companies, systematic career path planning were not identified, rather changes in individual roles seem to be reactions to acute needs.

In many cases, communication to/from suppliers is managed merely by sales, marketing and purchasing personnel. Communication allowing optimal consideration of product development aspects cannot be identified.

The company culture seems to be idolising technology, while customer focus and aims for efficiency are not as strong as in TNPD. There are cases where continuous improvement was not internalised by all the interviewees.

**Table 5** Examples of interviewee comments relating to people in small companies

<b>Small</b>	
+	“The line organisation is responsible for developing competences in accordance with technology areas set by strategy. One-to-ones with employees result in plans for individual training for the following year.”
+	“For the most critical aspects, the key personnel will have selected apprentices with great potential.”
+	“We use cross-organisational teams.”
+	“For example, outsourced IC architects have their own separate leader, who is responsible of their activities.”
+	“We are a technology business, and appreciate technical know-how in our key technologies. We do reward excellence, and arrange training.”
0	“We <u>try</u> to make sure that we are among the top companies globally, both in the key technologies, and in individual know-how.”
0	“The quality of our service is largely based on the know-how of individuals. The company invests in the individual expertise, to some degree, but it is also the responsibility of individuals.”
-	“Customer-oriented product development is assured by the steering group setting the product development projects, sales and marketing have strong representation in this. Marketing’s product managers also guide the realisation of product development projects.”
-	“Due to schedules and pressures to be profitable, we concentrate on keeping to the project schedules, and on successful completion.”
-	“The development of know-how is supported, but is dependent on the initiatives of each individual.”
-	“I would assume that our product development has been thought through at a higher level, so that it will be as rapid as possible.”

Examples of interviewee comments relating to people in supplier companies are presented in Table 6. Typical for suppliers is all work being initiated by clients, and customer focus is build into activities. Supplier’s key account managers are in charge of customer interface, although there are examples of supplier’s and client’s engineers communicating directly, without a buyer-seller interface. In some cases, trainers and other personnel from the customer company are sent to guide the supplier’s employees on following client’s practices.

According to the interviewees, suppliers and their customers often have common data systems for information sharing.

Suppliers also appreciate technical competence, thus quite often receive tips from their clients on critical issues. On the other hand, companies of this category have a tendency to follow trends in their field.

In other people related issues, suppliers resemble the small company category of this study.

**Table 6** Examples of interviewee comments relating to people in supplier companies

<b>Suppliers</b>	
+	“We have steady weekly meetings, where information is synchronised. In the meantime, day-to-day issues are addressed via email and phone.”
0	“As a small supplier, we all are directly involved with our customers.”
0	“Analysing the number of faults is a part of our bonus system.”
-	“The largest customers have key account managers, who take care of the customer interface on full time basis.”
-	“It is the key account manager’s who take care of the customer interface, and mainly negotiate our deals.”
-	“The greatest part of development is through daily work, or on employees own time. Unfortunately, once you are at a certain level of expertise, the company is unable to provide training in-house.”

### 3.2.3 Tools & Technology

Examples of interviewee comments relating to tools & technology in large companies are presented in Table 7. In large interviewed companies there is evidence using a ‘pull’ philosophy, similar to TNP, where real needs guide acquisitions of supporting technologies. This is to optimally enhance company processes and work of the employees. However, there are also indications of a ‘push’ attitude on technological issues, over-addressing the meaning of latest technology.

The interviews indicate some companies not sufficiently assuring that information is timely, or adapted to different users and in a suitable format. Overload of data from numerous sources characterises the current situation in companies. The problem has been identified, but not properly addressed. The interviewees have not acknowledged the need for simple visual communication, even though some templates have been developed.

In the interviewed large companies, databases are utilised to guide product development. There seems to be, however, variation in the success rate in utilising this data, and there is no clear evidence of categorisation of information based on its relevance. Proper solutions for further processing collected data have not been able to realise.

**Table 7** Examples of interviewee comments relating to tools & technology in large companies

<b>Large</b>
+ "The customer feedback, test results and any repair actions are recorded and collected into different type of electric databases. This data can later be utilised for improving the processes, new products and even subcontractors' activities."
+ "We have just launched a change milestone characteristic in our database, to allow adding new features easily. It is vital to be able to make last minute changes."
+ "Ownership is assigned to each attribute through our data owner network."
0 "Sufficiently arranged electric communication is essential for communicating relevant requirements and V&V related issues, especially if operations are decentralised"
- "Acquiring technology is guided by our need to be at the pinnacle of development."
- "The requirements information from different phases <u>should</u> be looped back more visibly."
- "Better visibility over <u>the true context</u> of requirements in other NPD phases <u>could</u> potentially raise the value of any given piece of information."
- "The speed of receiving any error indications is as an area of improvement, so that the testing activities can react quicker to any arising issues."
- "The large amount of collected data is a possible source of confusion. More effective ways of managing the collected data into a form that is both useful and unambiguous enough are desirable."
- "A challenge with bespoke data systems is that anything tailored will end up into the off-the-shelves version, which therefore is often more up-to-date."
- "The systems utilised for managing the requirements and test data are often too fragmented. This challenge is an area of current improvement actions."
- "In an ideal situation, every single phase would complete a report over verification and validation activities, describing everything essential. Unfortunately, this is not a possible practice."

Examples of interviewee comments relating to tools & technology in small companies are presented in Table 8. The interviews in small companies indicate less evidence over systematic consideration of tools & technology related issues than the ones of large companies. The small companies do not view support technology acquisitions critical for success requiring considerable attention. However, there were isolated indications of small companies acting differently, and highlighting the role of support technologies. In some cases, a follower strategy is applied, and technologies utilised by others are

considered worth attention. Also small companies have problems with optimal utilisation of stored data.

**Table 8.** Examples of interviewee comments relating to tools & technology in small companies

<b>Small</b>	
+	"We do not use the existing software tools, but code our own that will better fit our needs."
+	"For example, all the materials and the related test data are recorded."
0	"It is decisive to be able to receive timely information over <u>the most critical</u> characteristics of the product from the product development activities."
-	"It would be ideal, if we had the capacity to sufficiently analyse our needs, when considering procuring technology. In practice, we rarely have resources for this"
-	"Any recorded information on requirements should be better available."

Examples of interviewee comments relating to tools & technology in supplier companies are presented in Table 9. Those suppliers who consider tools & technology issues important invest significant resources to assure that technology acquisitions support business. Often, dominating clients give guidelines for the technologies to be utilised. In addition, suppliers typically follow the current technological trends in their field.

**Table 9.** Examples of interviewee comments relating to tools & technology in supplier companies

<b>Suppliers</b>	
+	"We use automated tools for testing software, as manual testing is experienced slow and boring."
+	"Faults are logged into the fault database, and are directed to the original developer, whom will receive personal feedback in this way."
+	"We usually follow which tools the others in the field are using."
0	"Our main client gives guidelines for the supporting technologies that we should use."
-	"We do not have adequate resources to invest in support technologies."

### 3.3 Potential learnings

The purpose of this analysis is to obtain potential development ideas for large, small, and supplier type ICT companies.

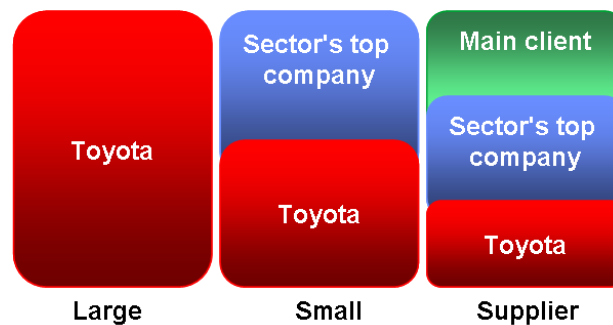
Toyota is a large, global company, who has all company functions including, research, product development, production and marketing represented, therefore resembling large ICT gadget and system providers in many ways. It is thus logical for large companies to fully benchmark powerful players, such as Toyota.

Toyota being a large company and its practices have been streamlined to meet the requirements of such a company. All the TNPD principles do not necessarily address the needs of small companies. However, Toyota being a successful company, it has a lot to give, even to smaller companies. On the other hand, small companies should analyse Toyota principles indirectly by benchmarking top companies in their own sector. Top companies in different fields have already addressed similar challenges as Toyota making them easier for small companies to benchmark. Benchmarking top companies in one's own sector is, however, not necessarily enough as even they have difficulties with today's challenges.

Suppliers, according to the interviews, resemble small companies in relation to whom they should benchmark. Additionally, suppliers typically have one or few dominating clients. Often dominating clients are well developed, therefore it can be beneficial to consider their way of addressing challenges similar to those in the TNPD. Through analysing how these significant clients approach product development issues increases the ability to understand one's own client.

Figure 4 summarises benchmarking targets relating to different company types and for gaining development ideas from the TNPD. Direct and all-inclusive Toyota benchmark serves the needs of large companies the best. For small companies, it may be more beneficial to benchmark Toyota directly only partially and to include indirect analyses through top companies in one's own business sector. Suppliers may also include their main clients as indirect benchmarking channels for obtaining ideas for improved product development.

**Figure 4.** Whom should companies benchmark in order to gain development ideas from TNPD



### 3.3.1 Potential learnings for large companies

According to the interviews, the strategy of using parallel technological alternatives and delayed decision-making is not widely applied. However, these companies do have a clear aim to shift the emphasis of their product development towards earlier phases, e.g. through platforms, the same way as highlighted in the TNPD. The study did not find evidence on companies systematically reducing all non-value adding activities and overlapping work. Better addressing the needs of internal customers, and today's goal for end-to-end optimisation over the entire product life-cycle, instead of partial optimisation, could potentially benefit from learnings of TNPD. Toyota utilises rigorous standardisation not only for products and their components, but also for processes, people and tools & technologies, making everything better predictable and manageable. New learning for large companies is to include people skill-sets in their standardisation efforts.

Programme management type arrangements are in place in the interviewed companies for the development process integration. Large companies could potentially improve their cross-functional integration, internal communication, and addressing internal customers through adopting CE type solutions. Although the interviewed companies recognise the importance of personnel competencies they are surprisingly non-systematic in relation to developing personnel competencies. Company-driven competence development is a potential way to address this issue.

Some of the interviewees seem to idolise technology and technological superiority over emphasising efficiency, quality and customer-orientation. Toyota does not see technology as value as such, but is required to add value, therefore their way of acquiring support technology is worth a deeper analysis. According to interviews, data overflow is a great, under-addressed challenge. Further processing of data into meaningful format, tailored for different purposes, is recommended for the studied companies. The way important information is communicated, including relevant visualisations, is a vital consideration.

A summary of learnings for large companies is presented in Table 10.

**Table 10.** Summary of potential learnings for large companies

<b>Sub-category</b>	<b>Potential learnings</b>
Processes	*Delay decision making *Separate value-added from waste *Better identify and communicate the needs of internal customers *Standardise people skill-sets
People	*CE type solutions for integrating NPD processes *Consider company driven career path planning *Improve communication with suppliers *Systematic continuous improvement
Tools & technologies	*Idolise technology less and strive for customer orientation and efficiency *Process data for individual needs *Use simple and visual communication

### 3.3.2 Potential learnings for small companies

Small companies should obtain ideas both directly from Toyota, and indirectly from top companies in their own field. Direct learnings from the TNPD include issues as summarised in Table 11.

The companies of this category could selectively adopt delayed decision-making, in order to reduce unnecessary changes in later product development. This can potentially save scarce resources of small companies. Also, a more thorough consideration over which activities do add value is critical for small companies, in order to rationalise costs. The interviews reveal that technological solutions are typically fixed as early as possible.

The interviews pointed out how small companies have invested in the efficiency of product development processes, sometimes even with the expense of functional expertise. The TNPD gives guidelines for balancing functional expertise and cross-functional integration.

Small ICT companies should develop the acquisition of support technologies towards pull-based philosophy by analysing the real needs of their processes and people, and when required through tailoring. The interviews indicate idolising latest technology over true needs.

**Table 11.** Summary of potential learnings for small companies

<b>Sub-category</b>	<b>Potential learnings</b>
Processes	*Deploy delayed decision-making selectively *Separate value-added from waste
People	*Pay more attention on developing functional expertise
Tools & technologies	*Pull-based technology acquisitions



### 3.3.3 Potential learnings for suppliers

Supplier type companies should obtain ideas directly from Toyota, and indirectly from both top companies in their own field, and from their advanced clients. Direct learnings from the TNPD include issues as summarised in Table 12.

Toyota highlights integration of suppliers and their customers into a common seamless process. Essential for suppliers is to fully integrate themselves into their clients' processes, in order to improve the overall efficiency of the supply chain. For more complicated supply chains, Toyota can provide learnings for suppliers how to integrate their own suppliers.

Often, assignments for suppliers are received over-the-wall, through a product manager, without broader integration of a larger number of people in these discussions. Physical presence of employees of both parties in proximity, and functional communication are issues that deserve also supplier's attention.

Supplier companies should develop the acquisition of support technologies towards pull-based philosophy by analysing the real needs of their own and their customers' processes and people. The interviewees indicate that this aspect is under-addressed.

The interviews highlighted the communication between suppliers and their clients being a challenge, making simplifying and visualising communication a potential learning from TNPD.

**Table 12.** Summary of potential learnings for suppliers

<b>Sub-category</b>	<b>Potential learnings</b>
Processes	*Aim to integrate into clients' processes
People	*Improve communication to/from customers
Tools & technologies	*Adopt pull-based technology acquisitions *Use simple and visual communication

## 4 Conclusions

Benchmarking other companies and business sectors is often used by companies to gain new ideas from outside. This study utilises TNPD as an analysis tool for obtaining fresh improvement ideas for product innovation process in ICT companies. This study aims to facilitate learning and provide development ideas for three different company types: large, small, and suppliers.

The results indicate the largest, and most advanced, companies typically applying similar principles to TNPD, more than their suppliers, and smaller ones. However, in all the interviewed companies some principles similar to Toyota can be identified. Regardless of large companies utilising practices similar to TNPD the most, this study indicates that they still have room to learn from more from Toyota. Large companies require higher level of structures, and are used to this, therefore, models such as TNPD suit their management mindset. Smaller companies requiring less bureaucracy, as well as suppliers, can utilise learnings from TNPD to some extent, however, they should also consider indirect benchmarking through analysing top companies in their own field, and possibly also their main clients.

This study highlights how ICT companies can benefit from Toyota's learnings. TNPD being well documented in the literature is a benefit for benchmarking purposes. Toyota is a credible example for managers in different sectors due to its well known business

success, making high quality products, cheaper than its competitors, and more importantly because of its profitability.

Potential considerations for ICT companies include development of several parallel alternatives, the role similar to Toyota's chief engineer for managing NPD, rigorous standardisation including people skill-set standardisation, and company driven competence development. Smaller companies, having limited resources, should only consider parallel options and delayed decision-making with critical technologies. TNPD, also gives good examples for supplier integration from both, supplier's and client's perspectives. Simple visual communication is an example that all the company types can learn from TNPD.

The goal of this study is to find new ideas for different type ICT companies for improving their product development. Although, TNPD fits Toyota, it is unrealistic for other companies to follow this model precisely, as there are differences among business sectors: in product price level, price erosion, sector's clock-speed, and so on. As one of the interviewees stated, "*product life-cycle in ICT is about 10 % of that of the automotive industry*". Cultural differences may also complicate a straightforward utilisation of TNPD outside Japan. This study is qualitative by nature and its intention is not to make an all-inclusive list on recommended action. Although, the participating companies are analysed by interviewing several people per company, conducting a more comprehensive analysis might give slightly different results.

Areas for further study include a more detailed analysis of the best performing ICT companies. This allows smaller ICT companies to learn from own business sector's representatives on applying the lucrative aspects of TNPD. Design for excellence is a topical issue among product development managers within ICT to better address the needs of internal customers. It would be interesting to study how TNPD practices and design for excellence interrelate. In addition, an interesting aspect for further study is how Toyota, with its rapid and efficient NPD, addresses environmental issues.

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