Received on September 23, 2016 / **Approved on** December 28, 2017
Responsible Editor: Leonel Cezar Rodrigues, Ph.D.
Evaluation Process: Double Blind Review
E-ISSN: 2318-9975

doi> https://doi.org/10.5585/iji.v6i1.198

SUCCESS FACTORS OF RADICAL BREAKTHGROUGH ICT PROJECTS – COMPARISON OF HARDWARE AND SOFTWARE CASES

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ABSTRACT

Because technology pushed product development projects are risky and failure rates are high, the success factors are valuable knowledge for the management of development-intensive firms. This paper provides a comparison of success factor weighting between hardware and software product development projects in the ICT industry improving existing success factor research. We analyze qualitatively interview data from nine intentionally selected start-up firms and identify which success factors were clearly supported by HW and SW firms, and in which area different types of firms could benchmark each other. The practical aim of this paper is that it helps management to recognize the real actions needed to reduce product development risks in HW and SW projects.

Keywords: New Product Development; NPD; Technology Push; Radical Innovation; Success Factor; Content Analysis; Quantification

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FACTORES DE ÉXITO DEL ASCENSO RADICAL DE LOS PROYECTOS DE ICT – COMPARACIÓN DE CASOS DE HARDWARE Y SOFTWARE

ABSTRACTO

Debido a que la tecnología impulsa proyectos de desarrollo de productos, éstos son arriesgados y las tazas de fracaso son altas. Los factores de éxito son un valioso conocimiento para la gestión de empresas de desarrollo intensivas. Este estudio proporciona una comparación del peso del factor de éxito entre los proyectos de desarrollo de productos de hardware y software en la industria de ICT(industria de la tecnología de la información y de las comunicaciones), mejorando la investigación sobre los factores de éxito existentes. Analiza cualitativamente los datos de las entrevistas de nueve empresas de nueva creación seleccionadas intencionalmente e identifica cuáles factores de éxito fueron claramente respaldados por las firmas de HW y SW y en cuál área los diferentes tipos de empresas podrían compararse entre si. El objetivo práctico de este estudio es que ayude a la gerencia/administración a reconocer las acciones reales necesarias para reducir el factor de riesgo en el desarrollo de productos en los projectos de HW y SW.

***Palabras clave**:* Desarrollo de nuevos productos, NPD, impulso de tecnología, innovación radical, factor de éxito, análisis de contenido, cuantificación

Cite it like this:

Sarja, J. (2018). Success Factors Of Radical Breakthgrough ICT Projects – Comparison Of Hardware And Software Cases. *International Journal of Innovation, 6*(1), 40-53. http://dx.doi.org/10.5585/iji.v6i1.198

INTRODUCTION

The main task for most development-intensive firms is to create, develop and commercialize new products and services. However, this is not an easy task. New product development (NPD) being the backbone of many industries, it is evident that it is of considerable interest to multisectoral research. The quantity of NPD research during recent decades has been tremendous (e.g. Balachandra & Friar, 1997; Ernst, 2002) and this research has, almost without exception, been aimed to identify the success factors of new products. The impulse for the development of a new product comes either from customer needs (*market pull* concept) or from internal or external research (*technology push* concept).

According to the concept of market pull (MP), market demand is the main driver of innovation. The concept of technology push (TP) suggests instead that the driver for innovation is internal or external research and that the target is to develop new technology or combination of technologies for commercial purposes. The TP-MP debate has evolved over the time. Today it is not so much a question of which one is the right approach, but rather what kind of end products we want to design. The TP strategy dominates radical innovation and MP dominates incremental innovation (Herstatt & Lettl, 2004). Regardless of the innovation type the product development process should be similar (Ulrich & Eppinger, 2008; Sarja, 2016).

Innovation is generally defined as a new technology, a combination of new technologies, or old technologies used for new purposes, that offer valuable benefits to the users. The difference between radical and incremental innovation is the degree of novelty. Radical innovation involves the development of remarkable new technologies or market ideas previously unknown or that require considerable changes to what currently exists in the market. Incremental innovation is an extension of current products or existing processes (e.g. McDermott & O'Connor, 2002).

Although the definition of radical innovation varies in the literature (e.g. McDermott & O'Connor, 2002), one measurable definition by Green et al. (1995) defines four dimensions: technological uncertainty, technical inexperience, business inexperience and technology cost. Many researchers have also added change dimensions to the definition of the radical innovation: the change of customer behavior (e.g. Samli & Weber, 2000) and the change of the existing market (e.g. McDermott & O'Connor, 2002). If these characteristics are collated, it is obvious that the development of radical projects has higher risks but also higher profit (e.g. Christensen, 1997) and life cycle expectations (Samli & Weber, 2000).

Because in the case of TP projects development processes are risky and failure rates are high, the success factors are valuable knowledge for the management of development-intensive firms. For the concept of success factor we have used a following definition by Rockart (1979):

"In general, [critical] success factors are defined to mean the limited number of elements or areas where "things must go right" for the business to flourish. These areas of activities must be constantly and carefully monitored by management, and they are necessary in order for an organization or project to achieve the end points that they try to reach."

Sarja (2014; 2015; 2015b; 2016; Sarja et al., 2017) has defined a handful of success factors of TP projects to appear to have been essential to the effective innovation management in ICT industry. In total 12 success factors emerged in a broad literature review (Sarja, 2014; 2015; 2015b) and three more emerged during empirical testing (Sarja, 2016; Sarja et al.,2017). The 15 factors found were grouped for four different categories: market-, product-, management- and organization [related] (e.g. Sarja, 2016, pp. 54), and they are represented in table 1. Based on a data collected in mentioned studies we examined whether the success factors differ between hardware (HW) and software (SW) projects or

not, or is some particular success factor more important to one or the other type of ICT project.

The practical aim of this paper is that it could help firm or project management to recognize the real actions needed to reduce [new] product development risks. The study will show to the management if the success factors are weighted differently in HW and SW projects. Theoretical aim of this paper is for one's part deepen the understanding the success factors of innovations in ICT scene (Sarja, 2014; 2015; 2015b; 2016; Sarja et al. 2017) by distinguishing different product types.

We discuss about the topic by proceeding as follows. We first discuss how we handled the data by introducing the used methodology. Secondly, we introduce the quantified results. Then, we discuss about the results and the limitations of the study, and finally we shortly conclude the study.

Table 1. TP success factors (adopted from Sarja, 2016).

Market-related	Product-related	Management-related	Organisation-related
MP methods used	TP for difficult adopted	Management support	Project team skills
Focus on customer needs	Life cycle	Degree of funding	Networking
Market development	Technological advantages	Visibility	
Alternative study	Scalability	Timing	
Adoption time and technophobia			

METHODS

The comparison between HW and SW cases has implemented by analyzing existing categorized interview data from previous case study by Sarja (2016). He was interviewed nine ICT start-up entrepreneurs, typically an inventors and founders of their businesses (called *informants* in further text). According the case study principles, the case selection was done intentionally (Eisenhardt, 1989; Runeson & Höst, 2009), and the requirements for the selection were that the firm has developed a technology push product and it has an evidence of commercial success (Sarja, 2016). The interviews were recorded and the results were transliterated and thematically organized.

In his original study Sarja (2016) processed case firms as one broad ICT category. It was discussed in semi-structured interviews with informants about the success factors and whether they were used them or not. In this paper we distinguish the informants for two groups based on the product of their firms, the HW and SW groups. We re-examined the audio and written (transliterated) data using the deductive [qualitative] content analysis approach (e.g. Sandelowski, 1995; Elo & Kyngäs, 2007). The qualitative content analysis is a general method for analyzing written, verbal or visual contents (e.g. Tuomi & Sarajärvi, 2003). The content analysis method may be used in an inductive or deductive way. A deductive approach is used when the structure of analysis is based on previous knowledge or earlier model (Elo & Kyngäs, 2007), like in our case. In the re-examination we counted from the data how many times the case firms were used the defined (Sarja, 2016) success factors. The original interview questions (Sarja, 2014; Sarja et al., 2017) were well structured and the answers were easy to find without the need for analyzing *the latent content* (Graneheim & Lundman, 2003). The unit of analysis can be a letter, word, portion of pages or words etc. (Elo & Kyngäs, 2007), or like in our case, the sentence(s). Based on informant's answer, we coded the sentences either as "yes" or "no", depending if the discussed success factor was used in practice in particular case or not. Fig. 1 provides graphical illustration of coding process as an example.

Finally, we quantified the coded answers of HW and SW cases. Quantification (or quantitizing) is a process of coding and analyzing qualitative data quantitatively (Polit & Beck, 2004), and potential continuation process for data categorizing. In that case it will be counted how many times same things occur in the collected data, and how many informants express the same thing (Burns & Grove, 1997; Tuomi & Sarajärvi, 2003; Polit & Beck, 2004). Quantified qualitative analysis can be seen a softer option comparing to quantitative methods (Eskola & Suoranta, 2008) and in our case it is sufficient approach to explain researched cases. As a result, we gained a calculation of "yes" and "no" attributes, percentage values of "yes" attributes and graphs in individual success factor level (see figures 2-16 in chapter 3). In this study we are interested only in "yes" attributes and we interpreted qualitatively the strength of the success factors as per them in HW and SW cases.

It is notable, that the same numbers of "yes" coded answers (columns yes/performed in a table in fig. 1) give a different weight (percentage value) because the number of HW cases (5) and SW cases (4) are not the same either. Another consideration is that all weights are represented in success factor theme level, not in interview question level. The weight of the success factor is calculated from the individual interview questions at issue.

Figure 1. Screen capture of the coding table, interview questions 2-11 (some questions, for example question 1, are off from the coding because they are not linked to the success factors in question).

Question	Key factor	Type	Yes	No	Performed	Percentage
2	Mpmethod	HW	2	3		
3	Mpmethod	HW	2	3		
4	Mpmethod	HW	4	1		
5	Mpmethod	HW	5	0	13	65
2	Mpmethod	SW	2	2		
3	Mpmethod	SW	4	0		
4	Mpmethod	SW	3	1		
5	Mpmethod	SW	4	0	13	81
6	FocusCust	HW	4	1		
7	FocusCust	HW	4	1		
8	FocusCust	HW	5	0		
9	FocusCust	HW	5	0		
10	FocusCust	HW	4	1		
11	FocusCust	HW	1	4	23	77
6	FocusCust	SW	4	0		
7	FocusCust	SW	4	0		
8	FocusCust	SW	4	0		
9	FocusCust	SW	4	0		
10	FocusCust	SW	4	0		
11	FocusCust	SW	4	0	24	100

RESULTS

As mentioned, Sarja (2016) have validated the success factors of technology push projects in the ICT industry. The detailed descriptions of the factors are represented in Sarja's research paper (2015b), and short descriptions in the beginning of each comparison below. In this paper, we concentrate to interpret the weight difference of the success factors between HW and SW cases based on the same data than original study.

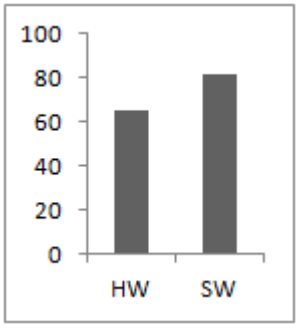
Market related success factors

The success factor *MP methods used* emphasizes that the customer involvement should be an early part of the development process (Ulrich &Eppinger, 2008; Sarja 2016) regardless of the type of innovative new product, MP or TP. Customer involvement activities were discussed with the informants, defining if the

technology-market match was implemented with the customer, if the marketing sector (person or organization) was a part of the development team and process, and if the customer was contacted and involved before and during the development process.

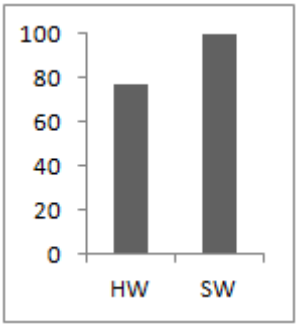
In this study case, the SW cases were more focused on customer involvement activities than HW cases (fig. 2). This was the case, regardless that none of the studied SW cases were not producing a tailored software products. Instead, they developed commercial technology pushed applications. It seems, that the customer involvement activities are slightly more natural approach with SW cases than with HW cases, but recognized also as an important issue in HW cases. Based on the informant's remarks, the minor gap is due to the fact that the SW firms started the customer involvement actions typically in the beginning or even before the development process. All HW firms also started the customer involvement, but in later phase of the development processes. This could be a valuable target for development also for HW firms.

Figure 2. *MP methods used* factor, HW and SW cases



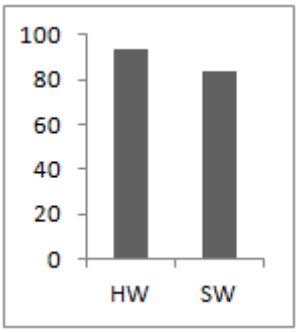
Factor *focus on customer needs* means firm's ability to identify the customer needs in the beginning of the development process (Sarja, 2015b). As a working process it means collecting data from the customers, interpreting it, organizing it in hierarchical order with importance weightings, acting accordingly (Kotler & Armstrong, 1987), and keeping related documents up to date. This process was implemented a hundred per cent in SW cases and almost completely in HW cases. The difference was mainly due to the implementation and updating the documentation, which gives a room for development in HW cases.

Figure 3. *Focus on customer needs* factor, HW and SW cases



Market development is a process of the firm's attempt to identify and develop new markets for its products. In a new product development process this can be done, simplifying, by developing new products for existing markets or new products for new markets (see Sarja, 2015b). In this case both HW and SW firms were defined the target market in sharply way. The difference comes from the iteration of the process. This is explained by the fact that it is typical for the development process of the radical physical item that the target customer can change during the development time. This was also a case in almost every HW cases in this study, but not with SW cases. Because the target customer of the SW firms were the same from the beginning to the end of the development process the redefinition was not needed, and that caused a difference in graph (see fig. 4).

Figure 4. *Market development* factor, HW and SW cases



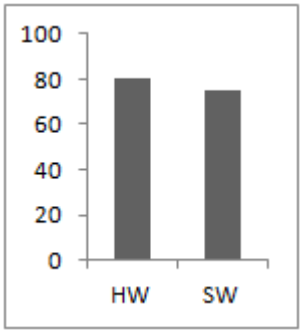
Alternative study regards a sub-process in the concept development phase of the development process that is similar to customer need identification and market development

processes. Time-wise these three sub-processes will be actualized simultaneously (Ulrich & Eppinger, 2008; Sarja, 2015b). It is a broader process than just competitor analysis. The management is encouraged to study business and growth opportunities more broadly (Peteraf & Bergen, 2003), not only in terms of product types but in terms customer needs to be served (Lewitt, 1960). In the other words, beside the competitors with the competing solutions, also technologically different alternative solutions have to be recognized.

The implementation of alternative study process resembles the implementation of previous sub-processes; Both HW and SW firms have performed alternative study conscientiously in the beginning of the development process, but the redefining during the process has not be considered so important. In this instance the HW firms have been more active.

The importance of the redefining or iterating the alternative study may depend on the length of the development process and development of new technologies during the project period.

Figure 5. *Alternative study* factor, HW and SW cases

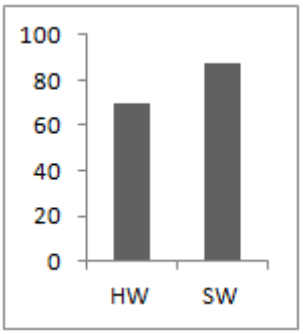


The two concepts, *adoption time* and *technophobia*, have a clear linkage in the field of NPD research, particularly in a case of technology push products. Adoption time means time period when the consumer adopts new products or ideas (Sarja, 2015b).

The more dramatic a new product is, the longer the adoption time (e.g. Samli & Weber, 2000). Research communities (e.g. Davis, 1989; Brosnan, 1998) emphasize a commercial motivation for continued user-friendliness in HW and SW products due to an attempt to appeal to technophobes. According to different acceptance models users must feel that the application is useful and easy to use (for example TAM model by Davis (1989) and its extensions). Both HW and SW firms took into account the usefulness and ease of use aspects in their products. The inadequacy of the process was mainly due to defective activities to shorten user's adoption time by other explicit actions in development process. However, SW firms were slightly better in this.

Lessons learned for both type of companies is that shortening adoption time and even technophobia have to be taken account already in the beginning product development process.

Figure 6. *Adoption time, technophobia* factor, HW and SW cases



Product related success factors

The success factor *TP for difficult adopted* is an adoption time domain from the developer's perspective, in contrast to *adoption time* factor which was defined from the user's perspective.

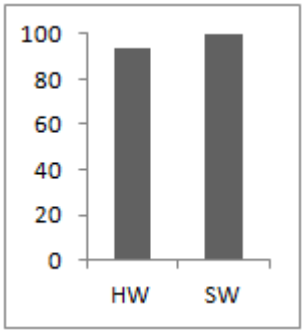
The longer the expected adoption time, the longer commitment is required, especially in terms of resource planning. The object of this factor is to reduce the risk of the TP projects (Sarja, 2015b).

In both HW and SW cases, the firm's management was fully committed to the project and adequate resources were ensured.

The small deficiency in HW side was due to that one firm was not realized the time gap between market entry and mass sales but in practice this factor was fully supported by both

cases in terms of management commitment and resource ensuring.

Figure 7. *TP for difficult to adopted* factor, HW and SW cases

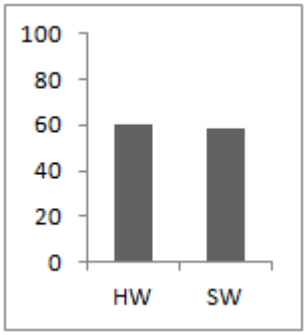


Product *life cycle* planning means economic planning from an idea until the end of a product's life. In this study product life cycle means total product existence from product development (Sarja, 2015b) to material sourcing, manufacturing steps, usage and, finally discarding or recycling (Tseng & Chen, 2004).

Both HW and SW firms stated that, as a rule, they have taken into account the product's life cycle into account during the development process. However, more detailed discussion proved that both economic and personnel planning were actualized rather as part of firm's standard practice instead of life cycle planning.

There was no significant difference between HW and SW companies in this activity. As a development proposal we suggest planning activities also based on the expected life cycle of the developed product apart from regular economic planning.

Figure 8. *Life cycle* factor, HW and SW cases

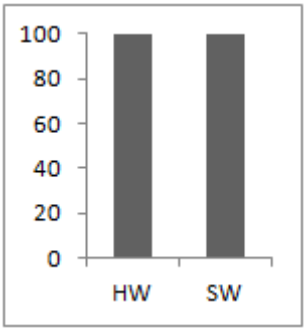


Technological advantage factor means firm's ability to develop technology pushed products instead of just incremental versions of the current products (Samli & Weber, 2000). At project level or product level it means the overall benefits of a product compared to other similar products in a market which has been designed on the basis of technology (Sarja, 2015b). When talking about this factor surfaced explicitly the entrepreneur's strong belief to their workings.

All informants, representing both HW and SW cases, were able to enthusiastic and descriptive conversation about the project's technological ability, as well as benefits of the product based on the technological solutions. Recurring aspects about the team member's ability in different fields of know-how, technology choices and combinations, and available tools were discussed at a detailed level.

We can conclude that ensuring technological advantage is remarkably important function for both HW and SW development projects when it comes to market entry.

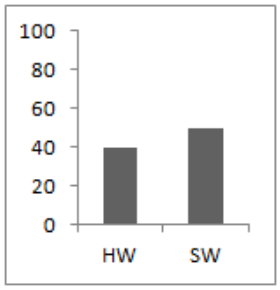
Figure 9. *Technological advantage* factor, HW and SW cases



Scalability is one out of three success factors (the others are *visibility* and *timing*) which did not arose in Sarja's (2014; 2015) literature review but in empirical study phase (2016, 2017). Half of the informants discussed about the necessity of the scalability, especially in the case of consumer products.

It was also noted that a scalable product will solve the problem of many different customers. There is not remarkable difference between HW and SW firms when developing scalability of the product, and it can be seen weighty success factor from customer, productivity and extension perspectives.

Figure 10. *Scalability* factor, HW and SW cases

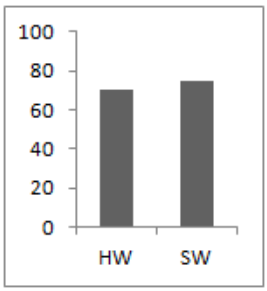


Management related success factors

Management support, in this context, means ensuring adequate financial and human resources for development project to generating breakthrough products (Samli & Weber, 2000; Ernst, 2002; Sarja 2015b). It is not surprise in a start-up field that informants were not fully contented when talking about resources but they were not completely dissatisfied either. Informants in both HW and SW firms were in same level (see fig. 11) but interestingly the coded weight formed differently. Determining the management support in their firms, the SW informants mentioned the resource, time, and continuity of operations ensuring a hundred per cent. Instead, almost half of the HW informants mentioned some vague immeasurable aspects which are irrelevant in this context.

Nevertheless, nearly all informants in HW cases were contented about the available resources. It has required adjustment and prioritization from the firms but the spirit has rather been like "the more you have, the more you spend. We did this with what we had!" Contrary to that, half of the SW firms complained about a shortage of resources.

Figure 11. *Management support* factor, HW and SW cases

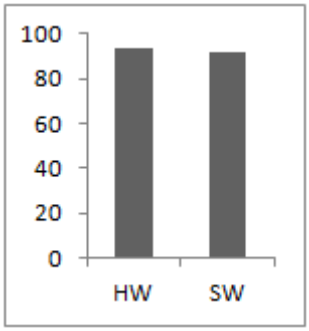


The *degree of funding* is a significant part of firm's NPD strategy. Adequate funding and personnel must be at their command and it must be maintained during the development project for carrying out the research and development process (Samli & Weber, 2000). Firms must prioritize the most important projects in terms of the success of the firm that are realizable with adequate resources (Ulrich & Eppinger, 2008). When implementing this thought there was no difference between SW and HW firms.

The data we used may not give a completely relevant picture of the factor's realization. Start-up cases, with the all-time scarcity, are forced to collect, plan and monitor money situation throughout the project.

Another weakness in interpreting this data in connection with this factor is that the researched start-ups had only one product program. However, the majority of informants were able to tell about the product feature prioritization inside the project.

Figure 12. *Degree of funding* factor, HW and SW cases

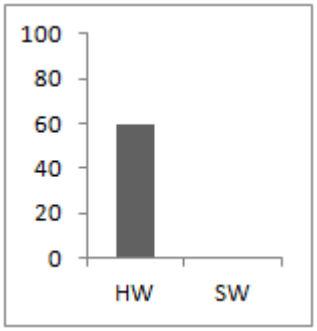


In this context, *visibility* means that the firms started to publicize and pre-sell products already in development phase.

The characteristic of visibility helped firms to create a kind of phenomenon around the solution and thereby in cash flow and funding negotiations (Sarja, 2016). It seems that the visibility success factor is significantly more important to HW products than to software.

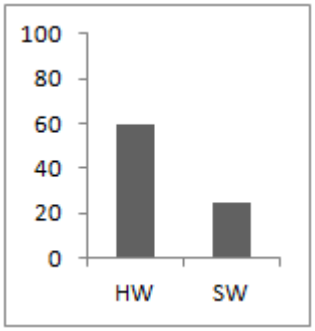
More than half of the informants of the HW firms explained that they utilized the visibility for pushing the awareness and market entry. Instead, none of the SW firms did the same.

Figure 13. *Visibility* factor, HW and SW cases



Timing refers here to the occasion of the market entry from a technology and product maturity point of view. The technology in use should be ready enough for commercial solutions, but a rough version of the product is enough for the market entry. Approximately half of the informants were seen successful timing as a success factor and performed accordingly. However, in this case it seems that timing is much more important to the HW firms.

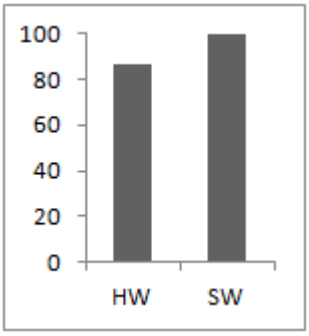
Figure 14. *Timing* factor, HW and SW cases



Organization related success factors

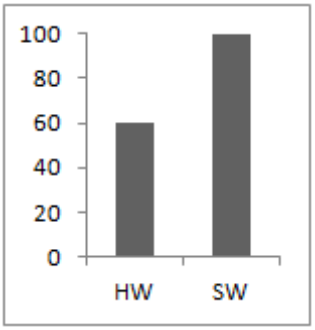
Sarja (2015) describes *project team skills* with six characteristics: training, experience, commitment, expertise, motivation and ability. In team level, skills are the consequence of cross-functional teams. Cross-functionality has been found systematically to be a success factor in NPD field (e.g. Cooper & Kleinschmidt, 1995). When discussing about the project team skills factor and each of its sub-characteristics, all informants highlighted their team's experience, commitment, motivation and ability to develop new products. In practice, there is no difference between HW and SW cases in that. The small gap ensued because one of the HW firms had started and run long time as a one-man firm, and according to informant, the cross-functionality did not fulfilled during that time. Both related literature and the data in question indicate that the project team skills and cross-functionality are essential and industry independent success factor for all development-intensive firms.

Figure 15. *Project team skills* factor, HW and SW cases



As a business function, *networking* is already an old concept and it is a self-evident truth for today's firms. The main task of networking is to consolidate in-house know how and resources, but also risk and cost sharing, access to new technologies and markets, and attempt to shorten development time (Ledwith & Coughlan, 2005). All SW firms were networked with other firms, research institutes [via research projects] and academies, but just a little over half of HW firms have operated alike. In common with, the informants of non-networked firms were not able to describe what benefits they would achieve or how would they choose the network partners. It can be concluded, that networking is more characteristic for SW firms than for HW firms.

Figure 16. *Networking* factor, HW and SW cases



DISCUSSION

The 15 success factors defined by Sarja (2016) were grouped for four categories: market-, product-, management- and organization related (table 1). The differences of the success factors supported by the studied ICT firms (HW firms and SW firms) were relatively slight. All success factors except one were supported by both types of ICT firms. The exception was a factor *visibility*, which gives an impression that it is not a significant factor in software industry.

As concluded, the product development process should be the same regardless whether the developed product is technology pushed or market pulled (Ulrich & Eppinger, 2008; Sarja, 2016). It can be said that all these studied firms have taken the market related success factors seriously, even though there is a room for deepen the processes. This investment reminds us that all studied firms have had successful market entry. Based on the quantified and weighted results we can deduced, that HW firms are slightly ahead in market creation (*market development*, *alternative study*), and SW firms in customer involvement operations in individual level (*MP methods used*, *focus on customer needs*, *adoption time/technophobia*). We see that it would be fruitful for both types of firms to benchmark the areas where the other types are performing in a more effective way.

When discussing about the product related success factors (*TP for difficult to adopted*, *life cycle*, *technological advantages*, *scalability*), the differences between HW and SW firms are non-existent. To interpret minor differences is impossible in such a small sampling. From a practical point of view it could be profitable for the firms to deepen knowledge of the life cycle planning and scalability issues.

Both HW and SW firms are equal in resource assurance point of view (*management support*, *degree of funding*). Instead, with other management related factors, *visibility* and *timing*, HW firms are explicitly ahead. The difference with these success factors is probably due to the fact, that all studied SW firms act in business-to-business (B2B) field, even the end user can also be a private consumer, and most of the HW firms developed the consumer products. Therefore, the factors *visibility* and *timing* must be treated differently. This also leads to the fact, that we cannot draw even preliminary conclusions in accordance with case study principles about the *visibility* and *timing* factors. As a conclusion about the management related success factors we can be said that both types of firms could benchmark successful firms in the market about the *visibility* and *timing* aspects.

Both types of firms were filled with the experienced, committed, motivated and capable people (*project team skills*), and the SW firms appear to be ahead in outside cooperation (*networking*). With organization related success factors, *networking* can be worth benchmarking for HW companies when needed, but naturally it is not an end in itself.

Validity and limitations

For discussing the validity and reliability of this paper we apply the three test approach by Yin (2009). These three tests are called *construct validity*, *external validity* and *reliability*. The fourth test, *internal validity*, is only concerned with explanatory case studies that have causality (how/why event x leads to event y) aspects. This logic is inapplicable to descriptive or exploratory studies (Yin, 2009; Runeson & Höst, 2009). Since we are describing a phenomenon without causality by using existing data from a previous exploratory case study, an *internal validity* test is not valid in this study.

Three strategies for improving *construct validity* consist of using multiple sources of evidence, establishing a chain of evidence and having key informants review the case study reports. Employing multiple sources of evidence improve the construct validity by providing multiple descriptions of the same phenomenon (Yin, 2009). Since the used data is based on the former multiple-case study, therefore the strategy materializes. The principle of the establishing a chain of evidence tactic is to allow a reader to follow the derivation of evidence from the initial research question(s) to the conclusions and vice versa, from conclusions to research question(s) (Sarja, 2016). This was implemented in original research (Sarja, 2016, Sarja et al., 2017)

by archiving all recorded interviews and transcription documents by the authors. As previously explained, this study was based on the data of the mentioned previous research, and therefore the informant's reviews were inapplicable in this further study.

External validity test deals with the thought whether the results are generalisable to other cases. In the original study, the author (Sarja, 2016) justified the results partly generalisable. We see that this further study gives a fair idea about the differences of the utilization of the success factors between HW and SW firms. The findings are valid within these particular cases, but we found some limitations that constrain the generalization. A more detailed study would require a larger number of cases, and they should represent more nationalities. In addition to that, more types of firms would be required for the generalization. For instance, as previously explained, none of SW firms represented pure consumer product development firm. These presented facts should be taken into account in the future studies in pursuit of better generalization.

The objective of the *reliability* test is to minimize errors and biases and ensure that if other researcher follows the same procedures with the same cases, they should arrive at the same results and conclusions. Following the same research documentation (see *construct validity*), the other researcher would achieve the same results and same conclusions with these particular cases.

CONCLUSION

This study complements the existing knowledge about the success factors in ICT industry. This accomplished by separating HW and SW companies into their own groups and by re-analyzing data from previous research (Sarja 2016; Sarja et al., 2017), and by finding differences between HW and SW firms. In the original study it was discussed in semi-structured interviews with informants about the success factors and whether they were used them or not during their development processes. The re-analyzing implemented by coding, quantitizing and weighting the recorded and transliterated discussions with informants. As a result we pointed which factors were more clearly supported by HW and SW firms, and in which area different types of firms could benchmark each other. The practical aim of this paper is that it could help management to recognize the real actions needed to reduce product development risks. The study will show to the management if the success factors are weighted differently in HW and SW projects. Theoretical aim of this paper is for one's part deepen the understanding the success factors of innovations in ICT scene. The results need to interpret with a certain amount of caution because of emerged limitations. As a future study we propose to replicate the research with a broader number of cases representing different nationalities and business models.

ACKNOWLEDGEMENTS

The author would like to acknowledge Liikesivistysrahasto (The Foundation for Economic Education, Finland) for supporting this research.

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