CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of Political Studies

Department of Political Science

Master's Thesis

2020 **Sai Shashanka Ravi**

CHARLES UNIVERSITY

FACULTY OF SOCIAL SCIENCES

Institute of Political Studies

Department of Political Science

Battle Mechanics in League of Legends: Investigating Analogies Between Real Warfare and Computer Games

Master's thesis

Author: Sai Shashanka Ravi

Study programme: Geopolitical Studies

Supervisor: Prof. RNDr. Jan Kofron, Ph.D.

Year of the defence: 2020

Declaration

1. I hereby declare that I have compiled this thesis using the listed literature and resources only.
2. I hereby declare that my thesis has not been used to gain any other academic title.
3. I fully agree to my work being used for study and scientific purposes.

In Prague on Sai Shashanka Ravi.

December 22, 2019.

REFERENCES:

MAIN BIBLIOGRAPHY

1. Carl von Clausewitz. *On War*. Published 1832.
2. Stephen Biddle, *Victory Misunderstood: What the Gulf War Tells Us about the Future of Conflict*. International Security, Vol. 21, Issue 2, Fall 1996 [p. 139-179].
3. Leo Blanken, Kai Thaxton, Michael Alexander. (Feb 27, 2018) *Shock of the Mundane: The Dangerous Diffusion of Basic Infantry Tactics*. War On The Rocks.
4. Erik K Clemons, Jason A Santamaria. (Apr 2002) *Maneuver Warfare: Can Modern Military Warfare Lead You to Victory?* Harvard Business Review.
5. Mark Whitmore. (May 29, 2018) *Transport and Supply During the First World War*. Imperial War Museums.
6. William Hickling Prescott, John Foster Kirk. (2011) *The History of the Conquest of Peru*. Internet Archive.
7. John E Wissler, Lt Gen, USMC (Retd.) (Oct 4, 2018) *Logistics: The Lifeblood of Military Power*. Military Strength Topical Essays, Heritage.org.
8. James T Quinlivan *Coup-Proofing: Its Practice and Consequences in the Middle East*. International Security Vol 24, No.2 (Fall 1999), pp.31-65.

REFERENCES FOR LEAGUE OF LEGENDS GAME INFO AND DATA

1. League of Legends Wiki.
2. Riot GMang, *Vision Score Details*. Dev Corner, Boards, League of Legends.
3. "Taybagger", *League of Legends 2018 World Championship 2018 Statistics*.
4. *World Championship 2018*, Games of Legends eSports. [gol.gg]
5. *World Championship 2017*, Games of Legends eSports. [gol.gg]
6. 2018 Season World Championship/Main Event/Scoreboards, Gamepedia.
7. *Summoning Insight Episode 87: Worlds Semifinals (ft. DoA and PaPaSmithy)*, Cloud9 Channel, YouTube.
8. (15 Oct 2018) *G2 vs PVB / Worlds Group Stage Day 6*, LoL Esports, YouTube.
9. (21 Oct 2018) *FNC vs EDG Quarterfinal Game 3 / Worlds Group Stage Day 6*, LoL Esports, YouTube.
10. (19 Oct 2018) *KT vs iG Quarterfinal Game 1 / Worlds Group Stage Day 6*, LoL Esports, YouTube.
11. (27 Oct 2018) *iG vs G2 Semifinal Game 3 / Worlds Group Stage Day 6*, EpicSkillShot – LoL VOD Library, YouTube.

Length of the thesis: 147,581 characters [with spaces] and 26,296 words.

Acknowledgements:

I intend to express my heartfelt thanks to Prof. RNDr. Jan Kofron, Ph.D., my thesis supervisor and guide for all the help and support he has provided me over the many months it took me to work on my thesis. And more importantly, for taking a chance and letting me work under him with what is frankly, a risky topic to undertake for both him and I.

Thanks also go out to the game itself, *League of Legends*, for keeping me playing the game over the last 4 years as well as making this type of analysis and approach possible in the first place.

Table of Contents

Table of Images

Table of Plots

Table of… Tables?

INTRODUCTION:

My Masters' thesis work will be about applying the logic, and certain strategies and tactics as well, from video games into real-life military scenarios. I will of course, be looking at the practicality of such an idea as well as its applicability regarding the setup of the chessboard of power, so to speak. The game I am choosing for this purpose is ***League of Legends***, a MOBA game [I shall explain the term in more detail in Chapter 1]. This is my choice for analysis because the games consist of ten players in a 5 vs 5 setting, hence I shall be able to observe the kind of long-term strategies being adopted by each team to triumph over the other.

My primary research question for thesis work is this:

1. **What are the primary predictors of victory in *LoL*?**
2. **How is geography being exploited in *LoL* for various strategies and tactics?**

And in exploration of this question, I intend to also explore how the consequences of my research findings can mirror an actual military situation that may transpire.

An important criterion for my choice is the availability of data. There are tens of thousands of games I can theoretically use for a statistical analysis, as at the end of every game pop up the game statistics regards each individual player, as well as the cumulative team statistics as well. This makes ***League of Legends*** a treasure mine of sorts, far as statistical information is concerned. In fact, if I wanted to simulate a new scenario by myself, all I'd have to do is start up a new game, and within an hour I will be in possession of yet another data point, at the very least.

I will be using the LoL Worlds 2018 games for my dataset of observations, for the purpose of my research. There is a strong reason behind this. In this competition, the best teams from various regions battle it out to take home the Summoners' Cup, which is the LoL equivalent of the World Championship in other games; which automatically means we have the absolute best players of the game in competition with each other. As these are professional teams, they will of course have pertinent data on their potential opponents, which enables them to observe, analyze and formulate certain strategies and short-term tactics10 to gain advantages

in their games. There are a total of 77 games played during the tournament; that will be a lot of high-quality data coming into my hands, making the analysis easier. As this is ***League*** being played at the highest level, the data that shall be generated in this tournament would be quite practical, unlike the kind of data in solo/duo queues of the game where there is not much co-ordination among the players of the team, making it hard to formulate and execute strategies. In these scenarios, the game often revolves around the best and worst players of the game, as execution of strategies and tactics is not very easy to perform with a lack of real-time voice communications.

The motivation for the players in the tournament is to win the tournament, of course. But one must identify that the game is not just a hobby to these players, it is their livelihood. It is not uncommon in the professional e-sports scene for players' contracts to get terminated following a string of poor performances. This has the effect of putting the player out of a job; if he is still decent enough at the game, a different team might seek to propose a contract with him. On the flip side of the coin, when a player is putting in stellar performances game after game, and especially at the big stage like Worlds, his stature in the scene rises dramatically, leading to higher-paying contracts. If the player happens to be from a relatively weak team, he will almost certainly get offers from other, better teams which are actively seeking to improve their team line-ups for the upcoming season. In this sense, it is just like professional football, baseball and other team sports.

The biggest parallel one can really draw between the tournament setting of LoL Worlds and soldiers in a war, would be that the stakes are high for both. Of course, for soldiers in a war setting, the stakes are life-or-death; it is not at the same level in professional sports/e-sports tournaments. Here it is more on the lines of the hours upon hours of practice put in, in order to win the biggest championship of the game. The moment a team crashes out of the tournament, all the practice the players have put in into the game has now effectively gone down the drain.

The overall discussion is restricted to land warfare to narrow down the focus of the work in its arrival of inferences.

CHAPTER ZERO: THE QUESTION

The research question for my work is, simply stated, the below:

1. **What are the most important predictors of victory?**
2. **How important is the use of geography in the game?**

The reason I choose *League* for my research, instead of just setting up computer simulations with initial factors, or playing against AI, is the lack of human factor, which is a crucial factor in military situations, tensions and, in the worst case, a full-scale war. Machines are mostly configured in such a way that they always choose the best possible decision to move ahead, which is quite often not the case with the human mind. It is a regular observation to notice someone fumble an easy job due to just the psychological factor; this is something the machines would not be able to replicate to the perfect extent. At most, one can set up a probability formula to randomize the end result, but that is the most that can be done.

To give an example, it is theoretically possible, in fact sometimes it is quite easy, to form an estimate on the winning side of any competition based on the available statistics alone; the forces on both the warring sides, the geography of the battlefield and such. But one can seldom penetrate the minds of the commanders; if you *could* do that with regular success, then so would the enemy and that would make the commander a pretty ineffective one to be leading the forces to anything other than consistent defeats.

But then, one cannot just analyse data from just about any random player; that would be like giving a low-ranked soldier the position of commander and then committing a total analysis of his actions and the end results. This is not something that is allowed to happen in the military for good reason: the commanders and generals are meant to have the highest mental strength, to cope with the stress of the job and all the information and disinformation flowing into the command centre[1]. They must be able to sift through all the intel they receive, then arrive at the final conclusions of which information might be true and which is planted, and even more importantly, which is actionable intel.

---

[1] "Planning versus Chaos in Clausewitz's On War." https://www.clausewitzstudies.org/readings/TMHolmes.pdf. Accessed 2 Jan. 2020.

Just because the intel is true, does not necessarily mean that the available intel is something that one can take action upon. Maybe one has to wait for an extended time period to take an action regarding that piece of intel, or that same piece of intel has been received by the enemy as well so there will be a change of circumstances. It is also quite frequent that the received intel is not quite important in the grand scheme of things, and hence is outright disregarded[2]. There are myriad reasons why a certain piece of intel is not being acted upon.

Anyways, the point is still the fact that one can only analyse someone at the highest level, for the analysis to really matter. Which is why I decided to choose the LoL Worlds 2018 tournament to analyse; it is equivalent to the World Cup in other sports, which implies that only the best of the best teams will be participating in the tournament for the ultimate glory of winning the Summoners' Cup, and their mental fortitude has to be at a high level to handle the situations thrown at them by their opponents, whether it be straight-up competition of who's better in game mechanics, or which is the team with the better, winning strategy and most importantly, which of the teams is able to execute their plans better in the game and come out with a win. All this is not possible if the players let every small thing get to them and upset their state of mind; which is, in many aspects, quite similar to the situation of a commander in the heat of battle.

[2] "Information in War - Carl von Clausewitz." http://www.clausewitz.com/readings/OnWar1873/BK1ch06.html. Accessed 2 Jan. 2020.

CHAPTER 1: THE GAME

League of Legends a MOBA game, infused with some strategy game elements as well. MOBA stands for **M**ultiplayer **O**nline **B**attle **A**rena. However, *LoL* is not an outright player vs player fight fest with both teams slugging it out over the map, which would make it a similar game to the myriad Team Deathmatch modes of online shooter games. Here in *LoL* the primary objective of the teams, is to destroy the enemy team's Nexus [= main base structure]. But along the way there are the enemy structures such as turrets and inhibitors that need to be destroyed, in order to gain access to the Nexus. Here I shall be only discussing about the main map of the game, called Summoners' Rift. *LoL* does have three other game maps as well, but Summoners' Rift is the main map in which most of the games are played; more importantly, all the competitive *LoL* games are played on this map alone.

There are many important facets of the game mechanics that tie into how strong a player's character [champion] and his/her team can get along the duration of the game. Each of them shall be explained in detail below, because a good understanding of how each of these features work, will improve one's understanding of how the game mechanics work together, and how they are used by the players in their strategies and tactics for victory.

OBJECTIVES:

The ultimate goal in every game is to destroy the enemy Nexus. But it is not possible to directly get there and destroy it, as the Nexus is invulnerable to any sort of damage, until and unless certain conditions are met. When I mention the word “objectives”, I refer to these conditions. And within the overarching space of objectives, we have two major categories. They are -

Image 1.1: *Map of the Summoner’s Rift with labelled objectives and major paths.*

A- outer turrets, B - inner turrets, C - inhibitor turrets, D - Nexus turrets

X- inhibitors

Blue Line – River

Main Objectives:

These are the objectives that absolutely need to be taken in order to progress towards a victory, while at the same time denying the loss of your own to the enemy.

Turrets: Turrets/towers are heavy fortifications that block the enemy team's path to their Nexus; turrets on one's own side prevent the enemy from doing the same[3]. They deal damage to the enemies, and provide vision and general control of the battlefield around itself. They absolutely need to be destroyed in order to progress towards the enemy Nexus. They deal heavy damage to enemy units within its firing range, but can target only one unit at a time.

There are 11 turrets per team; 3 turrets on each lane, and two more turrets right in front of the Nexus. They have 1095 sight range and 775 attack range; in comparison, the maximum range a champion has in the game comes to 661 units. Also, a turret can only be damaged if it is the first structure standing in its lane, so there is no way one can skip the outer turret and attack the next. When it comes to the Nexus turrets, they can only be destroyed if at least one of the inhibitors has been destroyed. Also, they take damage from basic attacks, most of the champions' abilities cannot affect the turret in any way; very few exceptions exist. Making it harder for the mage class to take down turrets.

Table 1.1: *Stats pertaining to different types of turrets.*

Turret Type	Health	Local Gold	Global Gold	Global experience points [XP]
Outer	5000 hp	250	50	0
Inner	3600 hp	300	50	0
Inhibitor	3300 hp	50	50	100
Nexus	2700 hp	0	50	0

[3] "Turret | League of Legends Wiki | Fandom." https://leagueoflegends.fandom.com/wiki/Turret. Accessed 2 Jan. 2020.

Note: Gold is the resource unit in the game, and it allows the player to purchase items that enhance the champion's damage and/or health and other defenses. More on it and experience points later. Incidentally, the first turret destroyed in the game, yields 150 bonus gold split between the nearby champions.

Among the turrets, the inhibitor and nexus turret types have the speciality of regenerating their lost health over time, with their health being divided over thirds.

Inhibitors: Inhibitors are structures that block the training of enemy super minions in their own lane[4]. Super minions are basically the stronger minions with 3x the health and at least twice the damage of regular minions. They tend to destroy structures quickly because of these characteristics, which makes keeping inhibitors intact, a significant aspect of the game. There are three inhibitors, all of which are positioned in the bases of both the teams, behind the inhibitor turrets.

Table 1.2: *Stats pertaining to the inhibitors.*

Inhibitor health	Health regeneration	Local Gold	Global gold
4000 hp	15 hp/sec	50 [on last hit only]	0

An important feature of the inhibitors is that they respawn 5 minutes after they are destroyed, again stopping the training of enemy super minions.

Nexus: It is the ultimate objective of the game; destroying it leads to the end of the game. The Nexus is invulnerable until both the Nexus turrets are destroyed and at least one of the inhibitors is destroyed.

Secondary Objectives:

There exist secondary objectives which show up on the map in two distinct locations; the locations are always the same, with fixed spawn timings [spawn: appearance]. They are referred to as secondary objectives, since clearing them is not necessary to winning the game

[4] "Inhibitor | League of Legends Wiki | Fandom." https://leagueoflegends.fandom.com/wiki/Inhibitor. Accessed 2 Jan. 2020.

as such, but they enhance the team which takes the objective and thus make it easier for them to eventually take down the enemy Nexus and win the game.

1. **Drake / Elder Dragon:** The drakes are a type of secondary objective in the game, which spawn at the 5-minute mark[5]. There are four types of drakes, depending on the kind of buffs [enhancements] they provide to the team taking it down. And the first drake is a random spawn from any of the 4 kinds. The next drake spawns 5 minutes after the first drake is killed, and so on, until the 35-minute mark, when the Elder Dragon spawns in the same location. It gives an extra damage buff to the players as well as enhancing the earlier buffs obtained from the drakes for 120 seconds, or until the death of the player; whichever event occurs earlier. However, the Elder Dragon has more health, which makes it a longer process to take it down, and thus a higher chance of it being stolen.

2.
    a. **Rift Herald:** It spawns in the Baron pit at the 10-minute mark, and stays till 19:45 mark[6], when it goes away and gets replaced by the Baron. Killing the Rift Herald, allows the team killing it to pick up the buff item; the buff item can be used [for the next 240 seconds] to spawn the Rift Herald and take down the enemy structures and make one's way to the enemy Nexus. Once it is killed, it disappears and does not respawn.
    b. **Baron Nashor:** It spawns in the Baron pit at the 20-minute mark, and respawns 7 minutes after it is killed by either of the teams[7]. Killing the baron grants increased damage to the killing team as well as granting extra health and damage to the allied minions near the players. The buff lasts for 210 seconds or until the player's death, whichever happens first.

---

[5] "Dragon | League of Legends Wiki | Fandom." https://leagueoflegends.fandom.com/wiki/Dragon. Accessed 2 Jan. 2020.
[6] "Rift Herald - Leaguepedia | League of Legends Esports Wiki." https://lol.gamepedia.com/Rift_Herald. Accessed 2 Jan. 2020.
[7] "Baron Nashor | League of Legends Wiki ...." 9 Nov. 2019, https://leagueoflegends.fandom.com/wiki/Baron_Nashor. Accessed 2 Jan. 2020.

The baron and the dragons cannot come outside the pit area, and also reset [i.e.; they begin regenerating their lost health, two seconds after they stop taking damage while they stop attacking the aggressors themselves].

Along the game, a myriad type of situations might develop around the baron pit, because both teams are trying to take the objective for themselves and thus push out towards the enemy base:

A. When both teams are contesting the baron objective, there are instances when one of the teams has a member head out towards destroying the enemy structures, in a bid to draw away the enemy from the baron area and defend its structures. When enough of the enemy is drawn away by the immediate threat, the first team can go in and push out the remaining enemy members, and set up their own vision in the area while destroying the enemy wards. It is also possible to take down the baron objective while the enemy is distracted, provided the team has enough damage dealing members in the area. The average time for taking down a baron is around 12 seconds generally, and can drop down to even 8 seconds depending on the number of members attacking the baron, as well as the stage of the game, so the enemy needs to be distracted for only something like 10 to 15 seconds for the play to work out. This strategy involves both getting a numbers advantage over the enemy in the baron vicinity, as well as setting up a diversionary tactic to get this plan going in the first place.

B. Sometimes, there is the ambush variation of this play being run by the first team; while the enemy is drawn away, the first team goes into the area, begins attacking the baron while clearing out the enemy vision at the same time, then the team members just go into a nearby brush area and wait for the enemy to show up and try to stop the baron attempt. Since the last thing the enemy sees before they lose their vision over the area is the enemy attempting to take down the baron, they have good reason to believe that the first team is still attacking the baron. And in their haste they might get blindsided by the first team's ambush when they do show up in the area; they already have zero vision, so they are trapped in a lose-lose situation unless they anticipate the ambush attempt beforehand.

C. There are times when one of the teams begins to start attacking the baron in a bid to take the objective and use its power, but without clearing out the enemy stealth wards. In this case, the other team may decide to stop the baron attempt of the enemy, by using the teleport summoner spell on one of the stealth wards in the vicinity of the baron, just to scare off the enemy. Of course, it leads to the situation where the player doesn't have it ready to use for the next 6 minutes of the game, which is why this is not something that is done frequently in the game. This is sometimes deliberately done by the team attacking the baron, just to make the enemy team use up their teleport summoner spell and thus decrease the pressure upon themselves for a later fight.

D. This is a highly risky move, where one of the teams has started taking down the baron objective, but the other team is not in a condition where it is able to devote many of its resources to stopping the enemy. In this situation, what they do, is send in just one of the members to wait behind the baron pit, and then when the baron health falls low enough, this member goes in using his dash ability or his flash summoner spell, and tries to last-hit the baron with a high-damage attack. If the first team hasn't cleared out the stealth wards in the area, then the player has at least an idea on when to go in for the baron steal. If they have already cleared out all the vision, then the player has no choice but to either go in blind and hope for a miracle steal, ot just give up on the objective and try to just keep the losses to a minimum. The players might also use some long-range abilities in hopes of stealing away the objective; the probability is really low for this to work, but the chances are not zero and there are rare instances where it does work out for the best.

Among the cases mentioned above case type A is quite frequently seen; B is attempted quite often as well, but it succeeds only rarely, because most players have had it happen to them before at least a few times, and with that experience they become more wary about walking in blind in strategic locations like the baron pit area. Case C happens occasionally, and is more common in the higher skill brackets of the game. Case D happens when one of the teams is quite far behind the enemy, which is the case with more than 60% of the games taking place; what with one team absolutely destroying their enemy.

Similar situations are prevalent around the dragon pit as well, which is on the bottom half of the map. There are also rare situation where the teams exchange buffs; one team takes down the baron, while the other team gives up on contesting the objective and instead goes on to kill the drake; the situation gets especially interesting when the teams share out the baron and elder dragon buffs, as the baron buff is really good for taking down objectives while the elder dragon buff is strong in 5 vs 5 battles because of the extra damage it provides; now it turns into a competition where the surviving team can well go on to end the game.

GOLD, ITEMS AND EXPERIENCE - HOW THEY TIE TOGETHER:

In *LoL* games, gathering resources and experience, together are the most important factors for a player to succeed in the game. Resources come in the form of gold in the game; and players are rewarded with different amounts of gold for different actions. And it is the same with experience points as well.

Gold:

Gold coins are the units of resource in LoL games, and is the backbone of the resource economy. Earning gold is most important as the player is able to purchase items from the Item Shop which enhance the player's health or damage or armor/magic resistance which decrease the damage taken etc[8]. In other words, gold and items are irrevocably tied together in the game, as more items → more damage dealt / greater survivability, depending on the items you do end up purchasing.

Experience:

Experience Points [XP] increase the player's level [which starts lvl 1, all the way up to lvl 18].[9] It is not a linear graph, if one plots the XP vs level-ups graph. As a players level up,

[8] "Gold | League of Legends Wiki | Fandom." https://leagueoflegends.fandom.com/wiki/Gold. Accessed 2 Jan. 2020.
[9] "Experience (summoner) | League of Legends Wiki | Fandom." https://leagueoflegends.fandom.com/wiki/Experience_(summoner). Accessed 2 Jan. 2020.

they get fractionally more damage and survivability, as well as access to more of their abilities [starts with one ability, and unlocks new abilities at lvl 2, 3 and 6 respectively].

Table 1.3: *Relation between the XP requirements and level-ups.*

To reach level	XP	Cumulative XP
1	0	0
2	280	280
3	380	660
4	480	1140
5	580	1720
6	680	2400
7	780	3180
8	880	4060
9	980	5040
10	1080	6120
11	1180	7300
12	1280	8580
13	1380	9960
14	1480	11440
15	1580	13020
16	1680	14700
17	1780	16480
18	1880	18360

When there is more than one champion in lane, the overall experience available goes up by 30.4%, and this total experience gets shared equally among all the champions in the vicinity.

Every player starts off with 500 G at the outset and earns passive gold at the rate of 20.4 G / 10 seconds from 1:20 onwards. Alongside this, different actions in the game yield different

amounts of gold, depending on various factors calculated beforehand by the game's software [rules of the game].

Table 1.4: *Stats pertaining to minions.*

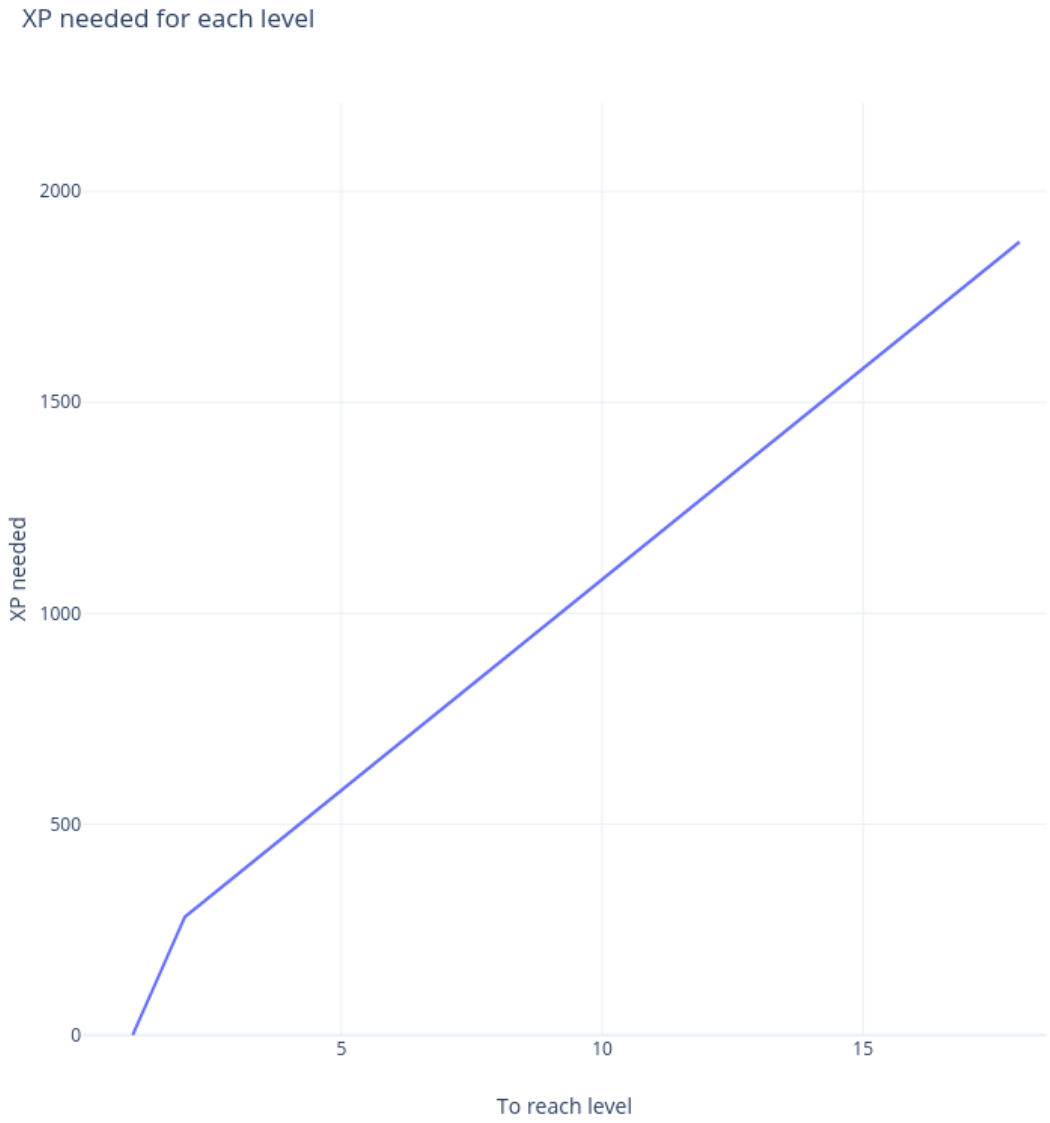
Type of creature/structure	Amount of G received	Amount of XP received
Melee minions	21	59
Caster minions	14	29
Siege minions	60-90	92
Super minions	60-90	97

The respective amount of gold is received by the player only upon last-hitting the minion, i.e; if the player's attack actually kills the minion. Otherwise the player loses out on the gold he could have received otherwise. The experience points are received by the player regardless of whether he last-hits the minion or not, so long as the player is within 1600 units of the minion.

Minions come in as waves, and each wave has 3 melee minions and 3 caster minions. In addition, every 3rd wave has a siege minion as well. It is the same in every lane. When an inhibitor is destroyed in a lane, each wave is accompanied by a super minion as well.

When we move over to the jungle monsters, the experience system works differently; here all the XP goes over to the one landing the last hit.

Plot 1.1: *XP requirements for level-ups [cumulative values].*



Another source of gold for the players is through killing the enemy, and the bounty system attached to it. Whenever an enemy player gets killed, the one landing the killing blow gets a certain amount of gold as a reward, with other players who aided in the kill getting a small fraction of assist gold.

The bounty system depends on how many consecutive kills a player has accumulated without dying to the enemy[10]. Conversely, there is also a negative bounty system of sorts, which devalues the kill bounty on the player if he has consecutively died multiple times.

Table 1.5: *Kill bounties for kill/death streaks.*

Consecutive Kills	**Consecutive Deaths**	**Kill Bounty** [in G]	**Assist Bounty** [in G]
8+		1000 [+100 per kill beyond the 7th]	150
7		1000	150
6		900	150
5		800	150
4		700	150
3		600	150
2		450	150
1		300	150
0	0	300	150
	1	274	137
	2	220	110
	3	176	88
	4	140	70
	5	112	56
	6+	100	50

So basically, it is worth more to kill an enemy who is doing well already in the game, than to keep repeatedly killing someone who is having a bad game. This gold mechanic serves the purpose of making the game a bit more even than it would otherwise be. If there was no bounty system, then the weak player would be worth the same amount of gold per kill as another player who is doing well, and this would prompt the enemy to target-focus the same weak player over and over again with zero consequences. But with the bounty system as it is,

[10] "Kill | League of Legends Wiki | Fandom." https://leagueoflegends.fandom.com/wiki/Kill. Accessed 2 Jan. 2020.

the weak player is now worth lesser and lesser gold, while at the same time the bounty upon the enemies killing him goes up with each kill, and now a single kill on the player with multiple consecutive kills might be worth more than 3 times the kill on the weak player.

Items:

Items can be purchased by players at their spawn location, behind their Nexus. Purchasing various items can boost the survivability, damage, movement speed and other aspects of the respective champion[11]. There are also certain utility items which can enhance the overall performance of the team during certain instances upon activation. Each champion has an item cap of six.

Purchasing items requires gold, and this means that if the player is able to perform last-hitting effectively, then their champion can maximise their resource gathering and thus purchase items faster. On top of this, getting kills on enemy champions also gives a good lump of gold to the player, as given above in the kill bounty table. This is the main incentive in trying to kill the enemy players in the early stages of the game: more gold. Because killing them in the early game is not really that helpful in taking down objectives due to the lower damage values of the champions, making them weak at taking down enemy turrets in the early game.

A completed item costs, on average, around 3000G [excluding wards and healing potions and such]. But one doesn't have to wait for the full gold; the player can buy parts of the items and they upgrade into a higher item when the necessary parts are there. And every player has a total of six item capacity, into which 5 tend to be the major items and the sixth is boots for the movement speed [costs anywhere from 900G to 1100G]. Even though it might seem tempting to just build a sixth complete item in place of boots, it is often a bad idea as with lesser movement speed, there is a greater chance of getting caught out by the enemy and thus, dying. Basically, all the items are worth zero value if the player gets taken down even before the fight begins.

[11] "Item | League of Legends Wiki | Fandom." https://leagueoflegends.fandom.com/wiki/Item. Accessed 2 Jan. 2020.

CHAMPIONS:

In the game *League of Legends*, each player gets to control one character of his/her choosing before the match begins. Basically, all such playable characters are referred to in the game as "Champions", or in an abbreviated version, champs[12]. There are a total of 143 champions in the game at present. In the competitive setting, a champ that has been picked already, cannot be picked again, whether the player be from one's own side or the opponent's. Even so, such a large number of champs allows for tons of diverse compositions. In the game, the champions can be categorized into the following classes:

- **Fighters:** Also called bruisers, this is a class of short-range champs [melee champs] which excels at dealing out continuous damage to the enemy champs, while having a reasonable degree of survivability to them as well. It further has two sub-classes within itself:
    - *Divers:* These are the more mobile ones among the Fighter class champs, and are good at focusing the high-priority enemy champs, and have enough survivability to cause serious damage if left unchecked.
    - *Juggernauts:* As their name indicates, they have a high degree of survivability [much more than divers], but at the same time they bring a moderate to high degree of damage to the table. However, they have a hard time getting to the enemy because of their limited mobility.

Table 1.6: *Fighters.*

Sub-class	Damage type	Survivability [0-5]	Mobility [0-2]	Range [0-3]	Crowd-control [0-2]	Dmg within a short timespan [0-5]	Dmg Over Time [0-4]
Divers	Physical	1	1	0	1	3	2
Juggernauts	Physical	4	0	0	1	1	2

[12] "Champions | League of Legends." https://na.leagueoflegends.com/en/game-info/champions/. Accessed 2 Jan. 2020.

- **Mages:** These champs possess high-range abilities which often tend to have an area of effect where they are able to dish out very high damage, as well as crowd-control [CC] abilities [like stun, snare, root etc.] .However, they tend to have low health and limited mobility which makes it harder to deal damage to the enemy without getting killed; as they are very susceptible to dying if an enemy shows up at melee range. Also, their abilities tend to be more difficult to land, as they often require anticipating the enemy's position consistently. There are three sub-classes here:
    - *Artillery Mages:* Possess high range, which allows them to deal high levels of damage from a great distance. However, if the enemy manages to get close to them, it almost always leads to the death of the mage, because of their low mobility and high fragility.
    - *Battlemage:* They deal high degrees of sustained area damage, but deal it from a shorter range; as such, they have a reasonable degree of defense to survive the fights for longer; whether it be through crowd-control abilities, or shielding themselves or such.
    - *Burst Mages:* They can deal incredibly high damage to a single target in the span of less than two seconds, even to the point of outright killing the enemy champion often. But once the abilities are used, they have some ability cooldown times before they can deal such levels of damage again.

Table 1.7: *Mages.*

Sub-class	**Dmg type**	**Survivability [0-5]**	**Mobility [0-3]**	**Range [0-3]**	**Crowd-control [0-2]**	**Dmg within a short timespan [0-4]**	**Dmg over time [0-4]**
Artillery Mage	Magic	0	0	3	0	2	3
Battlemage	Magic	2	0	1	1	2	3
Burst mages	Magic	0	0	1	2	3	1

- **Marksmen:** These champions are excellent at dealing out high amounts of sustained damage from range [usually by basic attacks] . The way for marksmen to stay safe in fights, is by moving constantly in fights and avoiding enemy aggression, while dishing out damage at the same time. But they are relatively fragile, and are also generally quite weak in the early points of the game; however as the game progresses onwards, their damage ramps up accordingly, until the point where they essentially decide the fights [and by extension, the game itself] during fights that happen post-30 minutes.
    - *Teamfighters:* These are the type of marksmen who excel in dealing out extreme damage in 5 vs 5 fights where they can stay safe thanks to their team, but may not be the best at duels.
    - *Duelists:* The type of marksmen who excel at dueling, because of their single-target damage. They have a somewhat harder time navigating teamfights, however; although they deal more or less the same damage as the teamfighters.

Table 1.8: *Marksmen champions.*

Sub-class	**Dmg type**	**Survivability [0-5]**	**Mobility [0-3]**	**Range [0-3]**	**Crowd-control [0-2]**	**Dmg within a short timespan [0-4]**	**Dmg over time [0-4]**
Teamfighters	Phy	0	0	2	0	0	4
Duelists	Phy	0	1	1	0	1	4

- **Slayers:** They are fragile but extremely mobile, damage-oriented melee champions whose motive is to take down their enemy as fast as possible**.**
    - *Assassins:* They specialize in infiltrating the enemy with their unrivaled mobility skills to dispatch quickly high-priority targets [namely mages and marksmen] . Their very nature of playstyle involves them to run straight into danger to kill the targets. But if they can use their mobility effectively, they might be able to execute the intended target, while at the same time escape successfully from the enemy team.

- *Skirmishers:* They are more of a duelist-type champion, who excel when involved in a 1 vs 1 fight with an enemy. The main difference is a lack of high burst damage vis-a-vis assassins or mages; they are akin to the melee-version of marksmen characters.

Table 1.9: *Slayer-class champions.*

Sub-class	Dmg type	Survivability [0-5]	Mobility [0-3]	Range [0-3]	Crowd-control [0-2]	Dmg within a short timespan [0-4]	Dmg over time [0-4]
Assassins	Phy/Mag	0	3	0	0	4	0
Skirmishers	Phy/Mag	1	2	0	0	2	3

- **Controllers:** They are defensive-type casters, who influence fights by protecting their allies and/or catching out their enemies. They are often paired [although not compulsory] with marksmen in the beginning of the game, as they tend to be effective in the early part of the game and thus balance out the marksmen's weakness.
  - *Enchanters:* They amplify the effectiveness of their allies, by either directly augmenting them and defending them from incoming threats. But they themselves are quite fragile [low health] and do not dish out much damage during fights.
  - *Catchers:* They specialize in locking down opponents or even entire battlefields by creating intense threat zones on the map. They are not as reliable as the enchanter subclass, however they have a higher impact on the game than enchanters [catchers - high risk/high reward] .

Table 1.10: *Controller-class champions.*

Sub-class	Dmg type	Survivability [0-5]	Mobility [0-3]	Range [0-2]	CC [0-2] / Empowerment [0-1]	Dmg within a short timespan [0-4]	Dmg over time [0-4]
Enchanters	Magic	0	1	1	0 / 1	1	0
Catchers	Magic	3	1	1	2 / 0	1	0

- **Tanks:** They are high-health characters generally, and are thus able to shrug off incoming damage and attempt to disrupt their enemies; but they cannot deal out high damages generally.
    - *Vanguards:* They specialize in getting the action started in fights, by leading their team's charge. Their fight-initiation abilities seek to catch enemies out of position and lock them down, so that allies can follow this up and kill the enemies as fast as possible. They are basically the offensive version of tanks, when seen this way.
    - *Wardens:* This kind of tanks choose to stick close to their own team, and seek to lock down threats that attempt to execute the ally marksmen/mages. And thus they allow their team to [ideally] play out the fights in relatively safer conditions. Defensive tanks, in the basic sense.

Table 1.11: *Tanks in LoL.*

Sub-class	**Dmg type**	**Survivability [0-5]**	**Mobility [0-3]**	**Range [0-2]**	**Crowd-control [0-2]**	**Dmg within a short timespan [0-4]**	**Dmg over time [0-4]**
Vanguards	Phy/Mag	5	1	0	2	1	2
Wardens	Phy/Mag	5	0	0	2	0	2

Apart from these main classes of champions in *League of Legends*, there also exist champions that do not necessarily fit into any of these classes, and are just referred to as **Specialists**.

To put it in a simplified way, the Slayer class excels at taking down high-priority targets like marksmen and mages when they are isolated from their team. However, they are near-useless against enemy tanks; and duels against fighter class enemy tend to go either way. Their ability to kill the enemy gets much higher when they manage to ambush their opponents.

With marksmen, they are brilliant against enemies with minimal mobility, and with the help of teammates who can defend them from the enemy, they excel at dealing high amounts of

damage to almost any type of enemy. Their main risk comes from Slayer class enemies, who can use their stealth abilities to get close to the marksmen and execute them before the marksmen can react. They are also quite susceptible to high magic damage coming from mages. Still, they are the only type of champion who can shred through enemy tanks with high reliability.

These are just the strengths and weaknesses of just two types of champions in the game. All the possible 1 vs 1 fights, with the expected results, are listed in the below table:

Table 1.12: *Type vs type matchups in general.*

	Fighters	*Mages*	*Marksmen*	*Slayers*	*Tanks*	*Controllers*
Fighters	-	W	L	-	L	W
Mages	L	-	W	L	L	W
Marksmen	W	L	-	L	W	W
Slayers	L	W	W	-	L	W
Tanks	-	W	L	W	-	W
Controllers	L	L	L	L	L	-

The above table is created assuming both the combatants are at roughly same strength [same level and same number of completed items]. When one side is way ahead of the other, the chart would prove incorrect oftentimes; even a controller-class champion can defeat an enemy mage or marksman if the player is sufficiently ahead of the enemy counterpart.

“VISION” IN LEAGUE OF LEGENDS:

Vision:

According to the mechanics of League of Legends, ***Sight*** is a property of units and structures, as well as certain items and abilities in the game[13]. Sight represents a team possessing vision of a certain area on the map. ***Fog of War*** is, in the simplest possible explanation, its opposite. So basically, the entire map is divided into two parts, looking at it from the vision point of view, i.e; Sight and Fog of War. Possessing sight is necessary to observe most of the information about the location of various units, health and mana of the enemy, the items in their possession, amongst various other important bits. It also gives one team an idea of what tactics the enemy is going to execute next, depending on their movements. This makes the aspect of vision, whether acquisition of it for one’s team, or denying it to the enemy, a crucial skill in the game.

All units in the game grant vision upto a specific, fixed radius [fixed beforehand by the game’s code, and is unalterable] . **Champions**, which are the player-controlled main characters in the game, have a sight range of **1200** units (units *here* refers to the in-game distance measurement), while allied **minions and pets** have a fractionally lower value of **1100** units [Pets : Some champions can spawn additional characters that function similar to minions, as part of their ability set] . **Turrets** in the game have a vision range of **1095**. Certain items and abilities in the game have the potential to grant sight, either as their main function, or as a byproduct [for example, some champions can place traps around the map, which also happen to grant vision around its position].

Obstacles to Vision:

There are two types of obstacles towards obtaining vision over the map. One of them is the **impassable terrain** over certain parts of the map. It is always opaque to vision that can be granted by units, structures and most items and abilities. Only very few champions can go through or dash over them. The second type of obstacle is **brush** [resembles a strip of high grass on the map] . Any unit that enters brush is granted a form of one-way stealth. When a unit(s) enters a brush, it is immediately rendered invisible to enemies which are positioned

[13] "Sight | League of Legends Wiki | Fandom." https://leagueoflegends.fandom.com/wiki/Sight. Accessed 2 Jan. 2020.

outside that patch of brush. The unit remains invisible unless revealed by a sight-granting ability, item or an enemy unit. The other way to come out of stealth is to engage in attacking the enemy; this invariably reveals the location of the user. Utilizing the properties of brush to manipulate the sight of the enemy, often leads to key tactical advantages within the game. Some example would be escaping certain death, luring an enemy into one's own team to quickly kill them in ambushes and so on.

Warding:

A ward is defined as a deployable unit, which serves the function of removing the fog of war around its position[14]. They may also have additional features, depending on the type of ward being used. They are referred to as vision wards as well.

1. **Totem Ward / Stealth Ward:** Grants sight over a radius of **900** units around itself. It is stealthed, which means an enemy would be unable to see it, unless certain items are used to reveal it. The lifespan is 90-120 seconds for totem wards, and 150 seconds for stealth wards. It takes 3 auto-attacks to destroy this type of ward.
2. **Control Ward:** It grants sight over a radius of 900 units; it also reveals and disables any enemy traps / wards in the region [excluding enemy Control Wards] , as well as camouflaged champions. It has unlimited lifetime, however a player can only have one active Control Ward on the map at any given time; placing a second ward would remove the first ward from the map. Also, it is visible to the enemy in plain sight unlike Stealth Wards. It takes 4 auto-attacks to destroy a Control Ward. Its health regenerates after 6 seconds of not being attacked.
3. **Farsight Ward:** It grants sight over a radius of 500 units, which is much lesser than the above ward types. But the advantage with this ward, is it **can be placed 4000 units away** from the player's position, unlike Stealth / Control wards which can only be placed 650 units from the player. It takes just one auto-attack to destroy it.
4. **Zombie Ward:** It grants vision over a radius of 1100 units, and can be destroyed by one auto attack. It is a special type of ward reliant on pre-game settings made by the player(s). It **spawns when a player destroys an enemy ward**; it takes the place of the enemy ward and has a lifetime of 120 seconds.

[14] "Ward | League of Legends Wiki | Fandom." https://leagueoflegends.fandom.com/wiki/Ward. Accessed 2 Jan. 2020.

Table 1.13: *Different ward types in LoL.*

Type of Ward	Vision Range (units)	Life Span	Can be purchased (Y/N)	Gold required for purchase	Attacks needed to destroy	Bounty [Gold/XP]
Totem Ward	900	90 - 120 sec	Y	0 G	3	10G/ 37XP
Stealth Ward	900	150 sec	N	-	3	30G/40XP
Control Ward	900	Unlimited	Y	75 G	4	30G/40XP
Farsight Ward	500	Unlimited	Y	0 G	1	15G/12XP
Zombie Ward	1100	120 sec	N	-	1	1G/0XP

The interaction between wards and enemy presence/absence in the vicinity of the ward is as shown in the table below:

Table 1.14: *Simplified version of how wards impact gameplay.*

	Enemy is not in the vicinity [0]	**Enemy is in the vicinity [1]**
Ward is absent [0]	Venturing into the area still risky, as there is no info on enemy movements	A possible enemy ambush has a high likelihood of success
Ward is present [1]	Team can proceed without risk	A potential enemy ambush is spotted out ahead of time

When there is no ward in the area, the team is essentially playing a percentages game according to how important the area is, to gain control of the game. For example, in the earlier stages of an average game, the enemy would most likely not be plotting ambushes near the team's base, so warding these areas is not very important. However, the areas around the baron or dragon pits are highly contested whenever these objectives are up for grabs, so it

is quite risky to venture into these areas without vision. When we look to the main objectives like turrets and inhibitors, even though there would inevitably be enemy presence in their proximity, these structures themselves grant vision around themselves, making it unnecessary to use wards here. The only times when the lack of a ward in a certain area does not prove detrimental, is when the positions of all the enemy team members can be accounted for by vision elsewhere.

Ward Clearing:

The act of destroying the enemy's wards in order to deny vision, is referred to as ward clearing. The main item used for this activity is called the Oracle Lens, although there are a few other items in the game that help in the same activity, although they are not vision-focused as such.

- **Oracle Lens:** When activated by a player, a sweeper lens is summoned that escorts the player for the next ten seconds. It has a detection radius of **750** units. It **grants obscured vision of all units within this radius**, regardless of whether they are in plain sight, or hidden within brush, or on the other side of impassable terrain. Unseen enemy units, as well as traps and wards within this detection radius, are displayed to the player's team as red silhouettes. Stealthed traps and wards are revealed; stealth wards get disabled during this time. The Oracle Lens can be used once every 90 seconds at the beginning of the game, scaling down to once every 60 seconds, depending on the level of the player's champion.

- **Scryer's Bloom:** They have 8 possible spawn locations, with 4 each on either side of the river. Attacking them releases pollen in a large conical area that flies in the direction the attacker is facing. The pollen reveals enemy wards and units for 12 seconds, and enemy champions for a span of 3 seconds.

- **Facechecking:** It refers to the player(s) walking into the terrain on the map where there is no vision for their own team, and then destroying whatever visible wards exist in that particular area they are scouting out. This is the risky part of ward clearing; since there is no vision of the enemy in this part of the map, one would be risking getting ambushed by the enemy team while clearing out wards this way. This process is made a bit safer when at least a teammate or two join you for support in this

venture; also if most of the enemy members [if not all] can be seen on the parts of the map where the team *does* have vision, this becomes an easy process.

Facechecking is also the way most of the ward clearing is done in the game, especially in lower tiers of the skill level where players are apt to take more uncalculated risks. This is something which is avoided as much as possible in the higher skill levels, because the punishments tend to be much harder; however it is something that is always a part of the game at some degree.

SUMMONER SPELLS:

Every player gets to pick two out of a total of 9 spells, each of which have different functionalities. These are abilities that enhance the champion (and sometimes even other teammates) in the game.[15]

The spells, along with their respective functions, are tabulated below:

Table 1.15: *Functions of the various summoner spells in LoL.*

Summoner Spell	Function	Range	Cooldown Time
Heal	Heals the user as well as a targeted ally for 90-345 HP [based on level], and grants 30% extra movement speed for 1 second.	850 units	240 seconds
Ghost	The player's champion gains increased movement speed of 28-45% [based on lvl] for the next 10 seconds.	-	180 seconds
Barrier	Shields the champion for 115-455 for 2 seconds.	-	180 seconds
Exhaust	Slows the targeted enemy champion by 30% of their total movement speed, as well as reducing their damage by 40% for the next 2.5 seconds.	650	210 seconds
Flash	Instantaneously teleports the champion a short	0 - 400	300 seconds

[15] "Summoner Spells | League of Legends." https://na.leagueoflegends.com/en/game-info/summoners/spells/. Accessed 2 Jan. 2020.

	distance in the direction of interest		
Teleport	Teleports the champion to a turret, minion or ward after a channeling time of 4 seconds. Can be interrupted by enemy crowd control abilities.	Global	360 seconds
Smite	Deals 390-1000 true damage to the target monster, enemy minion or pet.Using smite against Large Monsters restores 70 (+10% max health) HP.	500	15 seconds
Ignite	Deals 70-410 true damage (based on level) over 5 seconds and grants vision of them; during this timespan, health recovery is only 60% as effective as usual.	600	180 seconds
Cleanse	Removes all crowd-control abilities as well as summoner spell debuffs (i.e.; exhaust/ignite) , and reduces the duration of incoming crowd-control abilities by 65% for the next 3 seconds.	-	210 seconds

Among these summoner spells, the most popular one is the **Flash** spell, simply because it can help the player to dodge enemy abilities, or land the last hit to finish off enemy champions, or even to steal away secondary objectives from the enemy team. The first aspect is self-evident, whereas the second and third happens when the enemy champion/secondary objective is out of reach and low on health; flash can help the player get in range to attempt the kill. Simply because of its versatility, it is almost always the case that flash takes away one of the

summoner spell slots for each player. Proper use of flash can help navigate even surprise 1v2 fights and on rare occasion, come out with two kills. On the other hand, misuse of it makes the player more susceptible to future flanking attacks [called ganks in LoL terminology], especially if the champion does not have much mobility.

Smite is another mainstay spell. It deals a large amount of damage to jungle monsters and is instrumental to taking down secondary objectives, vis-a-vis baron/drake. The spell is always taken by the player filling the role of jungler in the game, the one who navigates through the jungle parts of the map and sets up ganks to get leads for his other teammates. Since smite can deal a very high damage, it is possible for the enemy jungler to walk/flash into the pit and steal the objective, if one's own jungler is unavailable for taking down the objective, or if the player's smite spell is under cooldown. So basically, the jungler's summoner spells are limited to Flash and Smite; unless the player wishes to switch flash for something less conventional in the role, like Ignite or Ghost.

Among the other spells, **Ignite** is taken by assassin champions mostly, in order to increase their kill threat; **Barrier** is often taken by mages, since if they can withstand the incoming damage for long enough, they will inevitably be dishing out great amounts of damage onto the enemy. **Exhaust** and **Heal** are used in the bottom lane mostly, although it isn't uncommon to see Ignite over Exhaust. Top laners often have **Teleport** for their second spell; it has a high impact on the game, being able to change a fight from a 2v2 to a 3v2 in the span of less than 5 seconds, for example; or threatening a teamfight near the baron/dragon pit in order to scare away the enemy from taking down the objective. **Cleanse** is a niche spell, used on rare occasions when the player has to deal with multiple crowd-control abilities from multiple sources. And **Ghost** is a spell which is really strong on a select few champions with extremely high mobility to start with, where the champs would benefit in sticking close to the enemy.

ROLE ASSIGNMENTS PROFILE

In every game on Summoners' Rift of 5v5 competition, there is a certain way the players spread out over the map, and for a very good reason too. Among the five players, one goes to the top lane, one to the middle[mid] lane and two to the bottom[bot] lane, while the one remaining player goes into the jungle on his team's half of the map. This distribution of players is based both on the kind of champions that are picked for these roles, as well as the secondary objectives in the vicinity.

First, let's begin with the **bot lane**. Here is where we have the marksmen champions going, as they provide consistent damage over a period of time; this is because their damage comes primarily from basic attacks, which consume zero mana. Why do we need a consistent damage champion on the bot lane? Because the drake spawns at the five minute mark, and the drake/dragon pit is just ten seconds away from the bot lane. So when either of the team decides to take down the drake, the presence of their bot lane **marksman** proves significant for the objective. Incidentally, the marksmen champions serve the role of carries [as they are called often], as they are meant to carry their teams through the end game teamfights.

But then, the marksmen champions are significantly weaker than other champion types in the early game part, in the sense that other champion types can deplete their health quite swiftly in duels, which makes it imperative for them to be helped along for at least the entire length of the laning phase. And this is where the **support** player comes in; they can enhance the marksmen's performances by either healing them, shielding them or making picks on the enemy players for kills.

Now we have an explanation for why we have two players in the bot lane, from either team. And since it is a 2v2 scenario in the bot lane, it makes it quite hard to pick a melee champion into the lane instead of a marksman. Suppose a melee champion *is* picked into the bot lane as the carry, the player making the melee pick is in the difficult situation where it is easy for both the enemy players to deal damage to him, while the player is trying to last-hit minions for gold. Of course, these choices still happen in games, but it is quite rare; for example, there was a phase during mid-2018 when most of the marksmen champions became extremely weak because of certain changes implemented by the game balance team. This led a

significant percentage of players in the professional scene to start picking melee champions into bot lane instead of marksmen.

Moving into the **mid lane**, the main characteristics of the champion here, must be their ability to deplete the enemy health bars as fast as possible; ideally this should happen in an instant. While this is a primary requirement, the mid lane players are also expected to roam around the map and get the jump on the enemy team and thus collect more kills, and in the ensuing buffer time push in the lanes and inflict damage to the enemy turrets. But if a player is to roam around the map, he should be able to clear out the minions on his own lane fast, otherwise he will be stuck in his lane trying to protect his own turret from the enemy.

So here, we have narrowed down on the three major requirements for a mid lane champion pick:

1. High burst damage
2. Fast wave clear [since the minions arrive in waves of 6 each]
3.
    a. High movement speed or dash abilities → Roaming potential [it has the additional effect of pressuring the enemy players to play extra carefully, as the player can visit their lane suddenly].
    b. Late-game potential → consistent magic damage output.

Into this category, come the assassin-class champions and mages; while both the major classes have good burst damage, assassins excel at duels and have higher roaming potential, while mages can function as a secondary carry champion in the late game.

Now, the **top lane**. This lane becomes important after the rift herald spawn, which happens at the 10-minute mark in the game; but until then the players in this lane tend to be mostly in a 1v1 match, with occasional interference from other players for a greater part. This is because the lane is off to one edge of the map, but unlike the bot lane there are no secondary objectives to play around for a while. In addition, rift herald as a secondary objective is something that can be attempted only when one of the teams is quite ahead of the enemy regarding items, as the rift herald has a large health bar [around 10000 hp], so taking it down is slow progress [as the champions are still at lower levels and have only one item completed

at this point, on average]; this factor makes the attempt prone to interruption from the opponent.

Since these players are left alone for the large part, it is imperative that these champions have either tanky characteristics, or good health regeneration built into their mechanics; whether it be via passive or active ability usage. Also, in the mid-late game stage, the top laners are expected to push the side lane minions [top and bot are being referred to as side lanes here] and take turrets down, or at the very least force enemy team members to respond to this push and thus draw them away from one's team; which becomes paramount to killing barons in the mid-late game. As such, these champions are expected to possess either a high degree of survivability, or a mixture of dueling capability and reasonable survivability. As such, it is mostly the tanks and fighter-class champions utilized for top lane.

And finally, the **jungle**. The player who goes into the jungle earns gold by killing the jungle monsters, and is tasked with the responsibility of helping out their teammates by ganking their lanes and trying to get kills on the enemy players[16]. Alongside this, they also should be using their wards to get the drop on the enemy movements, in case the enemy player(s) are planning to do the same.And finally, they play the main role in taking down the secondary objectives, because they are always equipped with the Smite summoner spell, which does a high amount of damage to monsters and secondary objectives. When the jungler is absent from a baron/drake attempt, the fact makes it reasonably likely for the enemy players to interfere and quite possibly, steal away the objective; as it is not about which team does more damage to these objectives, but which team lands the killing hit on them. To wit, the killing team gets all the bonuses from taking the objective, while the other team gets nothing whatsoever.

In this sense, the jungler's job looks more like a tactician than anything else, as their movements over the map often determine which team comes out with a victory. As to the kind of champions that are picked as junglers, we have the maximum variety here. All the jungling champion needs is some amount of survivability in the early stage of the game; other than that there is no real restriction, as there are a variety of strategies that can be

[16] "Jungling | League of Legends Wiki | Fandom." https://leagueoflegends.fandom.com/wiki/Jungling. Accessed 2 Jan. 2020.

implemented from the jungler's end, depending on how they wish to play the game out. There are early game junglers [specialize in securing kills early with high burst damage in ganks], objective-based junglers [excel at swiftly taking down drakes by themselves], teamfight junglers [tanky champions with high crowd-control], and late-game junglers who can effectively take over entire fights, when played right. As to which classes go into the jungle role, there is no limit; the game has melee assassins to tanks to even marksmen and support champions who can do the job, but this does not mean that every champion is playable in the jungle.

PHASES OF THE GAME:

In a general match of *League of Legends*, the match can be divided into three major sections, depending on how long the match has progressed for. Along with the three below-mentioned phases of the game, there is also a pre-game drafting phase[17].

Drafting Phase: This is the phase where both teams take turns banning out some champions, and then it goes into the champion pick phase. The pick/ban format for the Worlds 2018 phase is this:

1. Ban phase 1:

Blue team bans one champion, then Red team bans one champ and so on until both teams ban out three champions each. There is also an option to not ban out any champion here, although that scenario occurs very rarely.

2. Pick phase 1:
    A. Blue team picks one champion
    B. Red team picks two champions
    C. Blue team picks two champions
    D. Red team picks one champion

3. Ban phase 2:

[17] "Draft Pick | League of Legends Wiki | Fandom." https://leagueoflegends.fandom.com/wiki/Draft_Pick. Accessed 5 Jan. 2020.

Red team bans one champion, then Blue team bans one champion [2 iterations ⇒ 2 champion bans each]

4. Pick phase 2:

A. Red team picks one champion
B. Blue team picks two champions
C. Red team picks one champion

This rounds off the draft phase of the match. This phase is quite important, because it allows the teams to dictate to at least a small extent [or in some cases, even a major extent] on what kind of enemy composition they will be going up against.This goes both ways. Also, there were 143 champions in LoL at the time of Worlds 2018, and it is only natural that players tend to perform better on certain champions than others.

For example, the bottom lane carry role is often taken up by the same 20-odd champions, with some other champions also played there on occasion. Among these [say] 25 champions, there tend to be 5-7 champions that are "in the meta" [it refers to the most optimal ways of winning], and a few more valid picks, due to the buffs[+]/nerfs[-] made by the game developers every two weeks.

If one team knows that the opponent bot laner is really good at 2-3 of these champions, they can ban those champions out and force the player to play a champion he isn't as proficient at. However, each team gets only 5 bans each overall, so you can probably target out maybe 1-2 of the opponents at the most, or just ban out the champions who seem to be ridiculously overpowered, regardless of who plays it.

When we come to the champion picks aspect, the Blue team gets first pick, so they can always pick up the strongest champion available after the ban phase 1. But at the same time, this allows the Red team to take a champion to counter or neutralize the Blue team's pick. And so on.

The three phases in-game are:

1. **Laning phase:** This is the beginning phase of the game, where we have the above-mentioned lane assignments and each of the laners try to farm the enemy minions by last-hitting for gold. In the bot lane, it is generally the carry player who collects the farm, while the support is there to ensure he doesn't die to the enemy team. The junglers on both teams try to gank their laners to ideally kill the enemy; or at the very least lessen the pressure on their own players by making the enemy play more cautiously.

   There may also be some amount of teamwork required, far as taking down the drakes or the Rift Herald is concerned, but this depends largely on the jungling champion chosen. That is because some champions are great at taking down the drakes/rift herald solo, while there are other junglers who excel at ganks, because of their crowd-control abilities. The laning phase generally goes on for about 15 minutes, although earlier destruction of turrets can shorten the laning phase.

   High-priority lanes - Mid, Bot.

2. **Mid Game:** The match enters this phase after the destruction of one or two turrets by at least one team, generally top or bot lane. After the turret is destroyed, subsequently the laner(s) who managed to take the outer turret of their enemy, now shifts focus to the mid lane, as farming in their own lane becomes a bit harder. This happens because the enemy can set up a "freeze" near their inner turret. "Freeze" here is the process of balancing the push of the enemy minions with those of your own, while all the player does is last-hit for the gold.

   When other laner(s) abandon their lane and try to help get the enemy outer turret in mid lane, the opponent is faced with the only choice of gathering one's own teammates to counter the attack. Well, the other choice is to let the turret fall, but that immediately leads to a significant loss of map control. Mid game is a collection of this and the attempts of taking down the Rift Herald (if it is still available) or the Baron Nashor (post the 20-minute mark). This is the phase where the importance of the top lane spikes up significantly, due to the Baron. The baron is a highly important secondary objective, as in short it gives the killing team the pushing ability by empowering the players *and* the minions in their proximity, which can be used to take

down the enemy turrets. This phase of the game goes on from approximately the 15 minute-mark to around 35 minutes.

High-priority lanes - Mid, Top.

3. **Late Game:** The match, if it has not ended yet, goes into the late game stage after 35+ minutes. Incidentally, every player has a capacity of storing six items in their inventory and no more; in addition there is one slot reserved for the free ward/oracle lens. 35+ minutes is referred to as the late game phase, because at this point most of the players on both teams have at least three full items + upgraded boots (for the extra movement speed) in their inventory [Full items in the game may cost anywhere from 2800G to 3800G, depending on the item in consideration, and this is why last-hitting minions is so important]. At this point of time, even the Elder Dragon comes into play, which makes the situation even more complex. Now we have the two competing teams also being forced to prioritize one of the objectives over the other [TLDR : Baron is excellent for taking enemy turrets down, while Elder Dragon grants more damage to the champions, making it an excellent enhancement to have for 5v5 teamfights].

   This is the stage of the match where just one stray death on either team can end the game, or lead to the loss of Baron/Elder at the very least. This is also the phase when the marksmen champions become invaluable, as they have the highest consistent damage by this point of the match, making it imperative for both teams to somehow get the drop on the enemy marksman first and eliminate him/her from the fight. Getting kills at this point of the game is extremely important, because of the way longer death timers [time to respawn] at this point of the game.

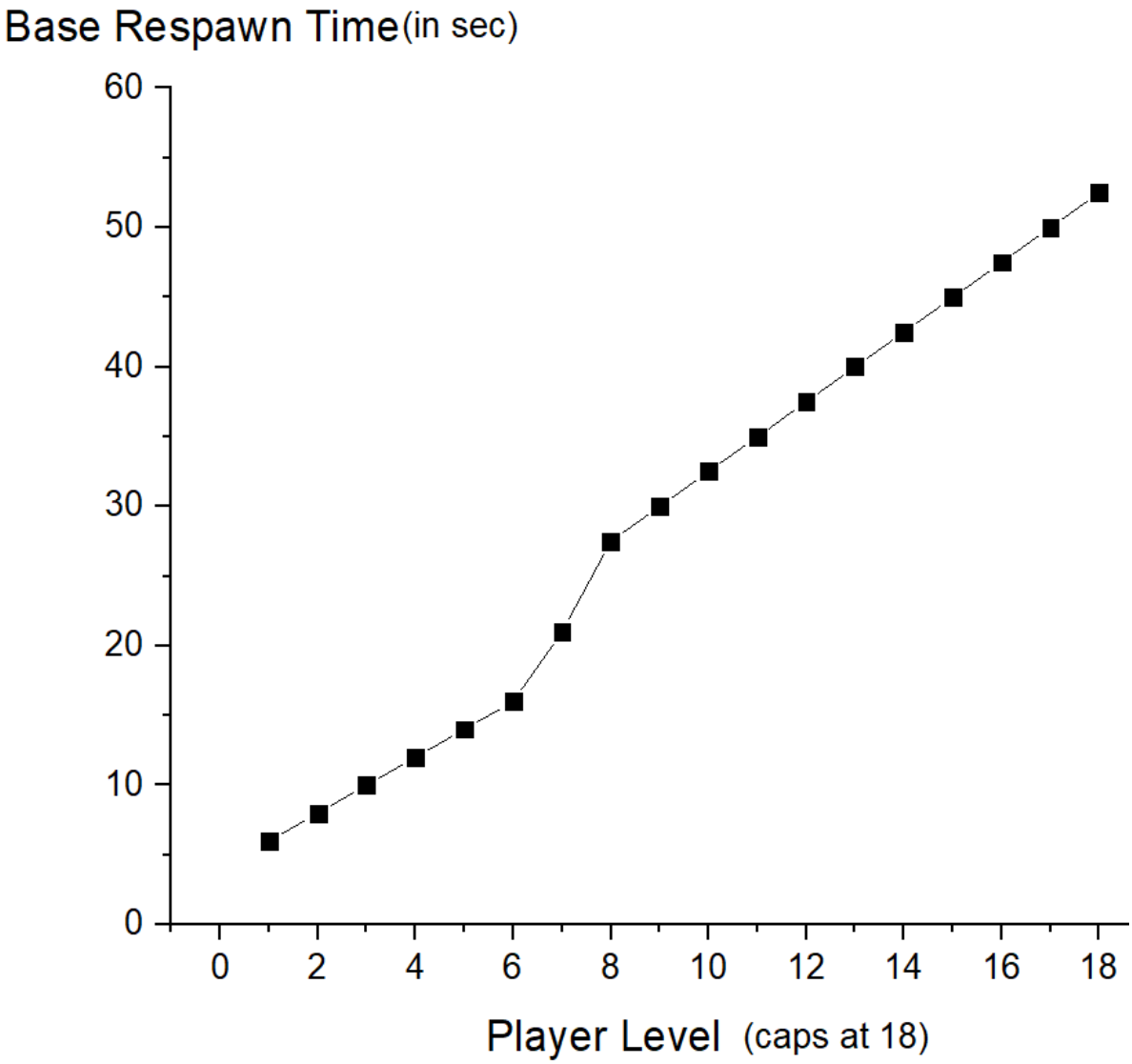
Table 1.16: *Respawn timers according to the player level.*[18]

Player Level	Base Respawn Time [in sec]
1	6
2	8
3	10

[18] "Death | League of Legends Wiki | Fandom." 19 Jul. 2019, https://leagueoflegends.fandom.com/wiki/Death. Accessed 2 Jan. 2020.

4	12
5	14
6	16
7	21
8	27.5
9	30
10	32.5
11	35
12	37.5
13	40
14	42.5
15	45
16	47.5
17	50
18	52.5

Plot 1.2: *Base respawn time vs player level.*



However, there is a further complication in that the respawn time gets longer as game time progresses as well, with increases at the 15, 20, 45 and 53.5 minute marks. For example, the respawn time after 53.5 minutes of the match is 50% more than the base respawn time. And since, by 35 minutes all the players are around level 16 already, if the players happen to die, then they are unable to actively influence the game in any way for the next 50-odd seconds at the very least, and that is a *significant* length of time in the game.

THE TOURNAMENT

The final event of the game every season, the *LoL Worlds* for the year 2018, took place in Busan, South Korea and consisted of three phases:

1. The Play-Ins [which are the equivalent of FIFA World Cup qualifiers for football]
2. The Group Stage [the final 16 teams were divided into 4 groups of 4 teams each]
3. The Knockout Stage [the quarterfinals, semifinals and finals]

In the group stage, each team was to play against every other team in its group twice, which comes to a total of 6 games per team. The two teams with the highest number of points in the group, would proceed into the quarterfinals. And in the event of a tie between teams for the first or second position, the teams in question would face off in a tiebreaker game. Also, coming in first place of the group was more advantageous than second place, because the first seed from each group would face off against the second seed from a different group; a matchup which should, in theory, favor the first seed team.

In the knockout stages, the competing teams would face off in a best of five games series; the winning team would proceed onward to the next level.

For the purpose of the thesis, I shall be taking into account, the data from the Group and Knockout stages; even though this reduces the sample size by a reasonable extent, the final sample count still comes up to an impressive 77; that is how many games were played overall in the tournament, excluding the Play-Ins.

Table A: *Progression of the LoL Worlds 2018 tournament.*[19]

Group A	**Quarter Finals**	**Semi Finals**	**Finals**	**Tournament Winner**
PVB (2-4)				
FW (3-3; 0-1)				
AFs (4-2)	KT vs **IG** (2-3)			
G2 (3-3; 1-0)				
Group B		**IG** vs G2 (3-0)		
RNG (4-2; 1-0)				
C9 (4-2; 0-1)	RNG vs **G2** (2-3)			
GenG (1-5)				
VIT (3-3)				
Group C			**IG** vs FNC (3-0)	**IG**
KT (5-1)				
TL (3-3)	**C9** vs AFs (3-0)			
EDG (4-2)				
MAD (0-6)		C9 vs **FNC** **(0-3)**		
Group D				
100T (2-4)	**FNC** vs EDG (3-1)			
FNC (5-1; 1-0)				
IG (5-1; 0-1)				
GRX (0-6)				

[19] "Worlds 2018 - Leaguepedia | League of Legends Esports Wiki." https://lol.gamepedia.com/2018_Season_World_Championship. Accessed 2 Jan. 2020.

CHAPTER 2: RESEARCH METHODOLOGY

In the thesis, my work will be focused on the statistical data pertaining to LoL Worlds 2018, which is the highest-level tournament for the game, held at the season end of each year.

Since LoL is a computer game, all the technical part of the game is tied to the game codes/algorithms; and as Worlds is the highest international tournament of LoL, statistics from every single game played in the tournament will be available in the game servers. The only trouble would be in putting together the relevant data so as to arrive at meaningful conclusions which may also resemble real world military tendencies.

There might be an important question posed by skeptics related to this research angle that has to be addressed: **how can one equate a real-life military scenario with an e-sports tournament situation?**

The reality is, in these tournaments [not just LoL Worlds, but tournaments for other games and sports as well] the stakes for everyone participating in the event are super high; every participant in the tournament is there to win, not just fill the numbers. And when someone does this for a living, it becomes highly important to perform well in tournaments as it could increase their salaries, as well as demand from other teams. Also on the flip side is this: if a player on the team has a mediocre performance over the course of a tournament, not only is he jeopardizing the team's chances of advancing in the event, there is also a significant likelihood of the player being removed from the team during[player gets subbed out for a reserve]/after the tournament itself. This would leave him unemployed for at least a few months, until there is some other team that might pick up the player for their team. Stakes get even higher in individual sports; when performing badly, forget advancing further, it could quite likely result in the player not even qualifying for the event.

Dependent Variable:

Win/Loss: The primary dependent variable to be used in the following analysis will be the final result, i.e.; whether the team under consideration has gone on to win the game or not, plotted against a variety of independent variables. This is in order to check just how much of an impact a particular parameter has upon the final result of the game.

Independent Variables:

Gold Difference: Since items are instrumental in enhancing the champion's damage values and survivability in case of fights, it follows that the players with more completed items will be at an advantage in respect to their counterparts. And as the only way to get more items is by gaining more gold, it serves that the team with more gold in their pockets would be able to outperform their enemies, both in being able to take down objectives and in straight-up fights between the teams.

To accurately verify just how important the **gold difference** is with respect to the end result, there shall be multiple graphs where the gold difference between the winning team and the losing team is plotted at various time stamps; at

- 15 minutes,
- 25 minutes
- change in Gold Difference from 15 minutes to 25 minutes, and
- end of the game respectively.

Secondary Objectives:

The secondary objectives, as mentioned in Chapter 1, refer to the neutral objectives which are not necessary in theory to win the game, but still do enhance the chances of the team upon taking it. The term refers to the Rift Herald, Baron and the Drakes/Elder Dragon.

Below is a table containing the details pertaining to how often the secondary objective under consideration was taken down by a team, and how frequently the team securing the respective objective has gone on to win the game [in a total number of 77 games.]

Table 2.1: *Win Percentage as a function of buff type.*[20]

Type of buff	No. of games it was taken by a team	No. of games won by the team securing the objective	Win Percentage
Drakes + Elder Dragon	77	47 [team with more dragons winning]	61.04 %
Elder Dragon	7	4	57.14% [sample size too low, however]
Rift Herald	72	55	76.39%
First Baron	71	63	88.73%

With the drakes and the Elder Dragon, the relation between taking the objective and winning the game is not very strong. Especially with the Elder Dragon; this is because the opportunity to take it arises only after 35 minutes, whereas a significant number of games in the tournament have ended before such game length is reached. Also, it competes with the Baron buff on the other side of the Summoners' Rift map, which makes taking either buff a tricky situation to deal with post-35 minutes.

There is a reasonably strong relation between the Rift Herald and team victory, while the relation between the team securing the first Baron buff and victory is highly robust, with more than 7 out of 8 games being won by the team securing it.

Kills vs Deaths Situation:

It seems only logical to expect that the team with more number of kills would naturally go on to win the game on most instances, because not only is the dead player removed from the map until his death timer runs out, the team taking the kill can also use their numbers

[20] "League of Legends 2018 World Stats." http://2018worlds.prololstats.com/. Accessed 2 Jan. 2020.

advantage to take down turrets and secondary objectives, or go for more kills on the enemy team.

In the overall tournament, there were only three recorded instances of teams winning the game despite having lesser kills than their opponent in a total of 77 games, and one instance where both teams had equal number of kills. All of these games laster for greater than 30 minutes, with three of them venturing into the 40 minute-territory.

Over the course of the analysis, the **kill ratios** [Kills by one team / Total Kills Recorded] of the various teams in all games shall be compared; from the above paragraph it is obvious that the winning team almost always has a kill ratio > 0.5 at the end of the game. Which is why the analysis will look at the state of the **kill ratios at the 15-minute mark**, then look at the impact it has on the final result of the game. Another statistic of interest is the **kill difference at the 10-minute mark**.

Vision:

The aspect of how vision works in *League of Legends* has been covered in great detail in Chapter 1. To summarize, every champion, along with their allied units and structures have a limited range of vision, so there are areas upon the Summoners' Rift where the players have no information on what is taking place; called the **Fog of War** because the terrain is known but the present situation is unknown. To gain vision in these areas the players need to put down wards, which serve to provide vision around themselves for a limited radius. However there is a limit on how many wards a player can place down on the map. On the other hand, there are ways to remove enemy wards as well as scanning nearby areas, which helps in defusing possible enemy ambushes by getting vision into previously unwarded bushes that might be hosting enemy player(s) who might be attempting to take one by surprise.

When we come to vision as a control variable, we can look at **wards placed and wards destroyed** by the competing teams, to observe what it is that is statistically different between them than causes one of the teams to win. Although there are other ways to achieve vision over the map, the data for these corresponding features was unavailable, so the study about vision is restricted to just these two main factors.

However there is a caveat to the above analysis. Quite often, in games that go on for longer than 35 minutes, it is either a single teamfight [3v3 or more players facing off] or an ambush that takes down one or two opponents that decide the final outcome. With vision it is possible to reduce the risk of ambushes from the enemy, however when players have completed item sets [each player has a maximum item slot limit of six, with a separate slot for stealth wards / farsight alteration / oracle], they are unable to purchase Control Wards anymore, while the players who haven't achieved this yet still might have an item slot to use for Control Wards. This means than even though the players with full item sets cannot set up as much vision for their team, they are still reasonably stronger in teamfights [more survivability / more damage output etc. depending on the champion type].

Jungle Control:

Another related aspect to vision is the jungle control, which is quite precisely reflected by the number of neutral monsters being killed by the two teams on their enemy's half of the jungle area. However, the most important factor relating to jungle control in the game, pertains to the jungler's kill participation [(no. of kills + no. of assists) / total no. of kills by team], as well as the flat numbers and the **difference in kill participation** between the two teams' junglers.

Also, the statistics related to the taking of secondary objectives [baron, drakes et al.] are also highly reliant upon either team's junglers, because they often have to be the ones dealing the killing blow on the secondary objectives with their Smite summoner spell and prevent the opponent team from stealing away the buff. Unlike a large percentage of games where the rewards depend upon the corresponding contributions, here in *LoL* it is the team dealing the killing blow which secures the objective. As such, it therefore becomes imperative for the teams to secure vision around the objective under consideration so as to ensure the taking of the objective safely, with minimal risk. On the other side, the opponent has to choose whether to give up the objective or take a risk and try to steal it away.

ANALYSIS PROCEDURE:

A. This part of the analysis deals with the predictors of victory.

The **first stage** of the analysis deals with determining just how efficient the independent variables under consideration are, at predicting the **final result** of the game [Win / Loss]. For this process, **probit analysis** will be used with the data sets of the independent variables plotted against the final result on the y-axis [Settings : Win = 1 and Loss = 0]. Upon completing this process with different independent variables under consideration, it will become more evident just which of the independent variables under consideration have a stronger impact on the final outcome of the matches.

Moving on to the **second stage** of the analysis, the independent variables with the strongest prediction capabilities will be used as a **proxy condition** to the win/loss condition of the first stage. From here, independent variables are again used, this time in **linear regression analysis** to determine which of the factors have a greater impact on the proxy variable. There will be both single variable regression analysis as well as multi-variable regression analyes. The multi-variable regression will help to identify which of the independent variables tend to impact the proxy variable when used in combination.

In this process there are way more restrictions on how the independent variables are selected. For example, if the change in gold difference between the 15 minute-mark and the 25 minute-mark is selected as the proxy variable, all the events that take place outside this time window are automatically disqualified, far as using them as independent variables is concerned.

In both stages of the analysis, the OLS coefficients will be compared to determine which of the independent variables serve as stronger predictors of the final result / proxy condition, whichever the case may be.

B. This part of the analysis deals with how geography of the map affects the game.

The **third** stage of the analysis pertains to the vision department of the game; although it is possible to look at the difference in the number of wards placed at the end of the game, there

are no available statistics to track the same statistic over the course of the game length, for example the ward difference at the 15 minute mark, for example. As such, this part of the analysis will be **qualitative**, with the research looking into some of the games [**case study analysis of 4 games**] where

1. both the teams were more or less evenly matched, or
2. the winning team happened to be lagging behind their opponent by a significant margin and vision proved to be the main difference maker in the final result.

Preceding this qualitative analysis will be a linear regression comparison between the 2018 and the 2017 iterations of the tournament. This will serve to highlight how certain changes that occurred between the two seasons regarding vision might [or might not] have impacted the game state over time.

CHAPTER 3: ANALYSIS

As explained in the Methodology chapter, there will be three stages of analysis moving forward, in order to find out just how impactful the various predictors of victory are. The three stages:

1. Probit Analysis
2. Linear Regression Analysis [both single variable and multi-variable]
3. Case study analysis regarding the factor of vision, followed by a linear regression comparison between the statistics from LoL Worlds 2018 and 2017.

Stage 1 - Probit Analysis:

Here is where we attempt to determine which are the strongest predictors of final result of the games. The independent variables being taken into consideration range from gold difference, kill difference and difference in the number of drakes + elder dragons taken.

The closer the OLS coefficient values are to 1, the better predictors the corresponding independent variables are at estimating the final result.

Table 3.1: *Analysis of final results of the game as a function of gold difference.*

Characteristics	Model A	Model B	Model C	Model D
y-intercept	-0.02437 (0.028)	0.02842 (0.04246)	-0.05321 (0.1867)	0.00374 (0.0456)
GD_{eom}	0.13694 (0.0238)			
GD_{25}		0.47169 (0.12)		
GD_{15}			0.27984 (0.1359)	
GD_{25-15}				0.39259 (0.0904)
N	154	142	154	142
Adjusted R^2	0.89861	0.68863	**0.34074**	0.69693
Reduced χ^2	0.02551	0.07839	0.16589	0.07626
p-value	1.218×10^{-96}	2.483×10^{-55}	8.335×10^{-36}	1.218×10^{-96}

Values used above are from the results of sigmoidal fits obtained from the relevant data sets; the respective p-values are quoted in the last row of the observations [$p << 0.01$ in all the cases].

The table below is an analysis of how the change in kill ratios of the teams facing off, can be a predictor of the final result of matches.

Calculations used in the data set are made according to the equations mentioned below :

$$\text{Kill Ratio of a team in a game} = \frac{No.of\ Kills\ by\ the\ team\ in\ the\ match}{No.of\ total\ kills\ recorded\ in\ the\ match}$$

$$\text{Kill ratio of a team at the 15-min mark} = \frac{No.of\ kills\ by\ the\ team\ at\ the\ 15-min\ mark}{No.of\ total\ kills\ recorded\ at\ the\ 15-min\ mark}$$

Table 3.2: *Analysis of the final result as a function of kill ratio of the teams, and final drake difference.*

Characteristics	Model E	Model F	Model G
y-intercept	-0.01191 (0.02494)	0.07329 (0.24236)	-10.36749 (5563.4045)
KR_{com}	9.75133 (1.6311)		
KR_{15}		2.49693 (1.9828)	
Drake Diff			0.00752 (4.1849)
N	154	152 [zero kills were recorded in one of the games up to the 15-min mark]	154
Adjusted R^2	0.87765	0.18171	0.19908
Reduced χ^2	0.03079	0.20593	0.20557
p-value	1.598×10^{-90}	1.951×10^{-28}	7.153×10^{-29}

Values used above are from the results of sigmoidal fits obtained from the relevant data sets; respective p-values are mentioned in the last row of the observations. As is evident, in all the cases, $p << 0.01$.

Looking at the results of all the models, it is evident that the best alternate variables to look at, instead of final result of a match tended to be [according to the OLS values obtained]

A. Gold Difference at the end of the match
B. Kill Ratio at the end of the match.

However, even though they serve as effective alternatives to looking at the win/loss situation, it is more important to look at the variables that describe the earlier stages of the game, as they are the variables that will be the predictors of the final result.

The **average game lengths** in *LoL Worlds 2018* is **32:30 minutes**. This means that even though Models B and D have great OLS regression coefficient values, they still rely upon the

situation at the 25-minute mark. Leaving the final calculations to predict only 7-8 minutes of game time, on average.

When one looks at the 15-minute situation, the gold difference OLS coefficient is reasonably good, while being sufficiently early in the game. This allows the model's calculations to use a wider time span to make predictions upon. This is not the case with the kill ratio at the 15-minute mark.

Therefore, the **proxy variable** that shall be used for the second stage of the analysis will be the **gold difference values at the 15-minute mark**.

Stage 2 - Linear Regression Analysis:

The objective of linear regression analysis here, would be to identify the strongest predictor(s) for the gold difference between the teams facing off. The main variables that can be analyzed would be the kill difference, drake difference and turret difference: all measured at the **10-minute mark**.

We only have these 3 variables because, simply stated, there simply are no other objectives available at this point of the match. The secondary objectives like Baron Nashor and Elder Dragon spawn later on, and hence cannot be used to explain the situation at the 15-minute mark.

Table 3.3: *Analysis of the observed gold difference values at the 15-minute mark with various parameters in simple regressions and multi-variable regressions.*

Characteristics	Model X1	Model X2	Model X3	Model X4	Model X5
y-intercept	-3.3×10^{-17} (0.1339)	-3.3×10^{-17} (0.1772)	-0.214 (0.2154)	-0.15 (0.147)	-3.3×10^{-17} (0.1287)
KD_{10}	0.772* (0.0626)			0.711* (0.0614)	0.723* (0.0617)
TD_{10}		1.755* (0.3772)		1.062* (0.2783)	1.032* (0.2808)
DD_{10}			0.867** (0.4337)	0.606** (0.2970)	
F-value	152.06	21.645	3.994	61.991	89.041
N	154	154	154	154	154
Adj. R^2	0.5001	0.1247	0.0256	0.5446	0.5351
p-value	1.18×10^{-24}	7.08×10^{-7}	0.047	3.98×10^{-26}	2.86×10^{-26}

KD_{10}: kill difference at the 10-minute mark
TD_{10}: turret difference at the 10-minute mark
DD_{10}: drake difference at the 10-minute mark

*: $p < 0.01$ **: $0.01 < p < 0.05$

From the above models, it is evident that Model X4 is the best model for predicting the gold difference situation at the 15-minute mark. However, when compared with Model X5 the conclusion would be that the drake difference at the 10-minute mark is able to explain only around 1% of the observed variations. Also, the F-value is drastically boosted by leaving out the DD_{10} parameter, which makes X5 a better model than X4, while having a reasonably better adjusted R^2 value than X1.

Therefore, one can conclude that the difference in the number of kills is the major contributor to the observed gold differences between competing teams at the 15-minute mark. This

contributor is supplemented by the difference in the number of turrets taken, to make a better estimate of the situation.

Stage 3 - Role of Vision:

To explain the impact of vision upon the game, there are two different types of analyses that will be carried out:

A. Linear regression analysis + comparison of certain statistics across the *LoL Worlds* 2018 and the 2017 iterations.
B. Case studies [4] of outlier games to underscore the impact of vision on the final results.

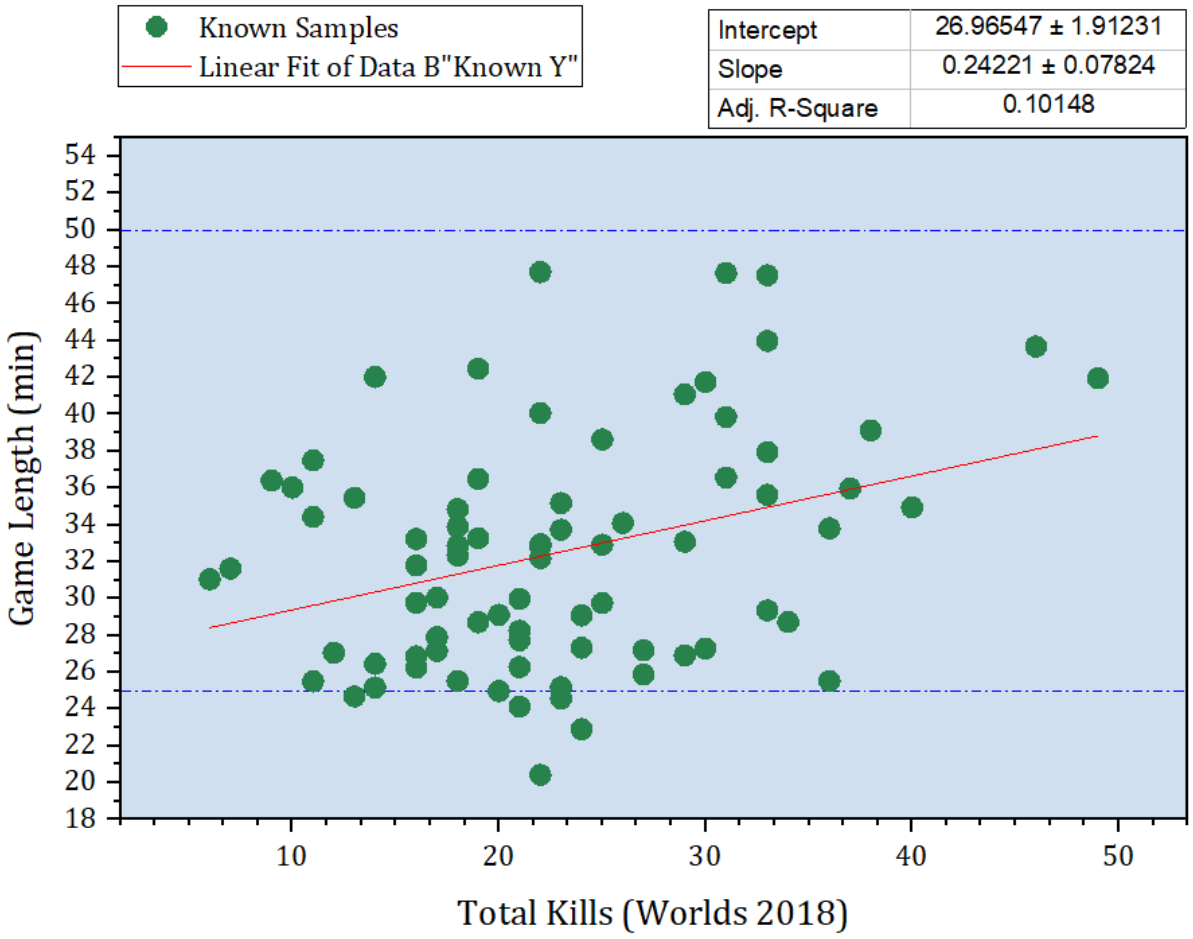
A. Linear Regression Analysis + Comparison:

Regarding the vision part, there were sweeping changes made to the game between the end of 2017 season and the start of the 2018 season: notably, how the wards worked as well as a jungler's item that got removed, which was essential for vision. In fact, the way vision worked was one of the fundamental aspects about LoL that changed from 2017 to 2018.

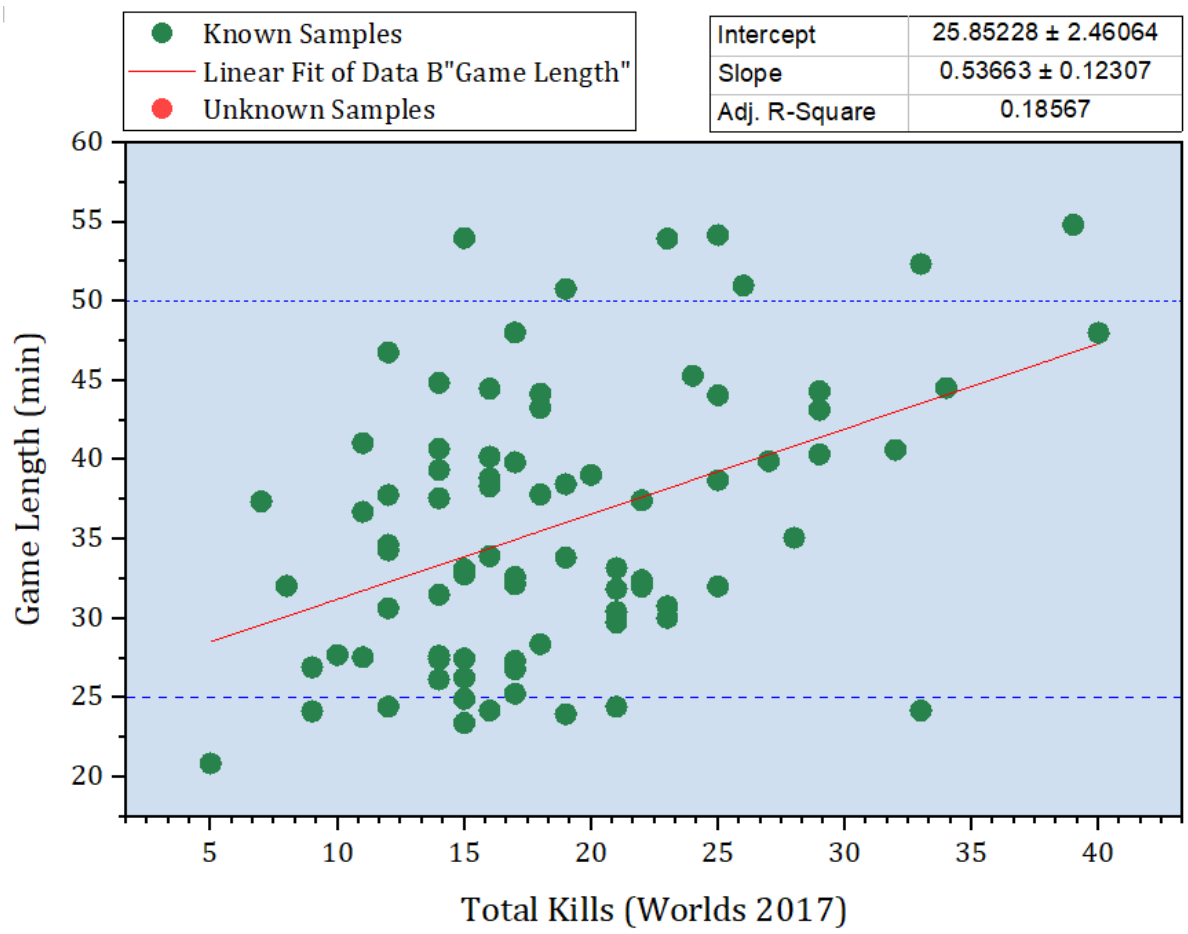
In 2017, the "pink ward" [as the Control Ward is also called] used to reveal stealthed enemies and enemy stealth wards, however it would not disable the said wards in consideration, the way the present Control Wards do. In other words, vision denial was nowhere near as prominent as in the 2018 season.

In addition to that, there was a jungler-specific item in the game which allowed the player purchasing it to put down stealth wards. The cooldown period for this item was 1 ward every 75 seconds, with a maximum of 3 wards on the map at any given time. This allowed a greater degree of safety for both teams with the additional ward coverage and no ward disabling items. This allowed the teams to play out games more safely, and would often lead to longer games. Also, there was a greater possibility of playing out "perfect games" [giving away zero kills to the enemy] when either team secured a significant lead in the game.

Plot V1: Game Length vs Total Kills in all games - Worlds 2018 [data obtained from gol.gg]



Plot V2: Game Length vs Total Kills in all games - Worlds 2017 [data obtained from gol.gg]



As is observable from both plots, there were 7 games in LoL Worlds 2017 that have gone on for greater than 50 minutes, whereas in the 2018 iteration of the tournament, not a single game was played out for that long.

Table 3.4: *Analysis of changes in game lengths and kills per game, on the backdrop of vision changes from 2017 to 2018 LoL season.* [data obtained from gol.gg]

Characteristics	Model V1 (2018)	Model V2 (2017)
y-intercept	26.96547 (1.91231)	25.85228 (2.46064)
KC_{2018}	0.2422** (0.07824)	
KC_{2017}		0.5366** (0.12307)
Game Length	32:30*	35:53*
Kills/Game	23*	19*
Shortest Game Time	20:26*	20:52*
Longest Game Time	47:43*	54:49*
Number of games above 50 min.	0	7
Number of games below 30 min.	34	22
Number of Elder Dragons taken in the tournament	9*	34*
Highest Kill Count in a Game	49*	40*
Lowest Kill Count in a Game	6	5
Number of Perfect Games	0	6
N	77	80
Adj. R^2	0.10148	0.18567

*: values marked by an asterisk (*) are taken from GoL GG statistics.

**: $p < 0.01$

Among the above statistics, the statistic that has clearly changed by a huge margin, is the total number of Elder Dragons taken over the course of the tournament. This number dropped from 34 in *Worlds 2017*, all the way down to just 9 in *Worlds 2018*. Since the Elder Dragons

are available for taking down only after the 35-minute mark, the sheer fact that there is a drastic drop in the number signifies the shorter game times on average.

Another point to take note of, is how there were no instances of “perfect games” that were recorded in LoL Worlds 2018 [perfect game: a win with zero kills given up to the enemy]. This is due to the additional vision denial that was introduced in the 2018 season, that increases the amount of unpredictability in games. It has led to an increase in the average number of kills being recorded in games, while simultaneously decreasing the game lengths too.

The impact of the vision changes was felt by all the teams in the game. For instance, SKT T1, the team which won the Worlds Championship 3 times [2013, 2015, 2016 seasons] and was runner-up in Worlds 2017, did not even qualify from its region (Korea). Whereas SSG, the title holder from 2017 [rebranded to GenG] was eliminated in the group stage itself with an abysmal record of 1-5. These are just two of the high-profile examples of how the changes in vision mechanics affected the players. There was a roster change in the SKT lineup [change in the top laner], so that might have affected the team play somewhat, but definitely not to the point where a team goes from runners-up to not qualifying, for sure. GenG retained all of its former team from its winning 2017 lineup, yet had no returns. Both teams were known for playing safely around their vision, however the new vision mechanics made the game more chaotic, with a greater number of fights and ambushes resulting in kill-heavy games. The teams under consideration could not adapt fast enough and failed to make much headway on their title ambitions.

B. Case Study Analysis of Vision:

- **G2 vs PVB, Group Stage**

In this match, PVB had the gold lead over their opponents for a majority of the game, despite being down on kills [PVB was up 2500 G on G2 despite the score being 7-16 on the kills department at the 45-minute mark]. This was due to them taking more turrets than G2, as well as being able to secure 4 Drakes, the Rift Herald and 2 Barons, in comparison to just two Drakes on G2's side. However, G2 stalled the game for long enough to more or less catch up with PVB in items.

Image 3.1: *Map movements post-45 min mark in G2 vs PVB.*

Around the 45-minute mark, G2 decide to engage their opponents in a 4v5 fight in the mid lane, starting with G2's jungler using his vision-denial ultimate ability [unique to the champion he was playing], which gave his teammates a bit of leeway in engaging their enemy in the fight. Meanwhile, G2's mid laner managed to flank PVB and get easy access to

the enemy damage dealers : the fight resulted in a 2-for-1 kill trade in G2's favor, which they converted into a Baron takedown with ease [the dead players had > 50- second respawn timers]. PVB was forced to give up the Baron contest, and switch to the Elder Dragon buff, as that was the only way they could save the game from this precarious position. Giving up the Elder Dragon buff as well would result in an instant loss, effectively.

G2 anticipated this move, as this was literally the only move PVB had remaining. As PVB's adc and jungler were trying to get back to their base after taking the Elder Dragon, G2's players caught up with them from multiple sides, and the resulting fight ended with PVB's adc falling. Now, it was G2 in a 5v4 advantage and Baron buff, just pushing their map lead to the win.

Result: G2 wins in 47:40.

- **FNC vs EDG, Quarterfinals Game 3**

At the 27-min mark, FNC was 5000+ G behind EDG as well as 2-6 in the kill score. At this point, FNC manages to secure the drake objective by posturing around the Baron area and drawing EDG there, and then immediately moving over to the drake. Meanwhile, EDG was still clearing out the wards set down by FNC to regain control of the Baron area. EDG decides to take a 5v5 fight near the drake pit, even though the drake is dead already. Here, EDG's support player ends up taking too many attacks from FNC and dies right at the start of the fight. This is followed up by EDG's jungler mispositioning in the fight [he's stuck inside the drake pit while the fight is taking place on the other side of the pit's wall]. This turns the fight into a 5v3 effectively, and FNC takes down all three of them. EDG's jungler takes down the FNC top laner at the back end of the fight, who was still in the area.

But it was not good enough, because with 4 dead on the EDG side and EDG's jungler still near the bot lane, FNC was free to go right over to the Baron and take the objective. This one fight evened up the game to a large extent, and using the buff FNC managed to cut down the gold deficit to around 1000 G within the next 3 minutes.

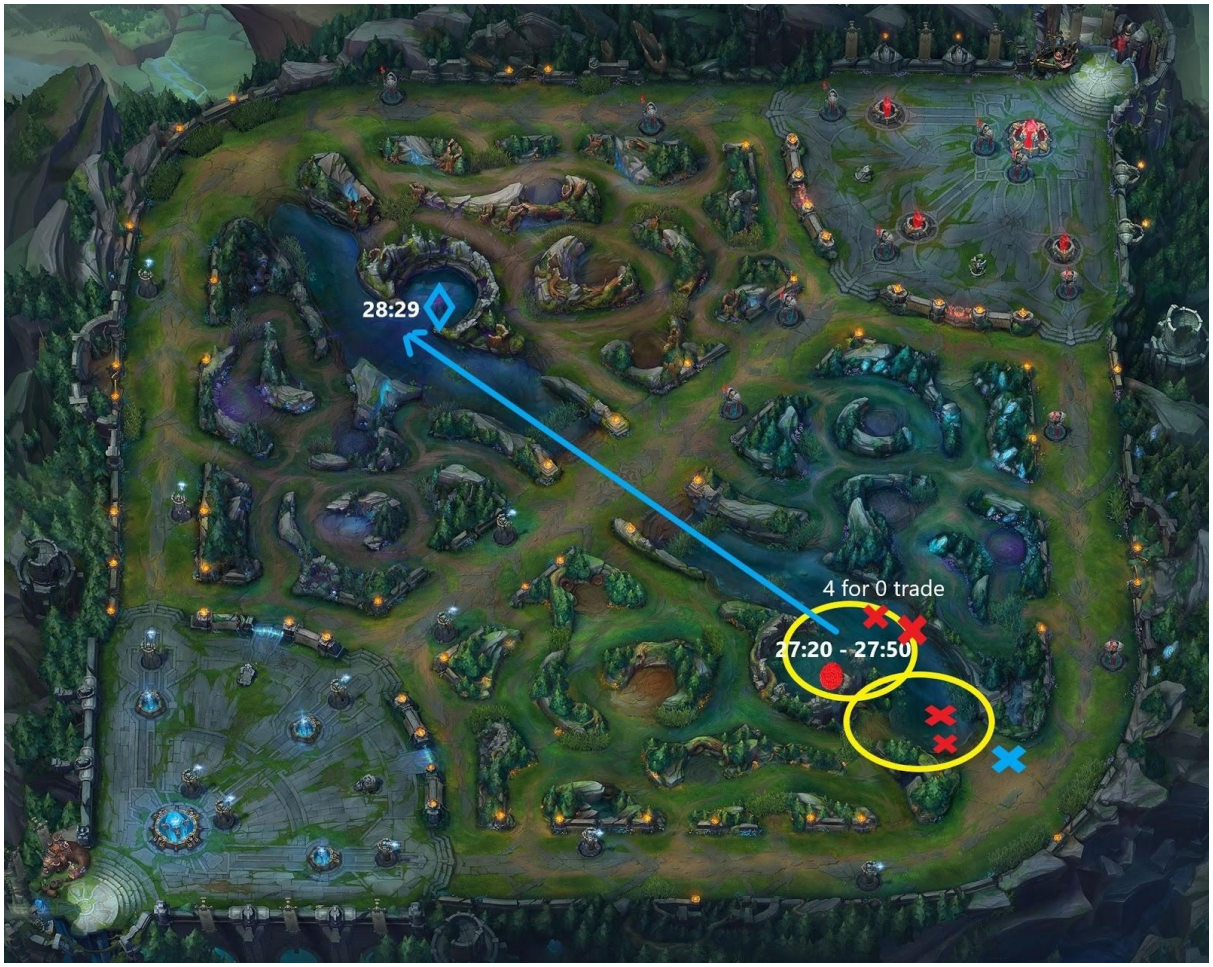


Image 3.2: *Map movements between 27 and 29 min-marks in FNC vs EDG.*

The final fight occurs at the 46-minute mark. FNC is 4000 G behind EDG, but since it is already late game, most players were done with their items. The gold difference was now just a statistic with no significance. FNC takes down EDG's top laner, then within the next 20 seconds get over to the Baron. EDG has a Control Ward in the pit, so they know FNC are attempting to take it down; however they are one person down and are behind the pit wall, with almost no access to the Baron itself.

As FNC is taking down the Baron, EDG's top laner respawns and uses his Teleport summoner spell [takes 4 seconds to reach the destination, and opponents get full vision of where you come in] on a ward to get behind FNC, and stop their Baron attempt. EDG's jungler actually manages to get into the pit while the Baron is low, then gets in the last hit to steal the buff. But now, the two EDG players are in the vicinity of FNC players, with zero escapes and no way for their teammates to help them. They die almost immediately, and now it was a 5v3 in favor of FNC and they just push onwards to the EDG Nexus.

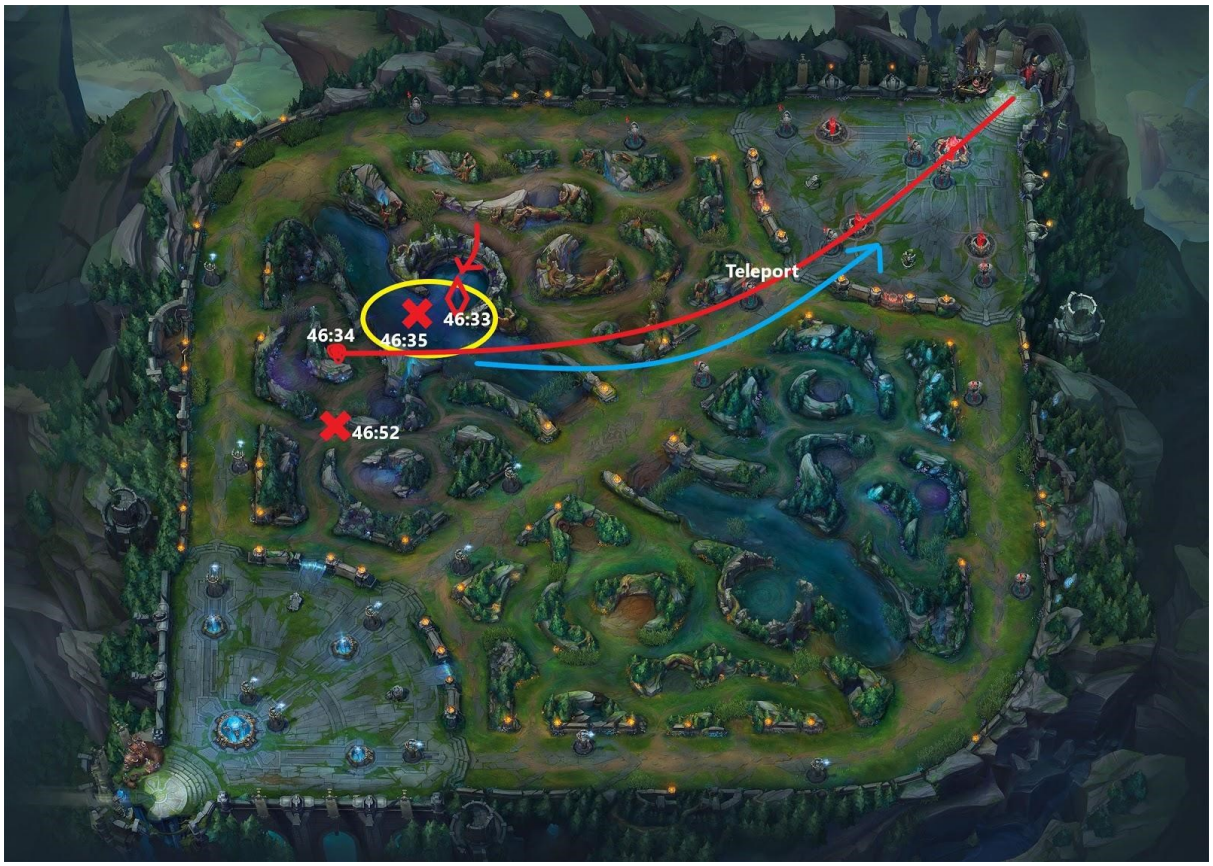


Image 3.3: *Map movements post-46 min to the end of the game in FNC vs EDG.*

Result: FNC wins in 47:43.

- **KT vs IG, Quarterfinals Game 1**

26-minute mark. IG has a gold lead of 2400 G and is 7-4 in the kill score. The gold lead is reasonable, but nothing too daunting yet and KT still has a very good chance of turning things around. This is when things begin to happen near the Baron pit.

IG first clears out all of KT's wards near the Baron area, while KT's top laner is pushing bot lane in an attempt to take IG's bot lane inner turret. After IG clears out KT vision, they start attacking the Baron, thus forcing KT to either take a bad 4v5 fight or lose Baron. KT decide to take the fight with IG. The bad thing here is, 3 of the KT members are in chokepoint A and 1 is in chokepoint B [shown in map]. With zero vision on IG members.

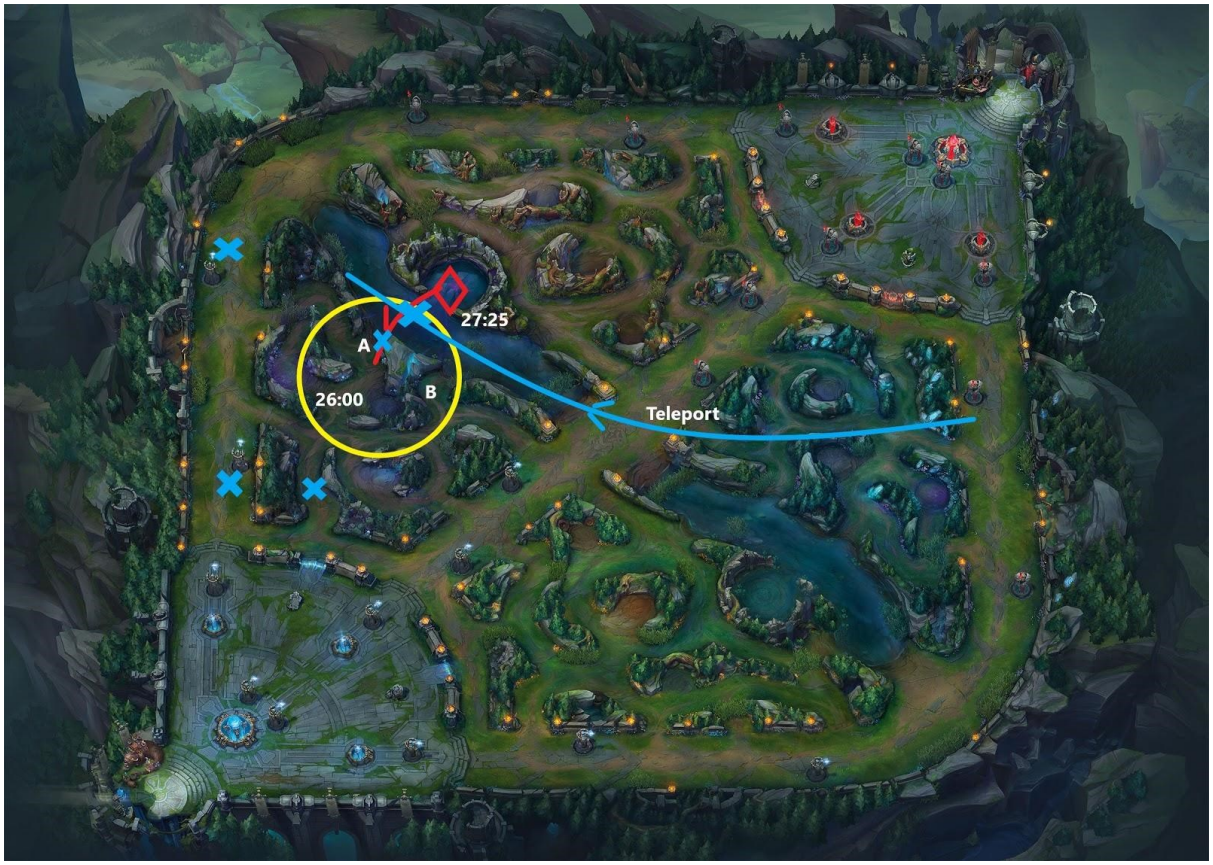


Image 3.4: *Map movements from 26 minutes onwards in KT vs IG.*

IG take the fight at chokepoint A, and this forces KT's top laner to use his Teleport Summoner Spell [4 seconds channel time] to join his team. By the time he joins his team, one of his teammates is almost dead in what was effectively a 3v5 till then, and 4 of IG members were surrounding his Teleport location. He dies on the spot, and the IG players force the issue and kill the remaining 3 KT members as well, then take the Baron. Within another 3 minutes, they end the game.

Result: IG wins in 29:58

- **IG vs G2, Semifinals Game 3**

As the game time hits 23:30, IG has a 12-10 kill lead and a gold lead of 2300 G. Nothing too substantial yet, as G2 has taken 2 turrets to IG's 1, which gave G2 a little more map control. At this point of time, IG has pushed out the minion waves in all the lanes. Either G2 has to answer this push or lose the bot turret, so G2's top laner goes to bot lane. IG has by now cleared out all of G2's vision around the Baron and decides to start attacking it. Meanwhile

IG's top laner pushes mid lane, forcing two G2 players to stay and hold the lane and protect the turret.

G2 realises too late that IG is attempting to take down the Baron; now G2's top laner uses his Teleport Summoner Spell to go in behind the IG team, while G2's jungler jumps in and tries to steal the Baron objective. The attempt is a failure. The other 3 G2 members are too far away to join the 2v5 their teammates are stuck in. So IG, on top of getting the Baron buff also take 2 kills over G2 to sweeten the deal. It is also quite possible that G2 were aware that IG players were near the Baron area beforehand, but just did not anticipate the Baron to die so quickly. From here, IG use the Baron buff to take over the game.

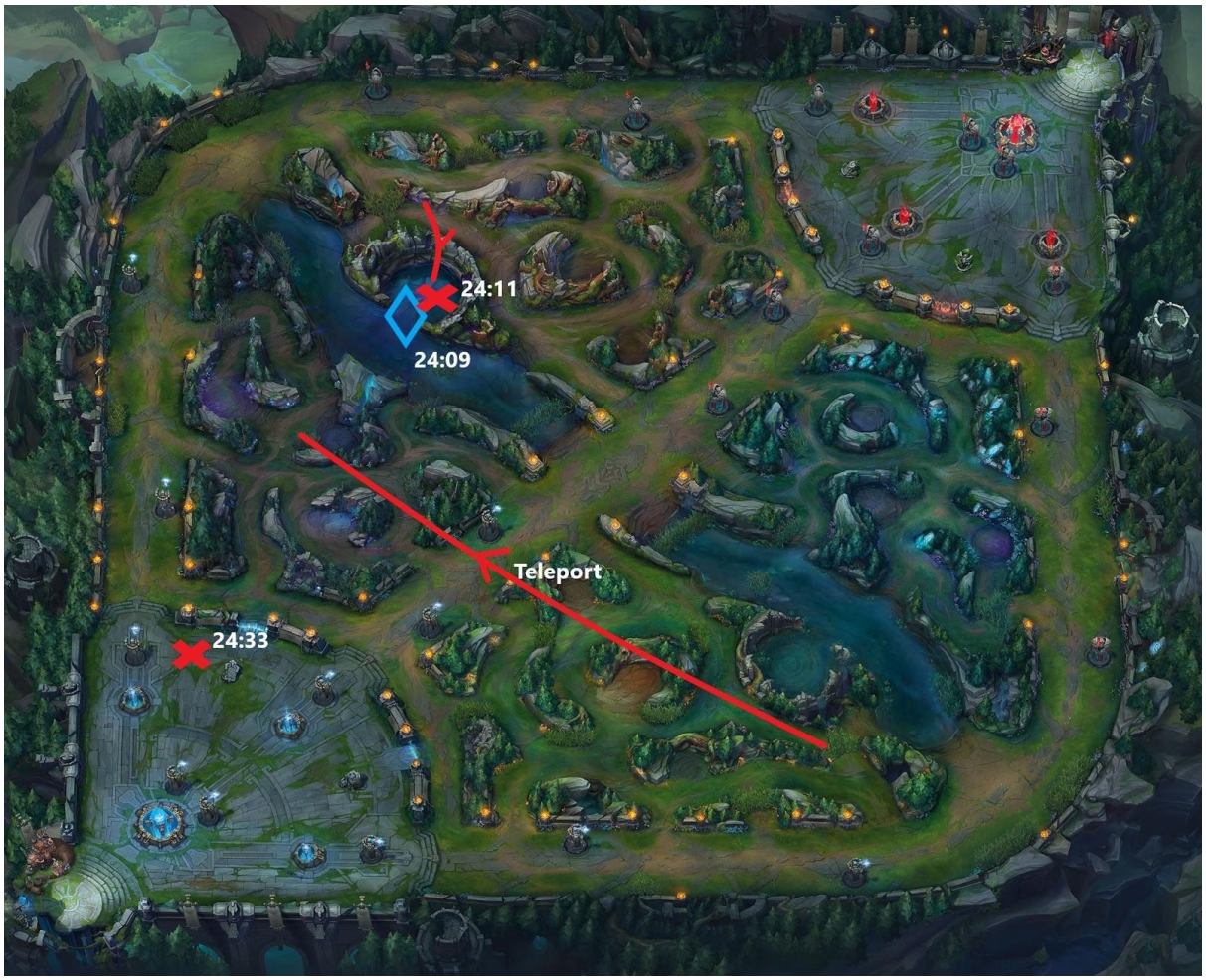


Image 3.5: *Map movements between 24 and 25 minutes in IG vs G2.*

Result: IG wins in 28:43.

CHAPTER 4: INFERENCES AND EQUIVALENCIES WITH REAL WARFARE:

From the regression analyses performed in the previous section, one can come to the major logical conclusion that ideally, the competing teams would need to secure a reasonably significant lead over the opponent within the first 10-15 minutes of the game. That is the best way to maximize their chances of victory in the game. Although there is an 87.5% chance for the team taking the first Baron to go on to a victory, it spawns only after the 20-minute mark is reached. The previous 20 minutes of the game do generally set up the situation so that one of the teams often has a greater chance of taking down the Baron. For example, if one of the teams gets more or less destroyed within the first 20 minutes itself, then it is almost a free Baron take for the other team to speed up the win [due to the nature of the Baron buff].

VISION AND INFORMATION WARFARE:

Basically, because the **amount of vision setup available has dropped** from 2017 season to the 2018 season, the **game turned much more volatile** than it used to be, enabling teams to take higher-risk approaches to fights. Up until the vision changes at the beginning of 2018 season, it was all too common to see games stretch on for 45+ minutes, with relatively less kills recorded over the game span. In Worlds 2017, the average number of kills recorded per game came out to be 19, while in Worlds 2018 the number rose to 23. And at the same time, the game time dropped by 3 min 23 sec.

The other major thing to mention here, is how the game of LoL has developed over the years from 2010 to 2017, to put the 2018 changes into perspective. During the period of 2010-17, more champions were added to the game, and certain modest changes were made to the map, but nothing too impactful in the overall sense. The core gameplay in the pro scene revolved around putting down a great number of wards and winning the vision game over the enemy team. The 2018 vision changes fundamentally altered how the game was played.

When it comes to drawing parallels, one could equate the function of wards in games as a kind of radar. Stealth Wards help in setting up vision for one’s team, while simultaneously being undetected by the enemy unless they use the Oracle Lens to scan it out and then destroy

it. The other way of dealing with Stealth Wards is by putting down a Control Ward, which reveals AND disables the enemy Stealth Wards in its vicinity. Thus we can say the Control Wards are acting like a radar detector and signal jammer both, while the Oracle Lens behaves like a scanner for the enemies and enemy wards. Up till 2017, a player could theoretically put down an infinite number of Stealth Wards on the map as well as have up to 2 Vision Wards, if he chose to. But in 2018, the vision changes made it so that a player could have a maximum of only 4 active Stealth Wards on the map, and just one Control Ward. Putting down an extra Stealth/Control Ward simply removes the first-placed ward of the same type off the map. Also, the removal of the warding-focused jungler item meant that he could not put down as many wards as before.

This meant that for instance, pre-2018 a team could set up vision around both the Baron and Drake without much difficulty. Whereas from 2018 onwards, the changes made it so that the same team would be able to set up effective vision around just one of the objectives [either the Baron or Drake]. This meant the team had to prioritize one over the other, depending on the game state.

There is an interesting aside made by Duncan "Thorin" Shields, a British e-sports journalist on Summoning Insight Ep. 87 [available for viewing on Cloud9's YouTube channel], where he compares the evolution of LoL to high-stakes poker, due to vision changes made by the game developers after 2017 season ended. He talks about how the most effective strategy to win in poker, used to be all about playing conservatively. The players would make estimates based on what cards they had, run the numbers in their heads and then decide on their moves. But then, over the decades of the game, the metagame in poker shifted to a hyper-aggressive style of play, where the opponents are forced to react to your moves. LoL has developed over the years in much the same way, and the post-season changes of 2017 did indeed turn the gameplay on its head. With lesser vision available to players overall, it is now quite possible to run similar aggressive plays.

The Korean region dominated the LoL e-sports scene in the international tournaments until the end of 2017 season; they had more or less perfected the vision game. It got to the point where the finals in Worlds for 2015-17 all had two Korean teams facing off for the trophy. Contrast this with 2018, where not one Korean team even made it to the semifinals, and that tells the story. The optimal playstyle had changed from 2017 to 2018 due to the vision

change: it had shifted from favoring a conservative, controlled playstyle to being favorable to teams that were willing to take bigger risks.

Compare the same to warfare, where the **availability of information is limited**: if both warring armies know exactly what the enemy is doing as well as their positions on the battlefield, their strategies will take a conservative shift, in general. If it is just one side holding all the cards while the other army has minimal information, then it becomes almost trivial for the first side to make their moves. They have a choice of setting up ambushes and encirclement/breakthrough strategies against the enemy. On the other hand, they can wait for the enemy units to make their move and respond accordingly by striking some strategic location that the enemy might have left relatively undefended. Either way, the side with all the info can cut down on losses while the enemy army is fighting blind.

When both warring sides have nearly complete real-time information, the battle turns into a sort of chess game played over a vast area. Both sides are trying to either provoke the enemy side into a mistake, or alternatively shifting their attention to a different battleground. If the terrain in concern is strategically crucial, then the action will eventually shift there, but the process is bound to take up a significant amount of time.

But if neither side has enough information to make low-risk-high-reward decisions, then situations where the two sides might run into each other could transpire. An interesting point about this feature is that it has the tendency to even out the playing field; at the very least the tech disparity can be nullified somewhat.

MOBILIZATION AND TRANSFER OF RESOURCES:

In the game of LoL, the difference in fighting capabilities of the competing teams boils down to a fight for resources [aka Gold in LoL], much like in real life. If one team is able to farm resources better while being efficient at denying the same to the opponent, then they automatically put themselves at an advantage. It's quite the same in reality too, especially in cases of drawn-out military conflicts where transport of resources between the mainland and war frontiers is highly important.

While comparing LoL with actual military conflicts, it is not too difficult to draw parallels between fighting capabilities of competing teams with military capabilities of warring armies and the **role of tech** here. Both ventures need adequate resources to be collected or 'farmed' to invest into the required tech. So basically, more gold in the players' pockets = more items on their champions, which translates to higher damage, or better fire rate, or higher survivability, or even a combination of these factors. Which more or less reflects the military situations as well. But when fights turn into protracted conflicts and there is a stalemate of sorts between warring armies, the fight gets distilled down to **mobilization**[21]. Whichever army/armies are able to mobilize troops over a longer time span [when the conflict has already dragged on for multiple months, or even years], will stand a better chance of emerging victorious, barring strategic blunders. This factor is represented in LoL by how the champions work : for instance, some of the champions are strong in the first 15-20 minutes of the game, but then start getting relatively weaker with time. Then you also have champions which are good at the 15-30 min section of the game [midgame champions, if you will], while there is a class of champions referred to as "hypercarries" that can effectively win the fight for their team by themselves when the game stretches on post-35 mins[so long as their team is able to protect them in teamfights for the first 5-7 sec].

So basically, the role of tech in warfare is reflected by how items work in LoL. Mobilization of armies is mirrored in LoL by how the champions themselves work, but the correlation in the second case is somewhat weak. Because in *LoL*, it is possible to give up gold leads to

[21] "Mobilization - Army Center of Military History." 3 Oct. 2003, https://history.army.mil/brochures/Mobilization/mobpam.htm. Accessed 5 Jan. 2020.

these late-game hypercarries in the first 5-10 min through bad gameplay and fast-track them to their win condition. One could argue that a parallel would be if an army captures an enemy tank factory and puts the factory to their own use, however such strategic victories seldom come in the first 2-3 months of a war.

Also, the role of tech and items in LoL equivalency breaks down when there is a **revolution in technology** for one of the warring states, which puts weapons of the next level in their hands. For instance, the game situations in LoL cannot explain the imperialist battles in Africa and Latin America, where the imperialist states were fighting the natives for control of the land. Pizarro's conquest of the Incas and the Anglo-Zulu war come to mind. The differences in military tech were so large that the humongous difference in numbers didn't even matter.

Resource transportation is a huge factor in large-scale warfighting, and takes a crucial role in how armies are able to function[22]. The importance of supply lines cannot be understated, and loss of these strategic locations can effectively cripple an army's fighting capacity. This factor made the development and protection of railways critical since WW I, as they were the most important link between the inland food supply, barracks, food supply etc. to the frontiers of warfare. And by reaction, increased the importance of artillery too. Artillery fire was the only major way of taking out enemy supply trains before they reached the frontlines. That is, barring allied engineers taking out railroads, which was only possible through infiltration or capture of railway stations. Or maybe, coming across undefended sections of the railway lines, which is quite possible in deserts.

And this crucial part of warfare is something that **does not have a parallel** in *LoL* games. To a small degree, it is possible to mirror this between the junglers. However, there is no way of entirely cutting off a team's resource line, as the main resource line for laners is the enemy minions which walk in through pre-defined sections of the map. Geography plays an extremely important role when it comes to transport of supplies and troops to the frontline in wars, but **in *LoL* the players have NO agency upon allied minions' pathing**. Also, a team which falls behind is able to access enemy minion waves easier, as they do not have to move

[22] "Logistics: The Lifeblood of Military Power | The Heritage ...." 4 Oct. 2018, https://www.heritage.org/military-strength-topical-essays/2019-essays/logistics-the-lifeblood-military-power. Accessed 5 Jan. 2020.

as far from their base as before. This is the game developers' way to giving disadvantaged teams a chance of making a comeback; if this feature didn't exist then all the matches would be determined by how the first 10-15 minutes went, and one could predict with 90%+ certainty which team would win, based off of looking at the stats for the first 10 minutes, unless the games being analyzed happen to be incredibly slow.

One can equate the lanes in LoL to the mainstream supply lines from the mainland to the frontiers, however when the main supply lines are hit by the enemy, the allies will try to find newer paths to transport supplies to their frontlines, which doesn't happen in LoL. Also in warfare, once the main lines are damaged enough, it takes significant time [in the order of weeks] to repair the structural damage and make the supply lines reusable.

TERRAIN:

Terrain plays a major role in skirmishes and duels when the participants are evenly matched [roughly equal gold], but not when the gold difference between the participants is too large. But when teamfights come around, terrain plays the all-important deciding role. This is because terrain in LoL has certain defined features. Walls restrict access as well as deny vision to the other side, while bushes deny vision unless there is an allied ward placed into it beforehand. About 95% of the teamfights take place in the midst of terrain, like near the Baron or the drake pits, or start off as ambushes in the jungle which turn into 5v5s in a span of a couple seconds. The only exception would be when one of the teams is at the enemy Nexus turrets, when the opposition has no choice but to fight and hope the first team makes a huge blunder or two in the fight.

In warfare, terrain plays a crucial role as well, but there are more facets to the role of terrain in actual warfare than in *LoL*. In both areas, it plays a huge role, it's just that there are many more ways terrain can impact the state of war. For instance, other than making the players go around the walls and denying vision, there is essentially no other way it can impact gameplay. There are **no elevations or depressions in terrain** in the game. And the **movement speed of the players is unaffected by geography**; it does not matter if the player is running around near the base, or the lanes, or the jungle area. [Terrain has the capacity of affecting the movements of 9 champions in the game directly, and that is out of a total of 142

champions at the end of 2018. And only one of those champions had a reasonable pick rate at Worlds 2018 while others were mostly left out of the games in favor of other, stronger picks at the time.] This is not the case with warfare. You can still go around bad terrain during warfare, but it is a long, drawn-out endeavor. And in some cases, the army might be faced with no choice but to climb up that mountain, or cut through the river by constructing rafts, if necessary.

And all this is while not even taking into account how the terrain can change during warfare. For instance, an artillery barrage over plain land can destroy roads which facilitate easy movement for vehicles and troops, however the change in local geography now presents the soldier with ways to take cover and move up, that were not previously available. It is still more complicated than just taking cover behind the tanks while they move up, but it can be done nonetheless, albeit in a different fashion now.

However, the end result does come out to be more or less similar in either case. Even though one can just walk around the terrain walls in LoL, it still does take 3-5 seconds to do it, depending on which part of the map the player is at. 3-5 seconds does not sound like much. But these few seconds quite often do turn out to be crucial in the game, since the fastest teamfights can end in a matter of just 10 seconds. If one or two players of team A [say] intend to walk around a certain part of the terrain and the enemy team B spots it out during the late game, they can capitalize on team A being split into two groups. It allows team B to break a possible tough 5v5 fight into two much easier fights of 5v3 and 5v2 fights, if played right. Basically, by the time the two players of team A do return to join the team, the fight may already be over in favor of team B, leaving them no choice but to retreat and defend their structures.

In warfare, if the numbers between the two opposing armies are more or less equal, the ideal course of action for an army to take would be to **divide the enemy** into two or more manageable parts. This is because it is easier for an army to deal with an enemy divided into two or more parts, than to deal with a single, large unit; it is one of the reasons why a breakthrough is so effective. When the army has to fight against an enemy that is significantly smaller than themselves, the army has additional options like encirclement open up for them during the course of the battle. If nothing else, the army can force the smaller enemy to take up defensive actions, because that would be the only way the enemy can hope

to survive the encounter for a reasonable length of time. Multiple ways are available to do this in reality, whether it be laying down artillery fire behind the enemy frontlines, or destroying bridges at opportune times.

MANEUVERS:

Most of the vision game is played over the principles of **outmaneuvering** and **forced friction** in professional games, where the players have been working as a team for a while, which minimizes any possible communication issues between the teammates. For instance, one of the teams can force an early turret dive in order to get a kill or two by creating a 3v1 or 4v2 situation. Some of these attempts can be mitigated by matching the numbers of the aggressor, and possibly even turned around. But this involves the defending team players to abandon their own lane to help out their teammate[s] which could set them behind by a reasonable amount. Basically, a situation where the defending team loses out either way, unless the aggressor decides to commit to the turret dive and then messes up the execution.

In professional play, just two or three mistakes [forced or unforced] are often enough for a team to take control from its opponent and start increasing their gold lead. When these gold leads start becoming untenable, it in turn forces the enemy to make a desperate play to take some control back. If the play works out fine, then the game might return to an even state again, or possibly even swing the momentum back to the enemy team. However, they are called “desperation plays” for a reason. They tend to be often high-risk plays with a relatively low chance of succeeding [often the chance of these plays succeeding is around 25-30% at most]. Some examples of these plays are sneaky Baron takedown attempts or Baron steal attempts with zero vision. If they work out they have the power to bring the game back to parity, but chances of success, as already mentioned, are super low. Especially if the team in the lead has good vision control over the map, these plays can be spotted out easily. Which leads to the enemy team dying almost for free, and end the game most times.

Unforced mistakes are quite frequent in League of Legends in lower skill levels of play. But then, these mistakes keep coming thick and fast from both sides, leading to longer games.

However, it is near-impossible to rely on the enemy's unforced errors in higher-tiers of play and especially professional play. Dying in a 1v1 duel in pro play is often a result of the dying player making a crucial error in gauging the enemy's damage. Which is why it is quite rare to see this in tournaments. For example, in a tournament as big as the Worlds, it happens maybe only once or twice in a game, that too when the skill disparity between the teams is high. Most of the kills recorded occur during teamfights in mid/late-game scenarios where the teams are fighting around objectives like the Baron, Drake or an inhibitor turret.

In the words of the US Marine Corps doctrinal manual "**Warfighting**"[23], maneuver warfare represents "a state of mind which focuses on shattering the enemy both physically and morally, by paralyzing and confounding him, by avoiding his strength, by quickly and aggressively exploiting his vulnerabilities, and by striking him in a way that will hurt him most." The ultimate lesson of the manual for the reader, is not necessarily to destroy the entirety of the enemy's forces, but to render them unable to fight as an effective, coordinated whole. One of the key features of maneuver warfare is that **it doesn't aim to avoid or resist the uncertainty and disorder that are at the center of armed conflicts; it embraces them as necessary to defeat the enemy**.

The parallels between maneuver warfare and post-vision changes League of Legends gameplay is uncanny. In LoL, since the 2018 season began, the game has begun to take on more of a 'maneuver warfare' type of gameplay, with both opposing teams playing around vision denial and efficient map movements to secure primary and secondary objectives to win games. For an example, there is something called an "early invade" in the game, where the jungler of one team invades the enemy's jungle side at the start of the game, with the support of 2-3 teammates in order to secure the jungle camps on the enemy side. If the opponent jungler chooses to avoid an early fight, he has the option of making the same move, i.e; invade his opponent's jungle side and take the jungle camps on his side.

A consequence of the early invade here would be how the map control is defined. In a standard game, the map is effectively divided into two equal halves **along the river**.

---

[23] "MCDP 1 Warfighting - Marines.mil." 20 Jun. 1997, https://www.marines.mil/Portals/1/Publications/MCDP%201%20Warfighting.pdf. Accessed 5 Jan. 2020.

However, in the case of the early invade, the map is instead divided into two halves **along the mid lane**.

Image 4.1: *Changes in map control depending on early invades.*
[Blue line divides the map control areas in standard games, while the red line divides the same in case of early-invades.]

Why would an early invade be necessary on some occasions? In some instances, it catches the enemy players off-guard and results in 1-2 kills right at the start, putting the invading team ahead. If the enemy susses out the invade attempt and decide to answer back by a counter-invade, then the map state is changed according to the red line in the image, without any kills. Even so, the early invade is sometimes quite beneficial to the jungler's teammates. For instance, maybe the top lane matchup for team A is quite unfavorable, and is liable to being ganked repeatedly by team B's jungler and giving up kills. In this case, team A's

jungler can perform an early invade into the enemy's topside jungle and split the map into top half and the bottom half, so to speak. Now team A has the top half under their control, but in exchange for team B taking the bottom half. In this map state, team A's top laner can play with more freedom, as the chances of him having to fight off ganks is minimized.

Similar actions can be taken in real warfare, where one army can, in theory, force the enemy into that part of the battlegrounds which would be safer for them. But with the downside of losing out control over certain strategic locations. For example, effectively cutting off supply lines without actually blowing them up, is a close equivalent here. Even though train station A and B might be under the enemy's control, if the allies can take over the control of a certain section of the railway tracks between A and B stations, it has a profound effect. In this case, station B can never rely on timely procurement of food and supplies. If the ally control into the enemy territory is considerable, then the enemy might be forced to abandon using these supply lines altogether.

But there are occasions when invades get botched, and it is team B which takes the kills on team A's invade. In this case, the top and mid laners are forced to play more cautiously, as depending on who takes the kill(s), that player on team B will now be accelerated with more gold (= more items), so to speak. This part doesn't really have an equivalent, as the failure in real warfare of securing enemy supply lines might result in a few tens of casualties, but nothing more. Losing tens of army men is not a huge loss in the grand scheme of things, as armies are typically built of tens, if not hundreds of thousands of soldiers.

But the ultimate use of terrain in LoL and real warfare, is how the competing teams/opposing armies make **use of chokepoints**. A case can be made that chokepoints are in fact even more important in LoL for the result than in actual warfare; and even in the case of warfare, exploiting chokepoints effectively lead to significant strategic victories. The reason for chokepoints being so much more important in LoL is that everyone playing the game knows the exact location of these chokepoints and how they can be exploited. This might not be the case in real warfare, where the reliance upon chokepoints is not as pivotal as it was in earlier times to defeat the enemy directly. However, the importance of chokepoints in the economic

side[24] has spiked up, with crucial locations like the Suez Canal and the Strait of Hormuz taking centerstage.

SLOW-PUSH INTO OBJECTIVES - OUTNUMBERING THE ENEMY MINIONS:

Slow-pushing a wave, in LoL is where the player kills 3 of the enemy minions while there is a 6 vs 6 minion fight going on in the middle of the lane [generally top/bot lane], and leaves. Now the fight between minions is a 6 vs 3 with the larger numbers coming out victorious. The more important point here is that in the time it takes the 6 minions to kill the 3 enemy minions, the next minion waves on both sides also reach the middle of the lane, Now it's a 12 vs 6. By the time this battle is concluded, the other minion waves will not have caught up yet so the larger minion wave pushes towards the enemy turret. The cycle repeats until the enlarged minion wave enters the enemy turret range and starts attacking the enemy turret. The turret will take a significant amount of damage by the time it is able to kill off all the minions, unless an enemy player moves over to stop the minion wave. If none of the enemy players respond to these pushes, it becomes quite easy for a team to knock down enemy turrets and gain map control.

In other words, this is the LoL equivalent of **overpowering enemies using the numbers advantage**. It is even more apparent in LoL because in real military engagements, one has to also account for disparity in available tech for both sides. In the game though, the 3 minion types have the exact same characteristics making it easy to gauge the impact of numbers for observers. A real-life military example would again bring us back to the German vs US tanks in WWII. Even though the Sherman tanks were inferior to German Tigers and Panthers, they were still able to overwhelm the German tanks through sheer numbers. But in real military engagements, the numbers superiority has to be much greater in order to beat the enemy [around 3-to-1 at least].

---

[24] "How trade chokepoints pose a growing threat to global food ...." 27 Nov. 2017, https://www.weforum.org/agenda/2017/11/how-trade-chokepoints-pose-a-growing-threat-to-global-food-security/. Accessed 5 Jan. 2020.

This is because the enemy, even with lesser numbers, can decide to set up a defensive perimeter and make a gradual withdrawal from the area, resulting in lesser casualties. When an army is on the offensive, they have to move through oftentimes unfamiliar, unscouted terrain and put themselves out in the open. This makes it easier for the enemy to kill them. But for a skirmishing squad/army that is slowly giving up the territory, they will be passing through known terrain in a vast majority of cases, and their movements will also be more deliberate, which puts them at significantly lesser risk than the aggressors. A full-blown retreat is a different matter entirely though.

SKILL VS NUMBERS DISPARITY OF PLAYERS:

When we observe LoL games in professional play, it is always a 5v5 match between the competing teams. The competing players are more or less on equal footing, so far as skill is concerned [of course, there are still certain players who are head and shoulders above the rest of the competition] . In case any player encounters certain issues during the match [sudden disconnections, mouse is malfunctioning etc.] , the game is instantly paused until the problem is rectified. Therefore, there is no instance where a team outright plays with a numbers disadvantage in pro play. As such, there is no way of ascertaining how much the numbers disadvantage can influence the result of the game; and also, if the difference in skill [if large enough] can overcome the numbers disadvantage.

There are cases where players have played the mismatched-in-numbers game, just to perform a sort of limit-testing in the game. Most of the games here involve 3 players at around the 97th percentile or greater facing off against 5 opponents of lesser skill [around 70th percentile in one of the games, for instance][25]. Upon observation, all the game followed a similar progression. Since there are only three players in the team with better players, they would all go into each of the lanes by themselves [one each to top, mid and bot lanes]. The enemy players would go one to top lane, one to mid and two to bot, with one player into the jungle, the traditional way.

[25] "3 PRO PLAYERS VS. 5 GOLD PLAYERS FT. BUNNYFUFUU ...." 9 Apr. 2019, https://www.youtube.com/watch?v=Qrh4sZg8rls. Accessed 5 Jan. 2020.

Basically, the player facing off against two opponents would suffer during laning phase, while the 1v1 lanes would outright beat the enemy in lane, coming out with 4-5 kills in the span of the first 10 minutes itself. From here on, the pro player with the extra kills would proceed to fight the enemy players 1v2, 2v3 or even 1v3 on occasion, and rely on his extra items and superior skill to win these fights. Meanwhile, the remaining player would focus on pushing top/bot lane and taking down the enemy turrets, until one or two of the enemy players tried to stop him, in which case he would back out.If it ever came to a 3v5 teamfight, the pro players would always win the fight, while losing at most only one player in the process. The one time the pro players ended up losing in the 3v5 was when the player with 45+ kills already at 28 minutes, wanted to get to 50 kills rather than end the game when his team had multiple opportunities to end the game.In the process, he happened to take an ill-advised 2v5 fight with his teammate, and both died. Then the enemy players used the Teleport summoner spell to immediately get to the base of the pro players, and end the game. The final kill score read 56-24 in favor of the pros in a 30:33 min game.

The most extreme case was when 2 players from the top 500 in the world [99.99th percentile] were made to play against 5 players of the 97th percentile[26]. The game ended in a victory for the 2 players with a final score line of 44-9 in their favor. It not only shows how much the skill disparity is between the top 3% player and the top 0.01% player, it also serves to reflect the skill level of professional play at tournaments like Worlds.

When the skill level is roughly the same between two teams though, the game is immediately shifted in favor of the team with more players, as they are able to use the numbers advantage to keep the enemy busy in a 4v4 back-and-forth skirmish while the 5th member is free to push out the bot/top lane and take turrets. When the 4-member team sends a player to deal with the splitpusher [that's how the player pushing the sidelanes is referred to in the game], the main fight immediately turns into a 4v3 where the 4 players need only kill one of the three enemies to make the other two retreat [as a 4v2 is an easy win unless the four players all make huge blunders in the fight], and then they are free to take baron/drake, whichever the contested objective may be.

---

[26] "2 Korean Challengers vs 5 NA Diamonds (2v5) - Who Wins ...." 16 May. 2017, https://www.youtube.com/watch?v=OF8AWpRQavc. Accessed 5 Jan. 2020.

The extreme cases shown here can be compared to a battle between untrained militias and well-trained armies. Even in the more reasonable cases, the game situations might act as mirrors to fights between two armies of differing skill levels.

One can harken back to the Iraqi forces during and beyond the Gulf War, during Saddam Hussein's time. Saddam Hussein was well aware of the probability of a coup to overthrow his rule, and prepared his Republican Guard as a contingency plan. The thought isn't unfounded; in the time span of 30 years between Mar 1949 and the end of 1980, 55 coups(!) were attempted in the Middle East, half of them proving successful[27]. The Republican Guard of Saddam were better in every way than the ordinary Iraqi soldiers and Fedayeen Saddam [paramilitary], and would also receive lavish bonuses from the government such as subsidized housing and even new cars. But this left Iraq relatively weak in battles, when they had to match up to the more disciplined and well-trained US forces and its allies.

[27] "Coup-Proofing - jstor." https://www.jstor.org/stable/2539255. Accessed 5 Jan. 2020.

TURRET MECHANICS IN *LoL* – POSSIBLE FUTURE IMPLICATIONS:

The way the turrets function in LoL is quite interesting, especially when viewed with the purpose of implementing a similar automated weapons system in the future. The turrets have a certain maximum range; any enemy unit coming within that range starts being attacked by the turret. How it functions in actual gameplay is this:

1. Turret starts sending a missile down onto the first enemy unit [minion or the player-controlled champion] that enters its range, until the unit either dies, or moves out of range again.
2. Once the unit is dead/out of range, the turret shifts focus to one of the other enemy units within its range.

The order of priority for the turret focus:
1st enemy unit to enter turret range > Cannon Minion [if it exists in the minion wave] > Melee Minions > Caster Minions > Player-controlled champions

But when a player attacks an enemy player while within the range of the enemy turret, the turret immediately shifts its focus onto the attacking player. This auto-lock can only be undone by stepping out of the turret range, or death of the player. In other words, the **highest priority goes out to killing enemies who are attacking the allied champions**. Even the minions behave the same way in the game, with them shifting their focus to the enemy champions when they engage in combat with allied champions. This system of auto-targeting can be implemented into future warfare. In fact right now, experiments are underway to create robots which work under a similar premise, i.e; robots which will deal with enemy threats but will not attack allied soldiers. An addition to what's already being tested, would be making allied robotic soldiers start focusing fire on enemy combatant[s] who might be attacking allies actively. In these cases, it might be better to think of allied players in the game as an equivalent to some sort of remotely-controlled super-units that might be deployed in future warfare.

However, the counterplay to beating the turret damage and still pull off successful dives did not take very long to discover; the execution is somewhat risky though. What the players did when executing a turret dive was this:

> One of the players [preferably the most tanky member in the vicinity] initiates the attack first, by attacking the enemy player under their turret. Now the turret starts focusing the tanky player here. While the turret is attacking him, his teammate(s) are free to go in and fight the enemy player(s) and get a kill or two. The tanky player here can soak up the turret damage until his health drops down to 15-20% of his maximum health, at which point he will step out of turret range. Now the enemy turret moves on to focus one of the players who are attacking the enemy players.
>
> If played out correctly, the aggressor team here can get out with 1-2 kills while not giving up any kills to the enemy. The additional advantage is that even if the enemy team realizes the possibility of the dive and backs off, the aggressor team can deal damage to the enemy turret at the very least, and deny some XP and gold to the enemy players [because the allied minions will die to the enemy turret, not to enemy players' last-hits].

At present, though, we only have extensive use of robots in bomb defusal, clear out minefields and scouting operations. The highest-grade military robots mostly are UGVs which can also fire at enemies, and some of them can be used in rescue ops. There do exist automated defense systems like the Phalanx system aboard warships, where the Gatling Gun would automatically fire at incoming targets. A near-identical parallel to LoL turrets would be the machine gun turret installations along the Gaza Strip, which is dessigned to automatically target Palestinian infiltrators[28]. However, at present the **biggest obstacles** to having a fully robotic army are the **extremely high costs** that would go into the R&D of creating these robots, as well as the **refueling issue**. The robots would be capped by the maximum distance they can travel with the amount of fuel they have.

---

[28] "Rise of the robots and the future of war | Technology | The ...." 20 Nov. 2010, https://www.theguardian.com/technology/2010/nov/21/military-robots-autonomous-machines. Accessed 5 Jan. 2020.

And all this is assuming these robots will not suffer **breakdowns** in the midst of traversing difficult terrain. For instance, even in WWII, most of the tanks [~90%] fell prey to breakdowns, rather than being destroyed in combat. That's where the US M-4 Shermans shone in WWII combat. Even though they suffered engine breakdowns as much as the German Tigers and Panthers [vastly superior in terms of firepower and armor], they were easily repaired and were easy to drive. The German tanks meanwhile suffered from the more subtle flaw of overengineering. They possessed heavy armor to withstand multiple tank hits and a lot of other additional features, but their engine wasn't powerful enough to sustain the load of the tank over large distances, leading to more frequent breakdowns.

Another possibility that needs to be mentioned here, is the **possibility of allied robots getting hacked by the enemy side**. This might result in malfunctions, complete shutdowns and in the worst-case scenario, a situation where one would have to battle their own robots. At the logical standpoint, it isn't out of the realm of possibility for robots to turn on their own allies off of hacking. This is because at the basic level, all that needs to be done by the enemy hacker(s) is to "flip the switch" which allows the robots to identify allies and enemy combatants and reverse its definitions. To fight against this possibility, the army will have to invest significant amount of resources to set up cybersecurity systems within the field robots. It is already something that is done in case of defense systems and highly classified info; this now needs to be extended to the robots as well.

An introduction of robots into active warfighting in the future will need to go hand-in-hand with effective cybersecurity. Or in other words, **the beginning of fully robotized warfare is intertwined with cyberwarfare**.

CONCLUSION

The thesis work began with the identification of two major questions, while using the game of League of Legends as the body of analysis:

A. What are the major predictors of victory in LoL?
B. How does geography affect the strategies and tactics of competing teams?

From there onwards we move towards the application of these results into military scenarios, to identify if similar trends are observable; and if so, if similar strategies and tactics may be used successfully.

From probit analysis, it is clear that the sides which **win** the games typically tend to have a **greater share of resources** [Gold in LoL]. The sides **winning** the games tend to have a **higher number of kills** than the enemy [kills → kill gold →more gold/resources to the side taking the kills]: corroborates the above point. This is keeping in line with what is traditionally expected.

The average game time at LoL Worlds was 32:30, which means it is more useful to find how early one can guess the victor of the game with a reasonable degree of success. The gold difference values at **25 min** are quite effective at predicting the result of the game. But it isn't good enough to make early predictions about the match, as the measurement happens only 7:30 min before the average game ends. The gold difference values at **15 min** though are reasonable enough, and the measurement also happens at about the halfway point of the game. This measurement is therefore way more useful for predictions than a measurement taken at ¾ of the game duration. The estimates for earlier time-stamps [5 min, 10 min etc.] could not be calculated, as a vast majority of the games were still at an equilibrium state.

Using the **GD at 15 min** estimates as the **dummy variable**, one needs to see which factor has the most impact at the 15 min mark. Using linear regression, we arrive at a result which determines using the kill difference and turret difference values at the 10 minute mark to be the most effective model at predicting the gold difference values at the 15 minute mark. And this, as proxy acts as the best model at predicting the final results of the games.

To put the role of geography and vision into perspective, the major stats from LoL Worlds 2017 and 2018 were compared. More vision was available in 2017 than in 2018; this was the only major change between the two seasons. Results [values below are rounded off for better readability]

- Drop in average game time from 35:53 min in 2017 to 32:30 in 2018.
- Rise in average kills recorded from 19 in 2017 to 23 in 2018.
- The slope values for **game length/kill count** dropped from **0.5366 in 2017** to **0.2422 in 2018**. This implies than a majority of the kills in 2017 occurred towards the latter stages of the game [= teamfights], while in 2018 the kills are more spread out over the course of the game [2v1 and 3v1 ambushes, high mobility].

From these three points itself, it becomes evident how impactful the role of vision has been in the way the game is played by the professionals. Geography is intertwined with vision in LoL, as the terrain serves two purposes in the game. One is to obstruct the movement across to another section of the map [forcing the players to go around], and the second is to deny real-time vision of the area on the other side of the terrain. In other words, whatever changes occur in vision will have an impact on how the map terrain is put to use by the players.

It is reflected in reality as well; when both sides know the risks involved to a high degree, then neither side will choose to take the risk for extended periods of time, hoping that the enemy will make a hasty decision instead. However, when the information is taken away from both warring sides, then it becomes more necessary to take the risk, than to give up strategic locations and resources for free. This is the one thing that has been a constant in warfare over the centuries, and will be the case for generations to come; this is the biggest takeaway of this analysis.

The **role of information** in battles, whether it be a multiplayer competitive game or a large-scale battle between two opposing armies, will take centerstage. And with improving tech, the importance of utilizing geography to deny information to the enemy only rises, as it gets harder and harder to conceal allied forces.

The **skill difference vs numbers disparity** makes for an interesting observation. This applies not only to LoL and warfare of the past, but even into future situations. The results encountered from the game, and also from warfare until the present indicate that superior skill trumps the number disparity in many occasions. There are certain pre-requisites here though. The skill difference has to be high enough between the two armies to achieve this. Also the ratio of soldiers cannot be too skewed, to the other side, otherwise this skill difference may not ever come to fruition. Something which was seen at the battle of Stalingrad, for instance; where the Germans were undoubtedly the better army; but a combination of the worst winter in decades and the way higher Russian numbers turned the tide. The change in strategy to capture both Stalingrad and the Caucasus simultaneously didn't help matters. In other words, **when one is low on numbers, strategic work has to be on point**, as mistakes have a larger impact when made by the army that is low on numbers.

The **use of terrain** in itself between LoL and real warfare is somewhat dissimilar, due to how the game works. But in the end, the strategic use of terrain does come out to be quite identical in both setups. Terrain turns out to be crucial in setting up counterattacks and ambushes, making effective withdrawals and diversion tactics too. A big difference is that because LoL is a 5v5 game, teams cannot actively set up multiple layers of defense the way real armies can. It is artificially set up in a sense, by the turrets and inhibitors. In real warfare, the available terrain is way larger in the sense that it takes way longer to go from one location to another on the map, days or even multiple weeks sometimes. This allows armies to set up multiple layers of defense going tens of kilometres deep when they are being invaded, for instance [assuming the country here is large enough, a smaller country doesn't have the same resources to work with ion this front]. This means there is no direct equivalent of a breakthrough scenario in LoL. One could get a somewhat similar scenario by making deep inroads into just one of the enemy lanes, while leaving others intact.

But the biggest dissimilarity between LoL and real warfare is the **will to fight**. It is very difficult for a soldier in a battle to keep his senses in the midst of artillery fire, gunshots whizzing by and watching his friends die or get injured in often-horrific ways. In these high-pressure situations where your life is on the line, it gets extremely hard to keep his sanity through the entirety of the fight and come out alive on the other side. You often do not get second chances here, after all. Even among those who do come out of the war alive, a significant portion suffer from PTSD.

Another aspect of the will to fight, comes from the **public perception of the war** being fought. For instance, the public perception of the Vietnam War in USA dropped all the way down, the longer the war progressed.

PUZZLES FOR THE FUTURE:

As military technology keeps improving, it is quite possible that we may witness a shift in the way of war to something closer to what is witnessed in strategic games [not necessarily LoL alone]. For instance, we know how the way war was fought changed significantly when muskets came into existence in the 19th century. All of a sudden, marching armies started taking heavy casualties from a threat that didn't exist before. This led to the development of trench warfare, use of camouflage uniforms and breaking down the army into smaller units for better movements across the terrain[29].

The next revolution in warfare might very well be **incorporating AI into warfare**. It is hard to predict how the use of AI may impact future warfare, because it is one of the greatest questions that plagues us now. When an artificial entity can think for itself and make its own decisions, one would expect the system to make the most perfect decisions possible depending on the circumstances. However, always making the perfect decision also makes the entity predictable and beatable. But if the entity can think for itself, it will realize this fact soon and start becoming more unpredictable, and this is where the AI entity has ascended to the next level. Not only can it process vast quantities of information that humans cannot hope to reach, now the AI entity can also make decisions by itself, and these might not make immediate logical sense to the observer. Another aspect of AI is that their moves are not affected by emotion. This is highly significant in the theater of war, where strategists will be put under tremendous pressure to win battles, especially if the army loses multiple territories in the recent past and emotions are running high.

This makes the AI more effective and frankly, scarier as a result. And all the dystopian films involving sinister AI like *1969: A Space Odyssey* and *The Terminator* do not help in this regard. Because once an AI can start thinking for itself, there is nothing, in theory at least,

---

[29] "Fighting in the Trenches | Imperial War Museums." http://www.iwm.org.uk/learning/resources/fighting-in-the-trenches. Accessed 5 Jan. 2020.

stopping it from turning against its creators and going rogue. At least with humans, the physical and mental limitations restrict the amount of damage they can do. AI would still have physical limitations, but the boundaries for mental capacity are way, way farther away. Present tech still has a considerable distance to go to reach that position though.

The aspect of **skill difference** also comes in when considering **AI**, in case there is a battle between two sides which have AI commanders, for instance. Depending on which AI is better developed and which side has more forces to fight with, the result can change accordingly. If the best strategy is just to brute-force the enemy into submission for both sides, then AI disparity goes out the window and the battle relies on the skill disparity between combating armies. In other words, there do exist certain scenarios where the AI difference can be nullified, and it is when the conditions for victory are simplified to just beating the enemy by raw numbers strength. The brings us to another conclusion**: in order to neutralize** AI, or even **strategic superiority** of the enemy commander, one needs to **devolve the fight down to a basic win condition that relies more upon numbers and pure force than effective strategies**. When you limit the win conditions down to one or two at the outset, you automatically remove the possibilities for the enemy to change his strategies mid-combat. Sometimes the simplest way is the best, after all.

That throws the question of AI in warfare up to debate again: which purpose will they serve? And what approach will they take if/when they are utilized actively in warfare in the future? All this remains to be seen.