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RESEARCH

How Randomness Affects Player Ability to Predict the Chance to Win at *PlayerUnknown's Battlegrounds* (PUBG)

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Abstract
This paper discusses how random factors affect player ability to predict the chance of winning the video game *PlayersUnknown's Battlegrounds* (PUBG) which is a genre of the *Battle Royale* online video game. The purpose of this study is to investigate the influence of random factors such as location, air drop, playzone, and weapon accuracy on the chance to win at PUBG. The study tested and used the *random effects model* where location, air drop, playzone, and weapon accuracy are classified as external factors that influence a perceived randomness in the game. Perceived randomness and perceived skills are predictors of the player's chance to win at this game. The proposed research model was tested by the *partial least squares regression* method of *structural equation modelling*. The study utilized an online survey to obtain data from 128 PUBG players. The data set was analyzed using SmartPLS 3 software. Results showed that the factor that best predicted levels of perceived randomness was weapon accuracy, followed by the playzone feature. The chance to win is predicted by the perceived randomness of the game as well as the perceived skill of the player. The findings presented in this paper shed light on the concept that randomness factors may determine the likelihood of winning at PUBG and may be relevant and of interest for players and spectators of other e-sport games.

Keywords Randomness · e-sport · PUBG · Video games · *Battle Royale*

1 Introduction

Over the last two decades, e-sport has followed the trend for traditional sport and has become extremely popular, attracting increasing numbers of viewers and generating escalating profits. However, the random factors that could affect player ability to

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predict their chances of winning a traditional sports game differs from those affecting e-sport. Currently, the rules surrounding football matches, golf tournaments, and most other traditional sports are aimed at levelling the chances for each team/player so that the result is dictated solely by player skill. Within the gaming industry, an important factor contributing to financial success is player engagement. This drives the requirement for publishers to introduce random elements into their games to reduce monotony and increase the level of thrill and commitment for players. This means that player skill is not the only element that may determine success as randomness is a deliberate feature of game design.

E-sport is an organized video game where participants compete on different virtual platforms. It was first developed in the 1990s as *First Person Shooters* and has now evolved to include various genres of games such as massive multiplayer online role-playing games (MMORPGs), multiplayer online battle arenas (MOBA), real-time strategies (RTS), *Battle Royale*, fighting, and many more (Zagała and Strzelecki 2019). Many people, especially players, like to watch e-sport games (Macey and Hamari 2018). They can easily access professional gaming venues by visiting websites or streaming platforms such as YouTube and Twitch (Sjöblom and Hamari 2017). On these platforms, they can follow championships, interact with similar enthusiasts of e-sport, and provide real-time feedback to both players and organizers. There are debates about whether e-sport should be considered as a traditional sport (Pizzo et al. 2018). Some researchers argue that because e-sport meets all the conditions for sport, it should be considered as such (Stępnik 2009). At the same time, research indicates that online computer games have become a universal feature of today's culture (Johnson et al. 2019) and that watching e-sport can be regarded as a similar activity to watching traditional sport (Macey and Hamari 2018). This most frequently occurs while watching a live Internet broadcast when viewers can also participate in social interactions such as in an online chat forum (Hamari and Sjöblom 2017). Although e-sport gaming availability is primarily accessed via personal computers and consoles, each year, popularity is increasing for using mobile devices to play these games (Arkenberg et al. 2018).

Battle Royale and First Person Shooter (FPS) games share common features and provide players with similar skills during a combat situation. However, the main aim for each game differs. *Battle Royale* games have similar gameplay features to those of FPS games which make it easier for the player to understand the game, but they also have unique features that provide a gameplay experience previously unknown to the player. This has driven a requirement to create the specific category of *Battle Royale* as it enables a clear differentiation between these game genres (GyuHyeok Choi 2018).

PUGB is a recent version of the *Battle Royale* game which was based on the film that was released in 2000 (it was originally called "*Batoru Rowaiaru*"). This is where a group of junior high school students are forced by the Japanese government to fight to the death in an alternative reality where the economy has collapsed, juvenile delinquency has erupted and unemployment is rampant. Inspired by this film, Brendan Greene (PUBG's creative director) helped create a 2009 modification called *DayZ* for the video game ARMA 2. This is an open military simulation, developed and published by Bohemia Interactive for Microsoft Windows. The term

'modification' ('mod') refers to a change of program made by players or fans of a given video game. 'Mods' allow one or more aspects of a game to change in appearance or operation. *DayZ* was officially released on 16 December 2013 and was later released in 2019 on other platforms, such as Xbox One and PlayStation.

In late 2014, Sony Online Entertainment asked Greene to participate in the creation of a game called *H1Z1*. In early 2016, the collaboration resulted in the creation of two game modes called *H1Z1: Just Survive* and a version of *Battle Royale* called *H1Z1: King of the Hill*. In 2016, Greene moved from Sony Online Entertainment to the Korean Bluehole game studio and in June 2016, PUBG publicly announced a plan to complete the game within a year. With this announcement, the game appeared on Steam while still undergoing the "alpha" and "beta" test periods, and enabled players to buy the game despite it being in this developmental stage. To Bluehole's surprise, the sudden interest in the PUBG game exceeded their expectations and in December 2017, the game finally ended its "beta" period becoming a fully fledged PC game. On 4 September 2018, PUBG was officially released on PCs and was also published on Xbox Live; on 4 December 2018, it then appeared on Playstation 4 (Aguilar 2019).

When starting a PUBG game, players can choose from four different game modes: "Solo", "Duo", "Squad", and a one-person version of "Squad". A "Solo" mode is when a player decides to play alone and face 99 other players to be the last survivor. In this mode, everyone is considered an enemy and is the default way to play *Battle Royale*. "Duo" mode is unique because the player can work with a friend or another player to form a team but also can work with other "Duo" teams. There is a total of 50 teams in "Duo" mode, each consisting of two members per team. Playing in this team manner will speed up cooperation by allowing four players to work together (i.e., where two "Duo" teams form a "Squad" team). Here, only 25 teams are allowed, mainly due to the 100-player limit. However, an exception occurs when the lobby does not reach this 100-player limit; in this instance a one-person "Squad" team can be formed from one player. A unique challenge when playing in a one-person "Squad" is that one player can fight in a mode where the odds can be four against one. One of the reasons why players choose to play in this one-person version of "Squad" is the satisfaction of winning when the opponent has such a big advantage. In addition to choosing these game modes, players can choose a perspective which refers to the view that players see on the screen. They can choose either a third-person perspective to see the character on the screen, or to view the action from a first-person perspective through the eyes of their character.

Each match starts with a parachute jump from a plane to one of four maps. The map's flight path map changes in each match which requires players to quickly determine the best time to jump and open the parachute. Players start without equipment except for a custom clothing choice that does not affect the game.

Then players must use the resources scattered on the map to increase their chances of survival. Resources include weapons such as assault rifles, sniper rifles, pistols, weapons accessories, or protection such as bullet-proof vests and helmets that can be found in various locations. In addition, means of transport, such as boats and cars, are available., Everything that a player may need in the fight against opponents can be found somewhere on different maps of the game. However, the

resources are finite which means that there is only a certain amount of each available resource. Therefore, players and teams need to use different strategies or get more items from other players to increase their chances of winning or will die in the process of trying (Aguilar 2019).

Since 2019, PUBG involves the use of four maps in four different environments: Erangel, Miramar, Sanhok, and Vikendi. Erangel takes place on a large island with a diverse terrain including giant mountains, forests, a smaller military island, and small towns. Miramar is a map similar to Erangel, but presents a desert environment where the lack of larger forests and difficult terrain is exchanged for larger cities and more roads for vehicles. Sanhok is the smallest map of the four and takes place on a tropical island similar to those found in South East Asia. There are more trees and fewer vehicles, but with more cliffs, plateaus, and dense vegetation where players can hide or use as a cover. Vikendi is a snow map and is considered to be the second smallest PUBG map. Unlike other maps, part of the river is frozen, and snow vehicles appear to cover difficult terrain. There are more diverse locations such as vineyard, castle, Dinosaur Park, and coal mine (Aguilar 2019). The map dimensions are as follows: Erangel and Miramar, 8×8 km; Vikendi, 6×6 km; Sanhok, 4×4 km (Rokad et al. 2019).

As in the *Battle Royale* movie, if a certain amount of time passes, players are forced to get closer to a certain location. In PUBG there is a similar feature called "playzone"—this is a game zone, also known as "the circle", which deals permanent damage to players who remain outside the circle. The circle is designed to force players to relocate if they don't want to risk death. Without the circle, players wouldn't have the motivation to either hunt for other players or wait for them in the hope of a successful ambush. The game zone mechanism is used to speed up the game (Aguilar 2019).

Shortly after its premiere, PUBG gained incredible popularity. By 2017, it had become the most-watched new game on Twitch, resulting in the transmission of 4.5 million hours of cumulative e-sports and 534.6 million hours of non-e-sports. In the following years, these values steadily increased (Newzoo 2020). The first e-sport tournament of the PUBG game was Gamescom PUBG Invitational 2017, which took place from 23 August 2017 to 26 August 2017. At the peak of its popularity, and with a prize pool of $350,000, it attracted 382,331 spectators in front of their monitors. These figures indicate the high popularity of the game, although at this point it still hadn't even had an official premiere. It became obvious that this trend would continue with increasing numbers of players participating. By 2020, there were many more tournaments, both local and international. One of them, the PUBG Global Championship 2019, was held last year from 8 November to 25 November with an initial prize pool of $2 million. This amount was then increased to reflect a final prize pool of $4 million which was funded from the sale of specially created cosmetic items. The winner was expected to receive 50% of the prize pool. The tournament was won by the Korean-American e-sport team Gen.G E-sports (Escharts 2019; Liquipedia 2019).

E-sport is a relatively new phenomenon; although an increasing number of scientific studies have been published, some areas are yet to be explored thoroughly. One such area is the impact of randomness on gaming results. This is probably due to the

complexity of the game, its constantly changing environment as a result of successive versions being published, as well as its rapidly changing rules.

Randomness is a concept that is not easy to define. However, mechanisms that are by definition random, such as the toss of a coin, can generate a series of results that do not seem random (Bar-Hillel and Wagenaar 1991). Dice games have also been an early part of human culture. When randomness is included in computer games, it includes different variations of the simulated dice toss. Some players are not too fond of randomness, especially strategy game players, because they feel that it invalidates any achievements they have made. Nevertheless, randomness is inherent in many computer games. In FPS games, shotgun accuracy can be random due to the multiple pellets that are contained in one shell which can cause a wide "spread" of pellet range. This is not the case for Role Playing Games (RPGs) as there is often a chance of a "critical strike" which drastically increases the damage per attack. Through uncertainty, randomness creates a sense of drama because players will commit to an action despite the outcome depending on luck. In computer games, randomness is not really random because any random number generated by a computer is actually pseudorandom. Computers can never create purely random numbers because the numbers created are always the result of algorithms. However, they do provide an impression of randomness (Fort 2015).

Randomness in previous studies was discussed from different perspectives. One perspective is gambling and addition. With randomness are connected loot boxes (von Meduna et al. 2020). Buying loot boxes, players increase their own chances to win, but they do not know what is inside the loot box. Another perspective is a mathematical solution to generate random numbers for creating randomness effect in games (Alimomeni and Safavi-Naini 2015). In our study, we have pointed on four major elements in PUBG which create the effect of perceiving randomness in the game. To our best knowledge, there was no prior study analyzing players' randomness perceiving.

The motivation behind this study is to explore randomness in PUBG e-sport games. Each PUBG game is built on several random elements. The authors would like to explore how PUBG players perceive randomness and how it affects a chance to win. This paper presents the findings from a survey of PUGB players and investigates how the random aspects of the game affect player outcomes.

2 Materials and Methods

2.1 Hypotheses Development

2.1.1 Random Landing (RL)

Each player starts a PUBG game with a parachute jump and is without any equipment except for a custom clothing choice that does not affect the game. The equipment necessary to provide the opportunity to defeat the opponents must be found on the game map (Aguilar 2019).

Not finding any weapon during the first few minutes of the match is equivalent to a death sentence for a player's character (Dagdee and Philip 2019). These items are placed procedurally on the map at the beginning of the match, with some high-risk zones containing better equipment. Players who are killed can also be robbed of their equipment (Rokad et al. 2019). PUBG uses random numbers to generate weapons on the map using the "loot table" method that is typical for games of many genres. PUBG uses the loot table to determine which weapon or object will appear on the map. Because it uses this type of feature whereby an item can potentially appear at any location, the loot table determines both the probability of an item appearing there and the type of the attribute associated with that item. By using the loot table and ensuring a variation in player equipment, this makes each match different. In one game the player can be a sniper, in another a shooter or he can win the game by possessing a revolver at all times (Macey and Hamari 2019). Some players create a rather aggressive strategy based on this concept by deliberately searching for other players and then fighting them to get better equipment. Examples of other strategies are: camping (hiding in one place and waiting for other players to show up) and escape (avoiding conflict to reach the final phase of the match) (Wei et al. 2018).

Equipment is a player's basic tool throughout the game so finding the right equipment plays a key role in improving their chance to win. In extreme cases, failure to find the right equipment can end the game in a few minutes or even seconds, even though 30–40 min is the standard length of game-time. The equipment available to players is generated randomly, using a pseudorandom number generator (Macey and Hamari 2019; Rokad et al. 2019), which increases the importance of randomness in the game. As a result of these conclusions, the following research hypothesis is proposed:

H1 The random landing site has a significant impact on the perceived randomness in the game.

2.1.2 Random Air Drop (RAD)

Air drops from a plane, as directed by the map, are another important element for the game as they will drop equipment of a higher quality compared to the standard type found randomly on the map at the beginning of the game. During the game, several such air drops are found on the map in random places. However, they are easily spotted as the plane with the drop is extremely noisy and can be heard from a very long distance. Also, the drop itself emits red smoke so is perfectly visible. Many players then head towards the air drop which becomes, without warning, a hot spot where several teams suddenly fight against each other (Rokad et al. 2019). The players who decide to follow the drop take a big risk in order to gain the best possible equipment for their game. Usually, players will risk losing a fight because they hope that if they win, they will gain the right equipment to give them an advantage at a later stage of the game. Players with a less aggressive strategy, such as those who avoid conflict hoping survive until the end of the game, will be forced to flee from these areas of mass enemy players (N00btoPro Gamer Guide 2018).

One of the ways to get good quality equipment is to follow an air drop as they usually have better equipment than is found on the rest of the playzone. This means they are usually highly sought after which inevitably provokes skirmishes between the players. The plane that supplies the air drop selects the drop site randomly (Rokad et al. 2019). The random nature of this important feature of the game clearly highlights the importance of randomness in the game. As a result, the following research hypothesis is proposed:

H2 Random air drops have a significant impact on the perceived randomness in the game.

2.1.3 Random Playzone (RP)

The center of the map's playable area is placed in a random location and begins to shrink every few minutes. Any player caught outside the safe area (i.e., the blue circle) receives damage gradually and is eventually eliminated if he does not return to this safe area in time. In the game, players see the border as a shiny blue wall that shrinks periodically. As this reduces the size of the map it increases the chance for players to meet each other. (Rokad et al. 2019). For example, on the Erangel map, the first white circle appears 2 min after the start of the match; 5 min later the blue game area starts to shrink (to the existing marked white circle) and which takes a further 5 min. So, 12 min after the start of the match, the blue circle (outside of which the player can become injured) meets the white circle (the safe zone marking) and the process is repeated. The center of the next zone is randomly determined, the white circle is marked, and after some time (on Erangel the second circle will appear in 200 s) the blue circle approaches the white circle, etc. This continues until the last zone when the safe zone shrinks to zero and the players constantly receive huge injuries (Ding 2018). In order that the game does not last forever, the game zone is reduced periodically and at random (Rokad et al. 2019). This results in a dynamically changing gaming environment that affects the gameplay for all players. This feature is based on pseudorandom numbers to ensure its unpredictability. As a result of these conclusions, the following research hypothesis is proposed:

H3 The random playzone of the game has a significant impact on the perceived randomness in the game.

2.1.4 Random Weapon Accuracy (RWA)

In PUBG, the bullets from a player's weapon are randomly fired with a wide "spread" and will not accurately hit those places that were indicated by the target sight at the moment of shooting. How does this affect the player's experience? Such a system places an importance on a player's ability to react quickly during shooting. In addition to considering the other variables of the game, a player who adapts faster will win more often. This feature distinguishes PUBG from some similar games,

such as *Counter-Strike: Global Offensive*, which uses predetermined spread patterns for each weapon (Macey and Hamari 2019).

Weapons are the most important element of a player's equipment but their behaviour is subject to random mechanisms and is not determined by any particular scheme (Macey and Hamari 2019). This is considered to be important because it's the basic method of defeating opponents. As a result of these conclusions, the following research hypothesis is proposed:

H4 Random weapon accuracy has a significant impact on the perceived randomness in the game.

2.1.5 Perceived Randomness in the Game (PRG)

Randomness is an integral part of every competition. The result of a single match depends on many factors, not only on the difference in players' skills (Ben-Naim et al. 2013). In the PUBG game, this is provided by a pseudorandom number generator which is sufficient for the game and creates an impression of randomness (Fort 2015). As a result of these conclusions, the following research hypothesis is proposed:

H5 Perceived randomness in the game has a significant impact on the player's chance to win.

2.1.6 Perceived Skills in the Game (PSG)

All types of sports and games maintain a positive correlation between skill and victory (Douglas 2018). Similarly, e-sport players rely on the important physical skill of fast and accurate eye-hand coordination to a degree that is far more diverse that in any other traditional sport. (Bornemark 2013). It can be assumed that this skill is the basic factor that will determine the course of the game. As a result of these conclusions, the following research hypothesis is proposed:

H6 Perceived skills in the game have a significant impact on the player's chance to win.

2.1.7 Chance to Win (CW)

The term "chance to win" is used to describe the importance of the relationship between randomness and player skill in determining the outcome of the game.

2.2 Methodology

This research on e-sport competition was aimed at gaining player opinion on the randomness of the PUBG game and investigating its influence on the chance to win. Towards this aim, the following steps were taken:

- a randomness model was created
- survey data and feedback from players were collected
- data was analysed using the SmartPLS3 model (Ringle et al. 2015)

The research used s*tructural equation modelling* (SEM) which includes a diverse set of mathematical models, algorithms, and statistical methods. SEM methodology is often used in social sciences because of its ability to assign relationships between unobservable constructs (latent variables) based on observable variables (Hancock 2003). To apply the SEM methodology correctly once the model has been created, it is necessary to make sure that the variables are correct and relevant, and that the accuracy of the hypotheses made earlier is checked. The measurement theory specifies how to measure latent variables. Our model contains both reflective measurement and formative measurement models (Sarstedt et al. 2017).

In order to work out the reflective measurement, the indicator loading must be checked. A loading above 0.7 mean that the structure is responsible for at least 50% of the variance of the indicator and shows that it has an adequate level of reliability. The reliability of the internal consistency should then be estimated, which should be between 0.6 and 0.95 (values above 0.95 are considered problematic because they may suggest that the constructs are identical and redundant. This is done by determining both the composite reliability value and the Cronbach's alpha value. This is where the first value reflects the upper limit and the second, the lower limit of the interval in which the internal consistency reliability value is located. Another important indicator is the AVE (average variance extracted) value, which takes the value of the average of the squares for the indicators that have been assigned to a given construction (Sarstedt et al. 2017). The last step is to determine the HTMT (heterotrait-monotrait ratio) which indicates whether a given construct is sufficiently different from others, and to what extent its indicators are representative of only that construct. The limit value for this indicator is variable depending on the specifics of the model (Henseler et al. 2015).

The reliability of formative measurements is determined on the values of convergent validity, and collinearity, as well as the statistical significance and usefulness of indicator weights. The value of convergent validity determines whether the indicators of a structure are correlated with it or with another structure. The collinearity is calculated from the VIF (variance inflation factor) value. Values above five are assumed to indicate high collinearity, which is undesirable (Hair et al. 2017). The significance of indicators is determined by their weight, which we obtained using the "*bootstrapping method*". The weights usually reach values ranging from −1 to 1, where extreme values (−1 and 1) mean a big influence of the indicator (negative or positive), and values near 0 mean a small (insignificant) influence. If an indicator turns out to be insignificant, it should be discarded from the model to improve its precision. However, an insignificant indicator may be left in the model when the value of its load is above 0.5 (Sarstedt et al. 2017).

After determining the accuracy of the variables, we were able to proceed with estimating the structural model. For this purpose, the values of the coefficient of determination (R^2) and the path coefficients should be established. R^2 reaches a value from 0 to 1, where a higher value means higher precision. Path factors help to

determine the relationship between constructions and understand if it is positive or negative (Sarstedt et al. 2017).

The model presented in Fig. 1 focuses on four of the many random elements that appear in the game (as described in the section entitled 2.1). These are: the random equipment found by the players on the game map, a shrinking game zone, air drops with supplies, and random weapon accuracy. These are assumed by the authors to affect player perception of randomness which, in addition to player skill levels, affects the perceived chance to win. The Likert Scale was used to scale the responses to the questionnaire with values ranging from 1 to 7. The questionnaire is presented below in Table 1.

3 Results

The survey was conducted from 20 February 2020 to 21 March 2020 using the Google Forms platform. On 20 February, information and invitations to complete the survey were posted on the Facebook group called "PUBG Polska - PC/MOBILE/PS4/XBOX – PlayerUnknown's Battlegrounds Polska". Results were collected after 21 March 2020.

The following factors can drive sample size in a structural equation model design (Hair et al. 2017); significance level, statistical power, minimum coefficient of determination (R2 values) used in the model and a maximum number of arrows pointing at a latent variable. In our study, we determine a significance level of 5%, a statistical power of 80%, and we would like to discover R2 values of at least 0.25. Our

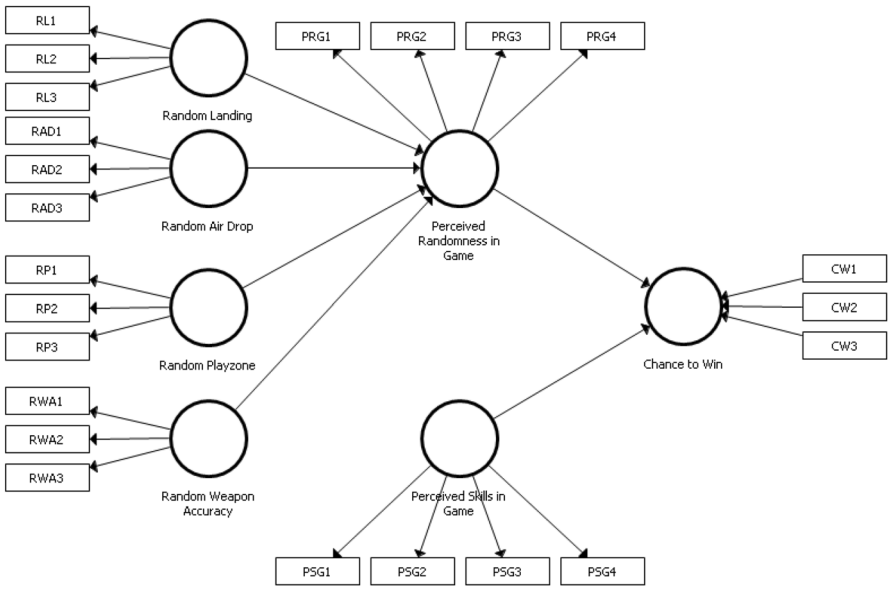

Fig. 1 The randomness model in PUBG

Table 1 The survey questions and scaled responses

Random Landing (RL)	RL1	The randomness of the equipment found, significantly changes the chances of winning
	RL2	In my games, the equipment I find often influences my win/losses
	RL3	In e-sport games, the equipment found has a significant impact on the outcome of the match
Random Air Drop (RAD)	RAD1	The randomness of supply air drops significantly changes the chances of winning
	RAD2	In my games, the supply air drops often affects my win/losses
	RAD3	In e-sport games, the supply drop has a significant impact on the outcome of the match
Random Playzone (RP)	RP1	The randomness of the playzone significantly changes the chances of winning
	RP2	In my games, the playzone often influences my win/losses
	RP3	In e-sport games, the playzone has a significant impact on the outcome of the match
Random Weapon Accuracy (RWA)	RWA1	The randomness of the discard of a weapon significantly changes the chances of winning
	RWA2	In my games, the random rejection of a weapon often affects my win/losses
	RWA3	In e-sport games, the discard of a weapon significantly affects the outcome of the match
Perceived Randomness in Game (PRG)	PRG1	Random elements has a big influence on the outcome of the match
	PRG2	In my games, I win due to random, lucky settings
	PRG3	Random elements in the game determine the outcome and cannot be used as an advantage (or be removed)
	PRG4	The results in e-sport games depend on random elements
Perceived Skills in Games (PSG)	PSG1	The player's skills have a large impact on the chances of winning
	PSG2	In my games, I win due to my skills
	PSG3	Each game can only be based on skills, reducing the importance of random elements to zero
	PSG4	The results in e-sport games depend on players' skills
Chance to Win (CW)	CW1	The rules for generating random elements are clear and transparent
	CW2	Random elements should have a greater impact on the outcome of the game
	CW3	A skillful player will be able to achieve 100% wins regardless of random elements

model has a maximum number of arrows pointing at a latent variable as 4. The minimum sample size for this setting is 65 (Kock 2018). Our sample size is 128.

It transpired that the study group was dominated by men; among 128 people there were only five women (3.91%). This result was expected as it is normal for men to be the majority of competitive computer games players. Additionally, the group was dominated by young people (under 34 years old)—as much as 90.8%, which was also expected due to the high engagement levels among this demographic who use electronic entertainment. Most of the group (59.37%) had achieved secondary education with one out of four (25.78%) having completed higher education. Regarding professional status, almost half (41.5%) declared themselves as a student with slightly more as full-time employees (48.5%). A large proportion of respondents declared considerable gaming experience with as many as 42.97% having played more than 1000 h. When analysed in conjunction with a group who had slightly fewer gaming hours (500–1000 h), they constituted as much as 70.31% of the population. The structure of the study group is presented below in Table 2.

Table 2 Respondents' details

	Number	Percentage (%)
Gender		
Women	5	3.91
Men	123	96.09
Age		
< 18	25	19.53
18–24	46	35.94
25–34	45	35.16
35–44	11	8.59
45–54	1	0.78
Education		
Primary	19	14.85
Secondary	76	59.37
BSc or MSc	33	25.78
Work status		
Not Hired	8	6.25
Student	54	42.19
Part-time hired	5	3.91
Full-time hired	61	47.66
Experience		
0–10 h (h)	1	0.78
10–100 h	12	9.38
100–500 h	25	19.53
500–1000 h	35	27.34
1000 h <	55	42.97

Table 3 The PLS-SEM assessment results of the reflective measurement model

Latent variable	Indicators	Convergent validity			Internal consistency reliability		
		Loadings	Indicator reliability	AVE	Composite reliability ρc	Reliability ρA (rho_A)	Cronbach's alpha
		> 0.70	> 0.50	> 0.50	> 0.70	> 0.70	0.70–0.95
RL	RL1	0.852	0.725	0.671	0.859	0.797	0.764
	RL2	0.770	0.592				
	RL3	0.833	0.693				
RAD	RAD1	0.914	0.835	0.812	0.928	0.893	0.885
	RAD2	0.898	0.806				
	RAD3	0.891	0.793				
RP	RP1	0.868	0.753	0.709	0.880	0.795	0.795
	RP2	0.837	0.700				
	RP3	0.820	0.672				
RWA	RWA1	0.915	0.837	0.812	0.928	0.891	0.884
	RWA2	0.910	0.828				
	RWA3	0.877	0.769				
PRG	PRG1	0.776	0.602	0.625	0.869	0.805	0.801
	PRG2	0.817	0.667				
	PRG3	0.783	0.613				
	PRG4	0.785	0.616				
PSG	PSG1	0.795	0.632	0.533	0.818	0.739	0.709
	PSG2	0.594	0.352				
	PSG3	0.713	0.508				
	PSG4	0.800	0.640				

Table 4 PLS-SEM assessment results of the formative measurement model

	VIF	Loading
CW1	1.114	0.738
CW2	1.100	0.760
CW3	1.075	0.582

The model analysis applied in this research used the basic PLS-SEM algorithm, the centroid weighting scheme, the maximum of 300 iterations, the stop criterion of 1×10^7, and equal indicator weights for the initialization.

Table 3 shows the results and evaluation of criteria outcomes. All the reflective measurement models met the relevant assessment criteria. Although only PSG2 had a loading of 0.594, removing this item from the model caused a worsening of AVE and Cronbach's alpha so we left this item in the model.

In Table 4, Variance Inflation Factor (VIF) values are less than five, indicating low collinearity. After checking the reliability of the variables, we decided

Table 5 HTMT values

	PRG	PSG	RAD	RL	RP	RWA
PRG						
PSG	0.193					
RAD	0.355	0.190				
RL	0.456	0.263	0.239			
RP	0.468	0.316	0.116	0.380		
RWA	0.569	0.128	0.359	0.453	0.208	

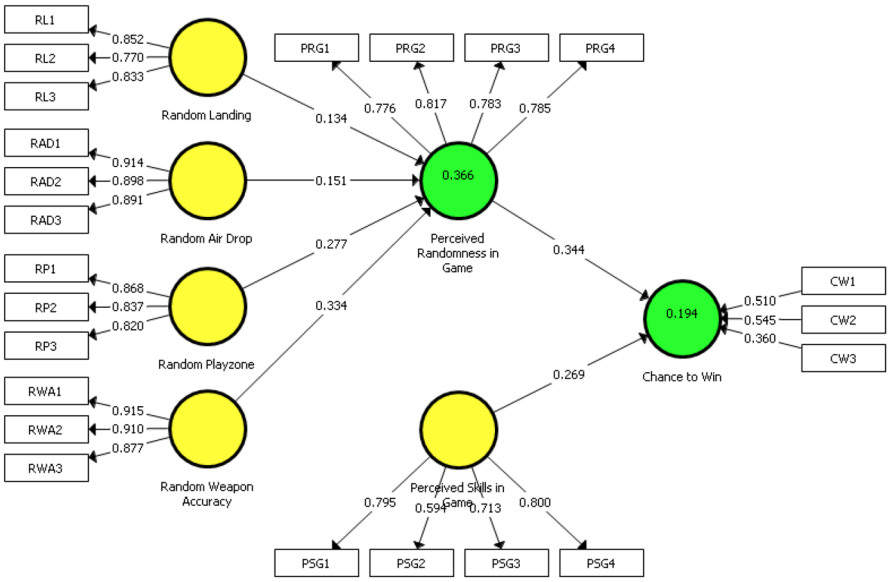

Fig. 2 Randomness model in PUBG with PLS-SEM Results

to leave all of them as they presented a satisfactory level of reliability and materiality. The loading of CW3 was 0.582, yet this was still satisfactory (Hair et al. 2017).

Finally, the discriminant validity was evaluated using the heterotrait-monotrait ration of correlations (HTMT) criterion. All the results are below the threshold of 0.85 and are presented below in Table 5.

Figure 2 shows the PLS-SEM results. The numbers on the path relationships represent the standardized regression coefficients, while the numbers displayed in the circles of the constructs represent the R^2 values.

The authors received the following effects for path coefficients presented in Table 6. The values of the path coefficient versus the perceived randomness in the game have been checked. The values are as follows: RL -> PRG (0.134), RAD -> PRG (0.151), RP -> PRG (0.227), and RWA -> PRG (0.334). Five hypotheses are

Table 6 Values of path coefficients, standard deviation, T statistics and *p* values

	Path coefficient	SD	T statistics	*p*-Values	Supported
RL > PRG	0.134	0.074	1.793	0.073	No
RAD > PRG	0.151	0.066	2.275	0.023	Yes
RP > PRG	0.277	0.085	3.257	0.001	Yes
RWA > PRG	0.334	0.071	4.707	0.000	Yes
PRG > CW	0.344	0.076	4.518	0.000	Yes
PSG > CW	0.269	0.101	2.659	0.008	Yes

significant at a 5% error level, whereas one effect is not significant and hypothesis H1 is not supported.

The HTMT factor determines whether variables are sufficiently different from each other and also ensures they don't affect each other significantly. This verification avoids testing similar or identical constructions. The lowest possible values for this factor are desirable as they indicate a sufficient diversity of constructions. Exceeding 0.85 is usually considered problematic. The matrix describing the HTMT coefficient (Table 5) for the model contains values lower than 0.569.

4 Discussion

Research in e-sport is at an early stage because, compared to traditional sports, it is a relatively new field. This also means that there isn't a great deal of understanding of the various factors that affect these competitions. Consequently, the aim of this study was to analyze only one element of these competitions, i.e., the impact of randomness on the outcome of a tournament, based on the player opinion.

To this end, we attempted to show player opinion on whether they thought that any elements of the game could influence their perception of how randomness may affect their ability to win.

Players thought that random weapon accuracy has a significant impact on their game performance. This may be because players are strongly aware of this feature of the game which has a direct impact on them, whereas other elements of the game (i.e., random playzone, air drops and landings) are indirectly experienced. The feature that had the next highest player impact and influence was the playzone which, due to its random nature, requires players to adapt to these changes in game location and situation. Air drops and equipment were felt to have low impact on player ability to win. This is probably due to the relative scarcity of air drops, while the differences in equipment are not felt to be advantageous because player skill and experience will determine the effectiveness of each type of available weapon.

An important element of the research was to determine how the relationship between both perceived skill and randomness may affect the chance to win the game. The values of PRG -> CW and PSG -> CW paths refer to this. A slight difference indicates the greater importance of randomness (0.344) over skills (0.269).

We verified the hypotheses by checking the *p-values* for the relevant paths. In order to confirm our hypothesis, the value could not exceed 0.05 (i.e., a higher value would mean rejecting the hypothesis). In the model, hypothesis H1 has not been confirmed. The equipment element of the game has the least impact on the randomness of the game; it is so small that the hypothesis could not been confirmed. All other hypotheses were confirmed.

Thus, these results point to the belief among players that the random standard equipment they may find at the start of the game has the least impact on their chance of winning; this could be a cumulative effect from playing more matches. It may also be possible that the differences between these standard weapons are not as noticeable as the higher quality equipment supplied from the air drops and which has proved to be an important factor for randomness. Similarly, the hypotheses for the remaining random elements, i.e., the random playzone and random weapon accuracy, have reached a *p value* less than 0.05. These results show that players can respond with appropriate action to these four elements that have a direct impact on the player's perception of the chance to win.

The low *p-values* for the last two hypotheses are also important. Players see the impact of randomness on their chance to win the game. However, in their opinion, the chances of winning can be influenced by their skills to a comparable extent. It can be concluded that the game is quite well-balanced in terms of the influence randomness has on the outcome for individual players.

These results illustrate the players' approach to randomness in computer games, as well as the presence of randomness in top-level professional e-sport games. The results could potentially contribute to further research on gaming, e-sports, or even game design. As these studies concern random elements they may be useful for researchers working in the probabilistic field. Additionally, because this research was based on player opinion, it could support research for psychology or sociology especially where topics are related to the gaming community, such as investigating in the broadest context, how users approach random elements of their game.

As the PUBG game is constantly being developed these results could be used by developers to maximize improvements. For example, by modifying, balancing, or deleting random elements in the game, developers would be able to ensure a level of randomness that is consistent with player assumptions. By understanding better how players perceive randomness, these results will also be able to guide the design of future games that contain elements of randomness. This is relevant for any electronic entertainment products aimed at e-sport as well as for casual users. Randomness is a hugely important element that has always been present in games and must not be underestimated or overlooked.

As an evolving discipline, theoretical studies about e-sport are important; therefore, this research is relevant and beneficial for the development and progress of e-sport as a whole. For example, this analysis of PUGB player perception that shows how randomness affects game outcome, how it could be used to develop e-sport games, and concerns not only the players but also the tournament organizers. By including more unpredictable elements within e-games, future broadcasts will increase their appeal and audience ratings.

E-sport players, professional or not, will find value in this analysis simply because the topic is about a computer game and, as such, will be a subject they can readily engage with. The results show clear scope in understanding which areas of their e-game could be improved. For example, player perception about the chance to win their game is shown in this analysis to be a factor for player success. Their perception of their chance to win will be positively affected if they identify elements of randomness within their sport. They can then create tailored strategies which either increase a focus on specific random elements proven to significantly increase player perception of being able to win, or could be aimed at abandoning strategies if they are based on elements that are simply too random to provide a solid basis for a chance of winning. These results enable greater understanding and player focus on aspects of their game that may have been ignored previously and will have specific importance and impact for e-sport teams, their training, and tournament preparation.

There are limitations to this study which may have negatively impacted the results. The number of respondents was further limited because not only was the questionnaire written in Polish, but also because PUGB is not the most popular e-game in Poland. Moreover, as is usual for every e-game still under development, there is an issue of variability of the research due to the fact that thousands of players still play this game which means that the publishers are forced to constantly change and improve the game. Therefore, the above research may well become outdated in the near future.

Compliance with Ethical Standards

Conflict of interest The authors declare no conflict of interest.

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