

# What Concerns Game Developers?

A Study on Game Development Processes, Sustainability and Metrics

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**Abstract**— *It can be argued, that software development and game development share a number of features in their process models, such as the need to design, develop and test software functionalities. However, while the software engineering (SE) models work successfully supporting the software development, their practical application for game development is frequently unsuccessful. To understand this problem and number of other aspects such as Green IT and business models, we conducted a survey with the game industry organizations. Based on our observations on the SE practices, the game industry applies mostly the agile process models or nothing at all, their major concerns for business were mobile development, digital marketing, employees with specific abilities and keeping innovation in their business, and their minor concerns were eco-impact elements, software reusability and financing. Based on our results, we identified areas which would warrant more studies to support the game industry practices, eco-aspects and business.*

**Keywords;** *software engineering; games as software; process models; marketing; game business; sustainability; quantitative study.*

## I. INTRODUCTION

There are similarities between the practices of software developers and game developers, such as the need to design, develop and conduct quality assurance work on the item-in-development. In a larger context, the similar needs to develop products within the budget and the schedule with the intended features and the required quality, is more or less the same between these two industries.

However, there are studies (Kasurinen et al. 2014, Murphy-Hill, Zimmermann and Nagappan 2014), which indicate that there are fundamental differences, especially when considering objectives of the item-in-development, target audiences and sources of information. Software products usually are developed to solve a problem or provide a service, whereas games are a form of entertainment, with no inherit value or usefulness beyond the scope of providing user experience (Dymek 2008).

In addition, the game development processes usually involve a highly iterative creative process, as the user requirements are rarely provided (Langer 2008). Because of aspects such as product design having trouble identifying the actual needs of the users late changes are needed, even in the last stages of development. This means that the entire product

design may change on the late stages of development (Kasurinen et al. 2014), or at least there will be several new requirements being introduced into the product while development is being done at the same time (Petrillo, Pimenta and Trindade 2008). All these activities are aspects, which would indicate that the games industry should apply agile process models in large numbers, since the traditional plan-driven process models do not facilitate these types of requirements.

To understand how game developers function, our research group conducted a quantitative study with the professional game developers to map their concerns over the different aspects of product development, important metrics and business management. The overall research objective of the study was to find out “*What are the main product development trends among the game developers?*”. This was further detailed in the following sub-questions: “*What are the characteristics of the game development processes?*”, “*How the game developers market their products?*” and “*How concerned are the game developers about sustainability and Green IT aspects?*”.

Our aim was to collect information on how game development is done, what aspects drive game development decision-making processes, and how, for example, decision to migrate product from one platform to another is done. Our data collection was conducted as a survey with the game development professionals from the development roles such as the game designers, programmers, artists and company owners. The survey collected 33 responses from various countries in four continents. In addition to the survey, we also conducted a qualitative study with 34 interviews with the software development professionals, but due to size restrictions, this data is not discussed in this manuscript. The results published from the qualitative data can be found for example in these (Kasurinen et al. 2014, Vanhala and Kasurinen 2014) publications.

Rest of the work is structured so that the Section 2 discusses the research work related to our study and the Section 3 introduces the applied data analysis methods. The results and collected data is introduced in the Section 4, and the implications of these results are further analyzed in the Section 5. Finally, the Section 6 closes the paper with the conclusions.

## II. RELATED RESEARCH

Video games industry is considered one of the fastest-growing areas of the international media sector (Bilton 2011), establishing itself as a significant contributor to the global entertainment economy (Marchand and Thorsten 2013). Video games industry has also become a significant part of the modern software development, with revenues three times higher than software retail in 2012 (Nayak 2013). Games have become not only a form of entertainment and social interaction for all ages and genders, but also a medium to train students, soldiers and medical professionals (Murphy-Hill, Zimmermann and Nagappan 2014).

Traditionally the game industry value chain has main five components (Hiltunen and Latva, 2011). The first component are the developers who represent the talent layer designing and developing games, and the second component are the publishers who are responsible for licensing the rights and the concept on which the game is to be based. The third component are the distributors who are in charge of marketing the game, handling packaging and transport and in some cases providing user support. Fourth are the retailers that commercialize games, such as counter trading, net trading (via downloads or post mail) and online gaming (example browser-based games), while the last fifth component are the end users (or consumers or customers or gamers) who buy and play the games (Tomaselli, Di Serio and de Oliveira 2008).

However, when the digital distribution and online elements are involved, this value chain is reduced to three components: 1) Developers, 2) Distributors (whom also act as retailers) and 3) Consumers. Due to the high volume of new products, the online value chain might also have a separate component called 4) Marketer, who mediates between the Developer and Distributor, generating sales, marketing visibility and revenue for a share of the profit. These business logistics are illustrated in Figure 1.

In the game business, there are several platforms such as the PC, dedicated game consoles and lately, the mobile platforms. This has introduced a way of development and business practices, where the game is developed for some platforms in the first release, and then migrated to the others

Table 1: Game's issues detailed by (Murphy-Hill, Zimmermann and Nagappan 2014)

Games Issues
"Architectural debt" from a poor design phase, which affects the lifespan of the game
Undisclosed details about how agile process integrate specific software engineering practices
High number of code parts which are thrown away instead of being reused
Maintenance delay for non-cloud games (the game is only maintained if it is successful)
Development physically demanding characterized by long hours work
Suboptimal effects from games testing such as motion sickness

if there is an indication of marketing potential. In some occasions, this migration process requires revisions for the product; for example when migrating from a game console to any mobile system, the input management requires redesign to allow usability with a touch screen (Bandelloni and Paternò, 2004).

In any case, there are essential differences between the game development and software development as detailed by (Murphy-Hill, Zimmermann and Nagappan 2014). Their study identifies at least the following aspects: 1) a lack of strict functional requirements, 2) a small design phase based on experience, expertise and emotions, 3) less automated testing processes, 4) delayed modules' maintenance (for non-cloud games) and 5) highly evolved configuration management techniques (due to high number of assets). As a result, the game development work is often unpredictable and highly iterative, which makes the agile methodologies seem suitable models for adoption. Similar observations has also been made for example by (Kultima and Alha 2009).

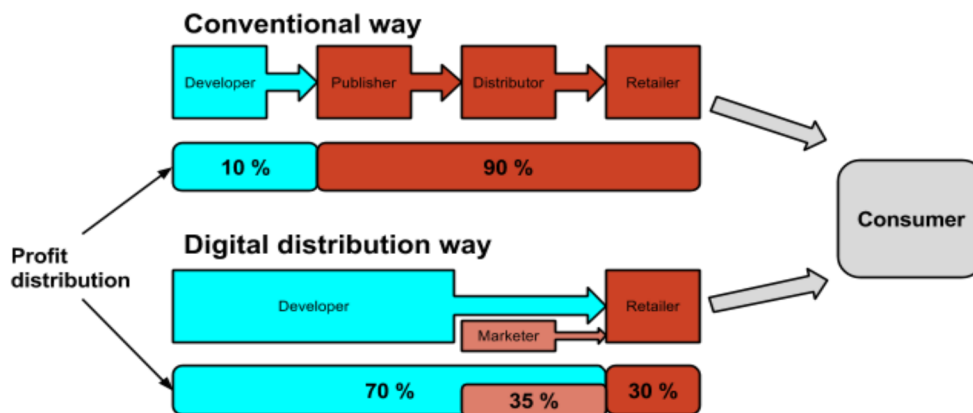


Figure 1. Business logistics of a game in traditional and digital distribution ways (adapted from Hiltunen and Latva, 2011).

In the software development in general, the games are becoming progressively influential area of industry, because of their growing impact and global revenues. Despite their rise in importance, there is a gap in models and methodologies that support game development from the software engineering perspective (Ampatzoglou & Stamelos 2010, Kasurinen et al. 2014). Considering this, it seems that the 1) SE methods have been strictly developed and framed for software development, and that 2) to train game developers, educators and companies should focus on the game industry-related creative skills along with the engineering skills (Murphy-Hill, Zimmermann and Nagappan 2014). In addition, green IT and sustainability in the industry (The Climate Group 2008) is another aspect which traditional SE do not support (Penzenstadler 2013).

By instance, the following four sustainability principles could address and improve upon the common Green IT issues in the game development described in the Table 1: 1) a responsible use of ecological, human and financial resources, 2) a continuous monitoring of quality and knowledge management, 3) using Green IT principles and sustainable produced hardware components and 4) having a responsible impact in society, economy and ecology. As of now, there isn't a specific body of knowledge of sustainability in the software engineering which can provide specific guidance to fulfil all sustainability aspects from a development perspective. However, common research areas such as green IT, efficient algorithms, code recycling, smart grids, agile practices and knowledge management could be effectively used to improve on the sustainability aspects (Penzenstadler 2012).

### III. RESEARCH METHODOLOGY

Our research methodology involved a quantitative survey, which was conducted during spring 2014 - winter 2015. The aim of this approach was to fortify or challenge the previous discoveries of our research work, and assess the topics such as development processes and business aspects in more detail. In this paper, the findings are based on survey data. The interview data itself is published separately, for example in paper (Vanhala and Kasurinen 2014). All of the data collection instruments for both the qualitative and quantitative parts can be found at our website (<http://www2.it.lut.fi/GRIP/>).

#### A. Protocol

We created a ten-minute self-administered structured online survey with twenty multiple choice and data collection questions. The survey was translated and offered in three languages; English, Spanish and Portuguese. From 33 answers, 29 was collected with the English form and 4 with the Spanish. The Portuguese form was opened several times, but no answers were submitted via the Portuguese form. Structurally, the survey form was divided to four main topics: Basic information, Green Aspects and Marketing, Game Business and Product Design and finally, Migration Process and Development Work. This design aimed to assess 1) the basic trends amongst the game developer organizations, 2) to categorize the relevance of the environmental and marketing aspects, 3) to classify the significant game business and

product design aspects and 4) to assess what drives the development migration work. The survey also collected demographic information on the submitting organizations to enable validity control over the collected results.

#### B. Participants

We contacted a random sample of game developer organizations with at least some experience on publishing games via social network sites, business contacts and prior research partners. Out of the 33 answers that we collected, the responses were distributed between the five different roles in the organizations: developer or tester (39%), artists (12%), project manager (21%), upper management (21%) and marketing, administration or other (6%). In addition the 73% of total answers have as source positions directly related to the game development phases such as technically-oriented, artistically-oriented and project-level management employees, and 27% from organization level and administrative related positions. From the management and administration positions, we rejected the 2 submissions from the role "administration or other", since these positions did not necessarily have professional development or business management tasks. Our contacts and open feedback also indicated, that we reached respondents from various countries from four continents.

#### C. Data Analysis

Our results follow the frequentist approach by (Kitchenham, et al. 2002), and the methods detailed by (Fink 2013), which include descriptive statistics with averages, summaries, cross tabulations and correlations. Z-test was utilized as Herkenhoff & Fogli (2013) argue its suitability for a dataset that is larger than 30 and as our study consists of 31 included answers, thus the Z-test was suitable. Additionally, we performed Kendall's tau correlation coefficient calculations, to quantify the relation or association between two measured variables. In our analysis, the correlations are classified as follows: small ( $\tau=.10$ ), medium ( $\tau=.30$ ) and large ( $\tau=.50$ ). The reason Kendall's tau statistic was used was because it tends to be more accurate in small samples (Lösch 2006). The data analysis work was conducted and visualized using Excel 2013, and Matlab R2013a.

### IV. RESULTS

In this section we report the results based on the survey topics, which are 1) general trends, 2) sustainability aspects, 3) business characteristics and 4) development & migration and work. (Kitchenham, et al. 2002).

#### A. General Trends

The survey questions collected information about the current role of the respondents, the current age of the organization they are working for, the developing platforms and whether or not the organization develop hardware components (controllers, consoles, devices, sensors etc.). Our results indicate that there are three main trends among the surveyed organizations, 1) a high preference for mobile development in less than two year old companies, which complies with the grow forecast of mobile platforms set by

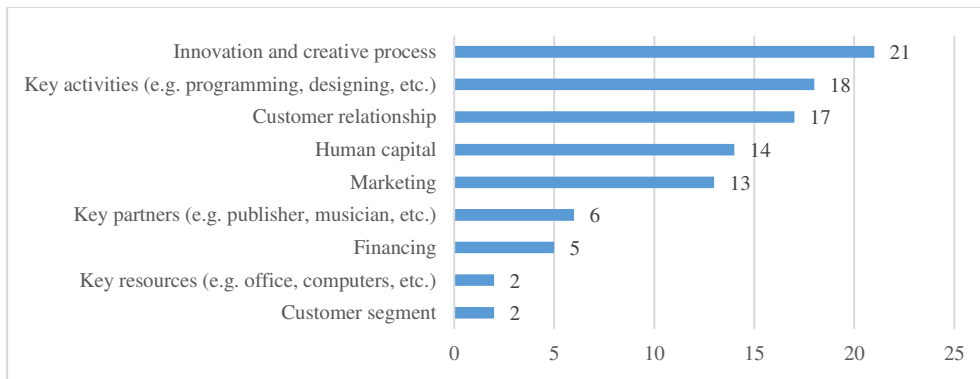


Figure 2. The most important elements in the computer game business model.

(PricewaterhouseCoopers 2012), 2) the no need for developing new hardware components and 3) the digitization of their marketing. It seems that the digital content has become the best component on the marketing channels, as also defined by (PricewaterhouseCoopers 2013; Forbes 2014).

On the other general trends collected from the survey, the three most common requirements for the skills for a new employee in the organization were 1) *ability to learn while working* (In Top 3 for 48% of respondents), 2) *ability to create production-quality content* (45%) and 3) *communication skills* (34%). In addition to these, *previous experience, no need to closely administer the person on daily tasks and trustworthiness* were ranked fourth (all 28%).

The survey respondents were also asked to rate the three most important elements of their business, which had most impact on the business success of the company. As illustrated in the Figure 2, the most impactful activity was the *innovation and creative process* (in Top 3 for 65% of respondents), while *key talent* in activities such as programming or design was named by 55%. The third aspect was *customer relationships* (48%). Also *human capital* (45%) and *marketing* (39%) were seen important. These five elements stand out from the rest and seem to be the most important elements. *Key resources* (6%) and *customer segment* (6%) were listed as the least important elements for the business. A bit surprisingly, *the financing* had only minimal effect (13%) as did *key partnerships* (19%) but this may be explained by the age of organizations. 71% of them have been in the business more

than two years and thus formed a working business model to have functional and independent financing.

Finally, the population of our survey indicated that 96% of respondent's organizations do not develop or apply hardware components on their products. The lack of responses to the hardware development is somewhat expected, since the amount of predefined platforms and the de-facto industry standards on such as mobile ecosystems or game console platforms more or less define what hardware the game products should support. The development of new sensor systems and new, dedicated controllers, can be a major financial risk so the game companies most likely do not want to invest into hardware development. In addition, the mobile systems do not usually facilitate or support peripheral devices such as separate controllers or sensor systems.

#### B. Sustainability aspects

Game developing organizations seem not likely to involve eco-impact factors (e.g. code reusability, energy-efficient programming, social awareness impact, reuse or repurpose of old hardware components or marketing materials or support to legacy systems) in their daily work (Figure 3). In all observed eco-impact categories, the average rate of involvement was between 1.4 and 3.5 (where 1= No involvement, 5= Focus area), code reusability obtained the highest rank with 3.5 average rate. However the lack of a common definition of sustainability in the field (Penzenstadler

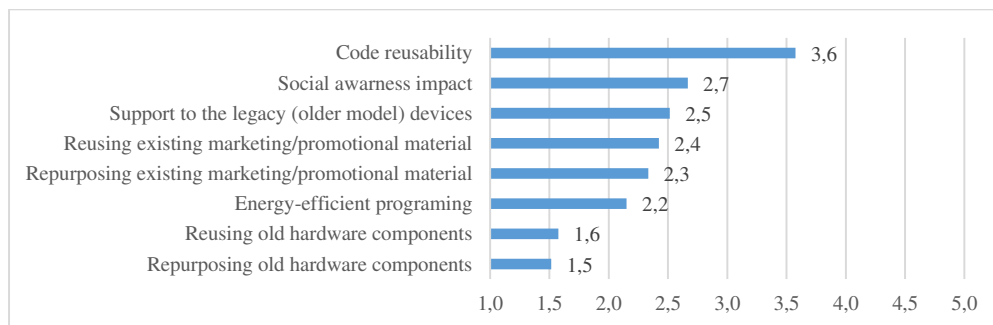


Figure 3: Green activities involvement (1 = Not important, 5 = Focus area of development)

2013) might explain the unclear understanding of eco-impact factors in this specific section.

Further, there were spotted low positive correlations between the role of the surveyed person, and the involvement of certain green activities (Figure 4), meaning that higher the role of the person in the company hierarchy goes, their preferences for involving three specific green activities decreases. This adhere to the findings from (Murphy-Hill, Zimmermann and Nagappan 2014), which reports that in the game organizations may not respect the good software engineering practices, because those activities have no immediate impact, but requires effort and may introduce risks to the overall process.

Large and low negative correlations were found between the company age and the involvement of certain green activities (Figure 5). This observation indicates that as company's age increases their willing for 1) reusing existing marketing/promotional material and 2) re-purposing existing marketing/promotional material decreases. Also, old companies have a slight lower appreciation for activities such as 1) reusing old hardware components and 2) social awareness impact.

### C. Business and Marketing aspects

In this section, the survey questions included topics such as different forms of advertisement, used marketing material, most important business partners and the effect of business decisions to the design and development processes. In marketing, the general trend for the game developing companies was that 87% of the UOs do not produce physical marketing items at all. This means that the organization completely relies on digital marketing and other means of promotion instead of giving out items or gadgets at industry exhibitions or as contest prizes. Out of the 13%, which still uses physical items in marketing, they apply articles such as toys, trinkets, clothes, posters and stickers. This trend is common for all entertainment and media companies, where digital content (became the best components on their marketing channel (PricewaterhouseCoopers 2013; Forbes 2014).

In addition of observing the success factors of their business, our study also collected information on what revenue and financing sources the organizations considered most important for their operations. The results indicate (Figure 6), that the most important source of income is the sales of the company product with rating of 3.6 (scale 1-5, 1 = Not important, 5 = Very important) (statistically significant,  $p=0.001$ ), whereas the second most important revenue source was own (private) savings with rating of 3.3 ( $p=0.001$ ). This reflects the generally young nature of the organizations which answered to the survey, as they still are dependent on their starting capital as a revenue source. In-app purchases were third most important, rated 2.9 and external funding organizations were fourth with 2.7 rating. Surprisingly, the traditional financing sources such as *venture capitalists* received only 2.2 rating, while *publishers and other business partners* were rated at 2.3. For example, *another day job* (rated 2.7) and *outsourcing work* (rated 2.6) were seen more important than these funding sources. Besides *in-app*

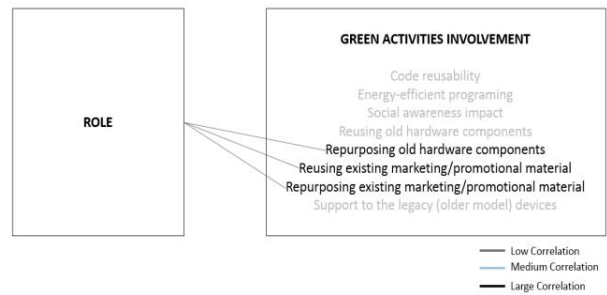


Figure 4: Kendall's tau correlations between role and green activities involvement opinion

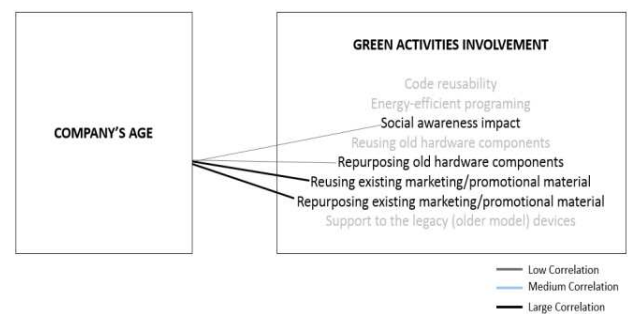


Figure 5: Kendall's tau correlations between company's age and green activities involvement opinion

*purchases*, which are the cornerstone of free-2-play models, *in-game advertisements* were only rated to 2.2, sharing the least important revenue source with *venture capitalists*.

### D. Development Process Models

The survey also collected information on how the game organizations developed their products. According to the data, 61% of total UOs do not follow any systematic development methodology. Consequently, 39% of the UOs follow a software development methodology, which could be characterized as "systematic", and out of those organizations, 67% (26% of the total) identified "Scrum" or "Partial Scrum" as their method, 33% (13% of the total) "Prototyping" or other agile approach.

Respondents were asked to define their development processes according to a list of statements which reflected the differences between the generic agile and plan-driven approaches. These statements took into account aspects such as preparation level, change of needs during the development and the documentation level of the development process. The results indicate that the game development processes often have changes to the product design during the development phase, and present recurrent reactive actions to daily problems. Furthermore, the processes are not extensively documented, and the measurement and control culture is

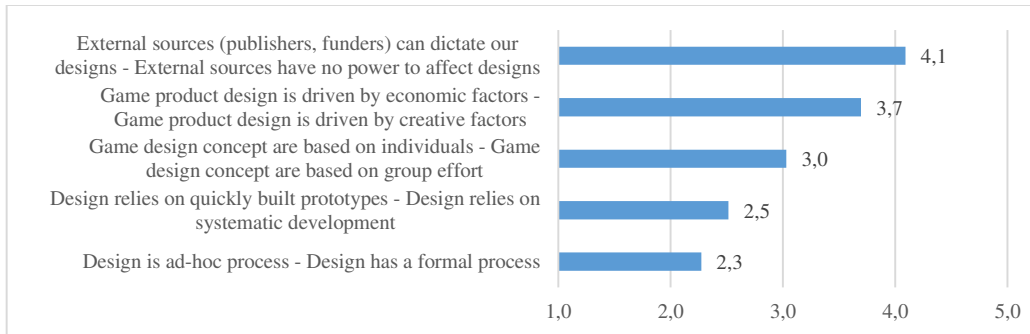


Figure 7: Process decision-making metrics (1 = leans heavily towards the 1st option, 5 = leans heavily towards the 2nd option.)

rather poor. In detail most of the respondents found their processes to be “Often reactive (We only react to problems that actually happen, and only prepare for the most probable problems.)”. Respondents also reported their way of working is far from a product design approach, where the design does not change much after the initial product design is completed. In their development processes, respondents rated four process phases as the most intensive phases according to their experiences on game development project, and they were 1) prototyping, 2) programming work, 3) art and audio production and 4) alpha and beta stages (of acceptance testing).

On the decision-making process, surveyors indicated that their approach is not systematic. As observed in Figure 7, the design process is more likely ad hoc than formal, and the design is based on rapid prototyping than using systematic, plan-driven design process. On the other hand, the result also indicates that the product design is driven by creative factors (not economic factors) and that the third parties and external sources do not have much influence on the product design. This result is interesting, since there are studies Vanhala and Kasurinen 2014, Kultima and Alha 2010) which indicate otherwise.

Besides the original development process itself, the game developers also conduct migration processes, where the product is launched or ported to a new platform or environment. Based on our survey, only 32% of the UOs have

Table 2: Kendall’s tau correlation between company’s age and migration experience

Correlated variables		Coefficient	Correlation
Company age	Migration experience	-0.2739	Low/Medium Correlation

Table 3: Kendall’s tau correlation between methodology use and migration experience

Correlated variables		Coefficient	Correlation
Methodology use	Migration experience	0.16	Low Correlation

had previous experiences with migration projects, which in our survey was defined as “modifying and releasing an existing product on a platform which was not originally one of the target platforms of development”. The results of the migration process management are available as Figure 8. As with the normal development processes, the applied process model was characterized as agile or informal with the result of 3.6 (where 1 = largely disagree, 5 largely agree). In addition, the estimated project schedules were mostly held (3.3), and the migration process costs were estimated rather accurately (3.5). Similarly as the results with the development processes, the processes were not very plan-based (2.7) but still predictable, as the need to learn new aspects of the target system before migration process was low (3.2). The

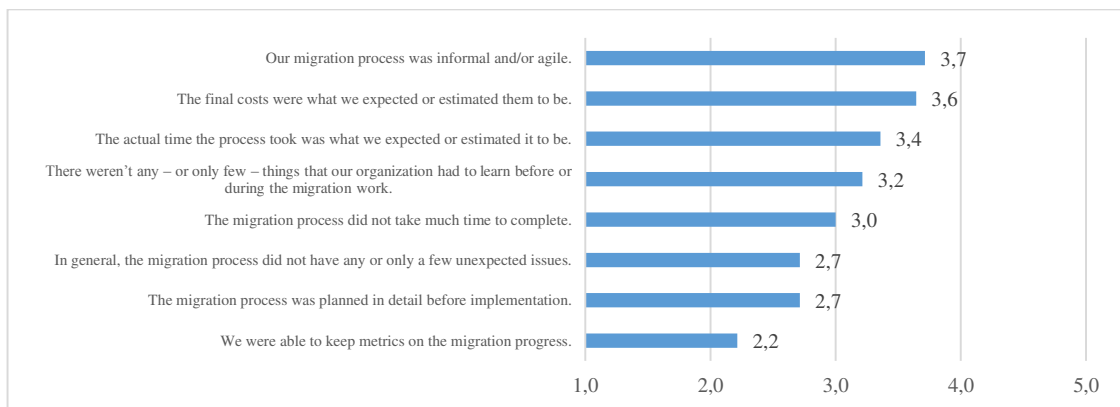


Figure 8: Outcomes of the migration processes (1 = Fully disagree, 5 = Fully agree)

application level of collected metrics was also very low (2.2), indicating that there is no strong culture of administration or project management involved with the migration work. The results indicate that the migration expertise of an organization is linked to the company's age (Table 2), with a coefficient was negative, meaning that old companies are less likely to have migration experience. Also seems the use of a methodology is correlated with the migration experience in a game developer organization (Table 3), with a positive low coefficient, which indicates that companies which follow any sort of development methodology have migration experience.

Finally, the survey collected information on how important the different types of employees were for the development process to work. On our previous studies we had identified several roles existing among the computer game organizations. In this survey, we supplemented the list of observed roles with a number of additional roles such as 'a researcher' or 'administrator', to cover and observe the importance of different types of work roles in the game developing organizations. On the scale of 1 to 5 (1 = not important, 5 = very important), the three most important roles were the *developers* (who do programming) with 4.9 rating ( $p=0.001$ ), the *artists* (who develop graphics) with 4.5 ( $p=0.001$ ) and the *designers* (who design content) with 4.0 rating ( $p=0.001$ ). Beyond these development-critical roles, *business* and *salesperson* were at 3.8 importance, *testers* at 3.2 and *musicians* at 3.0 rating. The least important roles in the game development processes were all related to the specializations in hardware or domain; *field/domain specialists* (2.3), *hardware specialists* (2.2) and *researchers* (2.1) were the bottom three. Summary of the results is in Figure 9.

## V. DISCUSSION

Our results indicate that there are three major trends in the game industry: 1) agile process models are applied if anything at all is used, 2) the major concerns are the mobile development, digital marketing, employees with specific abilities and keeping innovation in the business; 3) the minor concerns are eco-impact elements (such as reusability of

components, energy efficiency, long term support, and social impact), software reusability, financial aspects and certain development phases such as testing and crunch time development.

*Trend 1* has been also identified by (Murphy-Hill, Zimmermann and Nagappan 2014; Stacy and Nandhakumar 2009; Baba and Tschang 2001) about games having significant differences from "traditional" software development. However, there is an arguments game development is not a fully related creative industry (Tschang 2005) but rather a software engineering intersected field (Ampatzoglou and Stamelos 2010), sharing common problems and challenges (Petrillo et al. 2008; Petrillo et al. 2009; Petrillo and Pimienta 2010). Furthermore, our previous findings (for example Kasurinen et al. 2014) combined with the findings of (Musil and Schweda 2010), show that the agile models are adaptable to the processes of the games development industry. This also indicates that if we want measurements from the game development process, the measurements and metrics which agile practices apply are the most appropriate approach.

*Trend 2* complies with the industry forecasts (PricewaterhouseCoopers 2013; Forbes 2014). In addition to this observation, three specific abilities seem to be the most required by game organizations: 1) ability to learn while working, 2) ability to create production-quality content and 3) communication skills. Despite the high human value for the organizations observed earlier (Vanhalala and Kasurinen 2014), they believe that in order to achieve business success the most impactful activities are innovation & creative processes.

*Trend 3* adheres to the findings by (Penzenstadler 2013; Albertao 2004) about sustainable software engineering. This indicates that in the game development as in software development, there is a lack of a common and tangible definition of the concept of sustainability and a body of knowledge with specific sustainable development practices.

As described in the study by (Murphy-Hill, Zimmermann and Nagappan 2014), the computer game industry has similarities to the movie and music industry as games are forms of creative work, and creativeness dictates the product

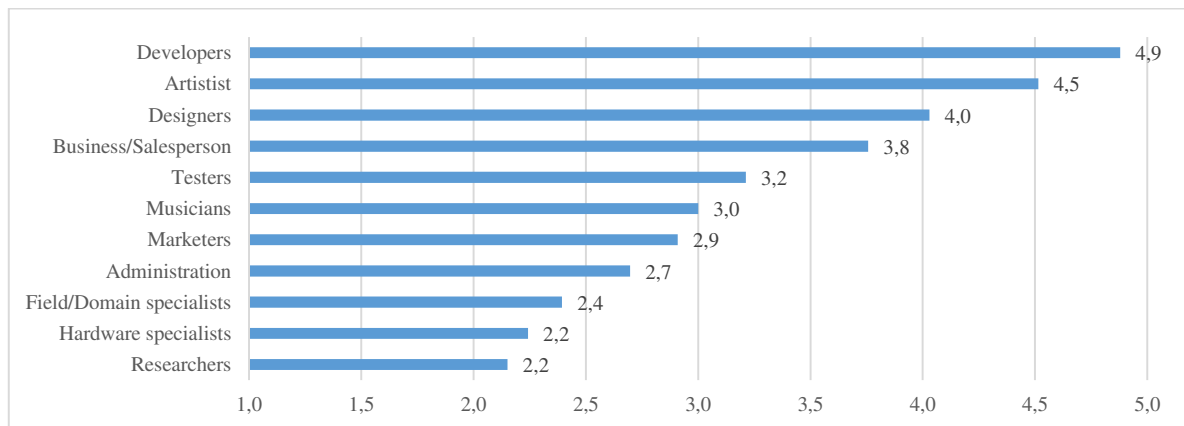


Figure 9: Importance of different roles (0 = not important, 5 = very important)

to a large degree, even though they still are commercial products aimed to generate profit. Even still, game development involves fundamental engineering activities such as design, develop and testing, and they could be improved with the proper use of certain software engineering practices, measurements and agile methodologies.

According to the survey results, designing games is not systematic, but rather ad-hoc work where the ideas flow and no strictly defined processes are used, as previously found also by (Kultima and Alha 2010). Game developers argue to design games independently without any external sources dictating what to do. The survey data indicates clear differences between the software and game development, even though they share several characteristics in the technical development work. For example, since there is no inherent value of usefulness or enhanced performance in games, the game products need to focus on user experience and fulfilling customer expectations.

Based on our earlier study we expected human capital, marketing and financing to be the top three elements in the game development industry. The earlier qualitative study indicated that the start-ups are dependent of their human capital and financing. The diverged results of this study indicate that the more mature organizations outgrow this state of dependency to their key talent and business partners. The human capital is still in top-3 and marketing also gained points but the financing lost its position most likely because it is not critical part of daily existence for established organizations as it is for start-ups. Additionally, the free-to-play business models has not completely saturated the game business, even though it currently is argued to be the *de-facto* model for mobile gaming (Tekes scene report, Tyni 2011). The survey results indicate that selling games is still the most common and important source of income for the general population of the industry. This result is interesting, since our findings in qualitative studies (Vanhala and Kasurinen 2014) implied that almost every type of game developer was looking into the application of free-to-play business model.

The other interesting observation on the business practices was that even though over 70% of the organizations had been in the business for more than two years, the revenue sources still included own savings and daily jobs. One explanation for this behavior could be that the start-up-phase takes time, and to build successful business model, which does not rely on externally generated funding sources, is achieved only after several years of existence. This observation was also supported by our earlier qualitative research with the growth models of game developers (Vanhala et al. 2015). It is also notable that although producing computer games requires little investment on the hardware or logistics, start-up operations require external funding or own savings cover the human capital costs. The role of external funding in the context of company surviving has also been discussed for example by Almeida & Fernando (2008).

Regarding the sustainability aspects in the game industry, our results suggest that the game developers do not recognize what sustainability means in their industry, thus the organization consider that they do not involve sustainable activities in their daily actions. However, they recognized

some practical definitions of green IT, such as design for reusability in the activities they perform. This complies with the claim from (Penzenstadler 2013), meaning that there is a lack of common and tangible definition for the concept of sustainability in the software industries, even though developers already implement several practical actions towards sustainability. (Albertao, Xiao and Tian 2010) claim that clear development and measuring practices of sustainability for software projects would incrementally improve the sustainability of end products, creating a potential business advantage.

The main limitation of this study is the sample organization limitations. Due to the applied contact methods – social websites, business contacts and existing university partners – we are certain that the observed organizations and the respondents are professional game developers, but there is no possibility to measure if these results reflect more the start-up organizations than game industry in general. Since most of the respondents are from less than five year old organizations, the results of this study may not fully reflect the concerns from the older organizations. However, our population does have a large variance of answers, for example both game console-targeting developers and hardware developers in addition of mobile developers, and based on the feedback and replies, we know that our responses are collected from several countries, cultures, and different economic areas. In any case, the organizations which rely on volunteers such as open source communities, or game companies which only sell assets or resources without own product development work, are not represented in this study.

## VI. CONCLUSIONS

In general, the game development and software development share a number of features, such as the design, development and testing work. According to our survey results, the game development differ from software development in a sense that the game development processes tend to be unstructured, or follow some form of agile development. Considering the software engineering practices, game developers could benefit from a simple, practical and highly iterative software engineering framework that takes into account the creative aspects, offers agile measurement tools and supports late changes.

Considering the business aspects, the free-2-play model has been in the headlines as the major approach for game business models. However, the survey results indicate that selling copies of the product is still the most used method to gain revenue, when considering the computer game industry in general. In addition, the role of the more traditional financing models such as venture capital or outsourcing work was not considered as important as own savings or second day job, although this may also reflect the situation of the young companies more than the general state of the business. The aspect of in-game advertisement is still rarely applied in the business model, even though it may seem a perfect match with the concept of free-2-play business.

The respondents reported several issues with their development processes and product migration. These



problems may stem from the lack of software engineering methodologies that support game development, causing them not to be able to keep clear metrics of their projects since the projects are in a state of constant changes. If an organization have not solved their issues with measuring and controlling the reactivity of their processes, it is no wonder that the companies also do not control, measure or improve the sustainability aspects such as code reuse, legacy system support or energy efficiency.

The topic of sustainability is a current trend in many industrial domains. To support the sustainability, game and software development should define a common definition for what are the sustainable activities that affect people, economy and environment in their specific discipline. Being sustainable is not anymore an extra feature for an organization but a competitive advantage in the market. The inclusion of the green activities can open opportunities for new efficient practices, give edge in against the competition and allow better use of resources, all which can create increase of revenues for any sort of organizations.

## VII. REFERENCES

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