Competitive Level Design

A study on *Counter-Strike*: Global Offensive Level Design

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Abstract

Counter-Strike: Global Offensive stands as one, if not the most popular competitive video game of all time. In fact, tens of millions are awarded at Esports tournaments – a testament to the game's popularity. As such, game designers should seek to understand exactly why the *Counter-Strike* series is so popular. One critical element to any game like *Counter-Strike* is the level design. This study attempts to provide an analysis of competitive level design by looking at the differences between a highly popular *Counter-Strike* level, Dust2, and one that is considerably less popular, Cobblestone.

Level design has already been scrutinized heavily by game designers throughout the years, and this also applies to *Counter-Strike*. The trend has mainly been to analyze levels from a high-level perspective, however. We hope that our study will contribute to the existing knowledge from an exceedingly low-level perspective.

The study relies on data acquired from the massive *Counter-Strike* statistics database HLTV.org which primarily consist of 2 heat-maps that display hotspots for "killer locations" on the levels' Bombsites. These heat-maps have since been subjected to two formal analyses and a subsequent comparative analysis.

The study found that the occurrence of several indicators of flawed level design are present in Cobblestone. These flaws contrast with the level design principles and guidelines laid out by experienced designers. As such, the study concludes that these flaws are the primary contributing factors to the drop in popularity for Cobblestone. However, the study also acknowledges the need for an expanded study comprising the entire levels and involving other types of data.

Key words: *Counter-Strike*, Competitive, Level Design, Heat-Maps, Data, Global Offensive

Abstrakt

Counter-Strike: Global Offensive är kanske det mest populära kompetitiva datorspelet någonsin. Det tilldelas miljoner av kronor vid Esports turneringar - ett bevis av många på spelets popularitet. Därför bör speldesigner försöka förstå precis varför *Counter-Strike* serien är så populär, och ett viktigt element i vilket spel som helst likt *Counter-Strike*, är dess level design. Därför försöker denna studie ge en analys av kompetitivt level design genom att analysera skillnaderna mellan en väldig populär nivå, Dust2, och en som är betydlig mindre populär, Cobblestone. Level design har redan blivit undersökt väldigt noggrant av speldesigner under många år och det gäller även för *Counter-Strike*. Trenden har dock varit att analysera ifrån ett high-level perspektiv. Därför försöker vi att bidra med en analys från ett low-level perspektiv. Vårt studie använder data som är hämtat från den enorma statistik databas: HLTV.org, som har samlat *Counter-Strike* statistiker i många år. Datan består huvudsakligen av 2 heat-maps som visar hotspots för positioner där en spelare har dödat en annan spelare i närheten av de fyra bombplatsen. Sen har dessa blivit analyserat separat och efterföljande jämfört med varandra i en komparativ analys. Studien hittar flera särskilda indikatorer på ohänsiktsmässigt level design. Dessa indikatorer går direkt emot fundamentala principer och riktningslinjer för level design som har blivit definierat av erfarna level designer. Slutligen konkluderar studien att dessa är de huvudsakliga grunder för Cobblestones minskade popularitet. Studien fastslår dock att det krävs ytterligare och mer kompletta undersökningar av de fullständiga nivån samt användandet av fler och olika typer av data för att uppnå en mer fullständig analys.

Nyckelord: *Counter-Strike*, Kompetitiv, Level Design, Heat-Map, Data, Global Offensive

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Preface

The authors

Edin Karakurt & Jeppe Willatzen are game design majors at Uppsala University with a special interest in competitive games. This thesis is the culmination of many hours of hard work and writing. It has been quite a journey. The arrival of covid-19 introduced several challenges during writing and also impacted many of those whose help has been invaluable.

In the future, the authors hope to continue their game design adventures by educating themselves further or working in the games industry.

Acknowledgement

We would like to thank our supervisor Don James Geyer for his advice & guidance during every stage of this project. Don's knowledge and commitment has been invaluable.

We would also like to thank Rob de Wit for all the help he has provided via images, statistics, and general feedback. Rob's interest in our work has been greatly appreciated throughout, and his own work has played a key role in our project.

Finally, we would like to take the opportunity to thank friends and family for their support. None mentioned - none forgotten.

Thank you!

- Edin & Jeppe

Glossary List

In an attempt to provide the reader with a quick overview of common *Counter-Strike*: Global Offensive terminology and wording used in this paper, we have compiled the following glossary.

Bomb (*or "**C4**")* - The C4-explosive game object in *Counter-Strike* games.

Bombsite - A larger area that includes the Bombsite proper and surrounding area.

Main Bombsite - The area of a CS:GO map specifically designated for planting a bomb.

Boosting - The act of aiding another player in reaching a certain area of a level. Typically done by a crouching player, whereby they allow a teammate to jump on top of them to get a height advantage.

Cobblestone - A *Counter-Strike* level. Also: de_cbble.

CS - *Counter-Strike*.

CS:GO - *Counter-Strike*: Global Offensive.

CT(s) - The Counter-Terrorist(s) team. The defending side at the start of a round.

Dust2 - A *Counter-Strike* level. Also: de_dust2.

Flashbang - Flashbang grenade. Utility.

Frag - Frag grenade. Utility.

Map - A specific level in *Counter-Strike*, examples: de_dust2, de_cbble, cs_italy, cs_office.

Match - The total amount of rounds played in a game of CS:GO.

Molotov - Incendiary grenade (*"**Incendiary**"* for CTs / *"**Molotov**"* for Ts). Utility.

Rotate - Strategic maneuver wherein a player changes their targeted Bombsite.

Round - A session of play which lasts a predefined a number of seconds, or until a winning condition has been met. A predefined amount of rounds defines a "Match".

Rush - Offensive strategic wherein a player aims to immediately reach a specific area.

Smoke - Smoke grenade. Utility.

T(s) - The Terrorist(s) team. The attacking side at the start of a round.

Utility - Any purchasable item which is not a firearm.

1 Introduction

Counter-Strike has been one of the most influential competitive video game series of all time. In the last decade it has surpassed its predecessors in popularity and set new standards for competitive gaming. Standards, which have led the media to turn its attention towards video games in a new light and taken competitive games and especially Esports to new heights with tens of millions awarded in prize money each year and a growing player base rivalling that of many traditional sports.

Many factors combine to create a successful competitive game, and every aspect of these factors ought to be scrutinized and analyzed. Perhaps more than any other factor: level design – *or* "*map-design*" – is the most crucial in creating a successful competitive gaming experience. We are not alone in thinking this. Players and designers alike know all too well the importance of the game space. After all, it is "... where the game takes place" as legendary level designer John Romero (2019) has remarked.

With the persistent advancement of Esports and an overall increased focus on competitive gaming in a wide variety of genres, the authors of this paper believe that it is worthwhile to examine what precisely determines a successful competitive level. Therefore, this paper will attempt to give an explanation as to why the development and consequent success of certain levels can be so vastly different. By looking into the key-areas that define *Counter-Strike* maps, we are aiming to provide exactly that.

Since the early days, the maps called "Dust2" and "Cobblestone" have been fan favorites. As years passed and new iterations of *Counter-Strike* were made, so were the maps' designs. In the latest version of *Counter-Strike*, namely *Counter-Strike*: Global Offensive (hereinafter referred to as CS:GO), some levels still stand as fan favorites while others have dropped heavily in popularity and are much less frequently played. This is especially true with the game's competitive community.

Besides the visuals, Dust2 has maintained much of its original design with only slight variations for many years. In fact, one might say it has remained the same since its inception. Considering its popularity, this stands as a testament to the level design. To help us understand the success behind Dust2's design it is only appropriate to analyze the downfall of a map that once was popular but unlike Dust2, has steadily declined with every passing year. Cobblestone is just that and by giving an analysis of each map and a subsequent comparative analysis, we will attempt to determine why that is the case.

Building on the work done by other game designers with expertise in level design, it is our hypothesis that each *Counter-Strike* level's competitive aptitude can be understood by analyzing the "*Bombsites*" as they are the most important areas of a map (Garozzo & Snelling, 2015). We will make use of the readily available data from internet-sources that have gathered their data across many years.

The findings will hopefully give answers to most of the questions and grant the reader increased insight into the design patterns of not only *Counter-Strike*, but other games in the "*First Person Shooter*" genre, and perhaps entirely different games with a competitive edge.

With all the above in mind, we propose the following research question to guide our study:

"What are the key features of level design that make the Dust2 Map a more popular map than the Cobblestone Map in competitive Counter-Strike: Global Offensive?"

1.1 Counter-Strike: Global Offensive Maps

Counter-Strike maps come in many different shapes. They are typically based on real world locations and tend to create an immersive atmosphere which is communicated through different cultural elements and an aesthetic design that a player might expect. Without going too deep into the aesthetic composition of *Counter-Strike*, this section will provide a brief introduction to "Dust2" and "Cobblestone".

1.1.1 Dust2

Fig 1. In-game screenshot of Bombsite A on "Dust2"

Dust2 is the successor to the map simply called "Dust", featuring a similar setting and appertaining visuals. Originally understood to have been based on a generic middle eastern setting, some changes were eventually made, and the map is now said to be based in Morocco.

Dust2 is a bomb defusal map, and contains two Bombsites, A & B. Counter-Terrorists aim to prevent the Terrorists from bombing chemical weapon crates using a C4 explosive (see: **Bomb** in Glossary).

1.1.2 Cobblestone

Fig 2. In-game screenshot of Bombsite B on "Cobblestone"

Cobblestone features a large castle with typical West-European architecture. It is not entirely sure where Cobblestone is based but is believed to be in France. The castle is also known as Lord William's country farmhouse.

Cobblestone is a bomb defusal map, and like Dust2 it contains two Bombsites called A & B. Counter-Terrorists try to prevent the Terrorists from bombing Lord William's country farmhouse using a C4 explosive.

2 Theoretical Framework

2.1 Background

Counter-Strike has been the subject of a plethora of studies from a vast amount of perspectives in various fields. Level design in the game is no different.

In order to best possibly analyze level design in *Counter-Strike*, we have made particular use of the work by Dan Taylor (2013), Rob de Wit (2015), and Salvatore Garozzo & Shawn Snelling (2015). These designers have all theorized and analyzed many important aspects of level design in *Counter-Strike*. While many of the topics these authors discuss are similar and can be suitably used in conjunction with one another, we have selected specific level design theory that define the core theory and background from which we base our own hypothesis and subsequent analysis.

While one could take many different approaches to studying and analyzing *Counter-Strike* and level design, we firmly believe that a quantitative data driven research approach is most befitting. In selecting the theory to drive and guide our project, we have therefore chosen the authors specifically for their data-driven approach to research.

To analyze this data, it seemed most appropriate to conduct the analysis in accordance with Björk's & Lankoski's *"formal analysis"***.** We aim to provide a formal analysis explicitly for both discrete analyses and a subsequent comparative analysis which will be explicitly explained in the methodology chapter.

By analyzing heat-maps in relation to level design, it is our aim to take *Counter-Strike* level design analysis into a new direction and present another approach to data-driven level design research. By extension, we strongly believe that our own analysis will continue, and contribute to the work of the authors whose work and theories will be presented below.

2.2 CS:GO Popularity & Level Analysis

de Wit (2015) presented comprehensive level design analyses of the 4 most popular CS:GO maps based on his map-popularity research. de Wit's (2015) analyses and research are done using a quantitative approach wherein he used data gathered from HLTV.org. The data for the maps: "Dust2", "Cache", "Mirage", and "Inferno" was used to give a high-level analysis of each map. To achieve this, de Wit (2015) abstracts the level design into 4 main areas: Entrances, Bombsites, Middle, and Spawns & Pathing.

Amongst many more, some notable findings are:

- Each Bombsite can be smoked off entirely with 1 smoke grenade.
- Bombsite A always features at least 1 big and 1 small entrance.
- Bombsite A has more entrances than Bombsite B
- Bombsite A provides 1 safe entrance for the CT side
- Bombsite B provides 2 safe entrances for the CT side

Each Bombsite can be smoked off entirely with 1 smoke grenade

de Wit (2015) remarks that it is important to maintain the same entrance count and size due to the mechanics limitation of having just 1 smoke grenade per player.

Bombsite A always features at least 1 big and 1 small entrance

Additionally, entrances should be variable in size; facilitating strategic variation by allowing for different types of entrances: grouped or chokepoints. That is, so attacking players can push through an entrance either together or individually.

Fig 3. de Wit (2015) explains the types of entrances like the above image where attacking players approach Long

Bombsite A has more entrances than Bombsite B

Disregarding entrances from middle areas, Bombsite B ought to be harder to overtake from defenders, and reverse for Bombsite A.

Bombsite A provides 1 safe entrance for the CT side

Furthermore, it is a typical design for CTs to have at least 1 path of reaching Bombsite A which cannot be observed by Ts. This is such that the defensive set-up is secured, and can maintain the general gameplay structure in which the attacking side typically makes the first move.

Bombsite B provides 2 safe entrance for the CT side

Disregarding connectors and middle areas, it is also typical for maps that Bombsite B has 2 separate and safe entrances. This design is visible throughout the levels, and usually reinforces the defender's position as one player can watch both entrances.

Lastly, de Wit's (2015) level design research indicates that there are specific design principles which the most popular CS:GO maps tend to have in common.

2.3 Level Design Principles

In 2013, Dan Taylor wrote an article for Gamasutra in which he presents several general level design principles in an attempt to formalize the core elements when designing a video game level. The principles are taken from the years of his own experiences he has gathered from working with level design at different companies.

While most of the principles Taylor (2013) lays out are geared towards level design for singleplayer games some can be used in the context of multiplayer games as well. These principles are:

- Level Design tells the player what to do, but not how to do it.
- Level Design is efficient.
- Level Design is driven by the game's mechanics.

Level Design tells the player what to do, but not how to do it

Taylor (2013) stresses the need for level design to suggest the players what to do but grant the players the freedom to decide what they want to do. For instance, the game's objectives should be clearly communicated but how a player will go about completing the objective should be entirely up to themselves.

Level Design is efficient

Taylor (2013) further elaborates that the design space should be efficient such that it is modular, bi-directional and makes use of the entire play-space. Therefore, a designer should design a series of modular encounters that can be strung together.

Fig 4. Taylor (2013) notes that Halo 3, Mission 6: The Ark is efficient design as the level space is replayed on the player's return journey but uses a tank to keep the gameplay fresh

Level Design is driven by the game's mechanics

The unique interactive experience of a game ought to be reinforced through the level design. Thereby, the level communicates the mechanics.

Finally, Taylor (2013) also adds that aesthetics, i.e. the experiences which the game aims to provide the player, should not be at odds with the level design.

2.4 Community Level Design for CS:GO

At the 2015 Game Developers Conference's eSports Summit, Snelling and Garozzo gave a talk on designing levels for CS:GO. Amongst many things, they discussed the importance of emphasizing player skill and strategic choices when designing levels.

Being a former professional CS:GO player, Sal "Volcano" Garozzo has accumulated much knowledge on what makes a great CS:GO map. Following his professional CS:GO career, he has been a community level designer and has released 5 maps that ship with CS:GO. Snelling has over a decade of level design knowledge from various games, and together with Garozzo they made the highly esteemed CS:GO map: Cache.

One of the crucial points which they outline is the importance for "*player skill to shine through via strategic depth*" (Garozzo 2015). Additionally, Garozzo and Snelling detail that a lot of popular maps tend to have 4 chokepoints which are based around a central dividing line, or "line of scrimmage" as Garozzo (2015) has coined it. The number of chokepoints is largely based on the size of the teams and with teams of 5, 4 chokepoints is the most appropriate. In relation to this, Garozzo notes that it is important to understand, despite what a designer might think, that more options for strategic maneuvers is not inherently good for the level design as it may introduce chaos and consequently diminish the strategic meaningfulness. Finally, Garozzo adds that due to the punishing nature of CS:GO mechanics; watching too many areas of danger at once is bad.

They also note that level design in CS:GO, contrary to level design in many other games, should have sparing amounts of verticality. Garozzo (2015) elaborates that verticality in level design is usually seen as an interesting element that allows for dynamic gameplay. In CS:GO, however, verticality should be used with great care. Players tend use extremely low sensitivities for their mice in order to focus on the game's primary mechanic, i.e. shooting precisely. Consequently, this makes it very difficult for players to make quick and wide adjustments to the direction they are looking. Garozzo (2015) points out, however, that verticality can be powerful in other ways, perhaps exactly because of the mechanics' restrictions, as reflected by "boosting" players. Boosting is the act of aiding a player on your team to gain sight and cover an area that is only possible by stacking two players. As such, the boosting can be seen as a method of enhancing teamwork and the strategic elements of CS:GO.

Furthermore, Garozzo (2015) also points out that the Bombsites, i.e. the location in the map where the Terrorists aim to plant the "*C4*", are the most important objective in CS, and adds that putting extra thought into designing the Bombsites goes a long way in creating a successful map. Allowing for players to be creative with their method of planting the bomb is important. By considering the covers and props placed in and around the Bombsite, the design may allow players to come up with specific strategies that can be particularly useful at certain stages of a round. More cover may result in a safer planting zone but may also lead to an easier defusal option. Garozzo (2015) notes that this gives players the option to "trade convenience for difficulty".

Like Garozzo, Snelling (2015) emphasizes the importance of rewarding player skill through the level design. Therefore, every aesthetic and design decision should accommodate it. Consequently, the distinction between aesthetic and level design in CS:GO becomes heavily blurred. Snelling further outlines that it is critical for the environments in a level to be readable. This is extremely important in order to reduce cognitive dissonance and ensure players do not feel they are "fighting the level".

2.5 Hypothesis

With the above theory in mind, we propose the following hypothesis for the study which will guide the analyses of the level design: In accordance with Day Taylor's Level Design Principles,

***Avoiding randomness is critical to successful level design*.** As such, the level design should always be designed to accommodate the game's mechanics. Additionally, due to CS:GO's strategic depth and punishing nature as outlined by Garozzo & Snelling (2015), **it is crucial that the level design provides skill based gunfights without introducing chaos.** Finally, Rob de Wit (2015) analysis stresses the importance of designing **entrances to Bombsites which adhere to the size constraints dictated by Smokes and Molotovs** to achieve optimal balancing.

We believe that the elements of level design described in bold in the above hypothesis are the best predictors of successful CS:GO level design and therefore, they will function as important assumptions in our research and shape our reasoning and direction of analysis.

3 Methodology

3.1 Introduction

Our objective throughout this study was to see why Dust2 has been consistently more popular than Cobblestone. The method we utilized to answer the question was to analyze the level designs of both map's Bombsites and then analyze the differences between them.

3.2 Explanation of Method

CS:GO has been around for many years and has accumulated large amounts of data that are available to anyone. That is why our research revolved around the already available data rather than gathering our own. This both in the interest of expediency and completeness as the data is up-to-date and exhaustive.
The data was eventually used for an analysis which utilizes the heat-maps of both "Dust2" and "Cobblestone" where hotspots showed the key-areas of the levels' designs. Thus, the analysis uses the data by interpreting how hotspots, with the addition of bird's eye-view maps, displayed the available covers and callouts that combine to reveal some interesting design patterns that set apart the two levels. The differences set apart in both maps were the aspects of randomness, line of sight and entrance size amounts which determined the way their datas would be interpreted. Randomness was analyzed using investigation of the amounts of primary hot zones which showcased the way the level layout orchestrated the majority of the matches. The Line of sight was analyzed by counting the possible angles coming from different hot zones looking right into the main Bombsite area which ensured the observer to understand the viability of the level surrounding the Bombsite. The amount of entrance sizes on the other hand was calculated by the amount of areas with enough width to encompass an area by the usage of smoke or Molotov grenades. This ensured the to show the observer how many of these areas could viability smoke off an entire section and how the amount of them changed the course of the level design. These images were edited using Photoshop to provide a deep, and comprehensive analysis.

3.3 Heat-map

HLTV.org contains all the required data, and their heat-maps have been the primary data used for this study. HLTV.org has gathered this data since the early days of CS:GO, and has been done throughout the *Counter-Strike* series.
The collected data shows the positions of players from which they were able to get a kill. THe information stems from official matches as played through the official servers. The way the data is integrated into the maps is done by applying colors to the locations of where players can get kills and subsequently projected onto a 2d map. This method of visualizing data means that the more kills players get from a given coordinate, the more intense the colors at the projected 2d location become in the heat-map. As such, this is a data visualization technique that shows the magnitude of kills.

3.4 Cover System

We have created the cover systems using the HLTV website's empty maps which represent obstacles, elevation, and corners within the actual levels. The data is collected by investigating the maps for notable walls, vehicles, barrels, or any obstacle that seem to affect the gameplay. The variation of the obstacles is represented by four different colors which are blue, green, red and black. Blue represents the corner of the map which is usually the area that has been seemingly designed to give players the possibility of getting a view of approaching enemy players, or a hiding area with limited angles that can more easily be held. The green color shows special objects that allow players to break through and reveal a new pathway. The red color on the other hand, displays the covers that can be used to look over or around, to hide the player's hit-box and get a better view of their surroundings. Finally, the black color represents the difference in elevation between other lanes.

Another detail that can be acquired from the cover maps is the red area called the Main Bombsite. This area is the place that can be utilized in order to plant the objective C4 within its perimeters.

3.5 Callout Maps

The callout maps have been created by us using the HLTV website's empty maps which represent some of the names key-areas and are used to rapidly identify an in-game location during a match. As such, these callouts are also the most appropriate ways to describe in-game locations and refer to them repeatedly during our analyses. These maps have been made by adding the most crucial information from other callout maps to HLTV's empty maps.

3.6 Screenshot Explanation

The screenshot explanations have been created by us by taking in-game screenshots of key-areas that would be subject to analysis. These in-game screenshots make it easier to understand the nature of the covers represented in the cover map as different elevations and angles are represented much clearer. The covers in the screenshots are represented in the same manner as the cover system mentioned previously whilst also presenting a side view of other areas of interest.

3.7 Analytical Approach

The methodology approach has been to use a quantitative method. In order to give the most accurate analysis, we have used a method that seemed most able to optimize the quality. As such, we have conducted a "Formal Comparative Analysis" on Dust2's and Cobblestone's level designs. This approach allows us to explain the two maps separately and then combine them together to create a final evaluation and analysis.
The way the analysis process can be explained in the most meaningful way was by examining the book "Game Research Methods" in which the authors explain how games can methodologically use quantitative and qualitative ways of approaching research within many different game research areas. The way the authors explain our chosen methodology, with the addition of examples, is by their own words: "Formal analysis of gameplay is a method used in many studies of games, sometimes implicitly. David Myers uses formal analysis of gameplay to study the aesthetics of games, whereas Björk and Holopainen used it to derive design patterns. In both, formal analysis is used explicitly as

a method. The study of psychophysiology in relation to video games by Ravaja, et al. is an example where formal analysis is used implicitly.”.

The methodology we chose from this book is the method called: “Formal Analysis of Gameplay”, this had the most similarities with our own way of desiring the analysis to occur. The authors explain it as: “Formal analysis focuses on describing the formal features of every work. These vary between fields: in visual art form, it consists of lines and colors; in poetry form includes rhythm; and in game form, it is the systemic features of the game such as game elements, rules, and goals.” (Björk & Lankoski, 2015).

These types of approaches helped us get a better understanding of how to conduct the analysis in a more structured way while also acknowledging the knowledge of using the theories acquired in the theoretical framework, and needed to be able to correlate with the end result of the thesis.

3.8 Evaluation of Method

Overall, our chosen methodology may suffer from lacking the authenticity of data-gathering conducted entirely by ourselves but instead, we have used the data from other sources on the internet. This could cause our information to be inaccurate or not sufficiently reflecting reality, and thereby not enough to justify the following arguments presented in the analysis.

4 Analysis

4.1 Cobblestone Bombsite A

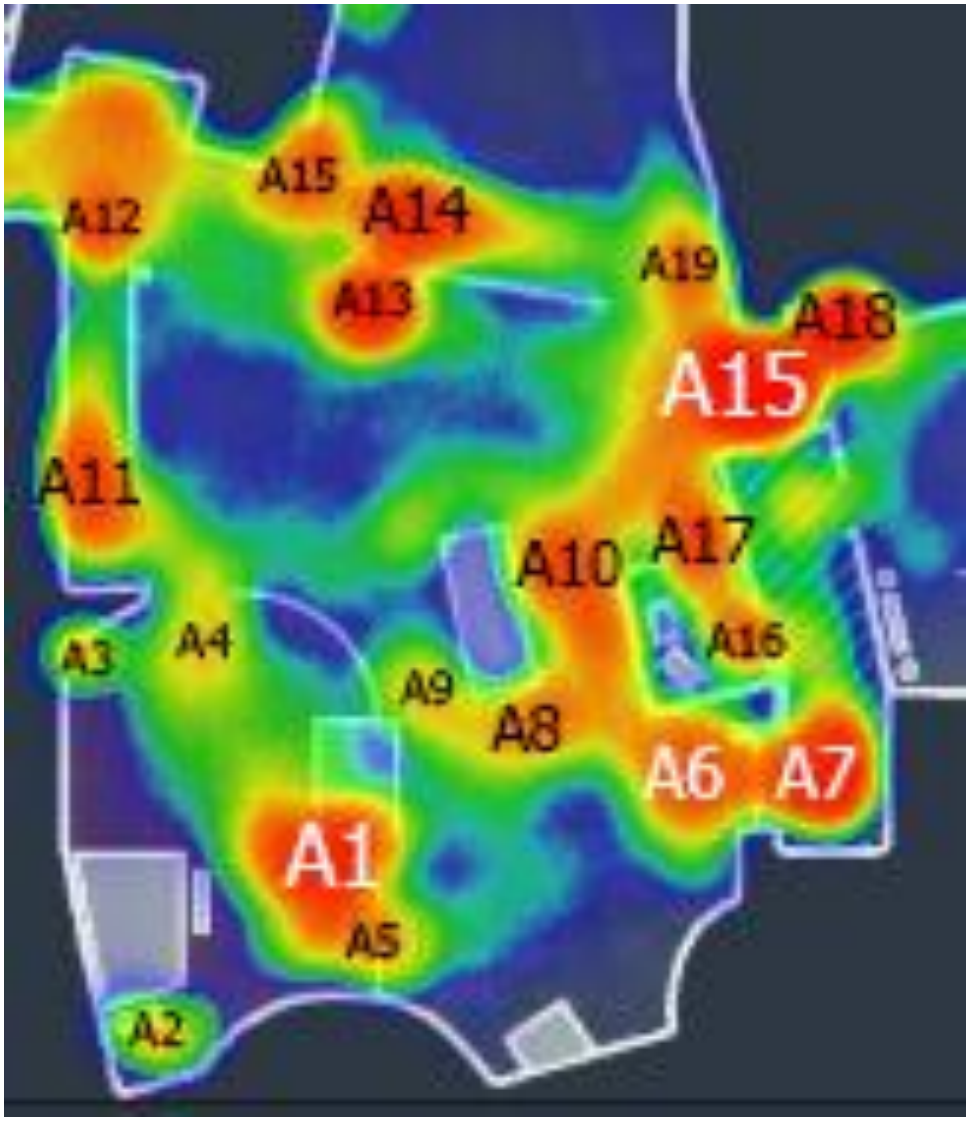

Fig 5. ***Heat-map of Cobblestone Bombsite A by Edin Karakurt (2020)***

Fig 6. Callouts of Cobblestone Bombsite A
by Edin Karakurt (2020)

Fig 7. Callouts of Cobblestone Bombsite A
by Edin Karakurt (2020)

Cobblestone's A Bombsite when first observed through the heat-map, and different angles from inside the game, can be seen as an open area filled with various objects that yields important cover for the current defender but also the attacker.

4.1.1 Main Bombsite

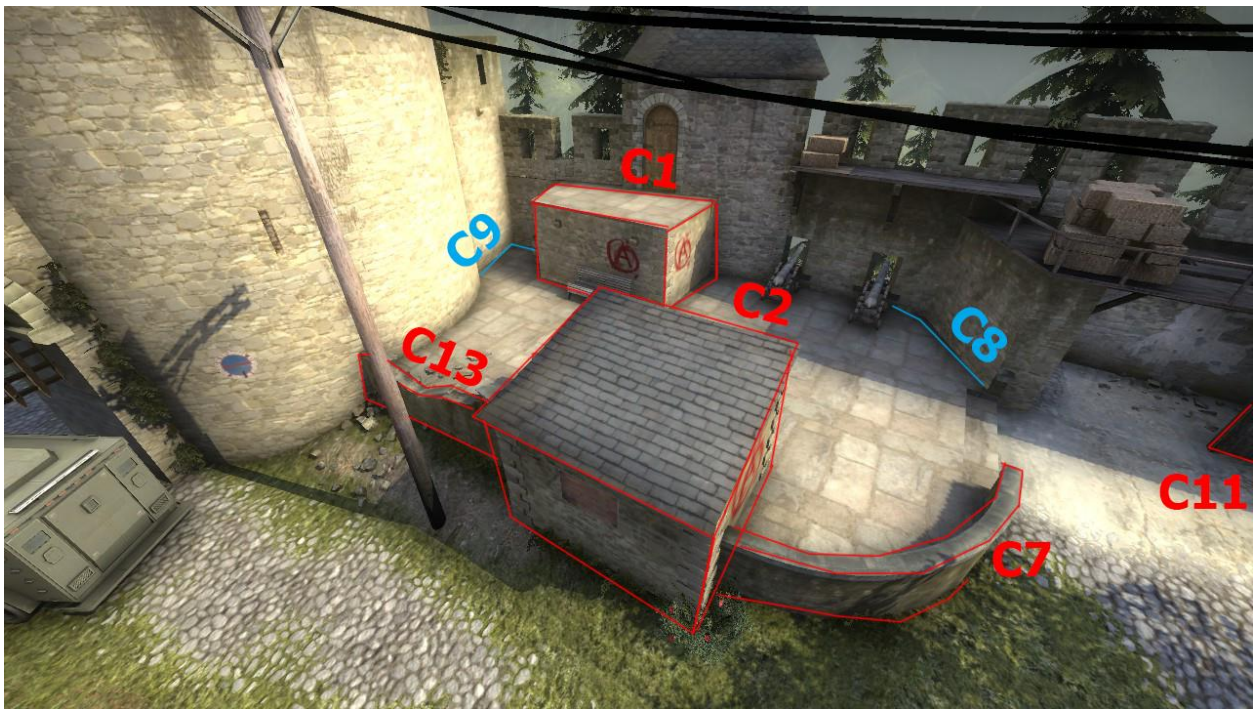

Fig 8. Bombsite A Cobblestone
by Edin Karakurt (2020)

One of the first things that can be observed within the Bombsite itself is the great red spot of A1. This area is an important killspot as it can be seen behind the C2 cover which is one of the main covers within the Bombsite. This cover is positioned in such a way that it is able to give the defenders using this position a great sightline of attackers coming from the Long area which would have to cross A4 or peek around A12 in order to deal with anyone using this position. A1 cover is also positioned to deal with any attacker coming from around A10, yet the truck that acts as a cover for the A10 has been positioned in order to make the A15 approaches simpler for attackers which balances the A1 position in terms of places it can cover. A5 heat spot right under A1 acts as an rotation area for the defenders in case the bomb area gets overwhelmed by attackers, yet the elevation difference and lack of cover makes this a vulnerable position from attacks coming from A7, A10 and A9. Another aspect that could be discussed about the A1 position is it's C2 cover being too close to the C1 cover which design wise, causes this area to be blocked off by the utilization of smokes and molotovs by the current attacker.
The other significant heat spots that exist within the Bombsite are A3 and A2. A3 is a corner designed to counter any attacker coming from A4 and A15 as mentioned before A1 lacks the sightline to achieve this goal. The short walls of C7 which is between A4 and A9 is able to yield some obstruction against the A15 position with the combination of a slight elevation difference between the hot spots. Yet as seen from the heat-map, it is not as favourable a position to defend as the A1 position as it lacks the kill amount when compared between each other, yet it can be utilized as a surprise position for unsuspecting attackers entering the Bombsite. The A2 hotspot on the other hand is in an interesting position where it has the whole large building of C2 as a cover which is able shield any defender from the sightlines of A4 and CT Ramp area. Because the hotspot is right in front of the C9 corner it is able to keep only one sightline, which in this case is the A5 hotspot and the balcony area which has the advantage of the C4 elevation. This makes the C9 corner ideal

to be used as an important hiding area for defenders which makes it showcase the design of sabotaging any bomb planting or outright having a crucial act in a diffusal situation. The advantages of this area doesn't change the fact that it suffers from the same weaknesses of any hiding area which is the fact that it can be easily flushed out by the usage of grenades and molotovs as it is a small area with limited flanking or escape routes.

Fig 9. Truck - Cobblestone Bombsite A
by Edin Karakurt (2020)

4.1.2 Truck

When the defensive positions outside of the Bombsite are observed, the first thing that comes to attention is the A8 hotspot which exists right behind the cover of C3 which is the truck. This area shares similarities with A1 hotspot in the sense that it is able to hold A4 and A12 positions, whilst also being able to hold additional sightlines of attackers arriving from the midsection of the map called CT Ramp, which are indicated in the spots of A19, A14 and A15. The C3 cover, positioned in the middle of the courtyard gives it other options for the defenders and attackers to utilize it in different angles which can be seen from the heat-map as A9 and A10. A10 position is used to shorten the distance of defenders against the underpass arriving attackers whilst losing the sightlines to the A4 and A11 areas. The weak point of this area can be analyzed to be seen as any attacker arriving from the Bombsite B can use the elevation difference of C4 from the balcony area to have an easy sightline of behind the C3 cover. On the other hand, the defender by being able to rotate to the A9 spot can in fact be used as the opposite of countering the C4 elevation by using the C3 cover whilst also exposing this player to Alley and Ct Ramp areas. Whilst the truck is a viable cover for the defenders, the same can also be said for any attacker that gets to use this area evident by the hotspot of A10 that is most likely used in order to get a sightline anyone around the A1 and A5 hotspots. Other weaknesses that can also be added to the lists of facts is the truck being too close to other covers such C1 and C12 which makes it extremely open for the attackers to utilize utilities such as smokes which can block off sightlines momentarily. All these weaknesses that are designed

for the truck-area is to make sure that it's allowance of this many options of possible sightlines shall not allow the defenders to utilize them all with too much efficiency.

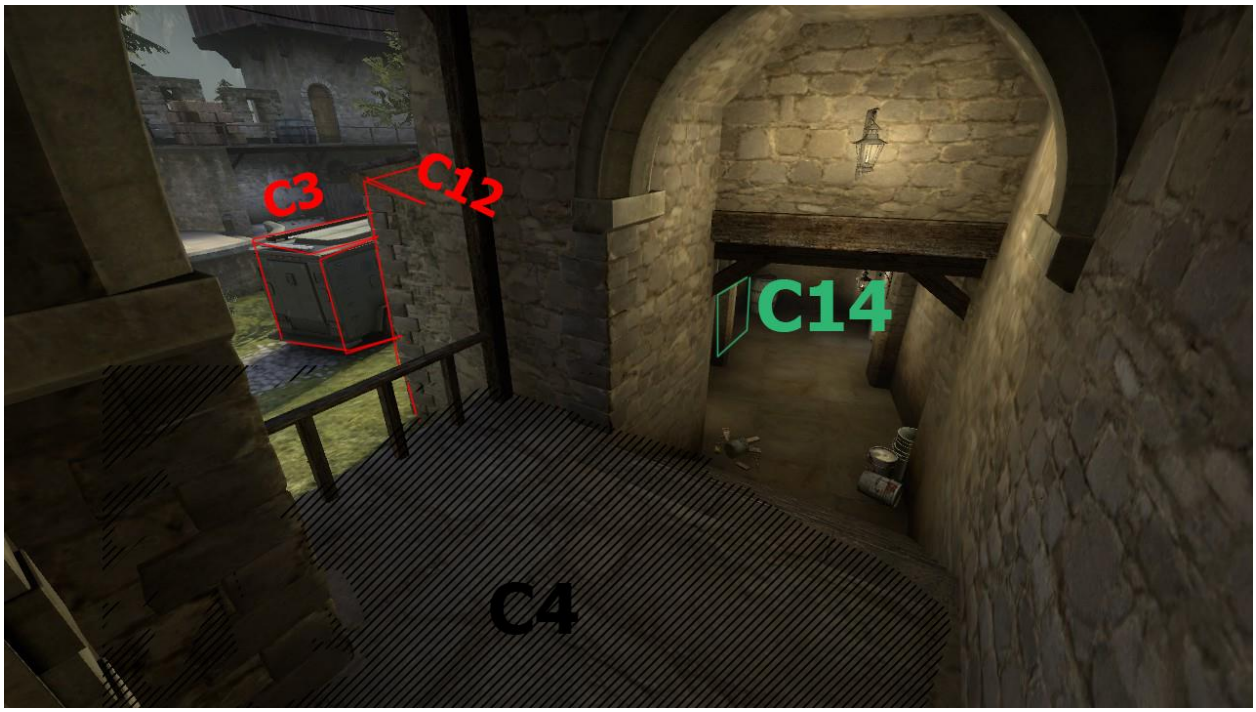

Fig 10. Balcony - Cobblestone Bombsite A
by Edin Karakurt (2020)

4.1.3 Balcony

The A7 heat-map position lies just on the C4 elevation on the balcony area which is an area able to give the player that uses this position almost the whole view of the Bombsite A where only C2 cover is able to block some of the view, with addition of being able to rotate or move in case getting flanked or smoked off. While this remains to be a huge advantage for this site, it is also designed to keep these advantages aspects minimal as they are quite possible to counter. In case the player in the A7 hotspot gets flanked from anyone coming from the B Bombsite, anyone in this area can move to other areas but lose their elevation advantage whilst also positioning themselves in a relatively unsafe position of around A6 hotspot which is open to many angles. Another design pattern that can be recognized as the narrow structure of the C4 area is that it can be easily blocked off by utilities such as smokes and molotovs and thus flushing the player within this area.

Another great thing to point out that affects the elevation of C4 is the fact that the unique design choice of a destructible metal crouch space also known as C14. Anyone trying to flank the C4 position will use this route in which they have to destroy this metal sheet wall which would make quite enough noise to alert anyone positioned in the A7 position. The area of A16 hotspot is recognizable as an area that showcases the player able to use the destructible cover as bait against people trying to counter them by hearing the noise. Right behind this cover is the closed wall of C12 which is designed to act as a safe area to operate for any attackers before entering the zones of various defender sightlines.

4.2 Cobblestone Bombsite B

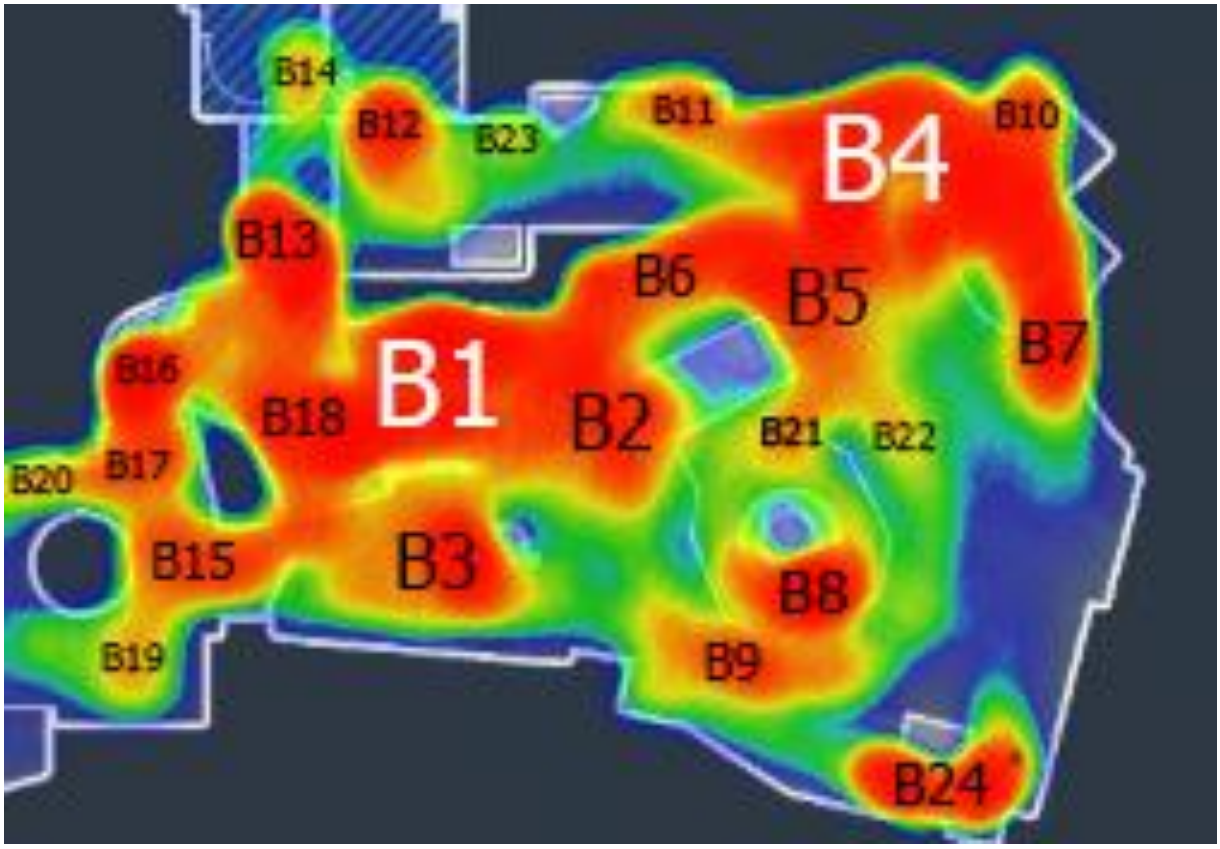

Fig 11. Heat-map of Cobblestone Bombsite B
by Edin Karakurt (2020)

Fig 12. Callouts of Cobblestone Bombsite B
by Edin Karakurt (2020)

Fig 13. Covers in Cobblestone Bombsite B
by Edin Karakurt (2020)

Cobblestone B Bombsite is one of the Bombsites in the game which has the necessary entrances for the attackers to operate a successful takeover of the area while also having unique aspects such as the Drop being a vertical playground.

4.2.1 Main Bombsite

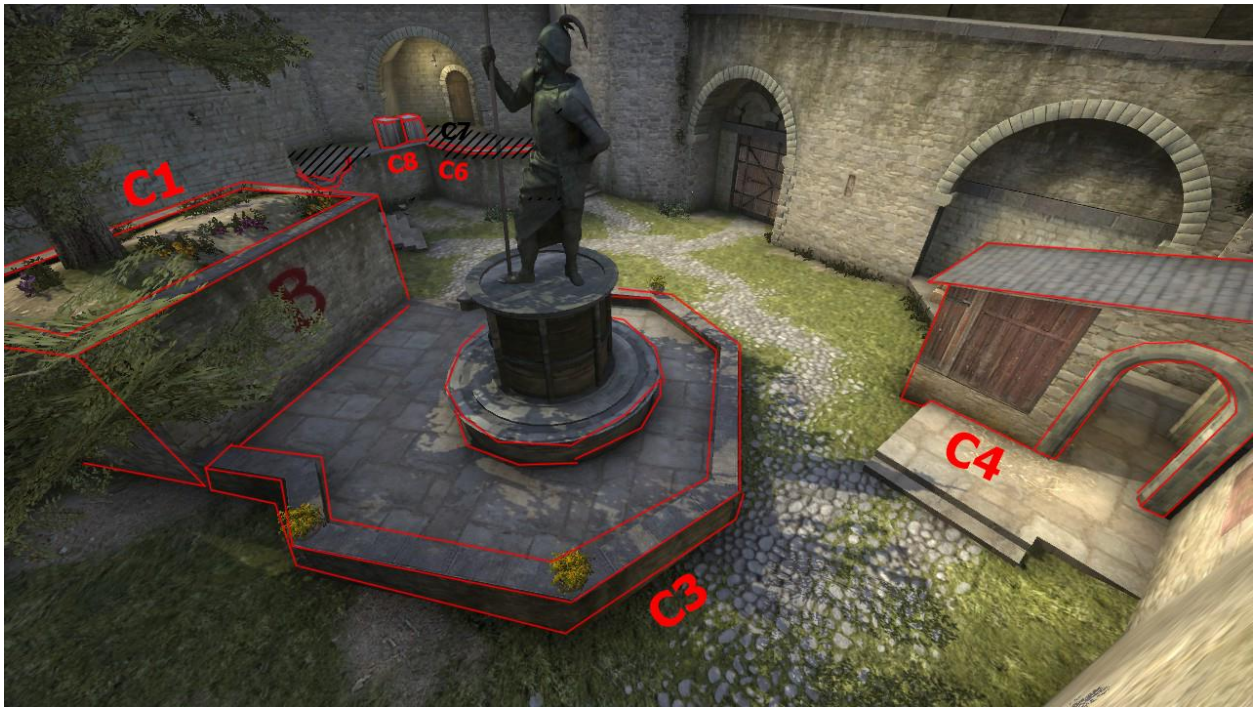

Fig 14. Bombsite B Cobblestone
by Edin Karakurt (2020)

One of the most striking things that can be acquired from the Main Bombsite when first observed is the C2 cover which is the fountain in the middle of the map, accompanied with the garden block of C1. It can also be observed that the fountain of C2 is protected with the short walls of C3 which can be utilized by any defender for minimal protection. The B8 redspot showcases that the C2 cover can be used more effectively as cover against attackers arriving from B4 position rather than B3 position caused by the C5 cover and the C7 elevation difference between the areas. The C2 cover is able to give better protection for the attackers here than the C1 showcased with the B8 hot spot being more intense than B21. Even though the C5 cover is located in the “Rock” area whilst giving the majority of the protection for the attackers after the C17 door, it lacks the same defensive capabilities for the defenders using the same area. It can also be deduced that the C16 corner creates the mediocre defensive position with the proof of the B9 not being as intense as many other hotspots but also is most likely caused by the attackers being able to flank through the B Long area and eventually arriving into the B2 hotspot which outflanks this corner. The upper section of the map around B6 hotspot has the C17 corner designed in such a way to give the defender a great sightline behind the rock of C5 and the B1 hotspot whilst also being able to hold the attackers coming from B1 hotspot. Yet it has the same weakness of the C16 corner where it is quite able to be flanked by B Long.

Another interesting design of the map is the B24 hot spot which exists right behind the C4 cover. This cover is utilized as a spot that can be used to hold angles against different approaches from B Plat and as well as Rock. These advantages can be negated by the fact that it lacks necessary escape routes in case the attackers utilize the utilities such as smokes or molotovs against the player behind this cover.

4.2.2 Drop

Fig 15. “Drop” area in Cobblestone Bombsite B
by Edin Karakurt (2020)

The design of the Drop area is quite peculiar in the sense that the vertical design dominates the area. Any attacker that dares to jump down into the area of B18 hotspot needs to firstly gain a favourable advantage beforehand in order to succeed as there is no essential cover to protect them even if they land before getting shot. The defenders have the sightline to shoot down the attackers jumping down as the attackers become unable to retaliate against them. This advantage of defenders can be exploited by using the verticality difference of C12 by using fast peeking and utilities such as smokes and molotovs which can prove to be the most viable to make an entrance into the area. This is supported by the close quarters nature of the Drop, observable with the B13 hot spot. Once the attackers capture the Drop, the design of the area allows the defenders to fall back to different cover positions, which proves to be vital to the covers that are necessary for the defense of the B Bombsite which in this case for the C11 and the C10 doors that can be used as last defense against any other opposition from the area. The interconnected area connected position being a connector and can be used as an effective flank that can either be used as a way to reach the A Bombsite or to reach the B Bombsite towards the B Doors in order to be used as the unique way to enter the B Bombsite form an different angle.

4.2.3 B Long

Fig 16. “B Long” in Cobblestone Bombsite B
by Edin Karakurt (2020)

The B Long area is one of the other significant areas for the attackers to be able to take an advantageous position against the Bombsite B. Whilst for the Defenders side, their objective is to stop an attacker coming from the B Main Bombsite area as the capture of B Plat would be detrimental by losing the verticality advantage. The design of the long corridor like structure makes it crucial to use utilities such as smokes, frag grenades and molotovs for the attacker side in order to smoke off the area indicated by the lack of intensity on the B23. The same rules of using utilities also apply to the defender side where utilities such as molotovs and hand grenades to stop an fast approaching group of attackers. For the defenders’ side the box, which is indicated as C8, gives excellent peeking options for the defenders of the area, against any attacker taking the opportunity of using the C9 cover or the C15. Right next to the box is the short wall of C8 that has the indication of the B4 and B7 hot spots and supported with the elevation difference compared to the Bombsite showcases that this area utilizes a potential for attackers and defenders to be able to hold this angle of the Bombsite and the B Long area. Another thing that can be pointed out for the design is the half broken wall part of C14 which allows the option to utilize a different excessive route for the attackers to drop down into the B6 hotspot in order to flank any defender using the walls of C6 or the box C8.

4.3 Dust2 Bombsite A

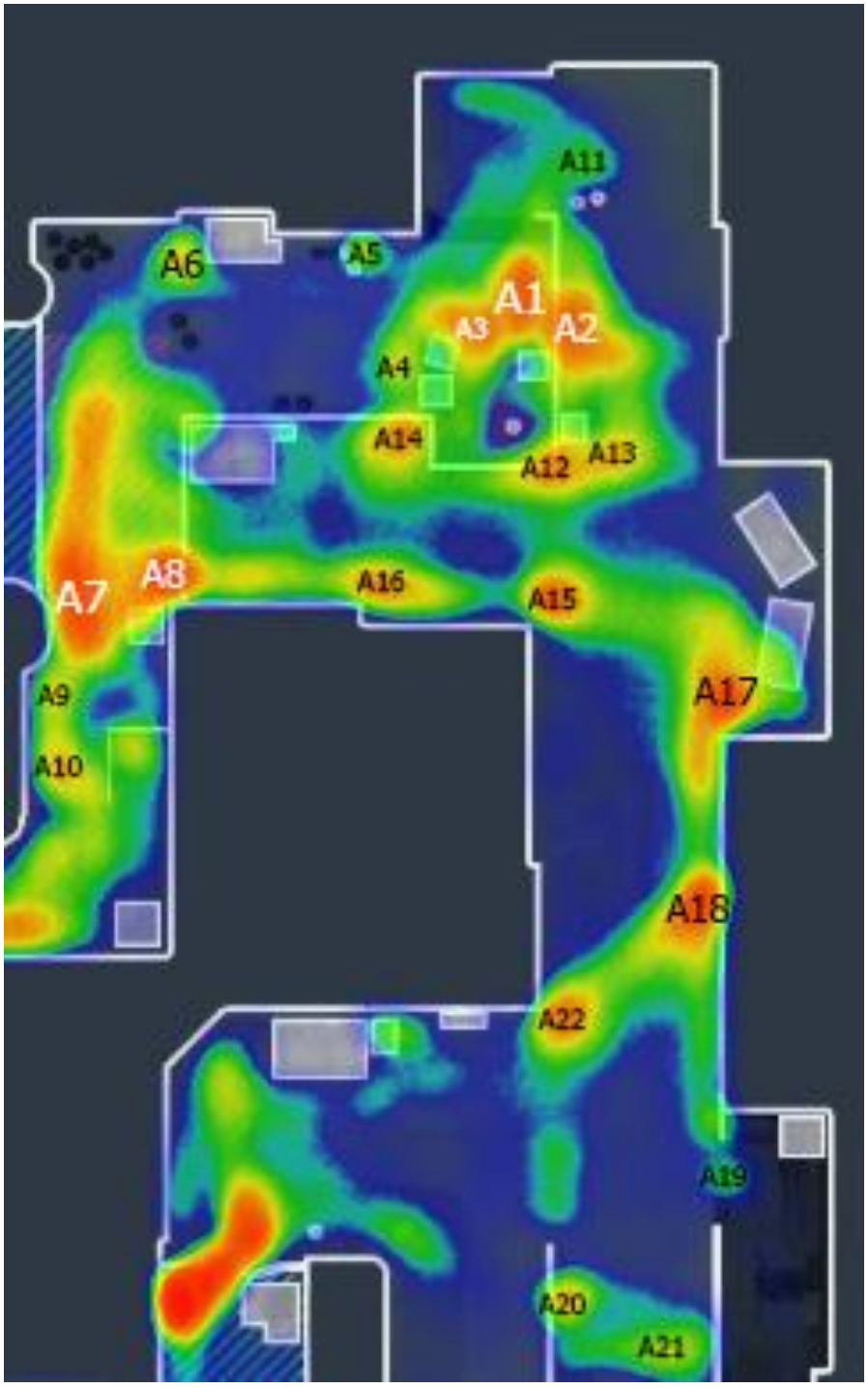

Fig 17. Heat-map of Dust2 Bombsite A
by Edin Karakurt (2020)

Fig 18. Callouts of Dust2 Bombsite A
by Edin Karakurt (2020)

Fig 19. Covers in Dust2 Bombsite A
by Edin Karakurt (2020)

4.3.1 Introduction

Bombsite A in Dust2 is perhaps the most memorable of the map's Bombsites. It offers a wide variety of scenarios for both attacking and defending sides.

At the start of a match, Bombsite A is the closest Bombsite for the defending CTs and setting up defensive positions is quick and without any considerable danger. With proper strategy however, Ts can easily contest the area and make holding the Bombsite difficult.

The attacking side has a total of 3 entrance options when trying to overtake Bombsite A. The most common ones are “Long” and “Short”. Long is the corridor that runs from hotspot A15 and down to about A19, and Short is the tight close-quarters area that encompasses the hotspots A7, A8, A9, and A10. Finally, the third entry is the CT’s spawn area. This area is slightly harder to describe using the map, as it is considered to encompass A16 and the area down the ramp, towards A8, but instead running underneath Short. A portion of the Spawn area is the striped section to the left of A7.

4.3.2 Long

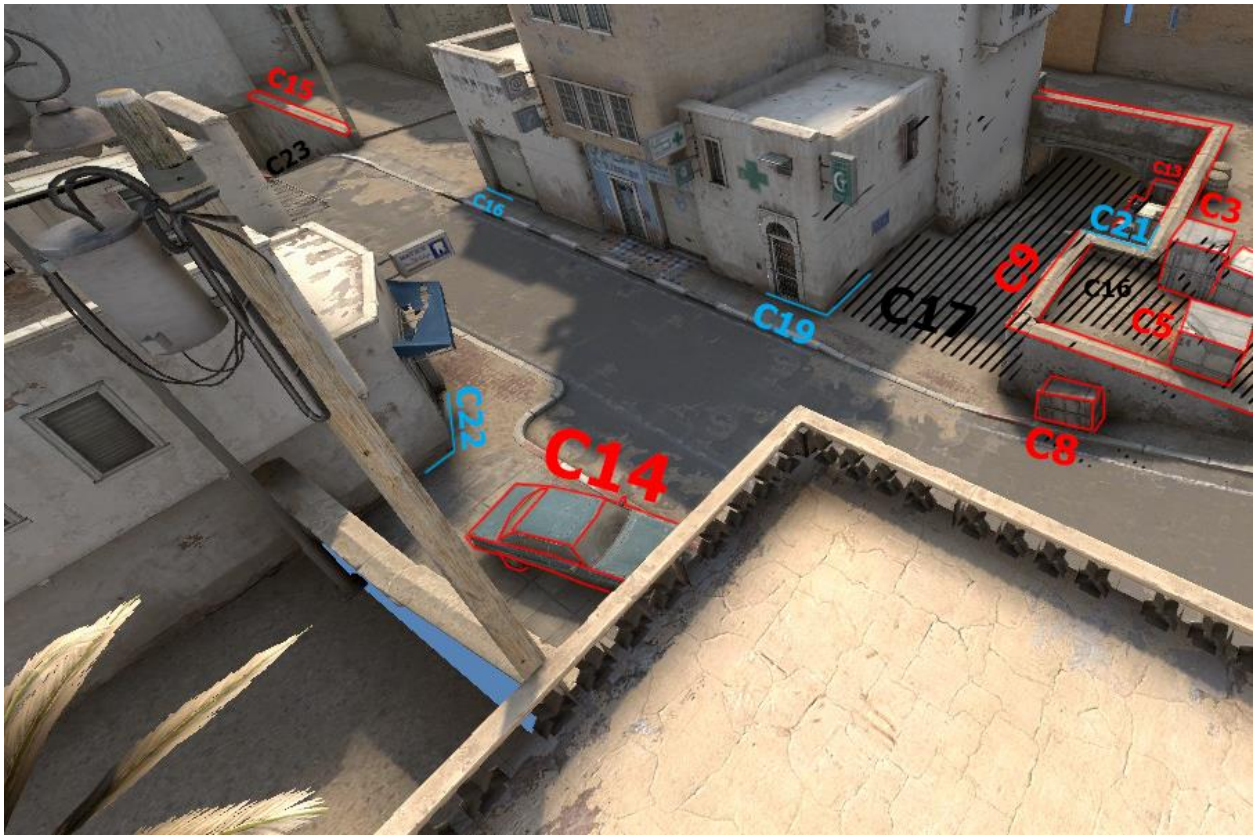

Fig 20. Long - Dust2 Bombsite A
by Edin Karakurt (2020)

A quick glance over the heat-map suggests that the gunfight positions are generally confined to few, but highly concentrated areas. The most notable hotspots are A15, A17, A18, and A22. One should not forget, however, that the part of Long which is closer to the double doors entrance of Long, i.e. hotspots A18, A20, and A22 also get a lot of heat from gunfights taking place in the unnamed hotspot at the bottom left of the map. This area is better suited for an analysis of the entrance to Long.

Long’s design is done in such a way that it suggests the attacking side to jump down into the pit, i.e. hotspots A20 & A21. The lowered elevation at C23 makes it possible for attackers to have plenty of cover while engaging the defenders in long range gunfights.

Although the hotspots in the pit, namely A20 & A21, do not specifically show that many kills are made from the pit. Instead, the design appears to benefit attackers indirectly by allowing them to survive for longer periods due to the elevation at C23, while persistently challenging any defenders in the positions closer to the Bombsite namely: A2, A11, A12, and A17.

A19 is only a small area. It is sometimes used by attackers to engage in gunfights when defenders are holding positions A1, A2, A3, or A11 – to spread out potential avenues of attack. The importance of this design is more evident during the later stages of a match. It is very common, should Ts plant the bomb, that a defending T player can more comfortably guard the planted bomb from A19 - especially if they are the last player alive. This area is designed to provide enough cover from the adjacent wall at C20 but also offer a clear view of the bomb should an attacking CT player attempt to defuse it. As the heat-map shows, A19 is not an area from which many kills are made. Yet, the design still allows for a viable strategy in a common phase of the game that is albeit, highly situational.

Defenders have several options too. One notable area is the alcove recessed into the rightmost wall on Long. In this alcove there are two cars denoted by C14. In combination with the wall at C22, there is ample cover for a defender. Due to Long's open space, this position allows a player to engage attackers before they reach the pit as shown by the intensity of the heat-map around A17. This also goes for any defender holding the position at A15, although with a smaller angle and therefore less time to catch any attackers jumping into the pit.

Most positions are analyzed in the above section, however, A17, A18, and A22 are also considerable hotspots. However, these hotspots are likely from gunfights with attacking players pushing through the doors at the entrance to Long which is unnamed in the above heat-map. As previously stated, analyzing this section is better reserved for an analysis of the entirety of the entrance area. It should be noted, however, that attackers may have success from these positions too, but there is very little in terms of cover, walls or other design elements to indicate that A17, A18, and A22 are designed for the attacking team to utilize. The cover at C11 offers some protection for both attacking and defending sides in gunfights with people at hotspots A17 - or from the Long entrance. The cover map does not show any notable level design features for A17 & A18, and attackers at these positions seem constantly open to gunfights with defenders at A1, A2, or A3. As such, these areas are most likely to generate kills for a defending side. Consequently, these hotspots are not designed with the intention of being crucial attacking positions.

4.3.3 Short

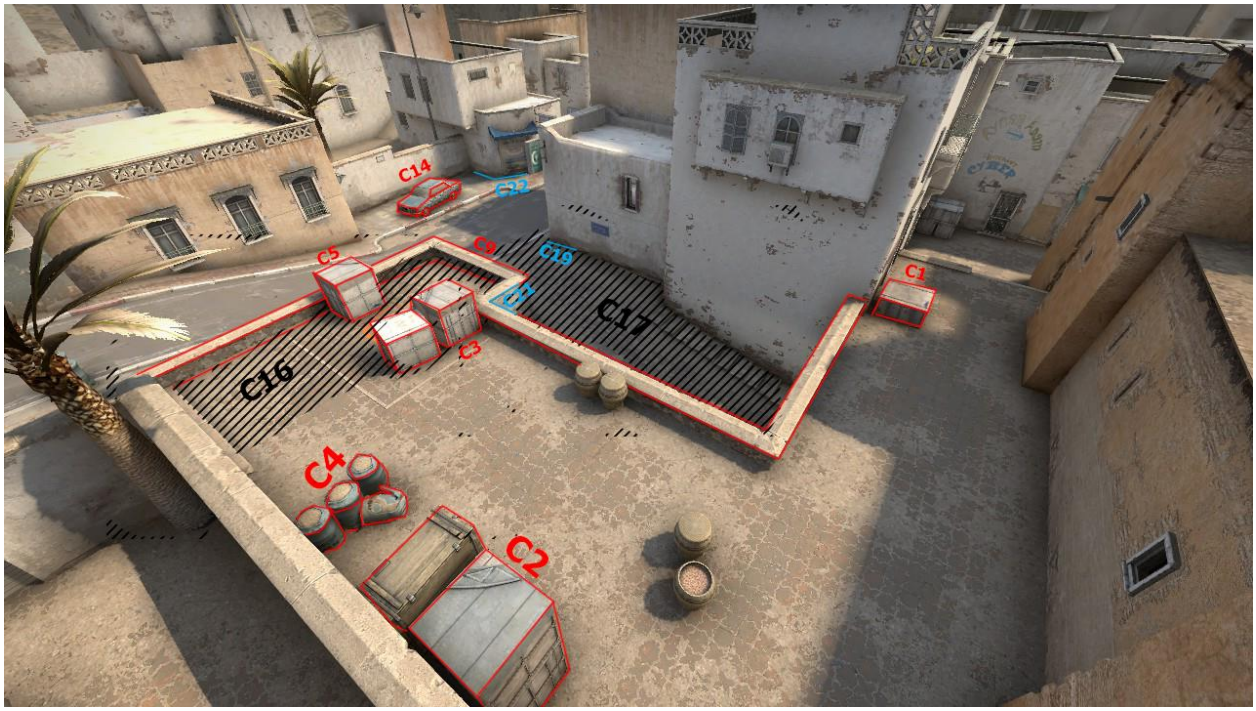

Fig 21. Short - Dust2 Bombsite A
by Edin Karakurt (2020)

In contrast to Long, Short seems to have considerably more spread-out hotspots. This is most evident from the large areas of green. Although green indicates few kills, it stands in contrast to the blue areas featured on Long which contain almost no kills.

Short is designed in such a way that some gunfights evolve from an attacking player peeking the box at C1 next to A7 & A8. The heat-maps are very hot for both A7 & A8. For A7 specifically, the heat-map seems to suggest that attackers are rewarded for peeking around the box at C1 by using the box as cover. Therefore, A7 appears to have a clear advantage over defenders at positions: A1, A2, A3, and A11. A8 is also a high-kill area, while not covered by anything other than the low wall overlooking the ramp leading down to the CT spawn, there is a substantial height advantage over defenders holding, A12, A13, A14, A15, or A16.

A9 & A10 are much less intense hotspots. One level design element which might explain this, is the staircase at A10 which provides slightly better protection from a gunfight against a defender on A6. The position at A9 receives cover from the slight area of wall jutting into Short's corridor. The difference between A9 & A10 can perhaps be explained by this. The lowered elevation from the staircase at A10 offers complete protection except for the head, while A9 only offers cover for the leftmost half of the player. As such, this indicates that difference in elevation offers a better strategic defense.

4.3.4 Spawn / Ramp

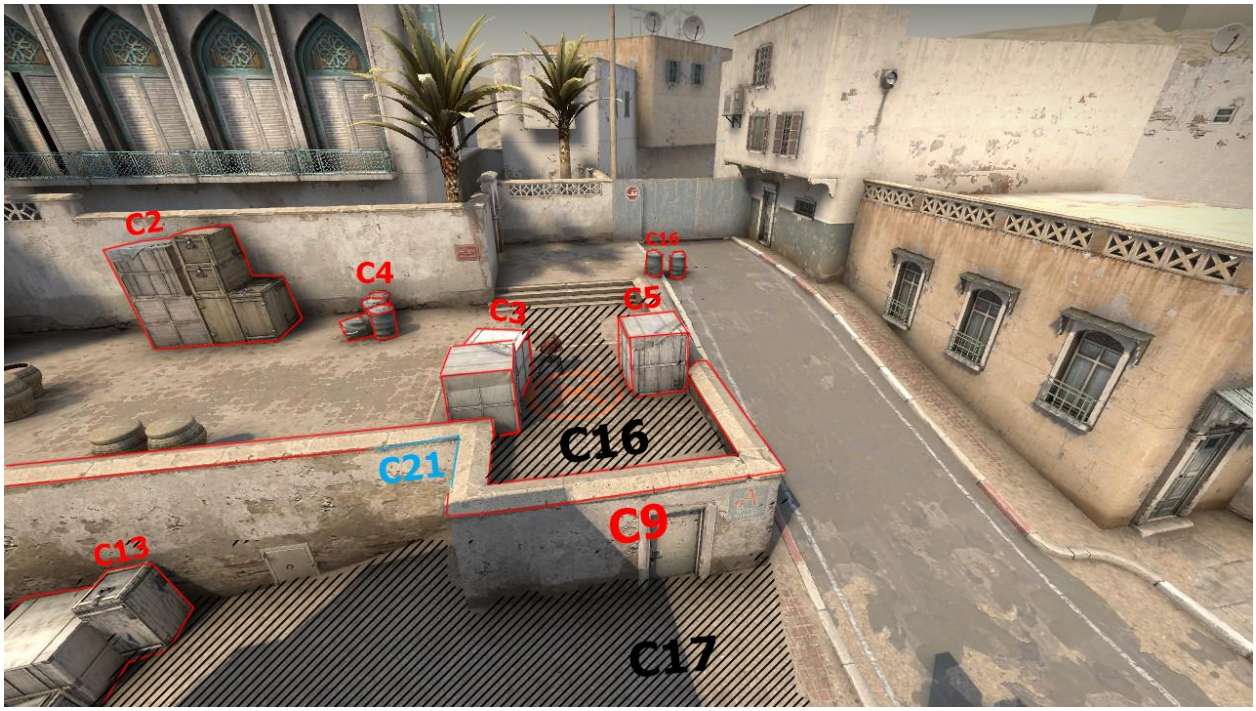

Fig 22. Ramp/Bombsite A Dust2
by Edin Karakurt (2020)

The Spawn / Ramp area at C17 has only a few outstanding areas: A12, A14, A15, A16. None of these are particularly intense in terms of heat, and it would also appear that almost the entirety of the ramp is covered.

The small indentation, C21, into the adjacent walls will offer some protection for defending players on position A14. These are particularly viable for defenders rotating from the B Bombsite. From these positions, they may try to challenge attackers crossing the intersection of the Ramp and Long. According to the heat-maps, this can be done with some success, however, it is a notorious danger zone for attacking players to cross without aid which is why this section is always smoked off, and usually results in little to no gain for defenders.

The sparse hotspots around the Ramp suggests that players refrain from using this area, and the cluttered hotspots behind A14 & A16 show a general lack of strategic approach. This can be explained with Ramp lacking covers to hide behind. The indents into the wall do not go very deep, except for A14. Additionally, this means that moving away from either A14 or A16 during gunfights is incredibly dangerous. Another problem arising from this design is that enemy players overtaking Short and moving closer to the Bombsite, can from any position around A8 engage players at C17 with confidence of better protection and clearer view. This makes it difficult for rotating players to retake the Bombsite as the design does not indicate any particularly good strategy for this phase of the game.

4.3.5 Main Bombsite

The Main Bombsite area features the most tightly congested heat-maps of this entire portion of Dust2.

The key-positions are A1, A2 & A3. These are some typical positions that defending players default to when the attackers are pushing further up Longor Short. This is largely due to the large boxes at C3, C5, and C7 which offer solid protection. The heat of these areas is considerably greater than that of the hotspot bulging upwards from A7 & A8 to A6 – which would indicate that A1, A2, and A3 are the most rewarding for defending players. It should be noted, however, that A2 is also likely to show the hotspot of attacking players killing defenders that might have rotated slightly to keep the enemies from attacking from behind. In this case, the attacker at A2 seems to have a clear advantage over that of a defending player on A3, A4, A5, or A6. This can likely be explained by the elevation in the level design as well. The Ramp elevation which is beneath the hotspot at A2 suggests that they have great cover from the wall encasing the Bombsite. As opposed to a player on A1, A3, A5, or A6.

It is also interesting to investigate the hotspots surrounding A5 & A11. Both seem to be low-reward hotspots but are nonetheless commonly used. A11, for instance, is often a go-to position for a defending sniper as they have a great view of the entirety of Long. Additionally, should the situation require it, the sniper at A11 can lockdown Short as well - almost entirely on their own. This is further difficult to understand considering the player has decent cover in the shape of two barrels at C6. Analyzing the position more closely, however, it becomes evident that there are several issues. Considering the gunfights, a player at A11 would likely engage i.e. players around the hotspots, A17, A18, A20, A21, and A22, it is evident that C6 does not offer equally solid cover. Additionally, it is extremely dangerous to move from C6 since there is some distance to the Main Bombsite area around hotspots A1, A2 & A3 and no alternative cover anywhere else. Therefore, the player at A11 will usually have to relocate enemies' heads popping up from the pit and may even have to contend with attackers approaching from Short at the same time. All these issues seem to explain the heat-map. Not only the difference in hotness, but also the tail that seems to project upwards into the top-left most corner. While there is no cover to be found, the defender at A11 can close the angle between themselves and Long while remaining hidden from players approaching Short.

A5 is a tiny area surrounding that of two barrels, C4, that offers little cover. It is evident from the heat-map that in between the Main Bombsite and Short, A5 & A6 are the only viable covers. A5 can be split into two sub-areas. The right most being the least rewarding. The difference is likely that this piece of cover has been placed in such a way that the right side is intended for defenders and the left for attackers. As such, it shows that the attackers enjoy an advantage of using the cover, C4, over that of the defenders.

4.4 Dust2 Bombsite B

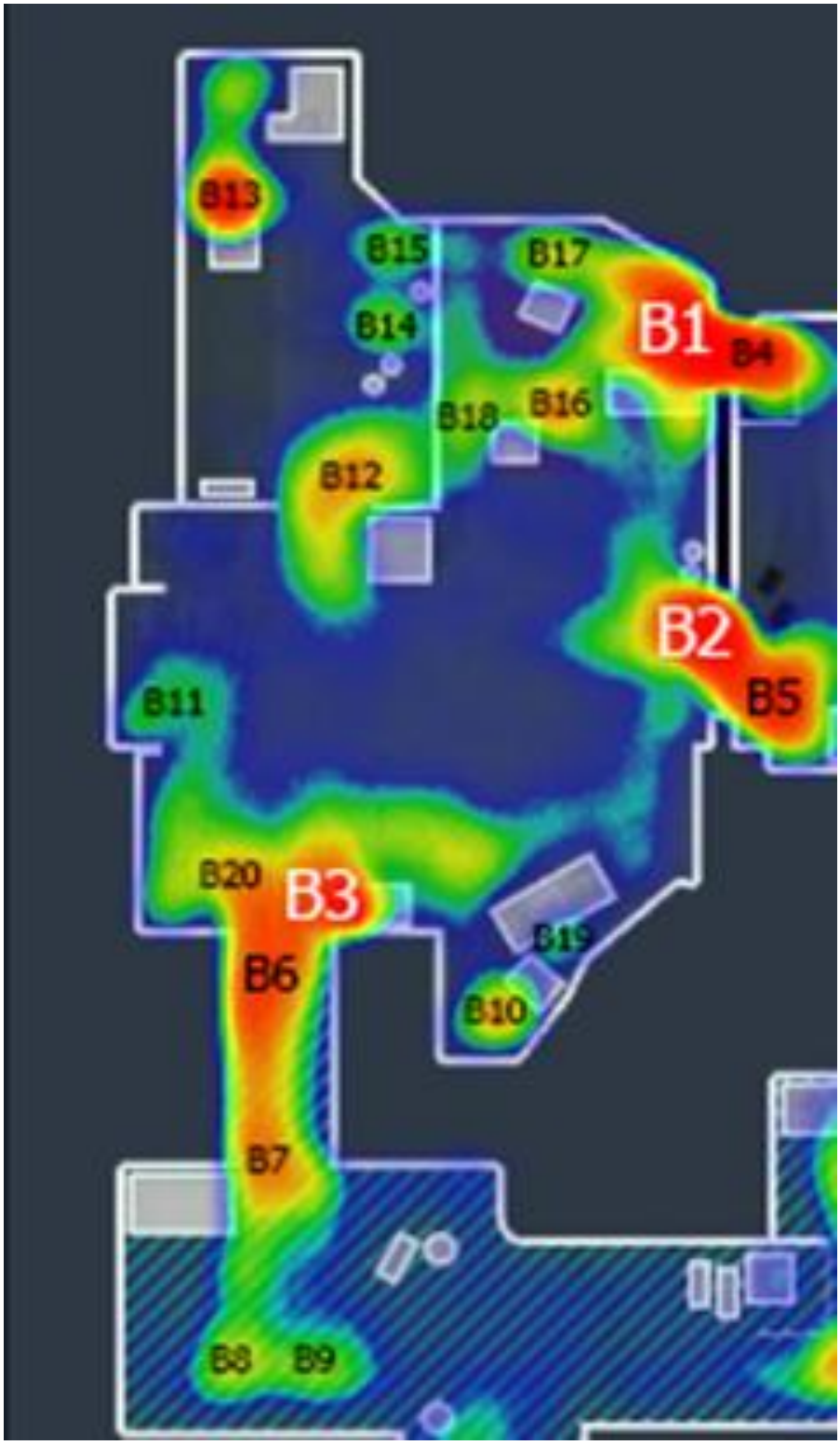

Fig 23. Heat-map of Dust2 Bombsite B
by Edin Karakurt (2020)

Fig 24. Callouts of Dust2 Bombsite B
by Edin Karakurt (2020)

Fig 25. Covers in Dust2 Bombsite B
by Edin Karakurt (2020)

4.4.1 Introduction

Bombsite B is arguably the epicenter of some of the most intense situations in *Counter-Strike*. At first glance, it would seem to stand in stark contrast to its opposite number. In contrast to Bombsite

A, Bombsite B is much smaller. Consisting of tight spaces, narrow entrances, and many corners for players to be vigilant of.

Bombsite B is some distance away from the CTs' spawn area but offers roughly the same distance for Ts. Setting up defensive positions can therefore be tricky for the CTs' since the preparation time is very short.

There are 3 entrances to Bombsite B: Doors, Window, and Tunnels. Using the covers map, doors is the area denoted by C10, window is denoted by C19, and the Tunnels entrance is the area in-between C13 & C16. Additionally, it is worth mentioning that the corridor which leads into the Tunnels area proper is generally considered a part of the Tunnels entrance as many gunfights and exchanges occur in this area. The corridor is shown with diagonal lines and covers the area between C13 & C15 up until C13 & C16. Additionally, the section referred to as "B Platform" will be considered a discrete Bombsite B area and will be analyzed separately.

4.4.2 Tunnels Entrance

Fig 26. Tunnels Entrance - Dust2 Bombsite B
by Edin Karakurt (2020)

Not unlike Long which is connected to Bombsite A – Bombsite B is connected to the area simply referred to as Tunnels which, precisely like Long, is best suited for a separate analysis. However, the Tunnels entrance plays an important role in understanding the level design of Bombsite B.

The heat-map indicates that there is a large number of gunfights happening with players entering from Tunnels. Especially hotspots B3, B6, B7, and B20 suggest that players at these positions win their gunfights. Some additional interesting factors come into play when cross-referencing with the cover map. The cover map reveals that for large parts of the Tunnels entrance there is no cover, and

only B8, B9, C13, and C16 have notable level components to take advantage of. As such, the hottest areas in the Tunnels entrance, namely B6 & B7, have no cover. While B7 is only more rewarding than the positions directly behind it at B8 & B9. It is difficult to explain why the area around B6 is so rewarding. B6 is not a typical position and the level design does not appear to suggest a player to stay there since there are no obvious advantages to be had.

It is important to note that B3 and B20 are most often considered defensive positions, from which defenders may benefit by using the adjacent box or wall at C13 & C16, respectively. B3 & B20 are therefore more likely to get their rewards from engaging attacking players at B6, B7, B8, or B9. As previously mentioned, this is likely explained by the lack of cover for the attacking side as they push up the Tunnels entrance. Furthermore, a player moving will have a penalty to their shooting. This means that they will be at a huge disadvantage if they try to move and shoot at the same time. Consequently, a player at B6 or B7 would most likely lose out considerably as there is no cover, and the Tunnels entrance allows for little movement to get out of sight. If that same player were to try and move anyway, they are very unlikely to win their gunfight by shooting due to the movement penalty. It can therefore be said that the Tunnels entrance, and especially the area around B6 & B7, works as a chokepoint.

With the analysis of B6 & B7 in mind, it might seem reasonable at a first glance to point out that B8 & B9 furthest back in the Tunnels are the illusive victims of B6. The hotspot's green color certainly suggests that they are low-rewarding for a player. Despite this, it is uncommon for either of B8 or B9 to be engaging players at any one of B3, B6, B7 or B20. In fact, through the narrow Tunnels entrance it is more likely that attacking snipers will take positions B8 & B9 and engage players at longer range, namely players at B12 and B13. This design is similar to that of Long on Bombsite A, and exactly like Long, B8 & B9 do not appear the most rewarding as according to the heat-map. Instead they offer protection to players by allowing them to hide behind the box at C13 or alternatively the wall at C15.

4.4.3 B Platform

Fig 27. Platform B - Dust2 Bombsite B
by Edin Karakurt (2020)

B Platform does not feature sizeable hotspots. There are only 4 notable areas namely: B12, B13, B14, and B15. The area is from its design clearly designated for defenders. Amongst the hotspots present, only B12 & B13 are particularly hot. An immediate comparison reveals that B12 is the second most rewarding of these positions. This likely due to the cover that is provided. C1 is a large box that provides full-cover for a player. As such, a player at B12 has considerable advantage over attacking players pushing through the Tunnels entrance at positions B6, B7, and B8 where there is no cover.

Further in the back B13 is found. The hottest of the B Platform hotspots. B13 is very compact, and compared with the Cover-map, it is evident that C6 provides great cover for a defending player. The reason why B13 is more rewarding than B12 is likely due to a combination of the range from the Tunnels entrance, but also that this position has a better view of the entirety of the Tunnels entrance, whereas B12 is at an angle and as such designed to not have as good a view. In fact, a player at B12 will not be able to have a view of another player at B9, which a defender at B13 would. Taking the availability for cover in mind, B13 has a greater chance of taking down attacking players from more positions. Additionally, this would also explain why the hotspot at B12 slightly protrudes around the edge of the C1 box – this allows the B12 defender to get a full view of the cover, however, it leaves them more exposed and as a consequence more likely to lose their gunfights with an attacking player.

B14 & B15 appear low-rewarding. These positions have some cover from the adjacent barrels which, however, are not very large and provide considerably inferior cover to that of B12 & B13. As with B12, B14, and B15, they are placed at an angle which could explain why these hotspots are comparably colder. C1 & C6 for B12 & B13 respectively, offer cover such that only the player's head is visible while at B14 & B15 there are several parts of the player model which are visible.

Finally, the reason why B12 & B13 might be considerably more rewarding is that these positions have been designed in such a way that they have cover from attackers entering the Bombsite from Window or Doors as well. Attacking players entering from these positions will not be in line of sight of players at B12 & B13 due to the clutter of boxes on Bombsite B. In contrast, B14 & B15 have no such cover and are very open to attacking players entering from Window or Doors.

4.4.4 Main Bombsite

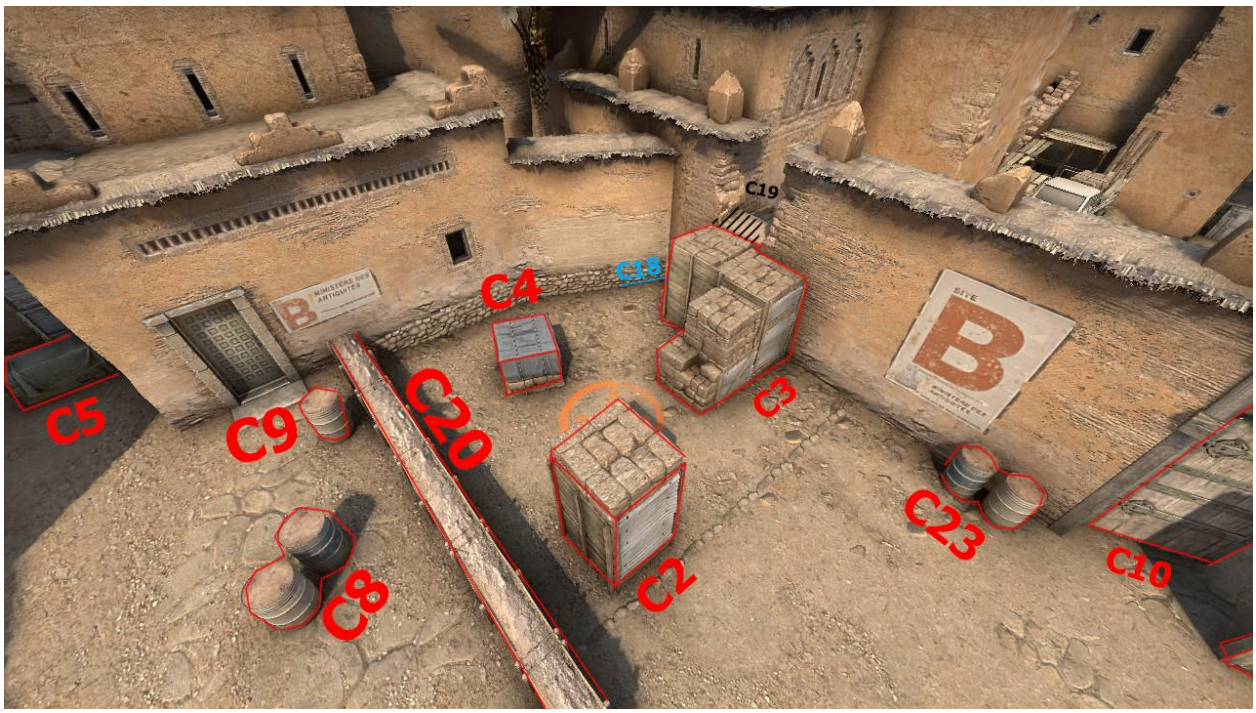

Fig 28. Bombsite B Dust2
by Edin Karakurt (2020)

Bombsite B proper is the most congested area. For the sake of expediency and completeness, the remaining two entrances, Doors and Windows are included in this section of the analysis.

It is important to note that B2, B4, and B5 are typically attacking positions, and B1 is typically a defending position. Effectively decided by the design as the wall which cuts through these areas, separates Bombsite B from Mid.

The area at Bombsite B proper is designed in such a way that there is plenty of clutter that allows for cover and staying out of sight of attacking players. These covers are designed to be effective against players entering from Doors and Windows, i.e. C10 and C19. These areas are B1, B16, B17, and B18. B1 aside, these hotspots are generally low-rewarding. Especially B17 & B18, which can be explained by the placement of the covers C2 & C4. C2 & C4 gives decent cover against players at either B2 or B4, and the reason as to why they are low-rewarding is likely because the gunfights will be initiated by the attackers at B2, B4, and B5. In the case of B16, which has a somewhat hotter area than B17 & B18, this is different. The most notable difference is that a player at B16 would be positioned such that they have the cover at C2 in their back – instead being directly in line of sight

of the two entrances. Therefore, B16 is likely to kill more attackers, but can be assumed to take heavier casualties as well.

The hottest zones are the entrances at Windows and Doors, and more specifically just outside and inside of these zones. B1 is perhaps the hotspot with the most intensity; it is the most rewarding of the defending positions. This is largely due to the fact that it enjoys all the advantages CS:GO offers for a defender: boxes for cover, a wall, and a difference in elevation. In contrast to most other situations, however, the higher elevation at C19 does not offer the attacker any considerable advantage over a defender hiding behind C3 & C18. C3 & C18 also obscures a player at B1 efficiently and as such, they are not only hard to find, but also extremely difficult to hit. On top of that, the player at B4 enjoys little cover – especially as they are entering the Bombsite. This is very evident from the heat-map. B1 is hotter than B4 as shown by the redness of B1 compared to B4's more orange hue. It is also worth pointing out that a player at B1 is protected from players entering from either Tunnels or Doors due to C2 & C3.

B2 & B5 are very hot as well. This entrance is the Doors entrance and is perhaps the most typical way for attackers to enter the Bombsite. It can be argued that it comes with more danger, however. A player entering from either of these positions will only have cover from the nearby barrels. Additionally, B2 is open to attacks from all sides. Leaving them especially vulnerable to defenders at B10, B19, or any other place amongst the clutter on Bombsite B proper. The relative difference in heat can be explained in the same way that B1 & B4 are different.

Lastly, it is worth mentioning that B10 & B19 are lesser, but often used defensive positions. Looking at the positions, C12 & C11 do not offer much cover, but the benefit of these positions is entirely based on the increased avenues from which attacking players might get shot from. Likely explaining the slightly hotter area around B10. As such, defending players seem to benefit more from this particular design.

5 Result & Comparative Analysis

5.1 Randomness

The theory concerning level design in videogames and CS:GO is clear: randomness is not desirable (Taylor, 2013; de Wit, 2015; Garozzo & Snelling, 2015). Consequently, this section of the analysis will attempt to present instances of randomness and random elements of the level design as found in the discrete analyses of both map's Bombsites.

Firstly, the results of the hotspot distributions will be presented for each section by maps with amounts of major hot zones represented by the striped ones with the inclusion of graphs showcasing the numbers followed by an analysis explaining why by correlating the respective preceding analyses with the known theory. Finally, the findings will be combined to briefly present a general analysis.

5.1.1 Bombsites A

The A Bombsite features varying degrees of randomness. Measuring the number of notable hotspots for the Bombsites respectively yielded the following data:

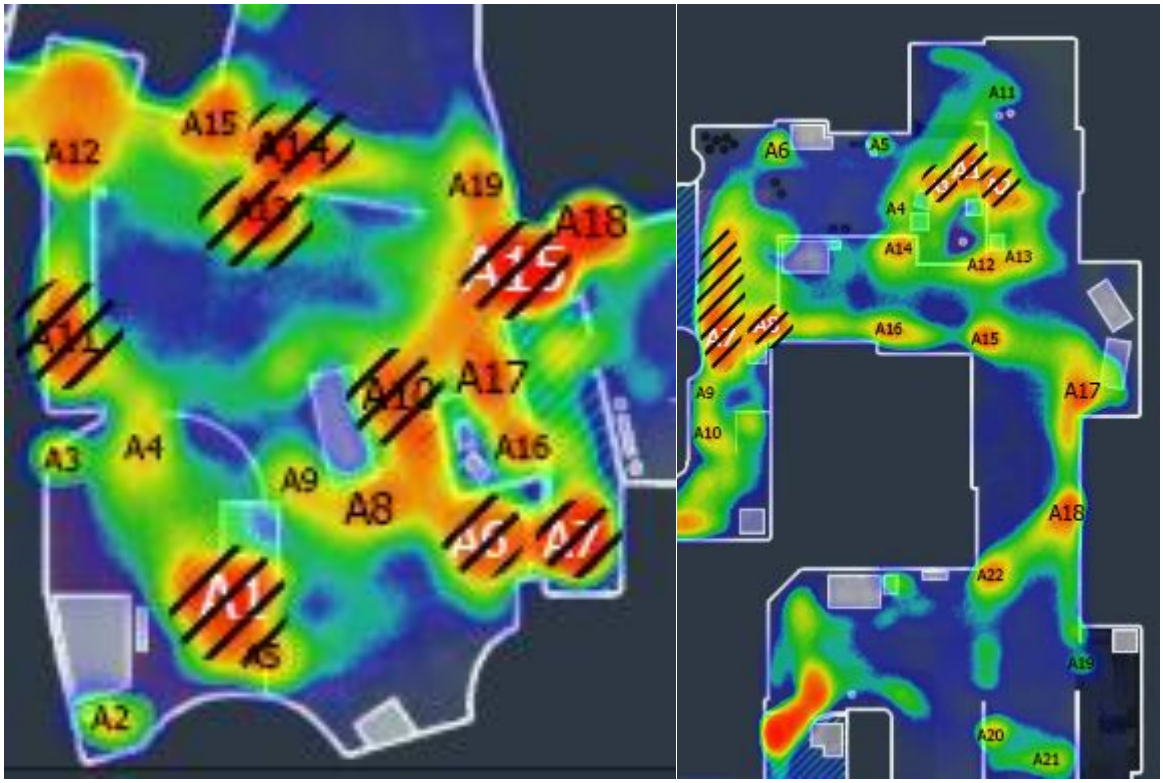

Fig 29. Bombsite A Hotzones
by Edin Karakurt (2020)

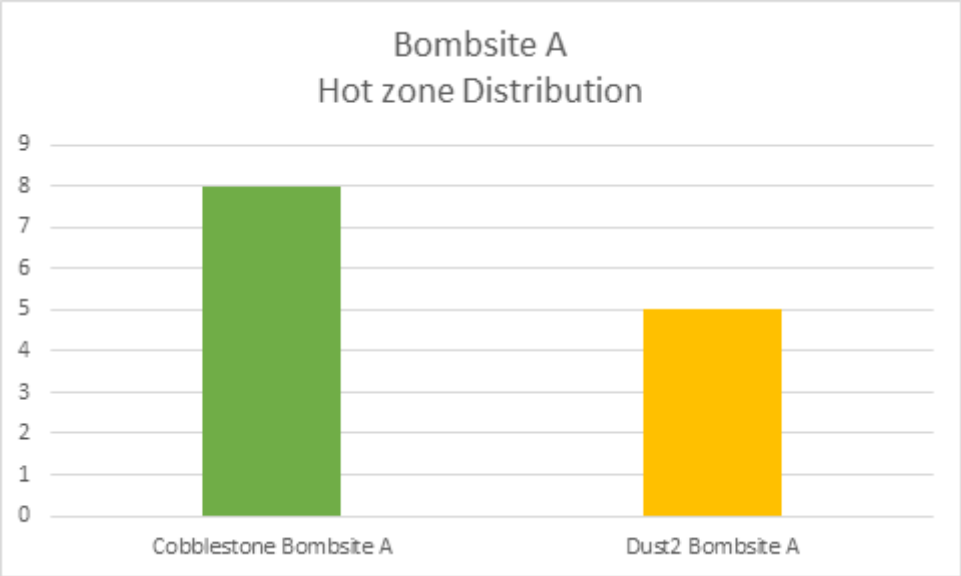

Fig 30. Bombsite A Hotzones
by Jeppe Willatzen (2020)

The data suggests that Bombsite A on Cobblestone has considerably more hotspots than Bombsite A on Dust2. Bombsite A on Cobblestone totals 8 hotspots that are particularly hot. Bombsite A on Dust2 on the other hand, manages close to just half that amount with 5 notable hotspots.

The analysis of Bombsite A on Cobblestone indicated a few different problems with randomness. One element revealing this issue is the weakness of the defensive positions just outside the Main Bombsite area. The van in-between the Main Bombsite and the balcony creates plenty of randomness, as evident with the hotspots around it. The solid protection offered by the van also means that players can easily move and position themselves to engage other players at various positions. Such a design would seem to stray from the principle of efficient design (Taylor, 2013). Additionally, since CS is a highly punishing game (Garozzo & Snelling, 2015), allowing players to move freely without challenging goes against another level design principle. I.e. level design ought to be driven by the game's mechanics (Taylor, 2013).

Looking closer at the hottest zones in and around Cobblestone's Bombsite A, it also becomes evident that many of these zones are not very congested either. The orange-red zones are quite large, and surrounding them are even greater areas with a yellow-green color. It would therefore seem that players get kills from a variety of positions which the design in no way suggests are apt. The design does not seem to sufficiently indicate an optimal setup or position for players to take advantage of. Thus, the design fails to suggest the players what to do – another violation of a level design principle by Dan Taylor (2013).

Bombsite A on Dust2 has quite a few hotspots as well. These areas seem to be generally confined to much smaller clusters, however. The preceding analysis indicated that there is an appropriate number of direct opposite hotspots from which there is an intended opponent. Thus, the analysis indicates that the level design presents options clearly to the players, and that these options are also balanced nicely to accommodate the mechanics of CS:GO. This is particularly evident from the hotspots at Long and Pit all the way to the Main Bombsite. Thus, it can be reasonably argued that Dust2 follows the design principles of Dan Taylor (2013) and Garozzo & Snelling (2015) regarding the understanding of game mechanics and verticality.

Furthermore, Dust2 appears to have a clearer design regarding strategic depth. The different corridors seem to intersect at areas in the level that are aptly designed for utilities to advance strategic advancement. For instance, the ramp leading up from the CT-spawn area is exactly wide enough such that a skillfully thrown smoke can aid an attacking side in moving closer to the Bombsite. As such, these are elements of careful level design that allow strategic depth and player skill as supported by de Wit (2015) and Garozzo & Snelling (2015).

Dust2 does have a few issues with spread out hotspots around Short – likely a result of the Main Bombsite area being hard to smoke such that the smoke effectively obscures the line of sight of defenders on the Bombsite. However, it is clear from the preceding analyses and the hotspot distribution data in conjunction with the established theory that there is more randomness to be found on Cobblestone's Bombsite A than Dust2's Bombsite A.

5.1.2 Bombsites B

The B-Bombsites are vastly different in terms of hotspot distribution. The most notable hotspots in and around the B-Bombsites for Cobblestone and Dust2 yielded the following data:

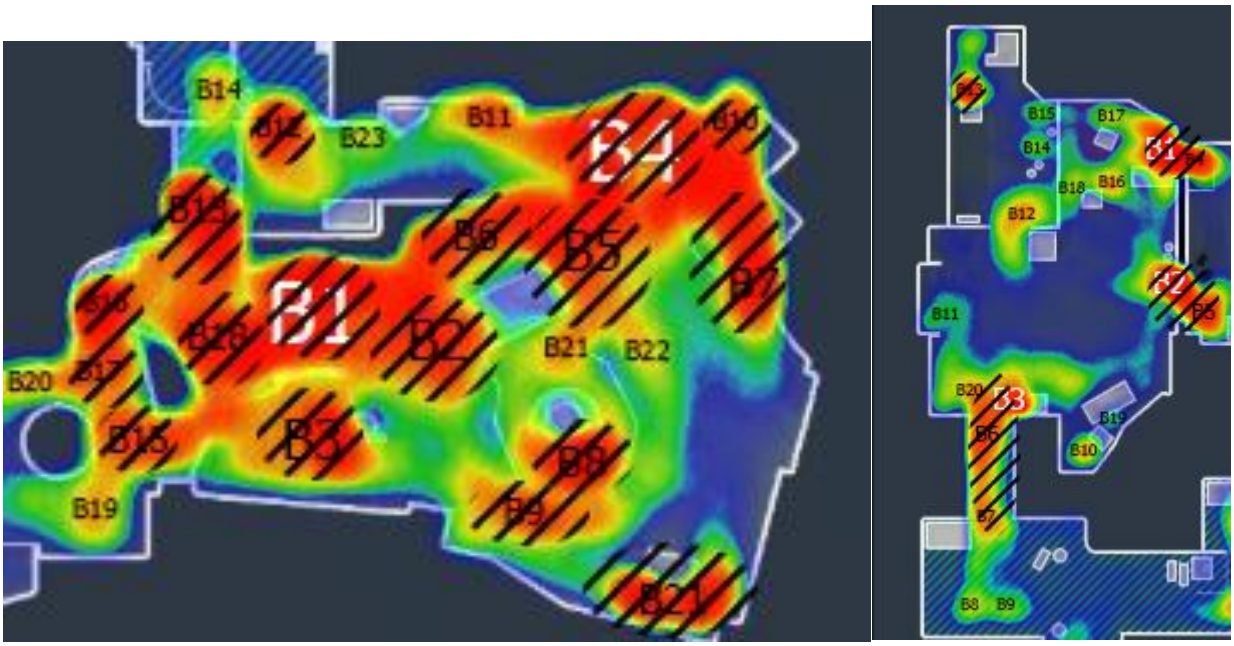

Fig 31. Bombsite B Hotzones
by Edin Karakurt (2020)

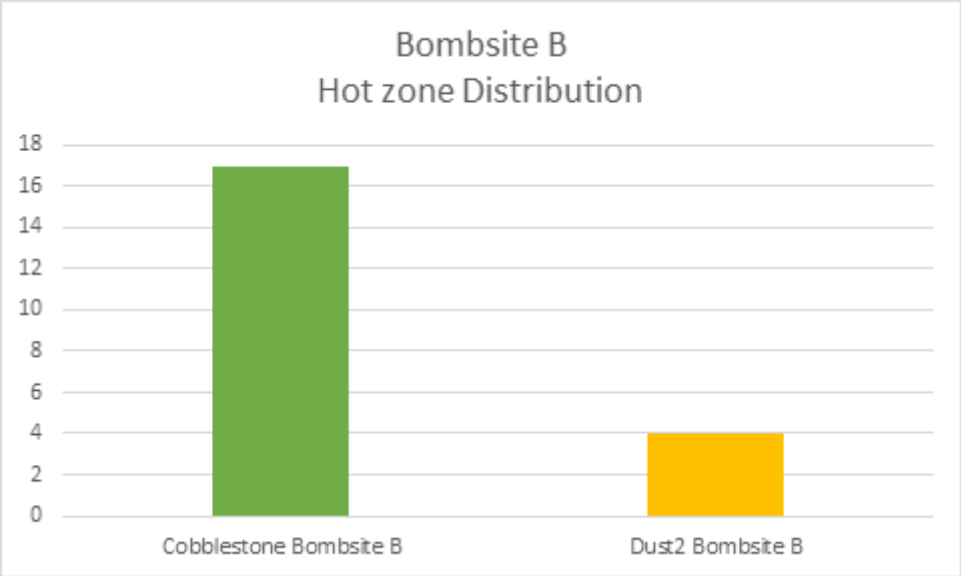

Fig 32. Bombsite B Hotzones
by Jeppe Willatzen (2020)

A first look would immediately suggest a considerably higher factor of randomness when playing the Cobblestone Bombsite B than Dust2's Bombsite B. Bombsite on Cobblestone stands at a huge 17 hotspots while Dust2 on Bombsite B only has 4.

As the preceding analysis shows, Bombsite B on Cobblestone makes particular use of verticality in its level design. Drop, which functions as an entrance for the attacking side, introduces considerable danger and randomness. Jumping down will make noise which in turn will alert defending players in the vicinity, and when falling, a major penalty is applied to the accuracy of the weapon. Additionally, it is unlikely that defending players will make themselves visible to an attacker at the top of Drop. This means that it is highly unlikely for an attacker to win a gunfight and makes any engagement very unpredictable. As such, this design introduces a lot of danger and randomness. Such a design could be seen as "high risk – high reward" - which could be true in some scenarios, but the level design, as stated in the preceding analysis does not seem to indicate that such an assessment is conducive to strategic depth nor player skill. As such, the vertical level design introduced with Drop seems to be ineffective. Its design contradicts Garozzo's & Snelling's (2015) verticality design theory and does not drive the game's mechanics in accordance with Taylor's (2013) level design principles.

The amount of heat around the areas that are further away from the entrances would also suggest that players are often caught out of position. This would indicate that the design in these areas fails to provide the players with strategic options when attackers advance further up Long or enter from Drop. It would seem, as stated in the preceding analysis, that the large, square brick-formation next to the fountain attempts to alleviate the need for cover, however, it fails to provide it satisfactorily. This consequently results in tremendously volatile gameplay in the area as reflected by the heat. The randomness introduced by this design goes against Garozzo's & Snelling's (2015) desires for level design that emphasizes strategic depth.

Lastly, the Main Bombsite area seems to suffer in terms of design, as players can move freely behind it while maintaining good cover. This provides defenders with too much freedom and too

many options and does not facilitate or contribute to the game's mechanics as outlined by Taylor (2013).

Bombsite B on Dust2 has just 4 notable hotspots. Most have very congested heat suggesting that player skill shines through very well. Additionally, two of the hotspots have very specific strategic purposes and are tightly connected to the entrances. Therefore, this design enhances the strategic depth considerably (Garozzo & Snelling, 2015).

The Tunnels entrance seems to be the most unpredictable area of Bombsite B on Dust2 as the hotspot extends far into the Tunnels area. This is expected because the Tunnel lacks solid cover but the danger of using Tunnels seems negligible compared to Drop on Cobblestone, for instance.

It is also interesting to note that there are comparatively few green-yellow areas than blue which would indicate that the design is extremely efficient and makes great use of the space. As such, the design seems to be in alignment with the Taylor's (2013) principle of modular, efficient design.

5.1.3 Final remarks

The overarching analysis with regards to randomness concludes that Cobblestone's Bombsites suffer from a far more volatile design which causes unpredictability.

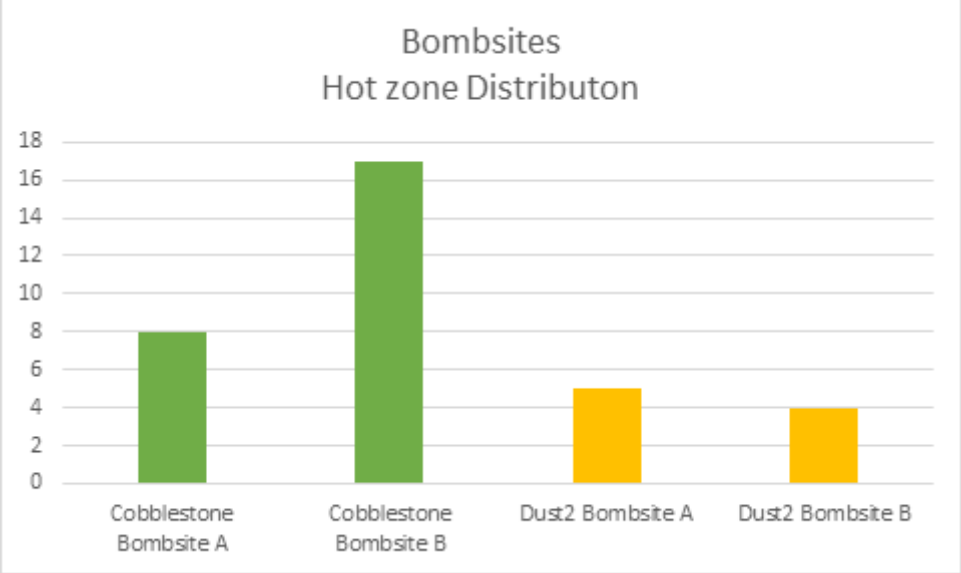

Fig 33. Combined Bombsites Hot zones by Jeppe Willatzen (2020)

Many of the level design principles as outlined by Day Taylor (2013), Garozzo & Snelling (2015), and de Wit (2015) are not satisfied in Cobblestone's design while being clear in the design of Dust2's Bombsites.

The most notable conducers of randomness are: design patterns which fail to accommodate the game's mechanics and strategic depth, improper use of verticality, and an overall insufficient use of space.

5.3 Line of Sight

Most multiplayer first person shooter games level design is dictated by the fact that line of sight plays a crucial role in balancing the advantages of each team in such a way, neither side will have the upper hand at all times. Thus, the reasoning behind this part of the comparative analysis to investigate the amount of lines of sights from the hotspots surrounding the Bombsites are correspondent with the flow of gameplay upon that area. In order to achieve this analysis, maps with arrows showcasing the amount of lines of sight into the main Bombsite with the inclusion of graphs will be presented before the sequence of the Bombsites A and B which will be investigated separately and then later all data will be analyzed in a general manner.

5.3.1 Bombsite B

When data acquired for both maps are analyzed for the amounts of sightlines available looking into their respective Bombsites, one is able to see an obvious difference between the different Bombsites.

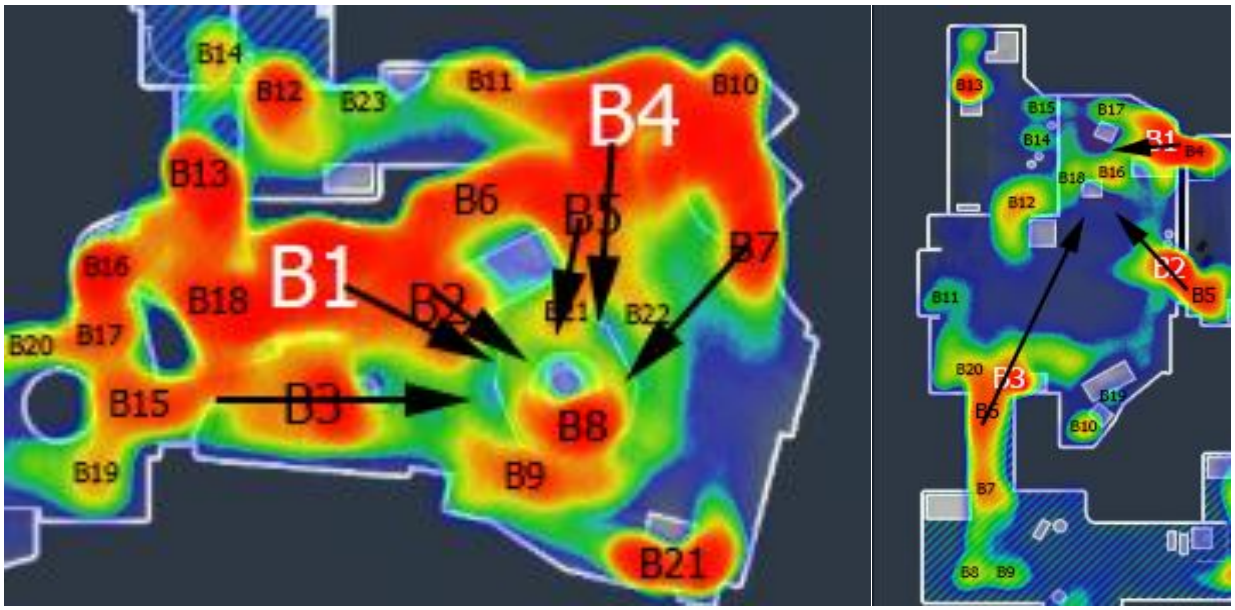

Fig 34. Bombsite B LOS
by Edin Karakurt (2020)

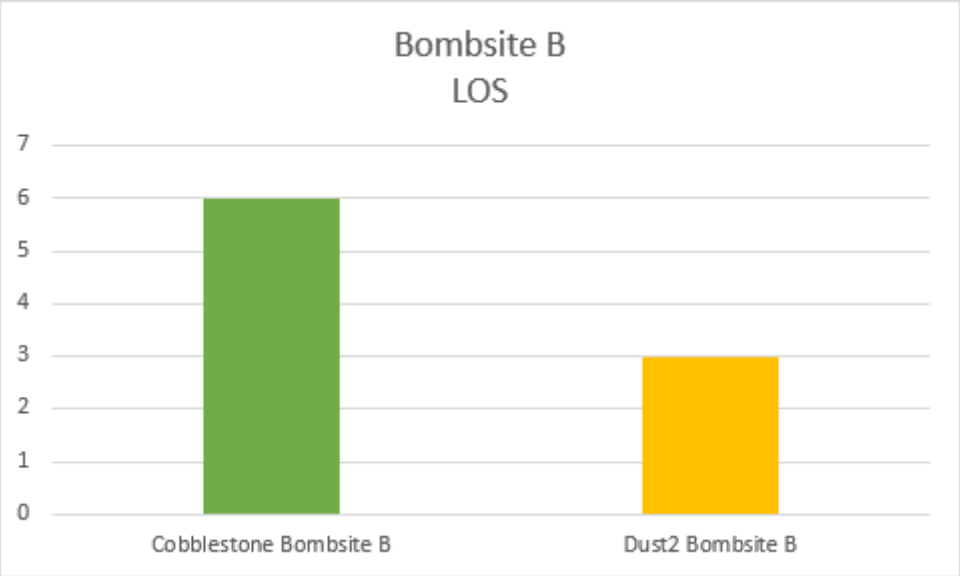

Fig 35. Bombsite B LOS
by Jeppe Willatzen (2020)

The difference of data here is caused by the entrances of Dust 2 Bombsite B which decreases it's amounts of sightlines significantly. With the addition of less entrances, there becomes a correlation of less sightlines directed upon the Main Bombsite.

Another aspect of the design of the map that corresponds with the sightlines are the covers around the Bombsite which are useful in balancing out the amount of possible sightlines the Bombsite has. This can be correlated with Taylor's(2013) argument of level design being efficient and that almost no detail is meaningless.

Cobblestone's Bombsite B utilizes some ways to protect the Bombsite itself, yet these efforts become futile caused by many sightlines that can be observed affecting the Bombsite itself. The only covers available are C1 and Possibly the short walls of C3, with the fountain of C2 not assisting the area as a viable cover even though it is within the Bombsite. Thus the cover of C3 goes against Taylar's(2013) argument and becomes a detriment to the level design.

Whilst the Bombsite B of Dust 2 when first analyzed seems to have plenty of cover as visible in the heat-map, which helps it additionally to have less sightlines into the Bombsites overall. Thus Dust 2 Bombsite B remains to be the dominant design between the two Bombsites by the support of Taylor's(2013) of keeping the balanced efficiency in the sense of the level design.

The addition of too many sightlines into Bombsite B objective also proves the points of Garozzo & Snelling(2015), where their argument is that too many options limit the quality of the design.

5.3.2 Bombsite A

When the Bombsite A's amount of lines of sights with respective origins of varying hotpots reaching into the Main Bombsites are analyzed, they give out a slight difference overall, yet enough to talk about differences.

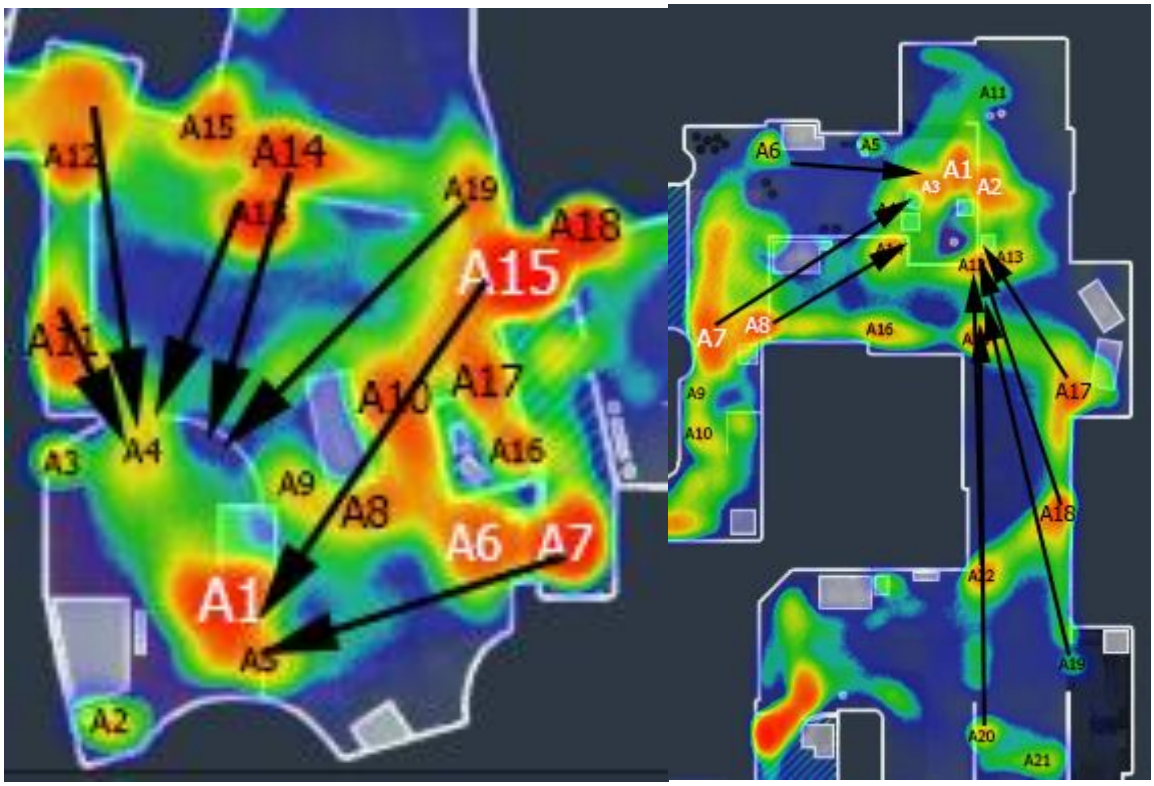

Fig 36. Bombsite A LOS
by Edin Karakurt (2020)

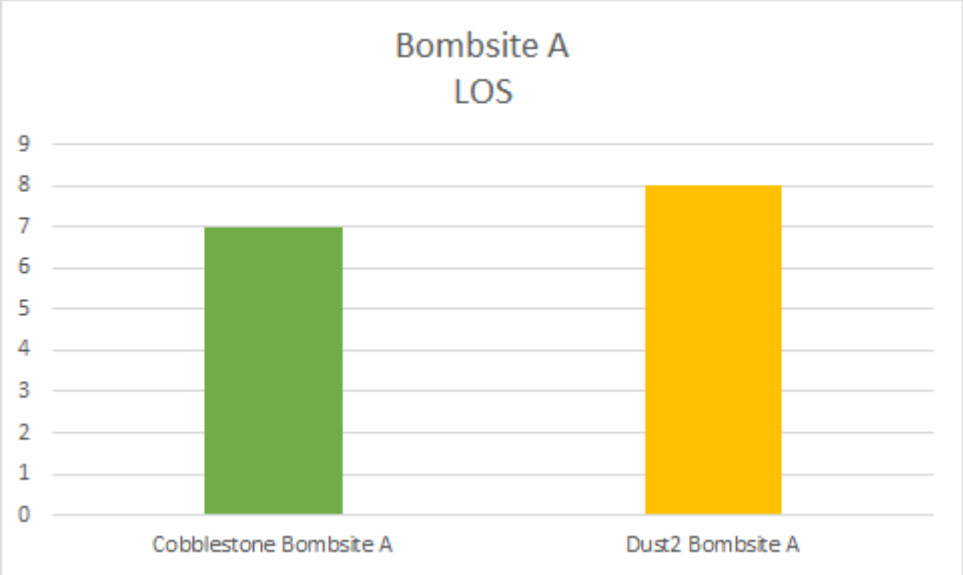

Fig 37. Bombsite A LOS
by Jeppe Willatzen (2020)

Here the data is able to represent the present small difference between the two maps. This data correlates well with de Wit's (2015) comprehensive level design analyses, where he argues that Bombsites A have more entrances than Bombsite B. His argument continues like "Disregarding entrances from middle areas, Bombsite B ought to be harder to overtake from defenders, and reverse for Bombsite A.". As the argument states, there ought to be more ways to enter Bombsite A

which correspond with the fact that there should be more sightlines evolving from these entrances that directly affects the Bombsite, compared to the Bombsite B. This is clearly visible within the charts as the number of sightlines are high and similar with each other.

Cobblestone's Bombsite A supports quite a lot of important covers that defend the surrounding area. Some of these major covers can be counted as C1, C7 and C3. These types of covers have become a vital protector of some portion of the Bombsite against different possible sightlines which is keeping this area from becoming too much cluttered.

Dust 2 Bombsite A shares similarities with Cobblestone Bombsite A in the sense it has similar covers that is able to keep off the attackers from utilizing unbalanced sightlines. These covers can be summarized by showcasing the C9, C3 and C5. Thus these Bombsites are able to support the argument of Taylor's (2013) of keeping the balanced efficiency in the sense of the level design.

5.3.3 Final Remarks

The overall analysis with regards to line of sight concludes that Cobblestone's Bombsite B is too open of a design that causes massive discrepancy within the overarching design that makes the attackers to have too many sightlines while the defenders to have too little too many sightlines to hold.

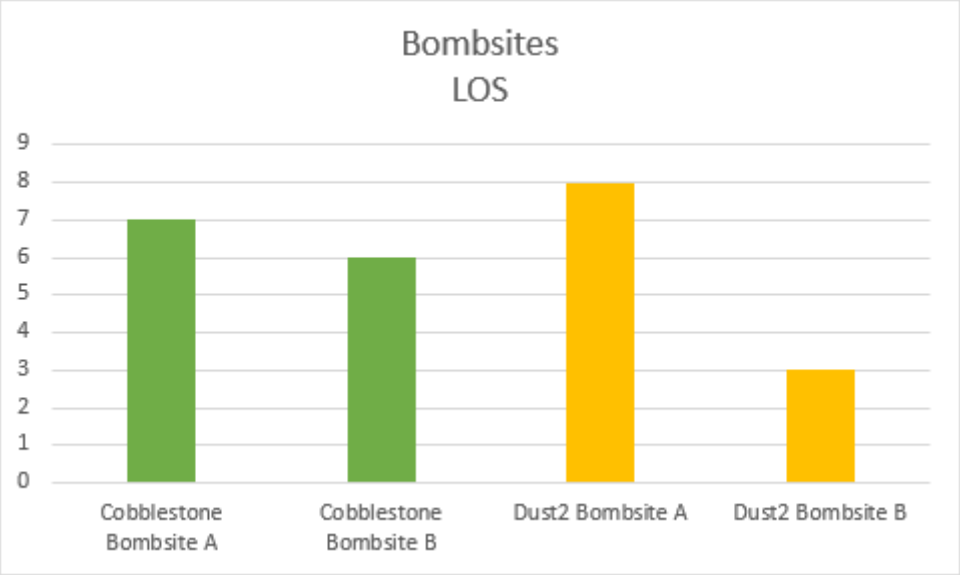

Fig 38. Combined Bombsites LOS
by Jeppe Willatzen (2020)

Theoretically, the argument from Garozzo & Snelling (2015): "...more options for strategic maneuvers is not inherently good for the level design as it may introduce chaos and diminishes the strategic meaningfulness." is proved to be right.
Taylor's (2013) argument is also proven right with the design of inefficient design of Bombsite B of Cobblestone

5.4 Entrance sizes

Within the *Counter-Strike* Global Offensive, every Bombsite needs balanced entrances in order to balance the flow of the game in some optimal way, which could be achieved by checking the amount of popped off smoke grenade sized entrances around Bombsites. Supported by the theory of de Wit (2015) put on, every Bombsite needs to have at least one entrance that is able to support a size that is able to be blocked off with a single smoke grenade, correlated with the fact that a player can only carry one of them at a time. In order to analyze this information optimally, maps showcasing said entrances and graphs of each Bombsite will be investigated first and then after that a general approach will be done in the final remarks.

5.4.1 Bombsite A

When both maps are first observed in the sense of amounts of smokable areas within their respective Bombsites, the amount of difference of smokable areas are quite visible to the eye with exceptionally low amounts in Dust 2 Bombsite A.

Fig 39. Bombsite A Entrance Sizes
by Edin Karakurt(2020)

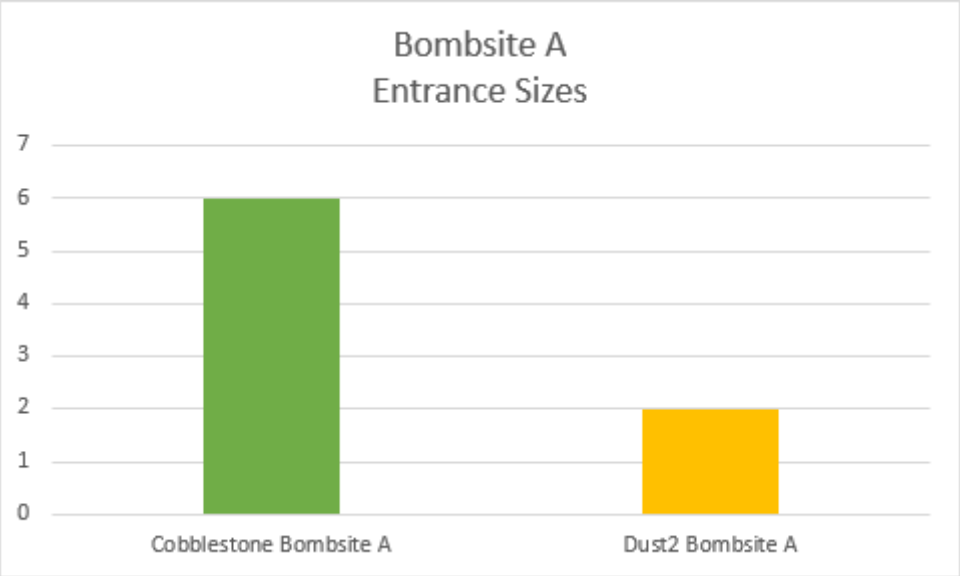

Fig 40. Bombsite A Entrance Sizes
by Jeppe Willatzen (2020)

First look at the graph showcase the fact that Dust2 utilizes less areas available to be smoked off entirely whilst Cobblestone has several that can be smoked off completely. This is caused by large areas of entrance availability that need to be smoked off by several smoke or else will be utilized to flank. Cobblestone's Bombsite A lacks these types of open areas caused by it's cover in and around Bombsite being especially close to each other, causing them to be smoked off extremely easily. Some of these covers can be exemplified as the surrounding area between the truck of C3, the building block of C2 and the sidewall of C12. Whilst this is the case for Cobblestone, Dust2 only has the A Cross and Short as any serious smokable areas visibly.

These findings can be correlated with the argument from de Wit (2015): "each Bombsite can be smoked off entirely with 1 smoke grenade" where he argues that 1 smoke should be able to do the trick blocking an entrance area. This here makes it quite visible that the Cobblestone Bombsite A can't even be smoked off by an entire teams arsenal of smokes, which makes it a large design flaw according to the theory.

5.4.2 Bombsite B

In the case of both maps observations, their amounts of smokable sized entrances, it is plausible to see a design pattern evolving similar to the A sites.

Fig 41. Bombsite A Entrance Sizes
by Edin Karakurt(2020)

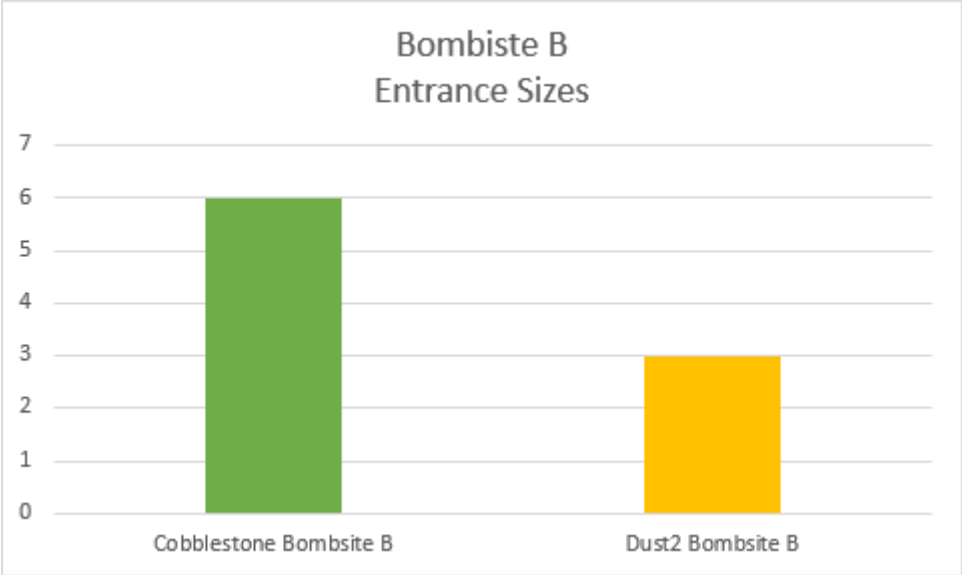

Fig 42. Bombsite B Entrance Sizes
by Jeppe Willatzen (2020)

When looking at the graph showcases the fact that Dust 2 Bombsite B utilizes less areas available to be smoked off entirely whilst Cobblestone Bombsite A has several that can be smoked off completely. This carries some design patterns as established like before. The close quarters nature of the Cobblestone Bombsite A have echoes on the B site too where several areas can be blocked off completely with smokes, some of these areas being B Long, Tree and B Door. The close quarter aspect can also be observed quite thoroughly in the Drop area where most of the area from there reaching the B Bombsite can be easily smoked out.

Dust2 B Bombsite on the other hand, similar to it's A site, can only be smoked off only within its three entrances, making it much viable for one person to hold or approach angle with the usage of smoke.

This way of design approves the argument of Garozzo & Snelling (2015) where their argument being the case of "... level Design is driven by the game's mechanics" which argues that the unique mechanics of the game facilitates the environment that shall be designed for it. And this is proven by the smoke size affecting every possible area of Dust 2 Bombsite whilst Cobblestone lacks the depth within this theory.

5.4.3 Final Remarks

The end result of the analysis with regards to amounts of sized smokable areas concludes that Cobblestone's design has too many optional areas that can be used to be smoked off which creates too many options for attackers and disrupts the flow of the game.

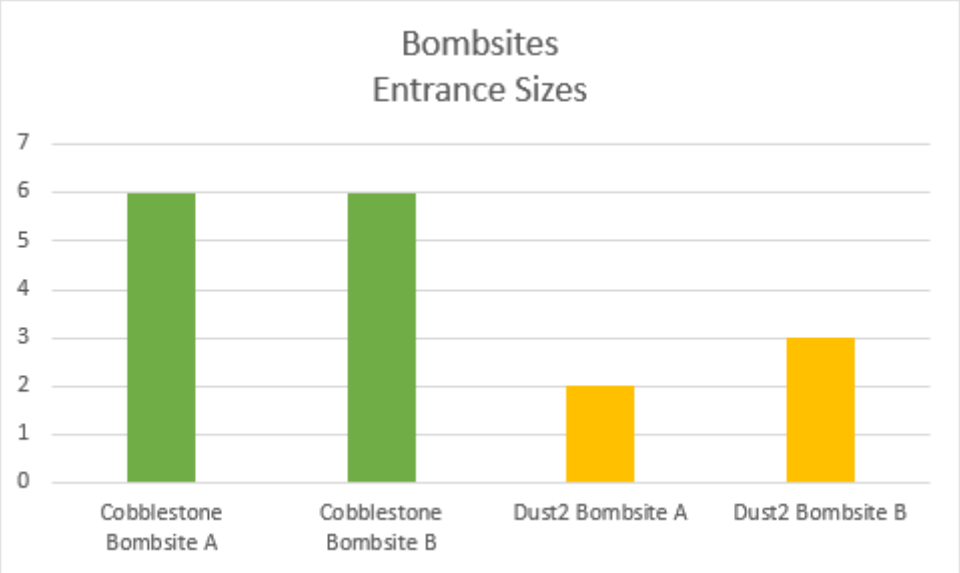

Fig 43. Combined Bombsite Entrance Sizes by Jeppe Willatzen (2020)

The theories of Garozzo & Snelling (2015) and de Wit (2015) are proven correct because of the more thorough design of Dust2 map whilst the more close quarters map of Cobblestone lacks the depth to field the necessary design quality.

6 Conclusion

Contemporary CS:GO level design research tends to focus on high-level analyses, and has revealed many interesting design patterns. This paper hopes to contribute to this research by taking on a low-level analytical approach and finds that less popular CS:GO maps may tend to have considerable level design flaws. Therefore, we decided to analyze level design patterns of the Bombsites of two classic CS maps. One of the maps having fallen out of favor with the CS:GO community, and the other being a fan-favorite that has stood the test of time. These are the maps called Cobblestone and Dust2, respectively.

The analyses utilize heat-maps in order to provide a data driven investigation of player behavior as a result of the level design. Employing a formal comparative analysis to this data while examining the levels, aids in understanding and explaining the levels' designs. The heat-maps reveal player positions at the time of killing an opponent, and as such reveal information about players' behavior and strategic approaches to the game. This data is subsequently used in conjunction with contemporary theory on level design relating to videogames in general and specific CS:GO level design. With the research already conducted by other designers, we hypothesize that some elements are particularly strong indicators of flawed level design. These indicators are issues with randomness, line-of-sight, and entrance sizes.

The analyses conclude that there are multiple instances of our hypothesized level design flaws. The Bombsites on Cobblestone, as hypothesized, were considerably more random than the Bombsites on Dust2. Regarding line-of-sight issues, Cobblestone's A-Bombsite was largely balanced while Bombsite B suffered severely from too many options. Dust2 on the other hand, did not display any notable instances of line-of-sight issues on its Bombsites. Finally, the amount of entrances shows that Cobblestone suffers from having too many areas that can be fully blocked with Smokes. Dust2 has limited entrances that can be fully Smoked and does not suffer from this issue. As such, Cobblestone's level design does not adhere to the level design principles and guidelines outlined by authors such as de Wit (2015), Dan Taylor (2013), and Garozzo & Snelling (2015) while Dust2 for the most part applies these theories. Therefore, this paper concludes that the answer to our research question: *"What are the key features of level design that make the Dust2 Map a more popular map than the Cobblestone Map in competitive CS:GO?"* is due to Cobblestone's higher presence of level design flaws relating to randomness, line-of-sight, and entrance size issues when compared to Dust2.

The analytical methodology and approach utilized in this study has its limitations, however. The data used in the analyses is acquired from 2nd hand sources on the internet of which we cannot confirm the accuracy. Furthermore, the analyses presented here only cover the Bombsites of the respective maps, and while these are the most important in a CS:GO map, they might not tell the whole story. In addition, more data relating to timing, game flow, in-game economy, and much more could contribute significantly to the completeness of the study. Consequently, we recommend that other designers, for future CS:GO level design studies, employ the knowledge we presented here, as well as that of the authors mentioned in this paper. It is our hope that future studies of CS:GO will increasingly use a low-level, data-driven analytical approach to examine the entirety of the game's mechanics and their relation to level design.

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APPENDIX

Figure 1. Bombsite A on "Dust2"

Figure 2. Bombsite B on “Cobblestone”

Figure 3. de Wit (2015) Entrance options on Long

Figure 4. Taylor (2013) Halo 3, Mission 6: The Ark

Figure 5. Heat-map of Cobblestone Bombsite A
by Edin Karakurt (2020)

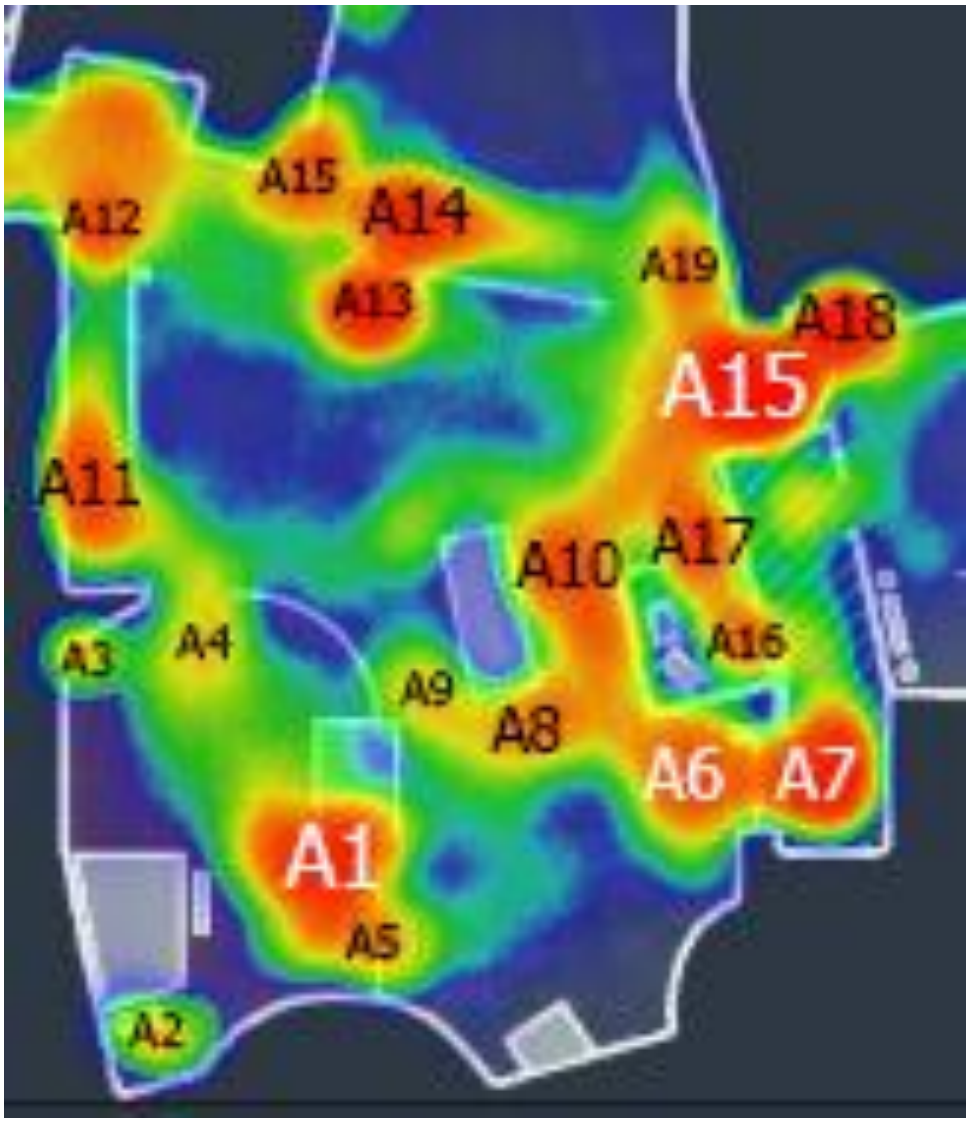

Figure 6. Callout of Cobblestone Bombsite A
by Edin Karakurt (2020)

Figure 7. Callout of Cobblestone Bombsite A
by Edin Karakurt (2020)

Figure 8. Bombsite A Cobblestone
by Edin Karakurt (2020)

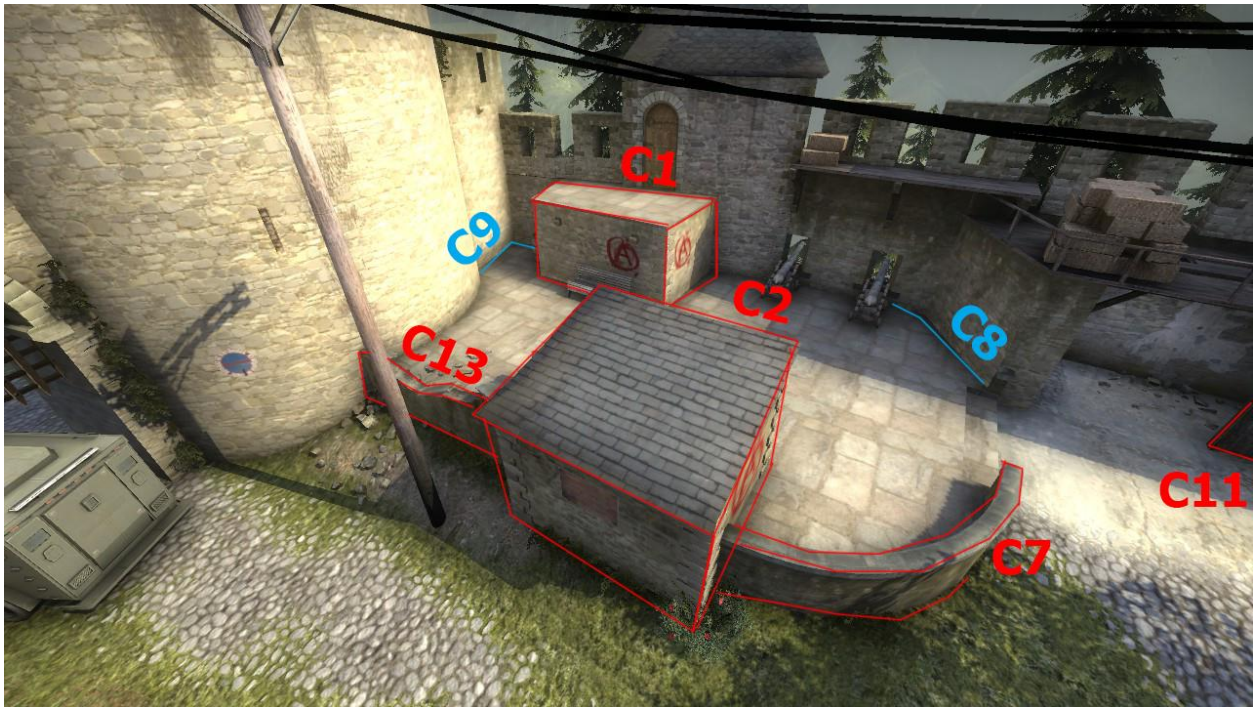

Figure 9. Truck - Cobblestone Bombsite A
by Edin Karakurt (2020)

Figure 10. Balcony - Cobblestone Bombsite A
by Edin Karakurt (2020)

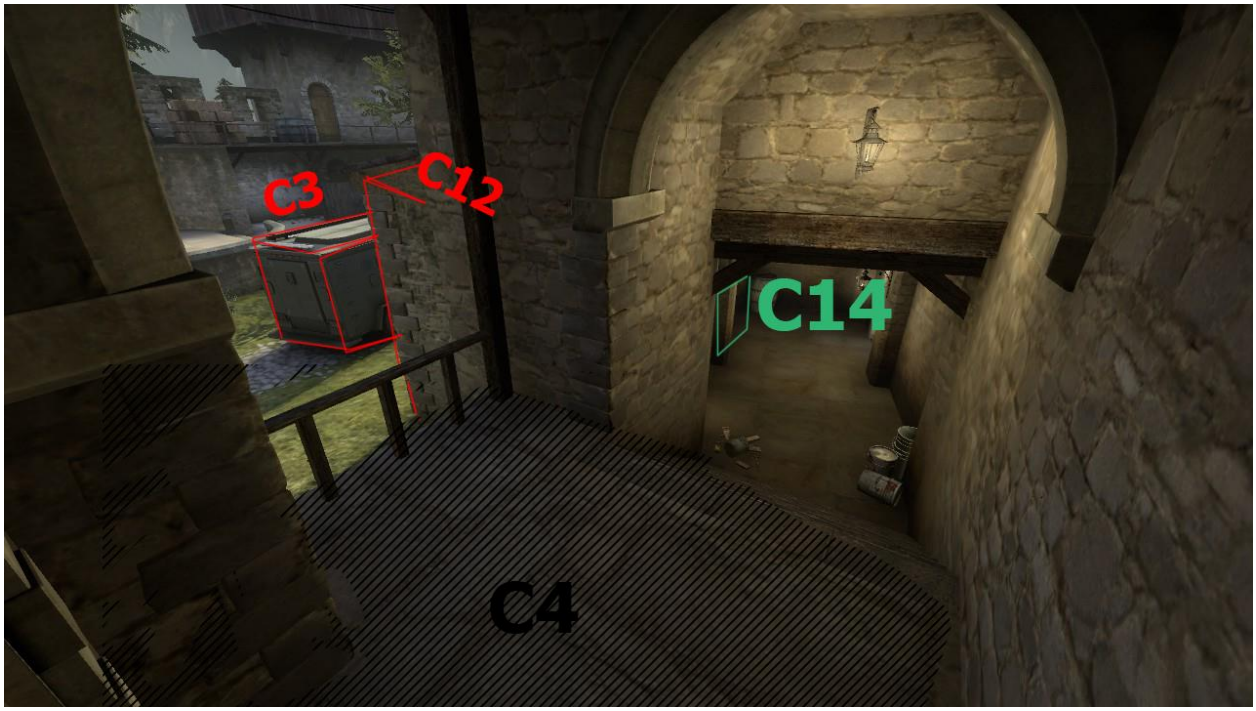

Figure 11. Heat-map of Cobblestone Bombsite B
by Edin Karakurt (2020)

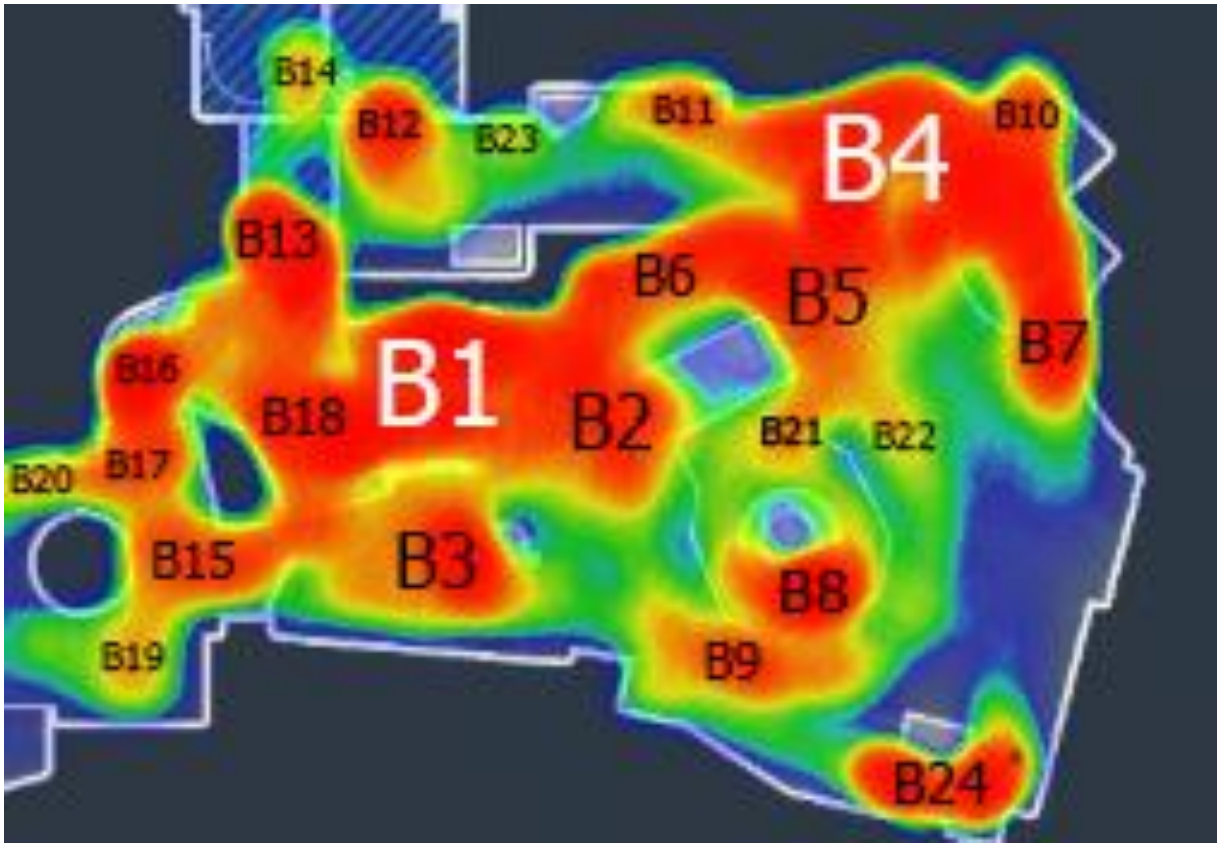

Figure 12. Callouts in Cobblestone Bombsite B
by Edin Karakurt (2020)

Figure 13. Covers in Cobblestone Bombsite B
by Edin Karakurt (2020)

Figure 14. Bombsite B Cobblestone
by Edin Karakurt (2020)

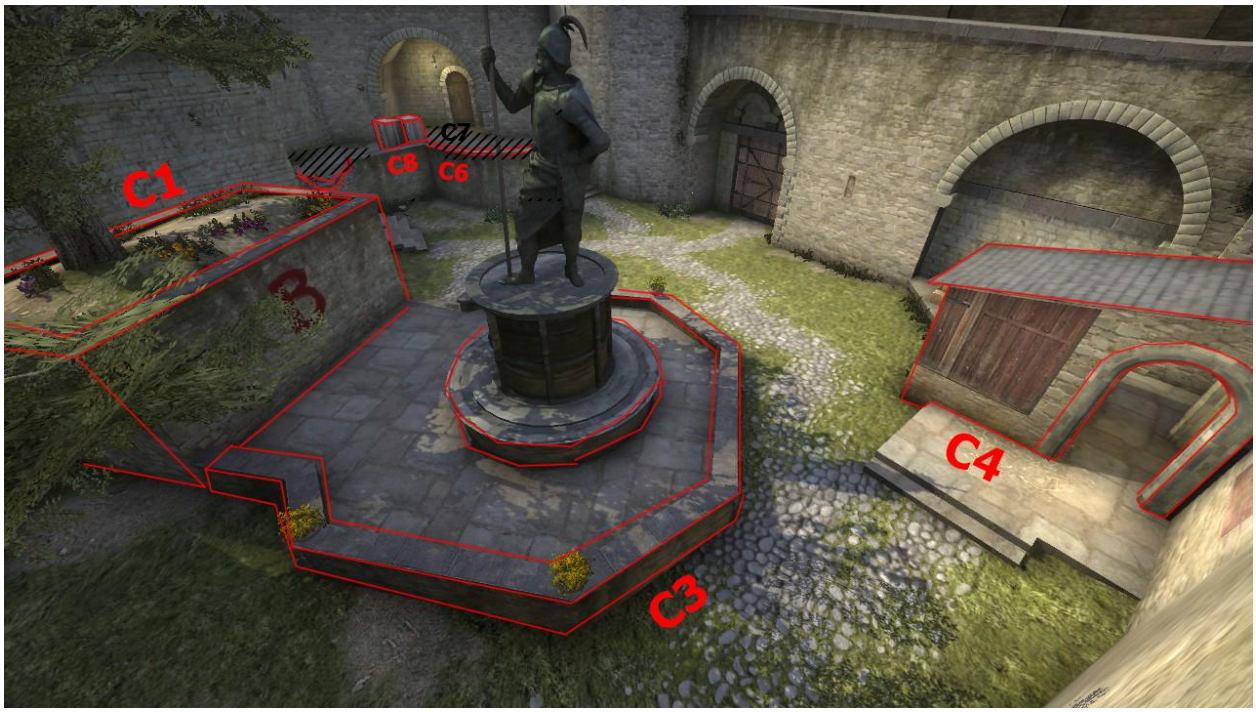

Figure 15. “Drop” in Cobblestone Bombsite B
by Edin Karakurt (2020)

Figure 16. “B Long” in Cobblestone Bombsite B
by Edin Karakurt (2020)

Figure 17. Heat-map of Dust2 Bombsite A
by Edin Karakurt (2020)

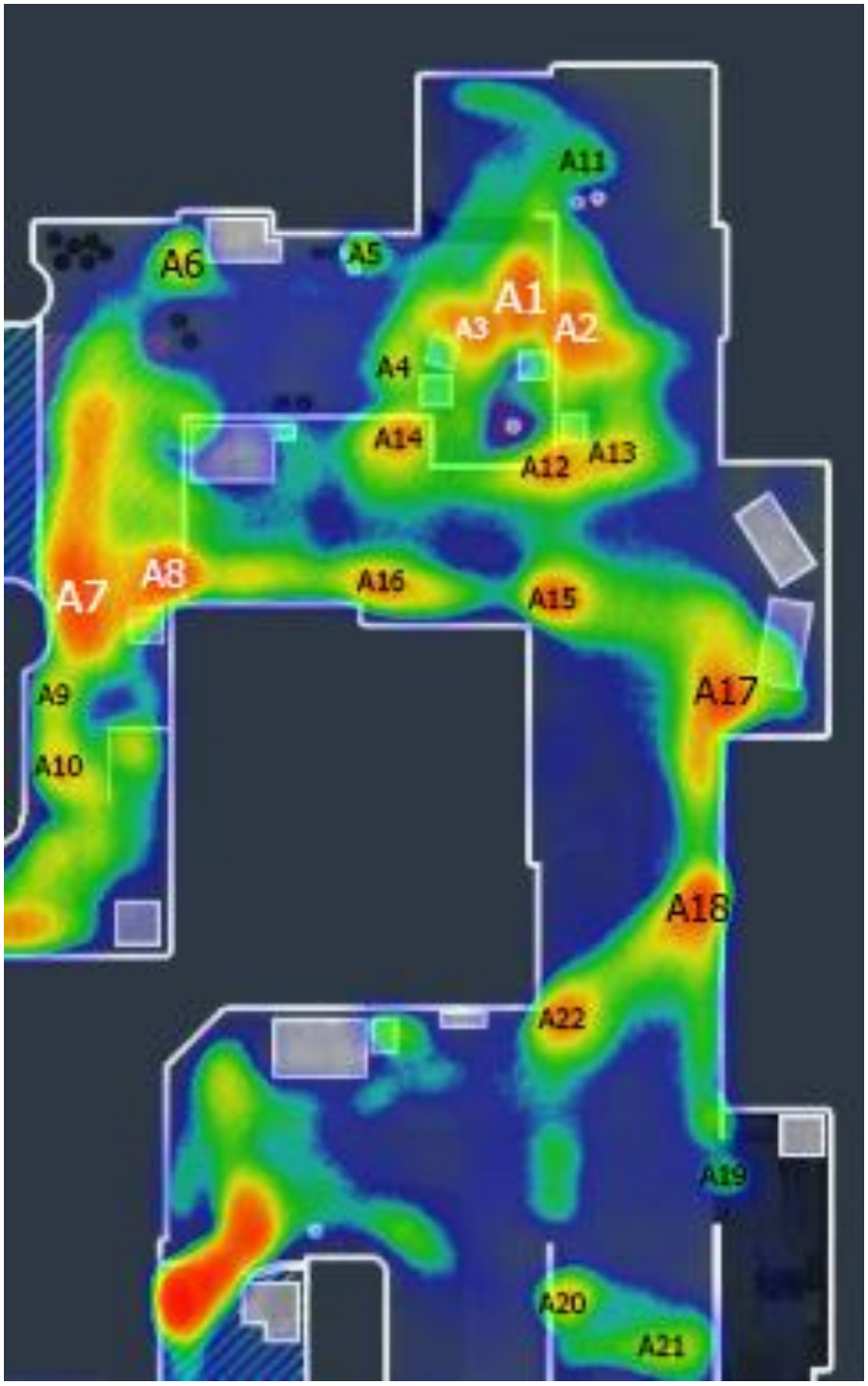

Figure 18. Callouts of Dust2 Bombsite A
by Edin Karakurt (2020)

Figure 19. Covers in Dust2 Bombsite A
by Edin Karakurt (2020)

Figure 20. Long - Dust2 Bombsite A
by Edin Karakurt (2020)

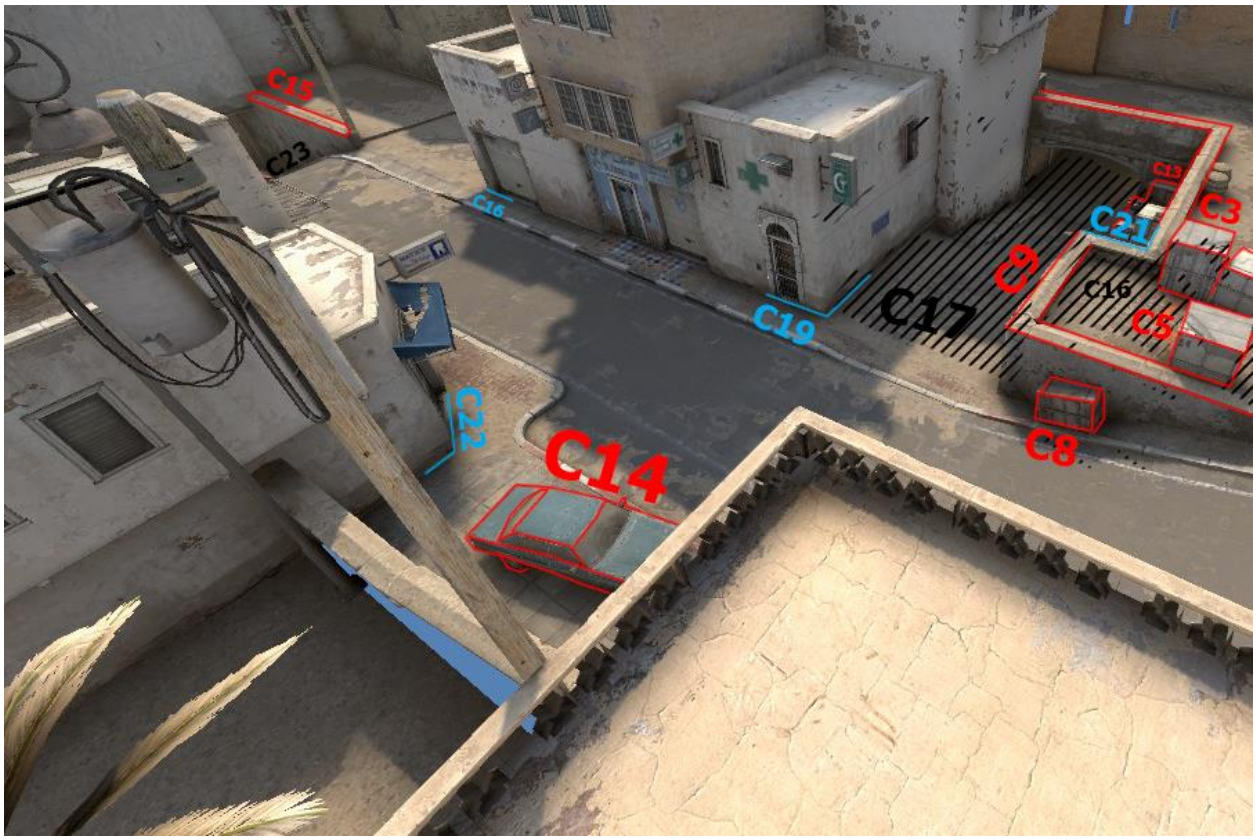

Figure 21. Short - Dust2 Bombsite A
by Edin Karakurt (2020)

Figure 22. Ramp/Bombsite A Dust2
by Edin Karakurt (2020)

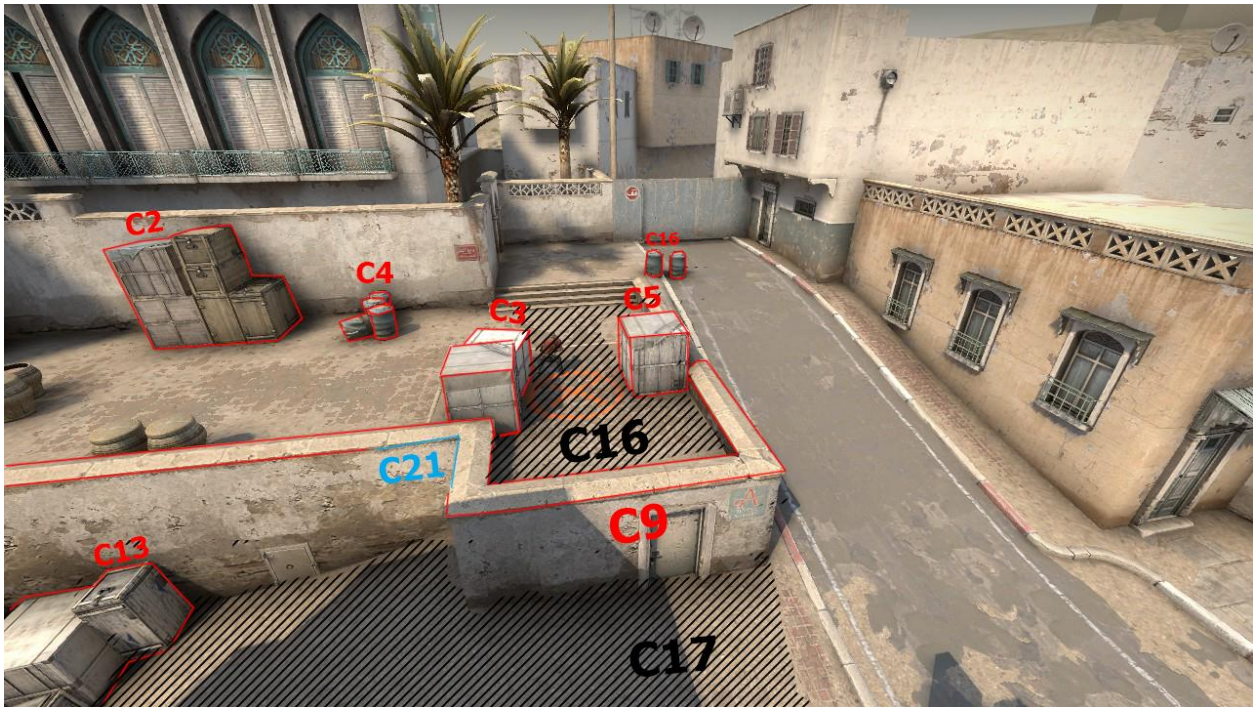

Figure 23. Heat-map of Dust2 Bombsite B
by Edin Karakurt (2020)

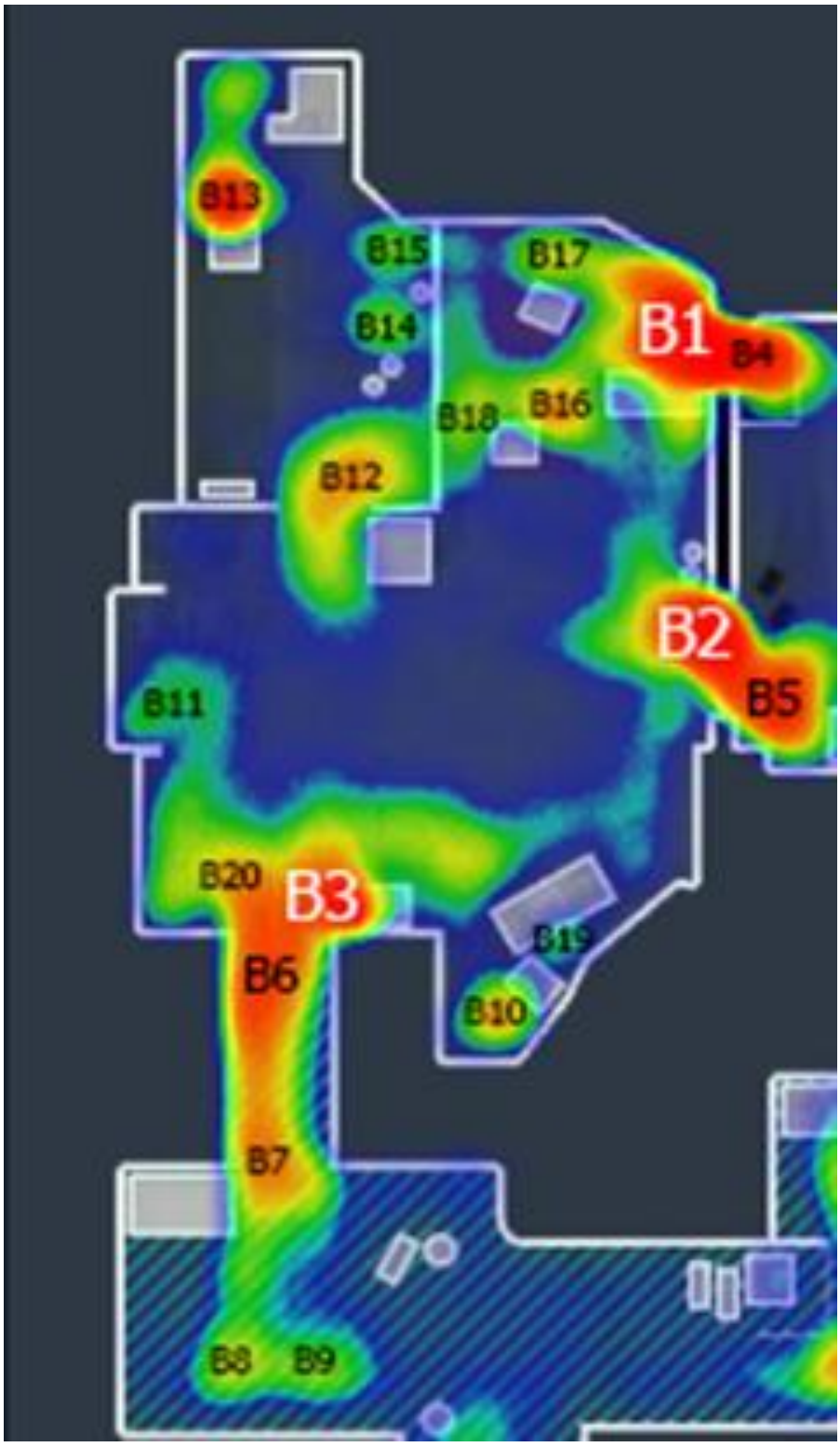

Figure 24. Callouts of Dust2 Bombsite B
by Edin Karakurt (2020)

Figure 25. Covers in Dust2 Bombsite B
by Edin Karakurt (2020)

Figure 26. Tunnels Entrance - Dust2 Bombsite B
by Edin Karakurt (2020)

Figure 27. Plat B - Dust2 Bombsite B
by Edin Karakurt (2020)

Figure 28. Bombsite B Dust2
by Edin Karakurt (2020)

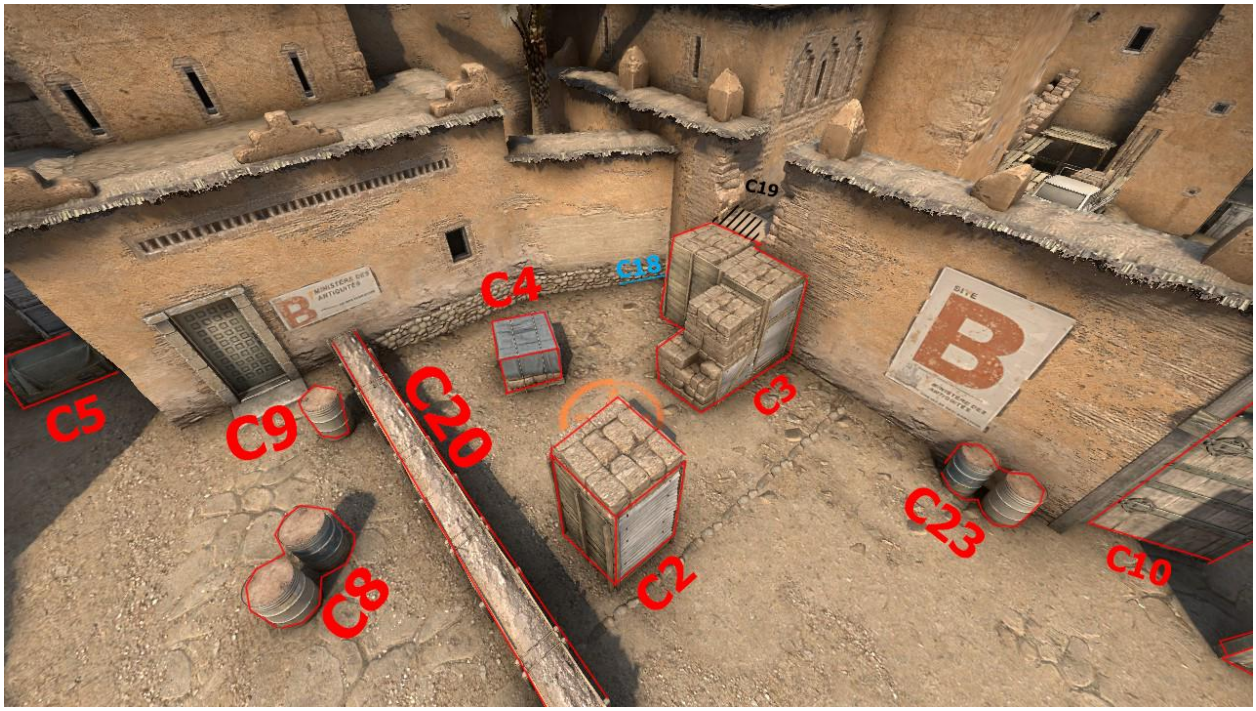

Figure 29. Bombsite A Hotzones
by Edin Karakurt (2020)

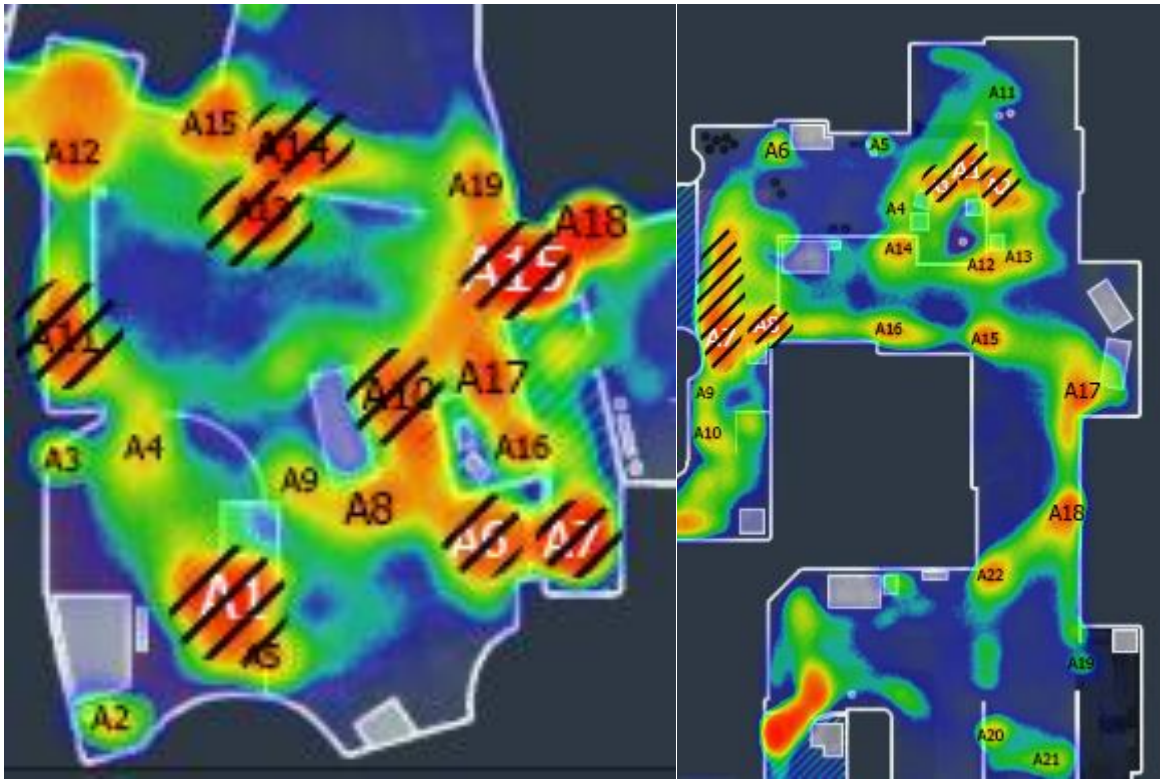

Figure 30. Bombsite A Hotzones
by Jeppe Willatzen (2020)

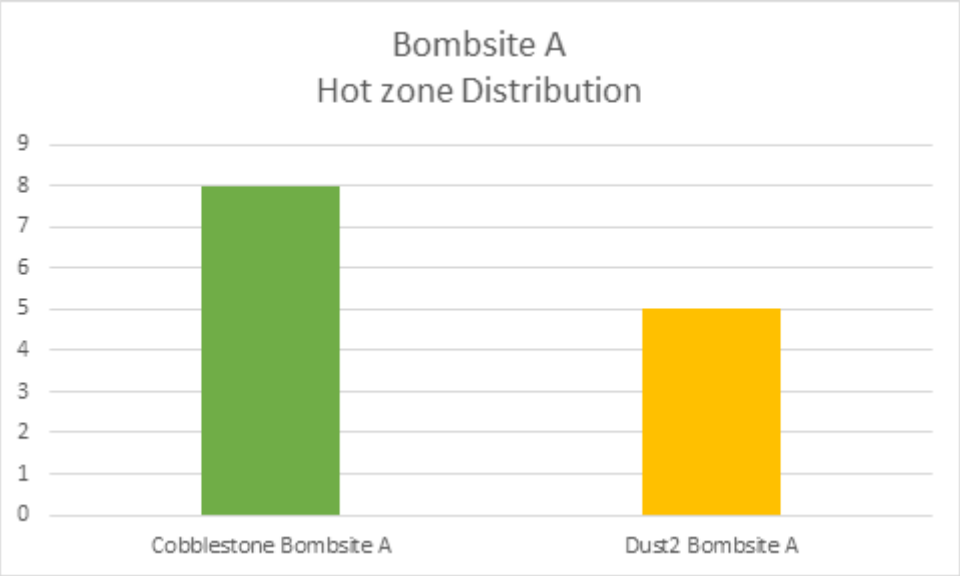

Figure 31. Bombsite B Hotzones
by Edin Karakurt (2020)

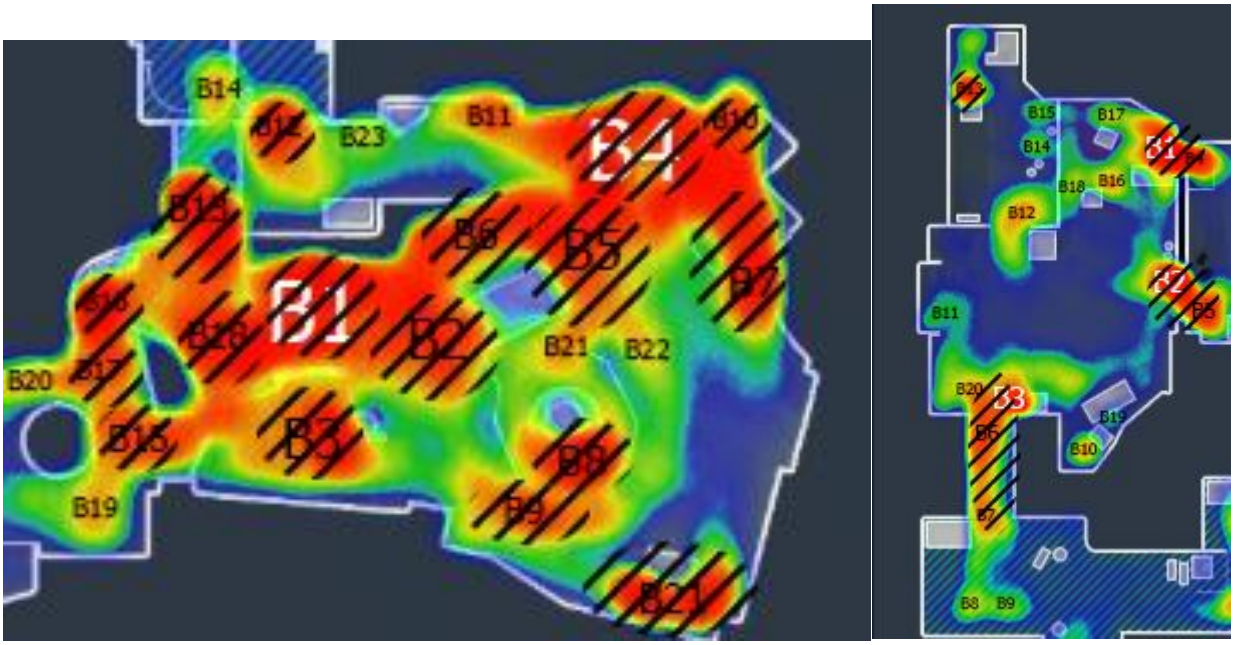

Figure 32. Bombsite B Hotzones
by Jeppe Willatzen (2020)

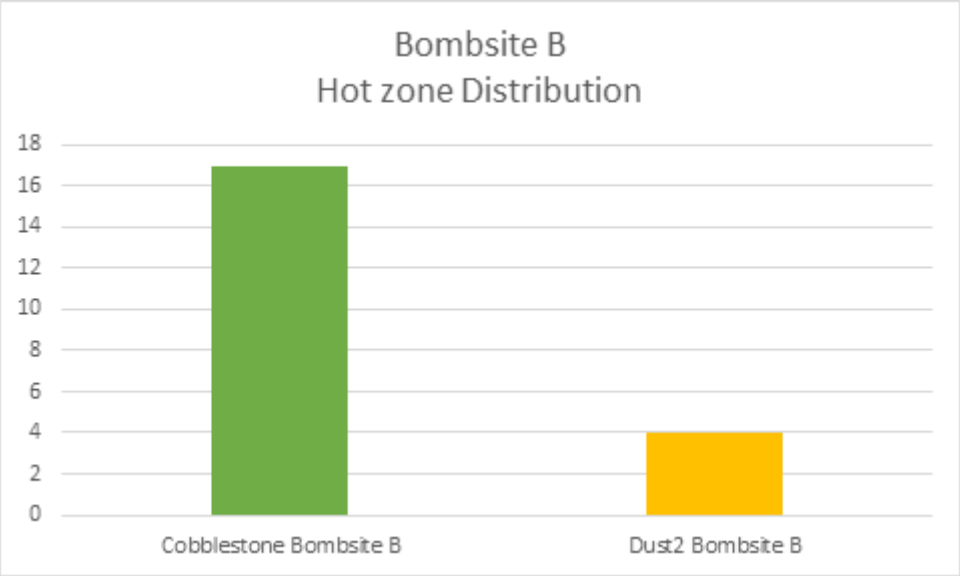

Figure 33. Combined Bombsites Hot zones
by Jeppe Willatzen (2020)

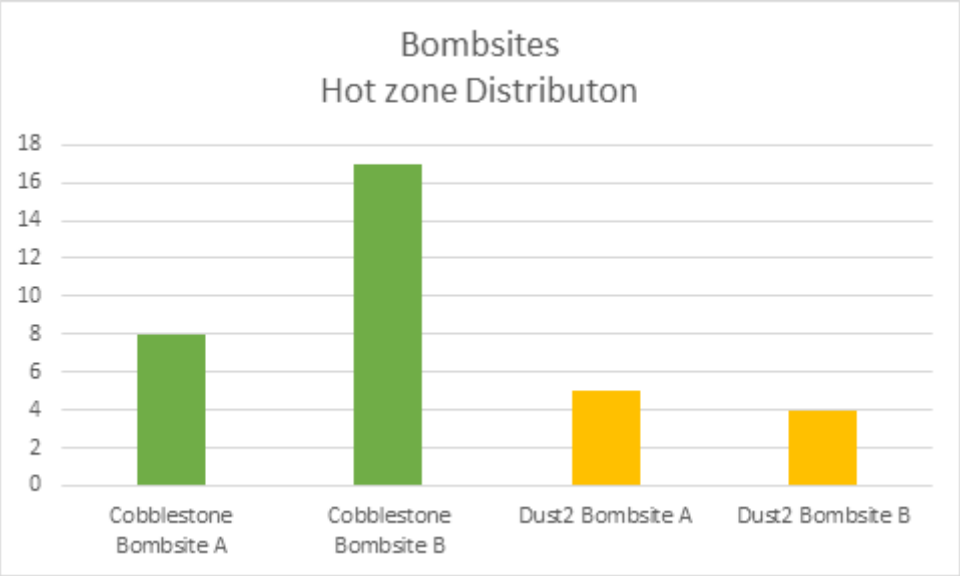

Figure 34. Bombsite B LOS
by Edin Karakurt (2020)

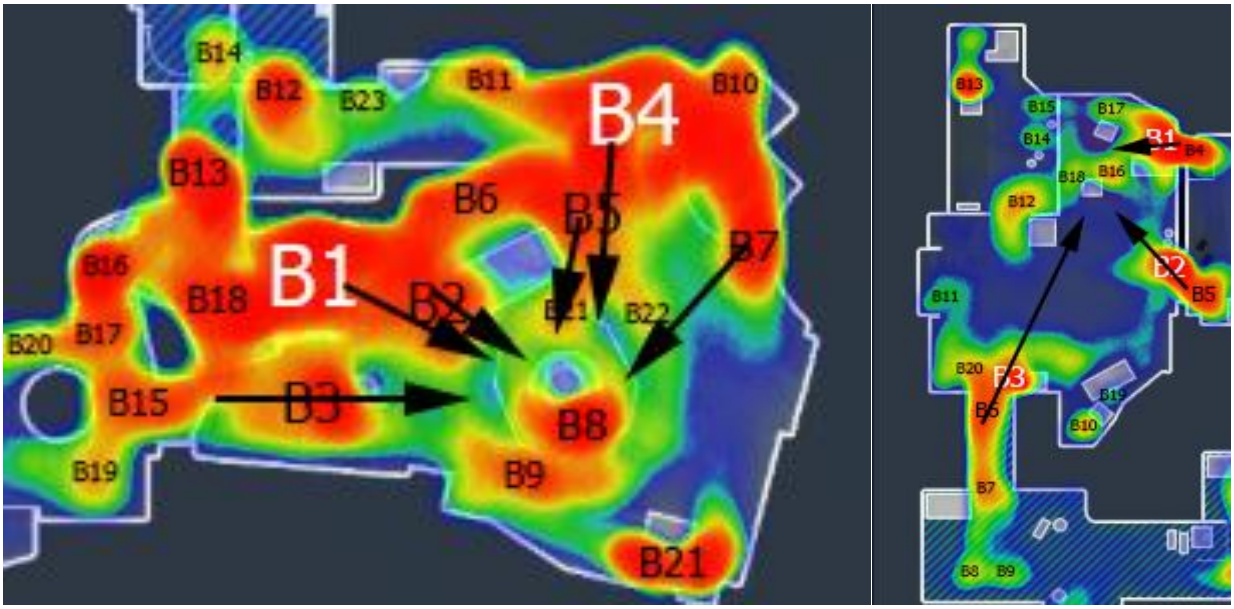

Figure 35. Bombsite B LOS
by Jeppe Willatzen (2020)

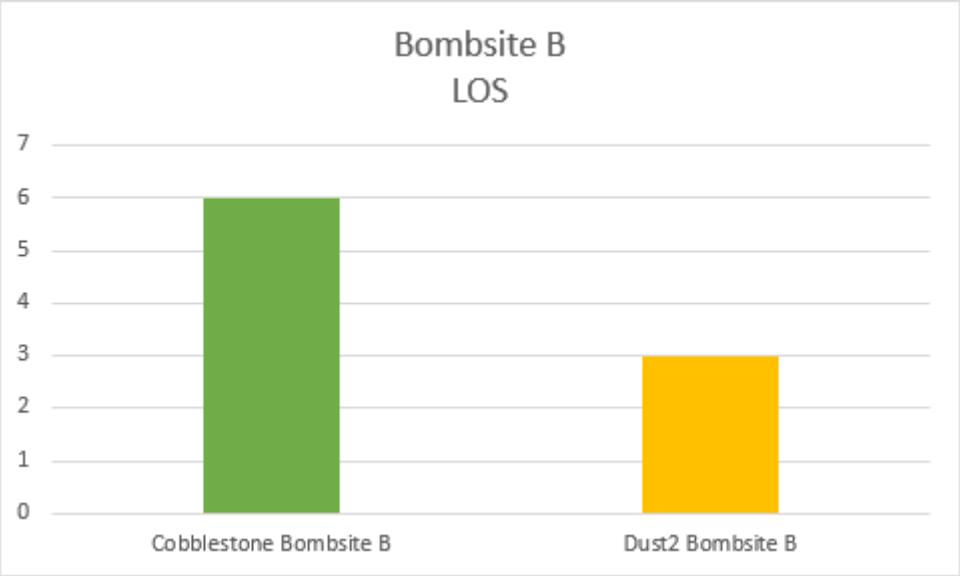

Figure 36. Bombsite A LOS
by Edin Karakurt (2020)

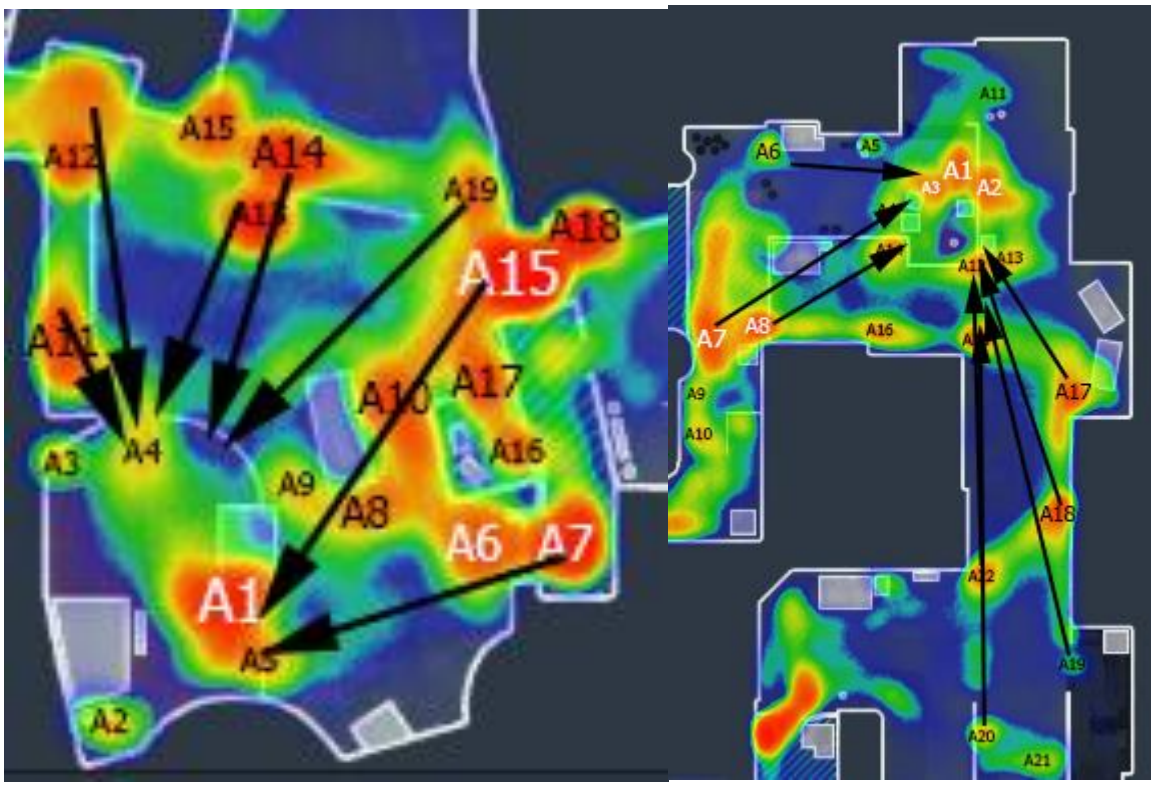

Figure 37. Bombsite A LOS
by Jeppe Willatzen (2020)

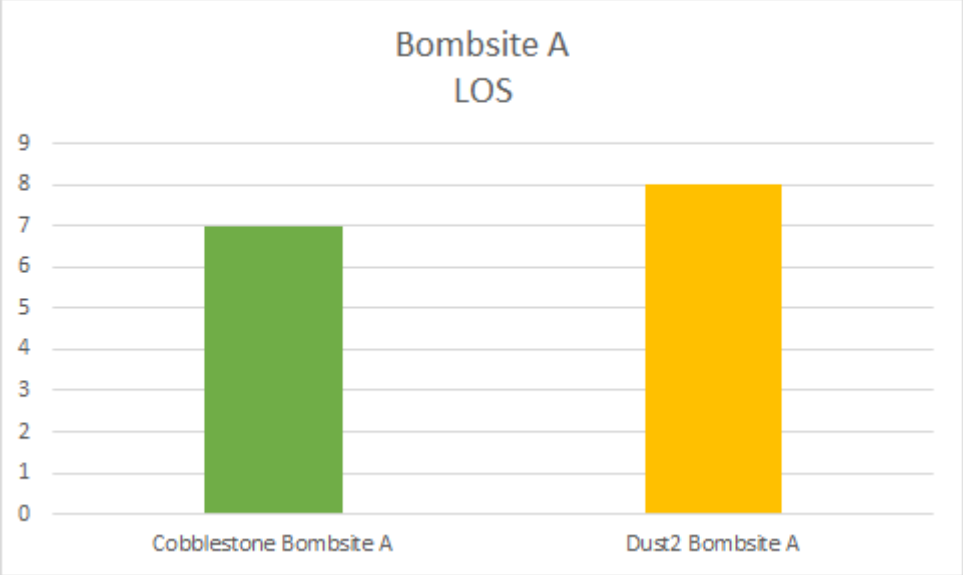

Figure 38. Combined Bombsites LOS
by Jeppe Willatzen (2020)

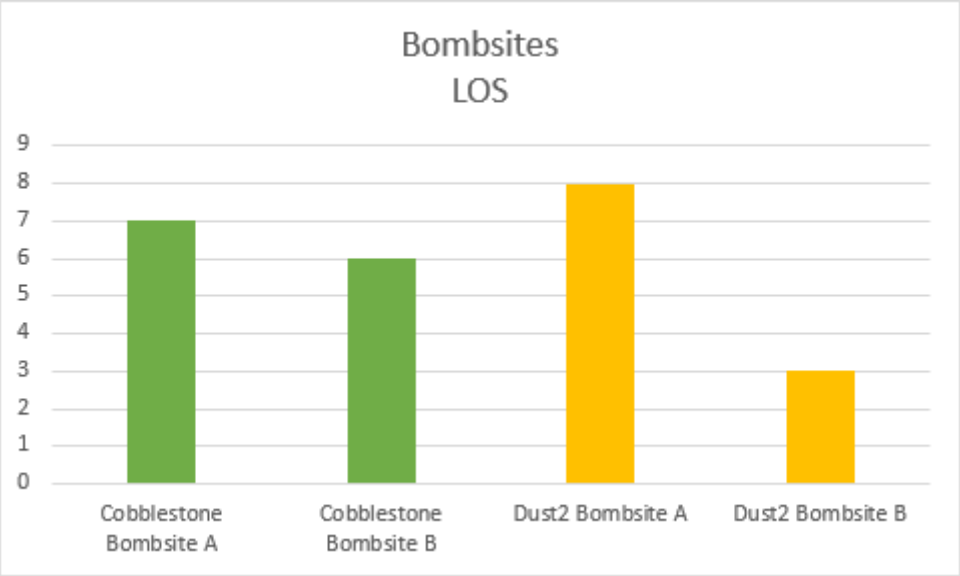

Figure 39. Bombsite A Entrance Sizes
by Edin Karakurt(2020)

Figure 40. Bombsite A Entrance Sizes
by Jeppe Willatzen (2020)

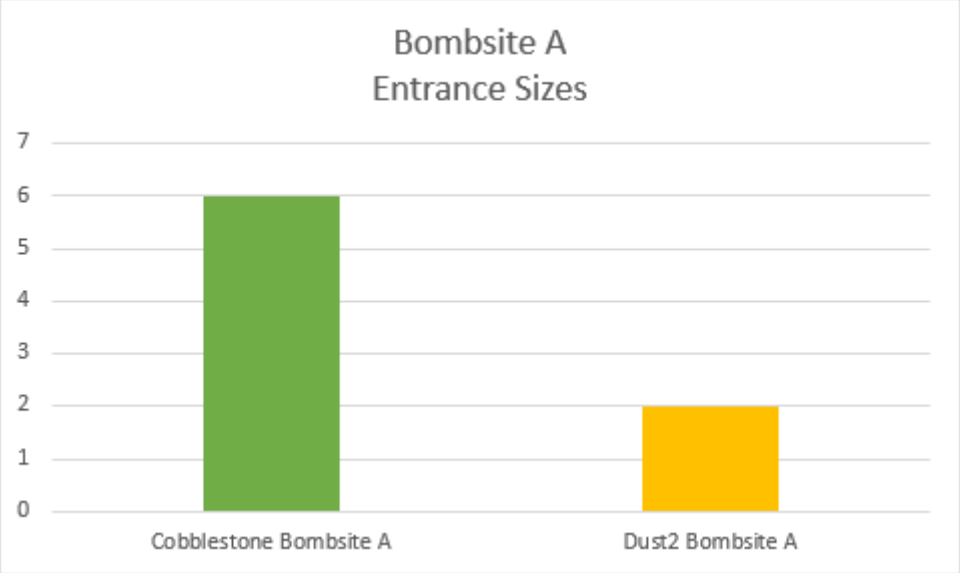

Figure 41. Bombsite A Entrance Sizes
by Edin Karakurt(2020)

Figure 42. Bombsite B Entrance Sizes
by Jeppe Willatzen (2020)

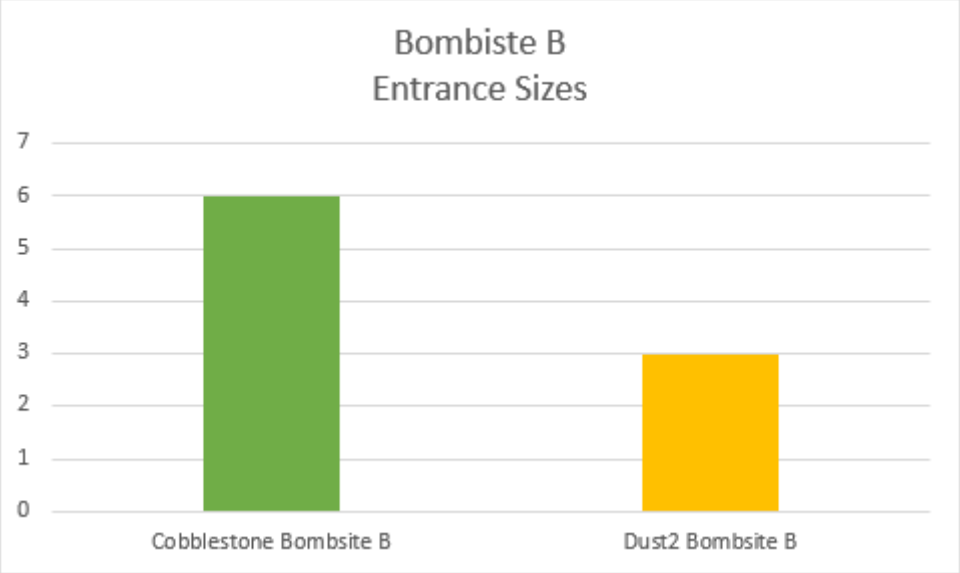

Figure 43. Combined Bombsite Entrance Sizes
by Jeppe Willatzen (2020)