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Investigating the Impact of Latency in Mobile-Based Multiplayer Online Battle Arena (MOBA) Games

Tan Chin Ike
citan@kdu.edu.my
University of Wollongong Malaysia KDU University College, Malaysia
University of Wollongong Malaysia KDU Penang University College, Malaysia
ORCID iD: 0000-0003-0237-4295
(Corresponding Author)

Tan Wee Hoe
Universiti Pendidikan Sultan Idris, Malaysia
ORCID iD: 0000-0001-7582-2859

Siti Fazilah binti Shamsudin
University of Wollongong Malaysia KDU University College, Malaysia
University of Wollongong Malaysia KDU Penang University College, Malaysia
ORCID iD: 0000-0002-0229-3797

Sujata Navaratnam
University of Wollongong Malaysia KDU University College, Malaysia
University of Wollongong Malaysia KDU Penang University College, Malaysia
ORCID iD: 0000-0003-1616-204X

Ng Yiing Y'ng
University of Wollongong Malaysia KDU University College, Malaysia
University of Wollongong Malaysia KDU Penang University College, Malaysia
ORCID iD: 0000-0001-6407-5421

Abstract

The mobile games industry dominates across Southeast Asia, a region reportedly with the highest smartphone ownership in the world and surprisingly, a below world average Internet speed in general. This begs the question then, how much latency is required for mobile games especially in competitive gaming? This research aims to examine players' perceived experience of latency in mobile games and how much latency drop would affect the players overall gameplay experience. Through a controlled testing environment and a variation of latency through a throttling system, the research was able to determine at which point the players perceived a drop in game playing experience. A group of 29 participants played

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nine rounds of popular MOBA game - Mobile Legends: Bang Bang (MLBB) sessions which were randomly conducted in a dedicated physical location. Each play session was around two hours, and all participants played a minimum of two games within that session. After each play session, the participants were given a survey of six questionnaire items to rate their perceived latency and the overall game playing experience. One-way ANOVA tests were run to determine whether there was significant difference across nine latency rates. The findings revealed that the optimum latency for playing MLBB was 55ms. However, the players' game performance was affected beyond the 55ms range, in which negative game playing experience may start to build. Thus, the research found that the optimum latency range for enhanced player performance and experience can be set at the 55ms rate and below when playing MOBA games on a mobile platform.

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Introduction

Video games are culturally one of the most popular recreational activities of the past two decades (Bányai, Griffiths, Király, & Demetrovics, 2019). The medium has evolved tremendously since the start of the entire video games revolution in 1958, thanks to Willy Higginbotham and his Tennis for Two game (Genres, Renteria & Irwin, 2017; Marras & Gadia, 2019). Video games are now sophisticated constructs that may contain hyper-immersive gameplay, photorealistic graphics, or large-scale persistent worlds. Adding to that recipe for success is an ever-increasing broadband Internet capability that has proven to be a key driver of growth for the video game industry (EIBN Sector Reports, 2016) resulting in an improved and a more interactive online experience. This has allowed an increasing number of developers and players to explore online games as an avenue for social game playing especially focusing on competitive electronic sports (eSports). Esports is now proving to be a fast-growing form of digital entertainment that highlights the core gaming mechanism and play experience of video games (Freeman & Wohn, 2017). According to Sjoblom et al., (2019), eSports can be defined as "a form of sports where the primary aspects of the sport are facilitated by electronic systems; the input of players and teams as well as the output of the eSports system are mediated by human-computer interfaces".

The growth of eSports can also be attributed to improved browsing speeds and rapid 4G networks (4g.co.uk, 2020). While not every player is fortunate enough to have access to a fibre broadband connection,

mobile broadband networks offer an alternative solution. 4G networks afford lower pings than the older 3G networks, resulting in an improved playing experience, and 5G technology will provide capabilities beyond that. Is it any wonder then, that revenues in mobile content especially for online mobile games have finally surpassed PC and consoles? By the end of 2020, the global mobile game industry is forecasted to generate over USD$100bn. In 2019, mobile games generated 25% more consumer spending that console, and PC gaming combined (Broughton, 2020). While market research analysts, Niko Partners (2020) stated that in China alone, the revenue of eSport games reached USD$19.9bn in 2020 and is expected to rise to USD$23.2bn by 2024. Nonetheless, it is worth noting that the revenue share of mobile games may also be attributing to the effects of mobile device reach and the effects of providing an app ecosystem that is mostly open to all entrants (Levin, 2014).

Background

The biggest benefactor of this mobile broadband technology revolution and penetration is the Southeast Asian game industry particularly in mobile games (The ASEAN post, 2020). According to Weustink (2020), in 2017 the Asia-Pacific region accounted for half of the of global eSports enthusiasts and that 82% of the region's urban online population are game players. He also stated that mobile games are the most played platform in the Southeast Asia. It is no surprise then, that the Southeast Region generated game revenues of up to $4.4 billion in 2019 (Fernandes, 2019) and the trend fueling this phenomenal growth is arguably the rise of eSports. Malaysia, as part of the ASEAN region in 2016 hosted the first regional ASEAN Games for eSports with a prize pool of around USD256,000 (The ASEAN post, 2020). Due to the ubiquitous nature of mobile phones and low barrier of entry for game developers in the mobile space, mobile games have experienced a proliferation unlike others in Southeast Asia.

However, despite this spike in mobile game players, Internet penetration in Southeast Asia is relatively poor. Only three countries in this region have over 80% Internet penetration (Jalli, 2020). While there have been improvements over the last few years, many families in this region are not able to afford unlimited and stable Internet connection. There is still an infrastructural gap within different regions which is the discrepancy of Internet speed and latency. For example, although being one of the more developed nations in Southeast Asia, Malaysia still faces low-speed and pricey broadband (Wong, 2018) which is a barrier to the nation's development and its adoption of digital technology. Alam, Sultana and Rayhan

(2019) states that although the rate of increase in broadband penetration is much slower for the South Asian countries than other developed countries, the use of mobile phones across these countries are just as prevalent. This dichotomy whereby on one hand, mobile games are the most played platform in the Southeast Asia and on the other, that the same region has very poor internet and mobile broadband penetration requires some answers. The question should be asked - just how a latency is required for competitive gaming.

To answer this question, a controlled research project was conducted to ascertain the effectiveness of latency on a real-time multiplayer game using a mobile device. This was done to understand a player's tolerance on low latency within the game experience and to track what is the tolerable level that mobile game players find acceptable. The first step in this controlled research project would be to choose an online game that is played extensively in Southeast Asia as both a competitive game and an online mobile game. As stated before, there is a gradual shift in the way Southeast Asian game players consume content due to the accessibility of mobile phones and mobile broadband. More and more game players in this region have switched from traditional online and eSports games like Defense of the Ancients (DOTA) 2 and Counter Strike Global Offensive (CSGO) to mobile games like Mobile Legends: Bang Bang (MLBB), Call of Duty Mobile, Hearthstone and PUBG Mobile. According to Lai (2020), in 2019, the Malaysian MLBB players accounted for 17% of the game's total revenue. IGN Southeast Asia notes that in both Singapore and Malaysia, the top grossing mobile game of 2019 is MLBB. In fact, MLBB was also featured as a part of the Southeast Asian Games 2019. The SEA games 2019, which is a sports competition sanctioned by the International Olympic Committee was a historical event where it marked the first time that an electronic game was played as a medal event (Ahmed, 2019). Hence, choosing Mobile Legends: Bang Bang is the ideal option as this game has among the highest requirements for low latency gameplay.

Carreira (2017), stated that latency is a critical element for online games as it determines how quickly data is communicated across a network. Games that rely on quick communication between device and server needs to have low lag times to function effectively. According to Carreira (2017) who did a comparison test between four mobile games and using network tools to manipulate latency, upload and download speeds at different levels to see its effects on gameplay, 50ms is the ideal speed for most online games. He states that MLBB of all the games tested requires a fast download speed due to rich graphics and demanded the highest upload speed as the game needed to constantly output information to the server. This statement may prompt a debate since download of rich graphics would not cause the latency since the

graphics were presumably downloaded and cached on the mobile device before playing the game. MLBB's outputs are mostly movement, instant player/avatar actions and chats all requires transmissions across the network. The game output and latency have a direct effect on gameplay. In MLBB, the latency is constantly displayed in a ping counter. Ping signals are measured in milliseconds (ms), which is the indication of the length of time it takes for a packet of data to travel between the mobile device (MLBB game) to the server and back, taking in consideration the actions of the other nine players as well. That measurement is referred to as the latency between the computer and its server. In most cases, the optimal value of a ping signal is in the lower two-digit range but sometimes depending on the connection or the server location, the ping rate can rise to a higher three-digit value.

According to Ward et al. (2017), geographical location of servers is associated with latency as certain servers located in certain regions may cause transmission delays between server and player. The terms high ping and low pings are numbers associated with latency that are measured within a certain range. In gameplay, any ping amounts lower than 20ms is considered very good. Ward et al., (2017), stated that a delay of up to 80ms is usually acceptable for most players. The statement was supported by de Moura, Araújo, Callado and Jucá (2019) who found low ping and latency rates between 50ms to 100ms are considered acceptable, while ping rates of 150ms and more are considered high pings and are detrimental to a good game experience especially in eSports (Dobbin, 2020). Despite offering a good indication of the speed and latency required for optimal game playing experience, the study conducted by Carreira (2017) was based on one device and person under a non-controlled environment; while de Moural et al (2019) was focusing on latency of an instance of MOBA (i.e. DOTA 2) played on personal computer (PC).

Hence, the goal of this case study was to verify the results of another instance of MOBA within a controlled environment. Two questions need to be answered. i) just how much latency drop would affect eSports enthusiasts' perception of MOBA? ii) Is there a difference in players' perception between a range of latency rate in mobile-based MOBA eSports? The null hypothesis of this study was: there is no significant difference in players' perception of latency between a range of latency rate when playing MLBB for eSports. The independent variable was the latency rate, while the dependent variable was the players' perception of latency, with a significance level or alpha of 0.05.

Research Methods

This research paper aims to understand the player's perception on latency in mobile-based MOBA game experiences and to track what are the tolerable levels of lag that these players accepted. The context of this research was Malaysia, where MLBB was chosen as an instance of MOBA. In this sense, this research was conducted as a single case to yield analytic generalization (Yin, 2017), although statistical tests were run when analyzing the latency data. The findings of this MLBB case study and the answers to both research questions would form analytic generalizations in terms of latency benchmark for other MOBA eSports games. Through the utilization of a controlled testing environment and a variation of latency through a throttling system, the research was able to determine at which point the players perceived a drop in game playing experience.

The case study was carried in a private university located in the central urban region of Peninsular Malaysia, and it involved having two groups of participants tested in a period of two days. A total of 29 participants were recruited on volunteering basis among students in the university population (see Table 1). The key selection criterion was that participants must be seasoned game players who had experience playing various online mobile games, assuming the experience can afford them to be sensitive enough to detect the latency. Most participants have been playing games for at least 3 years (27 out of 19), while over more than three quarters (23 out of 29) have over 5 years of experience. In terms of MLBB playing experience, more than one-third of the participants have been playing MLBB for over 6 months. Most participants (27 out of 29) were either somewhat comfortable or very comfortable when using a mobile device to play games, and they often use the Internet to play their games once or more a day (26 out of 29).

Table 1 Demographic profile of research participants

Characteristics		Count	Total
Age	18 – 21 Years old	21	29
	22 – 26 years old	8	
How long have you been playing video games?	3 < years	2	29
	3 – 5 years	4	
	5 – 10 years	11	
	>10 years	12	
How often do you play games on your mobile phone?	0 – 2 hours per day	11	29
	3 – 5 hours per day	15	
	>6 hours per day	3	
How comfortable do you feel when using a mobile device to play games?	Not very comfortable	2	29
	Somewhat comfortable	15	
	Very comfortable	12	
How often do you use the Internet to play your games?	Once or more a day	26	29
	A few times a week	3	

How long have you been playing Mobile Legends?	Less than a month	7	29
	1 – 6 months	11	
	6 – 12 months	3	
	> 12 months	8	
How do you see yourself as a Mobile Legends player?	Beginner	3	29
	High Beginner	12	
	Intermediate	11	
	Advanced	3	
Which network do you normally use to play online games with your mobile phone?	Wifi	19	29
	Mobile data	10	

For the various latency ranges, the participants were tested if they perceived a significant drop of latency when playing MLBB. The exact definition of lag during a game playing session differs from player to player; and from game to game (Long & Gutwin, 2018) but generally anything more than a delay of 3 seconds for skill or spell casting or a game freeze of 3 seconds constitutes a serious lag. Minor jitters or game stutters which is basically a minor fluctuation of latency over time is acceptable for most players. However, a high fluctuation of latency will give the game an unpredictable performance and affect game playing especially during periods when perfect timing is essential to winning.

To verify the findings of optimal latency stated in past studies, the range of latency rate included 3 instances (30ms, 35ms & 40ms) less than or equal to 40ms latency (see British Esports Association, 2020), 2 instances (45ms & 50ms) less than or equal to 50ms latency (see Carreira, 2017) and 4 instances (55ms, 60ms, 65ms & 70ms) less than or equal to 70ms latency (see de Moural et al, 2019). In practice, 9 rounds of play sessions were randomly conducted in a dedicated physical location. Each play session was around 2 hours and counted as one set of samples, where all participants played 2 to 3 games within that session. A typical MLBB session usually lasts around 30 to 45 minutes per game. The shuffling of volunteering participants was used to randomize the play experience in order to provide an element of chance in the study, in which 14 out of 29 volunteering participants were randomly recruited to take part in one of the nine sessions. The 14 participants were split into two groups in order to run the test based on the optimal server load. This limit set for each play session was determined as the optimal capacity, as these participants used the same wireless network and hub, which went through a throttling software to limit the bandwidth and latency in order to set the controlled game playing environment.

The test also ensured that the mobile devices were all within a similar specification of Quad-core 1.2 GHz Cortex-A53 for Android phones and Quad-core 2.34 GHz for iPhones (iPhone 7 or better). All the requirements and conditions that were present on the first day test was also implemented in the second

day test. Calibration sessions were also carried out before and in-between the data collection sessions by setting the 3 extreme latency rates (20ms, 100ms & 300ms) and 6 normal latency rates (40ms, 50ms & 70ms) to assure the direction of perceived latency was matching the physical setting of latency. Data collected during these calibration sessions was discarded and excluded in the data analysis process.

After each play session, the participants were given a survey of six questionnaire items to list down their overall game playing experience using a five-point Likert scale:

- Q1: On the scale of 1-5 (1 – Not Serious, 2 – Slight, 3 – Moderate, 4 – Serious, 5 – Very Serious), how serious was the lag or drop in the latency (example: ping/packet loss) overall?
- Q2: On the scale of 1-5 (1 – Never, 2 – Seldom, 3 – Sometimes, 4 – Very Often, 5 – Always), how often did you encounter lag during gameplay?
- Q3: On the scale of 1-5 (1 – Negligible, 2 – Around 3 - 5 seconds, 3 – Around 10 seconds, 4 – Around 20 seconds, 5 – More than 30 seconds), how long did the lag last?
- Q4: On the scale of 1-5 (1 – Very Related, 2 – Related, 3 – Neutral, 4 – Somewhat Related, 5 – Not Related), to what degree do you felt lag was related to the time of game playing?
- Q5: On the scale of 1-5 (1 – Never, 2 – Little, 3 – Sometimes, 4 – Much, 5 – A Great Deal), to what degree did the lag affect your game playing?
- Q6: On the scale of 1-5 (1 – Terrible, 2 – Bad, 3 – Neutral, 4 – Good, 5 – Great), how would you rate your overall game playing experience?

On average, this involved at least two games in three separate sessions during the day – morning, afternoon, and evening sessions. This ensured the allowance of the game servers when being loaded on various times of the day were also tracked.

Research Findings

Using SPSS, the assumption of homogeneity of variances was tested on each questionnaire item, as shown in Table 2. Item Q1 and item Q3 were found violating the assumption of homogeneity of variance, thus no further inferential statistical analysis was considered on these items to avoid falsely rejection of null hypothesis. One-way ANOVA tests were run to determine if there is a significant difference in means scores

on the participants' perception upon remaining questionnaire items. As a result, significant differences were found in item Q2, item Q5 and item Q6.

Table 2 Participants' perception on MLBB playing experience under different latency rates (THV: Test of Homogeneity of Variances; ANOVA: One-way Analysis of Variances)

In the scale of 1 to 5…	Latency (ms)	Rating					N	Mode	Median	Means	Std. Deviation	THV Sig.	ANOVA Sig.
		1	2	3	4	5							
… how serious was the lag or drop in the latency (i.e. ping / packet loss) overall?	30	0	3	5	3	2	13	3	3	3.31	1.032	.040	.000
	35	3	1	6	4	0	14	3	3	2.79	1.122		
	40	1	4	4	5	0	14	4	3	2.93	.997		
	45	1	2	1	8	2	14	4	4	3.57	1.158		
	50	0	2	8	1	3	14	3	3	3.36	1.008		
	55	0	0	0	4	10	14	5	5	4.71	.469		
	60	1	4	0	8	1	14	4	4	3.29	1.204		
	65	0	1	6	7	0	14	4	3 & 4	3.43	.646		
	70	0	2	5	7	0	14	4	3 & 4	3.36	.745		
…how often did you encounter lag during game playing?	30	0	3	6	3	1	13	3	3	3.15	.899	.083	.001
	35	1	3	4	6	0	14	4	3	3.07	.997		
	40	0	3	4	7	0	14	4	3 & 4	3.29	.825		
	45	0	1	2	9	2	14	4	4	3.86	.770		
	50	0	2	9	2	1	14	3	3	3.14	.770		
	55	0	0	0	12	2	14	4	4	4.14	.363		
	60	0	3	6	5	0	14	3	3	3.14	.770		
	65	0	1	4	9	0	14	4	4	3.57	.646		
	70	0	1	9	4	0	14	3	3	3.21	.579		
…how long did the lag last?	30	0	0	0	12	1	13	4	4	4.08	.277	.018	.000
	35	0	1	3	8	2	14	4	4	3.79	.802		
	40	0	0	2	10	2	14	4	4	4.00	.555		
	45	0	0	0	9	5	14	4	4	4.36	.497		
	50	0	2	1	10	1	14	4	4	3.71	.825		
	55	0	0	0	3	11	14	5	5	4.79	.426		
	60	0	0	4	10	0	14	4	4	3.71	.469		
	65	0	0	2	12	0	14	4	4	3.86	.363		
	70	0	0	2	8	4	14	4	4	4.14	.663		
…to what degree do you feel lag was related to the time of game playing?	30	1	1	3	6	2	13	4	4	3.54	1.127	.211	.259
	35	0	3	3	5	3	14	4	4	3.57	1.089		
	40	0	1	6	6	1	14	3 & 4	3 & 4	3.50	.760		
	45	0	0	2	6	6	14	4 & 5	4	4.29	.726		
	50	1	1	5	3	4	14	3	3 & 4	3.57	1.222		
	55	0	0	1	5	7	13	4	5	4.14	1.351		
	60	0	1	5	7	1	14	4	4	3.57	.756		
	65	0	1	4	9	0	14	4	4	3.57	.646		
	70	0	0	6	7	1	14	4	4	3.64	.633		
..to what degree did the lag affect your game playing?	30	1	2	5	4	1	13	3	3	3.15	1.068	.514	.001
	35	1	5	3	5	0	14	2 & 4	3	2.86	1.027		
	40	2	1	4	6	1	14	4	3 & 4	3.21	1.188		
	45	0	1	2	7	4	14	4	4	4.00	.877		
	50	0	3	5	5	1	14	3 & 4	3	3.29	.914		
	55	0	0	1	7	6	14	4	4	4.36	.633		
	60	0	4	4	6	0	14	4	3	3.14	.864		
	65	0	2	5	7	0	14	4	3 & 4	3.36	.745		
	70	0	2	6	5	1	14	3	3	3.36	.842		
…how would you rate your overall game playing experience?	30	0	0	5	7	1	13	4	4	3.69	.630	.174	.000
	35	0	5	3	5	1	14	2 & 4	3	3.14	1.027		
	40	0	4	2	7	1	14	4	4	3.36	1.008		
	45	0	0	5	4	5	14	3 & 5	4	4.00	.877		
	50	0	0	9	3	2	14	3	3	3.50	.760		
	55	0	0	0	7	7	14	4 & 5	4 & 5	4.50	.519		
	60	0	5	4	4	1	14	2	3	3.07	.997		
	65	0	2	7	4	1	14	3	3	3.29	.825		

Perceived Often Encounter of Lag during Game Play

When the participants were asked to rate how often they encountered lag during game playing across nine different latency rates, the assumption of homogeneity of variances was tested and found tenable using Levence's test F(8, 116) =2.112, p =.083. ANOVA test result showed a significant difference (p<.000) in means scores on the players' perception. Post hoc test indicated that significant differences exist between 35ms (Means: 3.07) and 55ms (Means: 4.14); 50ms (Means: 3.14) and 55ms, and 55ms and 60ms (Means: 3.14), with small effect size (Eta Squared =.194). In this sense, latency rate of 55ms was perceived as the most often encountered lag when playing MLBB in the study.

Perceived Degree of Lag that Affected Game Play

When the participants rated the degree that the lag affected their game playing across nine different latency rates, the assumption of homogeneity of variances was tested and found tenable using Levence's test F(8, 116) =.906, p =.211. ANOVA test result showed a significant difference (p =.001) in means scores on the players' perception. Post hoc test indicated that significant differences exist between 30ms (Means: 3.15) and 55ms (Means: 4.36); 35ms (Means: 2.86) and 45ms (Means: 4.00); 35ms and 55ms; 40ms (Means: 3.21) and 55ms; and 55ms and 60ms (Means: 3.14), with small effect size (Eta Squared =.199). In this sense, latency rate of 55ms was rated as the highest degree the lag affected the playing of MLBB in the study. One respondent stated, "At morning the ping was quite good where it didn't exceed 30ms but after lunch because of the server loads it was always above 60ms and sometimes 100ms. That affected gameplay a lot."

Perceived Degree of Lag that Affected Game Play

Perceived Overall Game Playing Experience

When the participants were asked to rate the overall game playing experience across nine different latency rates, the assumption of homogeneity of variances was tested and found tenable using Levence's test F(8, 116) =1.475, p =.174. ANOVA test result showed a significant difference (p<.000) in means scores on the players' perception. Post hoc test indicated that significant differences exist between 35ms (Means: 3.14) and 55ms (Means: 4.50); 40ms (Means: 3.36) and 55ms; 55ms and 60ms (Means: 3.07); 55ms and 65ms (Means: 3.29); and 55ms and 70ms (Means: 3.43), with small effect size (Eta Squared =.211). In this sense, latency rate of 55ms was rated as the overall best game playing experience of MLBB in the study. Lag spikes, however, create a negative play experience. This is evident in the survey feedback where some of the respondents stated, "When ping spikes, the ability to move around the map is greatly hindered and interrupts the gameplay experience especially for a MOBA game where dodging abilities is crucial." Another

respondent states that the overall gameplay was all around acceptable except for occasional lag spikes which ruins the gameplay experience.

Discussions

In terms of players' perception of lag encounters during game play, the lag issues or the perception of lag noted during gameplay session for all latency ranges, the standard deviation is much higher in the <40ms ranges than the other ranges. The findings showed that even at the <40ms range, lag would still occur occasionally as spikes of around 100ms, which is also termed as jitters, do happen from time to time (Mo, Zhu, Wang & Zhu, 2018). This indicates that the perception or encounter of lag is always evident regardless of latency but at the 50ms and above ranges, more players are perceptive of the drop in gameplay experience due to lag. For the degree of lag that affects gameplay, the indication is that after a certain point – the drop in latency is felt at the 55ms onwards range. Again, while there is an even distribution of responses to the question, the standard deviation is much higher in the <40ms ranges than the other ranges. This indicates that after the 40ms threshold, the degree of lag that affects gameplay is more evidently felt at the 50ms and above latency ranges primarily in the 55ms range. Perhaps at the higher latency ranges, the lag is more constant while in the 55ms range, the lag is more keenly felt as the latency straddles between good performance and staggered responses. For the perception of overall game playing experience, while it would be expected that the <40ms ranges would have the best responses for positive gameplay, the indication is that in terms of player experience, a consistent gameplay performance is more appreciated that a gameplay experience with intermittent spikes. The 55ms range, while being perceived as the most often encountered lag and the highest degree the lag affected when playing MLBB in the study, it is also the optimum playing experience. This indicates that the probable latency threshold for a good positive gameplay is the <55ms ranges. This verifies the statement by Carreira (2017) who indicated that 50ms is the ideal speed for most online games. The test done by Carreira (2017) was based on one device and one person under a non-controlled environment while this research has a larger and more diverse respondent count. This also adjusts the statement by Ward et al. (2017), that a delay of up to 80ms is usually acceptable for most players. This research indicates that for mobile games in particular, perhaps 55ms is the minimum acceptable limit for latency for a positive gameplay experience.

Conclusion

Generally, what this research showed is that players did not feel a significant change in performance during game playing when the latency rate was less then 55ms, and minor fluctuations in ping or latency were actually tolerable. The players within this range were not affected significantly when the latency rates fluctuated within the range of 30ms to 55ms and they would continue to play with no indication of performance issues even though the lag was noticed. Even though the latency did spike and there were variation changes between the 30ms to 55ms ranges, the players did not feel any significant gameplay performance issues. The indication is that up to 55ms ranges were considered the optimum latency ranges for overall mobile-based Multiplayer Online Battle Arena (MOBA) eSports game experience whether competitively or casually. However, above the 55ms range, particularly in the 70ms range and above, the players' game performance was affected, as with their overall game-play experience and the players were more acutely aware of the drop in performance. This showed a significant difference in terms of player respondents' game experience at the 70ms and above. This means that in terms of gameplay (for Mobile Legends and the hypothetical scenario that other games could create a similar type of performance), the optimum latency range for enhanced player performance and experience is at the 55ms range threshold and anything above this would significantly contribute to decrease in player gameplay experience and performance. Hence, this research showed that for MOBA games, latency at the 55ms and below ranges are ideal and anything above that range would start to slowly affect MOBA game players and their experience. Anything above that would see a drop in player performance especially in the area of competitive gaming. This is also echoed by de Moura et al., (2019), who stated that latency ranges of 50ms and 100ms levels impacted and influenced player performance. Future research would need to be conducted in the area of competitive gaming performance and other genres of mobile games including first-person and third person shooter games as well as racing mobile games. The possibility of also conducting a similar experiment but with a larger pool of test subjects to obtain more conclusive data will be particularly interesting. It would be valuable to separate subjects by mobile game playing experience between casual gamers and esports professional to analyze how these changes the overall results of latency perception.

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