

Estimating the Value of Multiplayer Modes in Video Games: An Analysis of Sales, Ratings, and Utilization Rates

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Keywords: Video Game Development, Online Multiplayer, Project Scope, Functional Scope, Project Management, Knowledge Discovery in Databases (KDD).

Abstract: Video game organizations are under pressure from growing development costs and competition from other sources of entertainment. Making informed project scope decisions is critical to avoiding budgetary and schedule waste, but little information regarding best development practices is made public, and many decisions are made, not informed by past data, but by the tacit knowledge of project owners. One way developers have attempted to improve sales on their games and follow-up content is through the inclusion of online multiplayer functionality. However, multiplayer functionality is expensive to develop and can significantly add to the costs and schedule of a game project, particularly if the decision to include it is made late in the process. This research explores publicly available data to discover the value that multiplayer functionality provides so that project owners can make a more informed decision earlier in the development process.

1 INTRODUCTION

Video game development companies often rely on the tacit knowledge of project owners, such as directors and producers, to decide critical project management issues such as scope, scheduling, and budgetary requirements. However, these tacit assumptions are not always checked against results in the market and may not reflect the reality of the ever-changing game development business. Mistakes in scope decisions can lead to resource waste and, in worst cases, project failure.

There is room for improvement with project management practices in video game development. (Musil et al., 2010) One way to improve project management is by incorporating data from both the developer and the larger industry's past results to better inform future decisions.

In this research, we examine one of the most time and resource intensive functional scope decisions: whether or not to include a multiplayer feature within a game. Through analyzing the sales and critical results of 34,263 applications on *Valve Corporation's Steam* PC game service, we provide decision makers with insight into the value including multiplayer can add to a video game project.

2 RESEARCH BACKGROUND

2.1 Video Game Development

Video game development is expensive, with development costs alone reaching \$100 million for one title. (Bleeker, 2013) "How much game to make?" is an important question that needs to be answered early in the development process to avoid costly rework later in production.

"Managing the project scope is primarily concerned with defining and controlling what is and is not included in the project." (Project Management Institute, 2017, p. 129) Scope can impact quality and the ability to deliver a game project on schedule. (Washburn et al., 2016) Scope in video games includes both functional scope – the unique features and systems available in the game – and content scope – the amount of content provided with the game. In particular, one aspect of functional scope that has the potential to increase the amount of time and cost required to develop a video game project is an online multiplayer feature. Games need to be built with multiplayer in mind from the beginning, as the entire game may need to be designed for it, and later implementation can force developers to rework much of what has already been made.

Including a multiplayer feature brings many potential benefits, but it comes with many drawbacks as well, particularly the expense involved in developing and maintaining an online mode.

Even when resources go into developing multiplayer, not all of the features are used by the majority of players. (Hullet et al., 2011) Within the game console market, prior research noted that, because of the need for an active community, multiplayer can be a valuable addition to the game towards the end of a console's life cycle, when there are enough players to justify it, while a single player focus can be a stronger strategy earlier in the console life cycle. (Marchand, 2016)

However, for PC games, the life cycle dynamics that dominate the console market are not present. Of the many PC game retail outlets, Valve Corporation's digital distribution platform, *Steam*, dominates the market with 18.5 million concurrent users in January 2018. (xPaw and Marlamin, 2018) There are positives and negatives to including online multiplayer functionality, so a more data-informed approach could help product owners decide early in the development process whether to pursue an online strategy or to focus resources on the single-player game.

2.2 Software Project Management

Game development organizations try to balance getting projects done on time and in budget with giving their employees the creative freedom they need to innovate. (Cohendet and Simon, 2007) However, few game development processes are well defined, and developers could benefit from improved project management processes. (Musil, Winkler and Biffl, 2010)

One aspect of project management in particular, scope management, is difficult in all software development (Brooks, 1995; DeMarco and Lister, 2003; Yourdon, 1997), but more so in video game development because the non-utilitarian, experiential nature of the product makes a definition of "value" elusive. (Bilton, 2007, p. xvii; Hirsch, 1972; Lampel, Lant and Shamsie, 2000) Deciding on an appropriate scope is critical to the quality of the final product. (Washburn et al., 2016)

2.3 Knowledge Discovery in Databases

Data is an effective way to check perceptions and possibly fix misperceptions within an organization. (Weber, 2005, p. 14) In particular, many organizations rely on their existing knowledge,

which can be difficult to change and lead to complacency or crises, especially when it has led to success in the past. (Leonard-Barton, 1995; Nystrom and Starbuck, 1984; Senge, 1990)

Intelligence gathering and learning not just from an organization's past history but from the past history and best practices of other organizations is an essential quality of a learning organization. (Garvin, 1993) Even if the final decision comes down to the project owner's judgment, data is essential for good decision making.

For this research, data mining of web-based sources is used to derive insights that could be helpful for video game businesses. We also introduce a technique that could be used to determine multiplayer usage through examining video game "achievements" on a limited sample.

3 RESEARCH METHODOLOGY

3.1 Research Questions

The principle research question that we are attempting to answer is whether the inclusion of a multiplayer feature is worth the development effort. We hypothesize that the inclusion of multiplayer has a positive impact on sales because it adds to the utility of a video game for players; however, we also hypothesize that the additional demands required for a positive multiplayer experience will have a negative impact on user ratings. We also hypothesize that this impact will not be felt as strongly in professional critic ratings because critics are testing the game in a more ideal, pre-release environment. Finally, we hypothesize that the multiplayer features of games that focus on single-player content are not used by the majority of players.

3.2 Research Scope

The sample used in this research includes games (PC, Mac, Linux) released on *Valve Corporation's Steam* service from its inception to early 2017. More recent data was not included because it could contain games that are still selling or receiving reviews.

The *Steam* service was chosen for three reasons: first, it is the most popular online PC game retail and digital distribution platform; second, much of *Steam's* data is publicly available, so it is more suitable for large-scale sampling; third, the service is a fully digital distribution platform for the PC, so it is not subject to game console lifecycles.

3.3 Data Sources

The primary source of data used in this research is data made publicly available for video games released on *Valve Corporation's Steam* service platform. This data includes aggregated professional critic scores from *Metacritic.com*. In addition, data from Sergey Galyonkin's *SteamSpy* and "xPaw" and "Marlamin's" *SteamDB* was employed for estimating the number of owners for each game.

Steam's Top Sellers of 2017 list (Valve Corporation, 2018), which is divided into "Platinum", "Gold", "Silver", and "Bronze" categories by gross revenue, and *The NPD Group's* 10 Best-Selling Games of the Year lists from 2001 to 2017 (The NPD Group, 2017) were used to find examples of the best-selling games on both *Steam* and video game consoles.

3.4 Data Preparation

The list of all applications on *Steam* was obtained from its API, available from the link: <http://api.steampowered.com/ISteamApps/GetAppList/v0001/> (last accessed April 27th, 2018) The unique AppID identifier was used as a base for collecting information from *Steam Store* pages for each game using *Python* to generate links of the form: [http://store.steampowered.com/app/\(AppID\)](http://store.steampowered.com/app/(AppID)) (last accessed April 27th, 2018) These store pages included tagging information that could be used to identify whether *Valve* had labelled the game content "Single-player", "Multiplayer", and/or "Co-op" as well as the *Metacritic* score and *Steam* user rating – both as percentages. The same AppID was used with *SteamDB*, using a link of the form: [https://steamdb.info/app/\(AppID\)](https://steamdb.info/app/(AppID)) to gather *SteamSpy* owner data for the games in the sample.

Many of the applications with AppIDs were not game applications and needed to be removed from the data set. This was done by only including entries that had either a "Single-player", "Multiplayer", or "Co-op" flag. Also, games without a release date were removed from the sample as they could indicate unreleased games or incomplete data. This reduced the sample from 34,263 to 19,621 (57% of the total). Games with either a "Multiplayer" or a "Co-op" flag were combined into one multiplayer category.

3.5 Data Modeling

Means (M) with 95% confidence intervals (95% CI), medians (Mdn) with interquartile ranges (IQR), and

maximums were calculated for owner counts, *Metacritic* scores, and user ratings of the total sample as well as for each category.

Two categories were created for sorting *Metacritic* scores and *Steam* user ratings based on *Metacritic's* game sorting: Favorable ($\geq 75\%$) and Unfavorable ($< 75\%$). (Metacritic, 2018) Statistics for each category were also calculated and analyzed for possible differences in trends between unfavorably and favorably rated games.

The data could not be expected to be normally distributed, so to determine whether the number of owners, *Metacritic* scores, and user ratings for single-player, multiplayer, single-player only, and multiplayer only games differed significantly from those of the overall sample population, a Wilcoxon rank-sum test was performed on each binary factor because it does not assume a normal distribution.

3.6 Outlier Testing

To discover outliers for further analysis, examples at the extremes for each of the categories were examined. In addition, *The NPD Group's* 10 Best-Selling Game lists for the period from 2001 – 2017 and *Steam's* Top Sellers of 2017 list were used to find examples at the top-selling end of the video game spectrum.

3.7 Achievement Analysis

As the results in Hullet et al. (2011) suggest, different aspects of multiplayer might be more utilized by players than others. In prior research, achievement data was used to analyze the utilization rates of single-player content. (Bailey and Miyata, 2017) For this research, *Steam* achievements were analyzed for single-player games with multiplayer modes from the "Platinum", "Gold", and "Silver" categories of *Steam's* Top Sellers of 2017 list to discover trends in player utilization of multiplayer functionality and modes in games with single-player content. Not all games have achievements related to multiplayer usage, but several cases were found in *Steam's* list.

4 RESULTS

4.1 Multiplayer Functionality

Of the 19,621 games in the sample, 18,220 games (93%) were tagged by *Steam* as "Single-player",

6,312 games (35%) were “Multiplayer”, and 5,071 games (26%) were “Co-op”. “Multiplayer” and “Co-Op” games were combined for a total of 8,285 games (42%) with multiplayer functionality. Games can be tagged in more than one category; only 11,336 games (58%) were single-player only and 1,401 games (7%) were multiplayer only.

Steam’s Top Sellers of 2017 list is divided into four tiers based on gross revenue: “Platinum”, “Gold”, “Silver”, and “Bronze”. In the Platinum tier, only one game, *The Witcher III*, was single-player only. However, single-player only games represent roughly a third of games in the remaining tiers. The distribution of game types is listed in Table 1.

Table 1: The number of games in each category of Steam’s Top Sellers of 2017.

Category	Single-Player Only	Multiplayer Only	Both
Platinum (n = 12)	1 (8%)	4 (33%)	7 (58%)
Gold (n = 12)	4 (33%)	1 (8%)	7 (58%)
Silver (n = 14)	5 (36%)	5 (36%)	4 (29%)
Bronze (n = 56)	18 (32%)	4 (7%)	34 (61%)
All (n = 94)	28 (30%)	14 (15%)	52 (55%)

4.2 Multiplayer and Sales

The first relationship tested was between the presence of single and multiplayer functionality and sales. (Table 2) This was done by examining the *Steam Spy* estimated owner counts for entries with the three flags. 4,943 samples had *Steam Spy* owner counts. The most owned multiplayer game in the

Table 2: The average number of owners for single and multiplayer games on Steam (in thousands).

Type	M (95% CI)	Mdn (IQR)
Single Player (n = 4,816)	146K (132 – 160K)	23K (7 – 104K)
Single Only (n = 3,508)	117K (104 – 130K)	21K (6 – 89K)
Multiplayer (n = 1,435)	267K (206 – 329K)	32K (9 – 167K)
Multi Only (n = 127)	722K (157 – 1,286K)	24K (5 – 186K)
Single & Multi (n = 1,308)	223K (185 – 262K)	33K (9 – 163K)
All (n = 4,943)	161K (141 – 181K)	24K (7 – 106K)

sample was *Counter-Strike: Global Offensive* with 30.6 million owners, while the most owned single-player game in the sample was *Half-Life 2* with 9.9 million owners.

The mean number of owners for multiplayer (M = 267K) and multiplayer-only (M = 722K) games was higher than the overall sample (M = 161K) and much higher than single-player only games (M = 117K). However, median sales showed a different trend, with games having both single and multiplayer modes (Mdn = 32K) being higher than the overall sample (Mdn = 24K). The presence of a few hit multiplayer-only titles likely pushed the mean high, but the median owners for multiplayer-only games (Mdn = 24K) was similar to that of the overall sample (Mdn = 24K).

Across the categories, a low median compared to the mean indicates a strong right skew, which could be expected given the “hit” nature of the video game business – a few highly owned outlier titles pull the mean higher.

A Wilcoxon rank-sum test on the presence of multiplayer showed a statistically significant difference (p < .001). Subdividing the data into “Favorable” and “Unfavorable” user rating and *Metacritic* score categories did not affect the results.

4.3 Multiplayer and Ratings

The next relationship tested was between the presence of single and multiplayer functionality and *Metacritic* scores (Table 3). Only a subset (n = 2,506) of games have enough professional reviews to have a *Metacritic* score.

Table 3: The average *Metacritic* scores for single and multiplayer games on Steam.

Type	M (95% CI)	Mdn (IQR)
Single (n = 2,417)	72% (72 – 73%)	74% (66% - 80%)
Single Only (n = 1,449)	72% (71 – 72%)	73% (66% - 79%)
Multiplayer (n = 1,057)	73% (72 – 74%)	75% (66 – 81%)
Multi Only (n = 89)	73% (70 – 76%)	76% (67 – 82%)
Single & Multi (n = 968)	73% (72 – 74%)	75% (66 – 80%)
All (n = 2,506)	72% (72 - 73%)	74% (66 – 80%)

The mean *Metacritic* scores are similar across categories, but the median was slightly higher for games with multiplayer (Mdn = 75%) and

multiplayer-only (Mdn = 76%) versus the overall sample (Mdn = 74%). A Wilcoxon rank-sum test on the presence of multiplayer on *Metacritic* scores indicated that its presence did result in a statistically significant difference ($p < .001$) from the overall sample.

After subdividing the data into “Favorable” and “Unfavorable” *Metacritic* score categories, the effect of multiplayer presence on *Metacritic* scores was no longer statistically significant for Unfavorable (*Metacritic* score $< 75\%$) games.

The third relationship tested was between the presence of single and multiplayer functionality and *Steam* user ratings. Given that users can rate all of the games on *Steam*, the sample available for testing user ratings is larger than the critic sample. Of the 19,621 games in the sample, 16,189 have user ratings associated with them. However, a majority of games have only a few reviews attached to them. To avoid overweighing games with few reviews, only games with more than 30 reviews were used for testing. This left 7,893 samples for testing. The results are shown in Table 4.

Table 4: The average user review scores for single and multiplayer games on *Steam*.

Type	M (95% CI)	Mdn (IQR)
Single (n = 7,470)	75% (74 – 75%)	79% (65 – 89%)
Single Only (n = 4,914)	75% (74 – 75%)	79% (65 – 89%)
Multiplayer (n = 2,979)	73% (72 – 73%)	76% (62 – 87%)
Multi Only (n = 423)	65% (63 – 66%)	66% (53 – 80%)
Single & Multi (n = 2,556)	74% (73 – 75%)	78% (64 – 88%)
All (n = 7,893)	74% (74%)	78% (64 – 88%)

The user rating was slightly lower for multiplayer games (M = 73%, Mdn = 76%) and much lower for multiplayer-only games (M = 65%, Mdn = 66%) versus other categories. To test whether this effect held for popular games with more owners, the means and medians were checked for games with more than 100K owners. While the average user ratings rose (n = 464, M = 74%, Mdn = 78%) for multiplayer games, the average also rose for the overall sample (n = 1,215, M = 77%, Mdn = 81%), and the difference remained.

A Wilcoxon rank-sum test on the single-player flag indicated that the presence of single-player resulted in a statistically significant difference (p

$< .001$) in user ratings from the overall sample. The presence of multiplayer also resulted in a statistically significant ($p < .001$) difference. However, when the data was divided into “Favorable” (user rating $\geq 75\%$) and “Unfavorable” (user rating $< 75\%$) groups, there was no longer a statistically significant difference for the presence of multiplayer in “Unfavorable” games.

4.4 Multiplayer Usage

Although it is not possible to make statistically significant judgments based on a limited sample, we examined a few cases of how many players took advantage of multiplayer features when they were included in single-player games. The achievement data for games with multiplayer modes in the Platinum, Gold, and Silver tiers of *Steam*’s Top Sellers of 2017 list was inspected for indications of multiplayer feature usage in games with single-player content.

In the Platinum tier, *Divinity: Original Sin 2* contained a co-operative play mode that could optionally be used throughout the game’s campaign, but it also released two special modes for use with other players. One mode, “Game Master”, allowed a player to design and host a game for others. The “Gather Your Party” achievement showed that only 4.2% of players tried the Game Master mode. The other mode, Arena, gave players a chance to fight each other. The achievement “Venture Forth” showed that only 3.5% of players began a match in this mode.

Within the Gold tier, the game *Total War: Warhammer* has both single and multiplayer modes, but the achievement “Up For A Scrap” showed only 27.5% of players started a multiplayer battle, with “Armchair General” indicating 18.7% continued to play for at least five battles and “Armchair Emperor” indicating that 7.5% continued to play for 25 battles. *Total War: Warhammer* also had a longer multiplayer campaign mode. “A Confrontational Nature” showed 23.1% of players participated in a multiplayer campaign, while “First Among Equals” indicates only 2.9% went on to win it. Within the Silver tier, the sequel, *Total War: Warhammer II* demonstrated a similar pattern of use. “Spoiling for a Fight” indicated 26.3% of players participated in a multiplayer battle, while “First Among Equals” indicated 10.9% remained for 10 multiplayer battles. “A Taste for Glory” showed 22.4% participated in a multiplayer campaign.

Another game in the Gold tier, *Civilization VI*, also has both single and multiplayer modes. The

“Land Party” achievement showed that 28.6% of players participated in at least one multiplayer game.

In the Silver tier game *XCOM 2*, “The Most Dangerous Game” indicated only 2.0% of players went on to win a multiplayer match. In another Silver tier game, *Path of Exile*, players could join up with up to six others. “Band Together” showed 13.6% of players joined a party. However, another game mode, “Capture the Flag”, was less popular; only 0.8% of players captured a flag according to the statistics for the “Capture the Flag” achievement.

4.5 Single-Player Outliers

Although there may be a perceived pressure that online multiplayer is required in the current market to succeed, there are examples of single-player only games that have sold well. Three examples of console games without online multiplayer features from *The NPD Group’s 10 Best-Selling Games of 2017* list were: *Nintendo’s Super Mario Odyssey*, *The Legend of Zelda: Breath of the Wild*, and *Ubisoft’s Assassin’s Creed: Origins*. In the latter case, previous installments of the *Assassin’s Creed* series featured online multiplayer, so it is notable that it was not included in the most recent game.

Also, *The Witcher III* made Steam’s Top Sellers of 2017 highest “Platinum” category despite having only a single-player experience. Although *The Witcher III* was the only example in the “Platinum” gross revenue list, roughly a third of games in the “Gold” (4 out of 12), “Silver” (5 out of 14), and “Bronze” (18 out of 56) were single-player only experiences.

5 DISCUSSION

5.1 Multiplayer Effect on Sales

The data indicates that games including an online multiplayer feature tend to do better in sales than games without one. As one goal in implementing a multiplayer feature is to create a hit, it is important to consider both the mean, even if it is sensitive to outliers, and the median values. In particular, the “owners” ceiling is much higher for the best-selling outliers, which results in a mean of 117K owners for single-player only games versus a higher mean of 223K owners for games with a single-player mode and a multiplayer mode. The median values are closer, with 21K for single-player only games versus 33K for games with both modes.

Also, although there are some notable exceptions, most of the games in *Steam’s Top Sellers of 2017* list and *The NPD Group’s 10 Best-Selling Games of 2017* list do have online multiplayer. However, even if games with multiplayer tend to sell better, the sales numbers may not justify the development risks and expenses involved.

5.2 Single-Player Only Option

One important observation to make is that every example of a best-selling game, in both *The NPD Group’s top 10 best-selling games of 2017* list and the “Platinum” and “Gold” categories of Steam’s Top Sellers of 2017 list, without online multiplayer contained a significant volume of single-player content. For developers aiming for a top-selling hit, the question comes down to whether it is better to devote resources to expanding functionality by adding online multiplayer, and risk diluting the single player experience, or by expanding or improving the single-player content. However, adding single-player content is expensive, and may only add value for a limited number of players. (Bailey and Miyata, 2017) *Cuphead* and *Resident Evil VII*, two examples from the “Silver” category, do show that games with a more compact single-player experience still have the potential to sell well. However, the lack of shorter, more linear single-player experiences from the top of both lists does seem to indicate that it is unlikely for such a game to reach the top. A developer either has to focus on creating a strong multiplayer experience or an open, expansive single-player experience – both of which are development resource-intensive, high-risk, high-reward options.

From a ratings perspective, based on *Metacritic* scores, there is no significant advantage to critical reception for including an online multiplayer feature. However, when it comes to user ratings, the data showed that games including online multiplayer tended to fare worse than single-player games. This is likely due to user reactions to a range of issues, such as player and connectivity issues, and inspection of negative user reviews for games with multiplayer features supports this could be the case. An absent online community could certainly impact the multiplayer experience, but the data showed that popularity is not the only issue; even for games with more than 100K owners, user ratings were lower for games with multiplayer than games in the overall sample. This seems to indicate that the inclusion of multiplayer will tend to result in lower user ratings, possibly due to issues outside of the developer’s control.

Some games with a single-player focus but some multiplayer features did have a significant portion of players trying the multiplayer content. *Total War: Warhammer I* and *II* as well as *Civilization VI* had more than a quarter of its user base trying multiplayer. However, only roughly a tenth of players continued to use the multiplayer features in *Total War: Warhammer II* for at least ten matches, indicating the fall-off could be steep in some cases.

In games with strong single-player content, multiplayer may not be necessary. In one example from the limited achievement sample, *XCOM 2*, only 2% of players won a multiplayer match against other players online, which indicates few players obtained utility from the multiplayer functionality.

5.3 Multiplayer Variety

Even if the decision is made to include online multiplayer, reducing the amount of variety to focus on more popular modes is an option for controlling development costs without reducing the utility provided to players. When analyzing data from *Microsoft's Xbox 360* racing game *Project Gotham Racing 4*, Hullet et al. (2011) found that 30 - 40% of the content in the features they analyzed was used in less than 1% of races, 12 of 29 event types were used less than 1% of the time, and 50 out of 134 unique vehicles were used in less than 0.25% of races.

One example from this research, *Path of Exile's* "Capture the Flag" mode was used by less than 1% of players. In *Divinity: Original Sin 2*, less than 5% of players used the multiplayer "Game Master" mode, and less than 4% of players fought each other online in the "Arena" mode. Both games have a large number of players, meaning the modes did not go unused, but they only contributed value for a fraction of the user base and may not have justified the development time and cost.

Lower user ratings for multiplayer games suggest the hurdle to developing satisfying multiplayer content is higher. Players not only need functioning multiplayer, they also need enough other players using the same online features. If a mode or multiplayer in general is not likely to support a large enough community, then it would be better left out of the game.

5.4 Directions for Future Research

Further research into the value and utilization of multiplayer functionality in games is required to help project owners make better decisions.

Currently, few numbers are available regarding development costs for multiplayer projects. What numbers do exist are either anecdotal, or are given in a post-mortem fashion, which has two problems: post-mortems tend to have a success bias because they are done for games that survive to release, and post-mortems only cover the final numbers, not the initial projections or the amount of resources lost due to scope underestimation or change. Detailed research into the actual cost and schedule impact of multiplayer is required, particularly on the impact of making the decision in the early phases of development versus later phases.

Also, although a limited sample of multiplayer usage rates based on *Steam* achievements was included, a comprehensive survey of multiplayer usage rates is needed to provide specific insight into multiplayer utility value, particularly the multiplayer value to players from different implementation varieties.

Finally, text mining *Steam Store* rating and community pages for multiplayer issues could yield valuable insights into which areas in particular contribute to lower user ratings.

6 CONCLUSION

Developers not only need to make scope decisions based on the potential value that scope will provide to their players, developers need to make those decisions early in the process and stick to them to avoid the costs that come from re-scoping.

Given that the highest selling games tend to have multiplayer, and that the average number of owners with both single and multiplayer features was higher than that of games with only single-player functionality, there seems to be a sales benefit to including multiplayer. However, relatively low utilization of multiplayer features in games with a single-player focus seems to indicate that forcing a multiplayer feature into a game will not provide additional value to most users, and could result in lower satisfaction, as judged by user ratings and reviews. Multiplayer-only games have the potential to become the biggest hits, and do not appear to suffer from the lack of single-player features. However, players have high expectations for multiplayer; if these expectations cannot be met, results can suffer.

Traditionally, there has been a pressure to implement multiplayer features because they add utility for players, discourage piracy, and prevent used sales, but in a digital distribution environment,

the latter two reasons no longer apply. The results of this research demonstrated that there is value to including multiplayer functionality; however, that value may not be enough to justify the additional costs, time, and risks added to development or the diluting of the single-player experience. Based on the data, unless a developer is confident that their multiplayer mode will be capable of maintaining a strong audience as well as contribute significantly and positively to the game experience, it would be better to avoid it if the costs and risks of implementing it are high.

REFERENCES

- Bailey, E. N., Miyata, K., 2017. Analyzing video game completion achievements: Implications for game project scope. *16th International Conference on Entertainment Computing*, 469-472. doi: 10.1007/978-3-319-66715-7_65
- Bilton, C., 2007. *Management and creativity: From creative industries to creative management*, Blackwell Publishing.
- Bleeker, E., 2013. *Grand Theft Auto 5 sales hit \$1 billion, will outsell entire global music industry* [Online]. Available: <https://www.fool.com/investing/general/2013/09/28/gta-5-sales-hit-1-billion.aspx> [Accessed February 28, 2017].
- Brooks, F. P. J., 1995. *The mythical man month, anniversary edition: Essays on software engineering*, Pearson Education.
- Cohendet, P., Simon, L., 2007. Playing across the playground: Paradoxes of knowledge creation in the videogame firm. *Journal of Organizational Behavior*, 28(5), 587-605. doi: 10.1002/job.460
- DeMarco, T., Lister, T., 2003. *Waltzing with bears: Managing risk on software projects*, New York, NY, Dorset House.
- Garvin, D. A., 1993. Building a learning organization. *Harvard Business Review*, 71(4), 78-91.
- Hirsch, P. M., 1972. Processing fads and fashions: An organization-set analysis of cultural industry system. *American Journal of Sociology*, 77(4), 639-659. doi: 10.1086/225192
- Hullet, K., Nagappan, N., Schuh, E., Hopson, J., 2011. Data analytics for game development. *Proceedings of the 33rd International Conference on Software Engineering, 2011*, ICSE '11, 940-943. doi: 10.1145/1985793.1985952
- Lampel, J., Lant, T., Shamsie, J., 2000. Balancing act: Learning from organizing practices in cultural industries. *Organization Science*, 11(3), 263-269. doi: 10.1287/orsc.11.3.263.12503
- Leonard-Barton, D., 1995. *Wellsprings of knowledge*, Boston, MA, Harvard Business School Press.
- Marchand, A., 2016. The power of an installed base to combat lifecycle decline: The case of video games. *International Journal of Research in Marketing*, 33(1), 140-154. doi: 10.1016/j.ijresmar.2015.06.006
- Metacritic, 2018. *How we create the Metascore magic* [Online]. CBS Interactive, Inc. Available: <http://www.metacritic.com/about-metascores> [Accessed April 30, 2018 2018].
- Musil, J., Schweda, A., Winkler, D., Biffi, S., 2010. A survey on the state of the practice in video game software development. *Technical Report No. IFS-QSE 10/04*.
- The NPD Group's 10 Best-Selling Game Lists (2001-2017), 2017. The NPD Group.
- Nystrom, P. C., Starbuck, W. H., 1984. To avoid organizational crises: Unlearn. *Organizational Dynamics*, 12(4), 53-65. doi: 10.1016/0090-2616(84)90011-1
- Project Management Institute, 2017. *A guide to the project management body of knowledge (PMBOK guide)*, Newtown Square, Pennsylvania, Project Management Institute, Inc.
- Senge, P. M., 1990. *The fifth discipline: The art and science of the learning organization*, New York, NY, Currency Doubleday.
- Valve Corporation, 2018. *Best of 2017: Top sellers* [Online]. Available: https://store.steampowered.com/sale/2017_best_sellers/ [Accessed April 30, 2018 2018].
- Washburn, M. J., Sathiyarayanan, P., Nagappan, M., Zimmerman, T., Bird, C., 2016. What went right and what went wrong: An analysis of 155 postmortems from game development. *Proceedings of the 38th International Conference on Software Engineering Companion, 2016*, ICSE '16, 280-289. doi: 10.1145/2889160.2889253
- Weber, A., 2005. *Data-driven business models*, South-Western Pub.
- xPaw, Marlamin, 2018. *Steam online charts: Concurrent steam users* [Online]. Available: <https://steamdb.info/graph/> [Accessed April 30, 2018 2018].
- Yourdon, E., 1997. *Death march*, Prentice Hall PTR.