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The influence of pattern language: Bridging physical and digital architecture in video game design through the case of *The Witcher III*

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Abstract. Christopher Alexander introduced in 1997 the concept of "pattern language" as a framework for architectural design. Subsequently, video game designers and programmers sought to integrate these design patterns into the creation of virtual cities. These underlying design patterns, embedded within digital architectures, often stem from fundamental principles already present in physical architecture, despite their intangible nature. While the patterns cannot be physically touched, navigating through these virtual environments offers a sensory experience that requires careful planning. Therefore, developing an analytical method to elucidate these design patterns inherent in the materialization and design of digital worlds becomes urgent. By using an applied approach to delve into The Witcher III video game, the main objective is to establish a methodology that unveils the implicit connections within these non-physical realities. Finally, this method aims to identify significant insights applicable to the design of architectural environments within video games by considering architectural, urban and social parameters.

Keywords: Interaction Design; Virtual City; Digital architecture; Design patern; Data visualization; Videogame Design.

1 Introduction: From Architectural Design to Game Design

During the 20th century, cities like Brasilia, Canberra, Chandigarh, New Delhi, or Ottawa were completely built from scratch [1]. For this design task, a master plan is required to make the whole function in an integrated way, involving various ingredients that have been debated on multiple occasions. How city planning should be has been the subject of discussion and study throughout history, and there

are multiple ideas that underpin the foundations of architectural design today [2]. These same urban planning and design strategies applied in ordinary architecture are often applicable to the field of game design, especially when dealing with challenges that do not stem from an identifiable physical frame of reference, such as a virtual world.

There have been multiple clashes of ideas regarding how to find harmony when designing a city, one of the most notable debates[1] was between architects Peter Eisenman[2] and Christopher Alexander in 1982 [3]. P. Eisenman argued that good architecture was incongruent, made for thinking rather than feeling, while Christopher Alexander defended the need to focus on the human being when designing and to consider these nuances: without ego, alive, integral, free, exact, comfortable, eternal, and common. A good design should have its essence, which he called "the quality without a name[3]." In the 1970s, his research[4] focused on determining whether it was possible to define an objective basis that would reveal the quality of architectural design. Thus, he published *A Pattern Language: Towns, Buildings, and Construction* [4]. It included a catalog of 253 problem-solving processes that addressed issues such as the scale of cities, constructions (rooms, houses, buildings, neighborhoods, cities, and regions), culture, etc. This objective framework that underpinned space he called "pattern language[5]," understood as something that describes a problem that occurs over and over again in our environment, and that describes the essence of the solution to that problem, so that this solution can be used a million times more, without using it twice in the same way[6].

The research significance of this paper is that presents an analytical method applicable to digital architectures, based on the pattern language approach. It aims to exptrapolate insighs from the analysis of physical architectures into the digital worlds, allowing for the extraction of desing related conclusions.

[1] On November 17th, 1982 at the Graduate School of Design at Harvard University.

[2] Partner with Frank Ghery, Zaha Hadid, Rem Koolhaas, Daniel Libeskind, Bernard Tschumi and Coop Himmelb(l)au, precursors of architectural deconstructivism, which emerged in 1980

[3] Quality without a name o QWAN.

[4] The timeless way to build, originally published in 1979, belongs to a trilogy along with: *A pattern language* (1977) and *The Oregon Experiment* (1975)

[5] The pattern concept let to the publication of the book: *Design patterns: Elements of reusable object-Oriented software* (Gamma et al., 1994), annual conferences - e.g. the PLOP series, *Pattern Languages Of Programs* (PLOP, 2008) – and study groups in different areas – (Hillside Group, 2007), (IFIP TC13 HCI Patterns Task Group, 2005) o *Security Patterns Community* (Security Patterns Comunity, 2008).

[6] Alexander et al., 1977, p. x

1.1. State of the Art and Related Works: Video game metodologies based on pattern design

By identifying recurring gameplay elements, mechanics, and interactions across different games, complex system can be deconstructed into understandable and reusable components. This process enables a deeper understanding of design practice within virtual environments. Through identifying recurring gameplay elements, mechanics and interactions that appear across different games, we can break down complex systems into understandable and reusable companents that enables a better design understanding in virtual world. A comprehensive review of existing methodologies for videogame analysis based on pattern design has been conducted to establish a clear understanding of the current state of research in this field.

Pattern language has not only had an impact on the architectural field [5], but also in the field of informatics, specifically in the field of game design, laying the methodological foundations for object-oriented programming. Through the book *Organizational Patterns of Agile Software Development* [6], templates were defined to solve specific problems. Also Paschali et al. (2021) propose the use of Gang of Four (GoF) design patterns to generate cleaner, more scalable and efficient code in software development, providing a common language and solutions to design challenges. [7]

The ideas derived from this pattern language are nowadays a reference when designing a virtual world and underpin many of the approaches to game design. Björk and Holopainen are widely recognized as pioneers in introducing this concept into game design. They chose to focus upon the gameplay as an esential part of game design, defining it as those structures of player interaction with the game system and with the other players in the game [8]. Through this approach, they define different uses of game design patterns when performing analysis or design.

Continuing with this idea, Lemay, P. [9] in 2007 established design patterns that promote a state of flow[10], fostering a smooth and satisfying experience, such as: progressive goals; immediate feedback; adjustable challenges; player control; minimizing distractions; pacing and balance; and meaningful rewards.

Another pattern design methodological approach is presented by Will, C. (2013) whose work also builds upon the scholarly tradition of adapting Christopher Alexander´s architectural pattern language to domain of video game design. His tesis [11] introduces a expecialized focus on games that merge digital mechanics with physical, real-world environments. In doing so, it extends pattern-based design thinking into the realm of location-based gameplay, addresing the distinct challenges and desing opportunities inherent in this hybrid context.

Another recent contribution to the field comes from the book *Pattern Language for Game Design* [12], authored by Chris Barney, who defines a methodology that analyzes these behavior patterns in different video games as case studies, based on

the fifteen fundamental principles that govern the entirety of a video game's design, derived from the concept of "wholeness"[7] explained in his book *The Nature of Order: The Phenomenon of Life* [13]. These principles include: levels of scale, strong centers, boundaries, alternating repetition, positive space, good shape, local symmetries, deep interlock, contrasts, gradual variation, roughness, echoes, voids, inner calm, and non-separation.

Through a series of exercises applied to different case studies, Barney analyzes the patterns derived from game mechanics, identifies absent and negative patterns, and seeks to understand and interpret the design techniques and strategies behind each of them to draw design conclusions. He also identifies "variations" that differ from the general base design strategy. Following Alexander's example, the author defines a similar pattern template that aids in his studies.

1.2. Research Objectives

The main aim of this article is to lay the foundations for a new, generalizable methodology for the analysis of virtual world, which seeks to identify patterns based on different parameters examined across multiple scales of analysis.

The relevance of this methodology lies in the incorporation of tools from the field of architectural analysis, traditionally applied to physical environments, in order to test their validity in the design of digital worlds. To achive this, it is essential to apply analytical patterns that enable the sequential and scalable extraction of data, making it possible for the results to be extrapoled later on.

To achive this main objetive, it is essential to establish a secondary objetive: to study and understand the established design foundations in digital worlds. As a result of applying the proposed methodology, the ultimate goal is to define fundamental design concepts and universal parameters that can guide the development of future digital architectures, optimizing them for more accurate and meaningful user experiences [14-19]. These also require the same ideation process as physical architectures, but, nevertheless, they materialize in different ways and operate under different rules, design guidelines that are yet to be defined and deciphered by the communicating architect [20,21].

2 Framework: Large Scale Virtual Maps

Understanding how those design patterns work can be a daunting task, especially when the object of study is a video game that aimed to be very ambitious in terms

[7] The website of the TKWA Urban Lab has an excellent discussion of these properties (Kubala 2020a)

of size and scale from the outset, with this territorial complexity being a potential factor of interest for analysis.

Projekt RED released on May 19, 2015, *The Witcher III: The Wild Hunt* [22], a role-playing video game for PlayStation 4, Xbox One, Nintendo Switch, and PC, distributed by Warner Bros Interactive and Bandai Namco. This game would complete a saga and trilogy based on the literary saga of Geralt of Rivia [23] written by Andrzej Sapkowski[8]. Following its success, in 2021, it would be adapted to the screens as a series on Netflix [24], further analyzing its fantasy world and illustrated in various books [25, 26, 27].

What CD Projekt was really announcing was a video game with a massive scale unlike anything done before. Throughout 2014, in the final stages of the game's development, they announced their high expectations for the project's scale: "We knew it would be an ambitious game. We aim to provide you with an incredible experience, an epic adventure in a vast, completely open fantasy universe..." [9] adding, "...we wanted to expand creative boundaries, set new benchmarks, and develop the genre as a whole[10]."

Compared to other open-world games, its maps were announced to have an approximate size of around 136 km². It sought to establish itself within the video game industry, being 3.7 times larger than *GTA: San Andreas* (36km²), 1.5 times larger than *GTA 5* (81km²), 3.3 times larger than *Red Dead Redemption* (41km²), 3 times larger than *Far Cry* (46km²), and 3.5 times larger than *Skyrim* (39km²). The reason why this study focuses on analyzing this video game lies in its scale, examining the design mechanisms implemented for a project of this magnitude, immensely large and open with a non-linear story, with a detailed environment, acclaimed by the public as a seemingly living game.

3 Analysis Methodology

Aldo Rossi already spoke almost poetically about invisible distances [28], aspects that go unnoticed at first glance if we don't delve into detail. Disassembling complexity to understand it from its base is enlightening [29] and helps us grasp the underlying thread of each story [30]. Today, as discussed earlier, we find various analysis methodologies configured to reconstruct, deconstruct, or in some way, attempt to decipher a specific spatial reality [31-38], seeking to decode the imperceptible [39].

[8] Was born on June 21, 1948 in Poland.

[9] Open letter to gamers. December 8, 2014. Open letter to Gamers - CD PROJEKT

[10] Release *Date of the witcher 3: wild hunt – An open letter*. March 11, 2014. Release Date of The Witcher 3: Wild Hunt – An Open Letter - CD PROJEKT

To carry out this study, a new methodology has been developed, referred to as "the case method". This methodology will involve applying graphic scales [40,41], which are a very powerful graphic means of understanding any reality, and will help us understand the foundations of the design of the cited video game.

Working in a multiscalar context is essential when analyzing large terrains, such as those found in open-world video games, as it allows for a structured and manageable examination of complex environments. Different scales reveal distinct patterns: some of them only become evident at a broader level, while others emerge through detailed observation. Therefore, after extracting the data, software tools will be used to croos-reference the information and generate graphs that hep reveal less evident patterns through the use of artificial intelligence algorithms.

The main goal behind the multiscalar approach is a clear understanding of the relationship between global structures and local interactions, providing a comprehensive framework for both analysis and design.

The motivation behind designing and proposing a novel anaylisis methodology is the lack of a combined approach in the existing state of the arts from both, one field and the other one.

The case method has already been applied previously in another open-world case study*: Cyberpunk 2077* [42]. This demonstrates the method´s replicability and its flexibility to adapt to different distribution models, whether vertical, as in the cited case, or horizontal, as in the case to be presented in this study. This therefore leaves the door open for future applications to other case studies.

According to Robert K. Yin, *in Case study research: Design and Methods*, [43] when conducting multiple-case studies, it is advisable to employ multiple-case design (types 3 and 4) based on replication logic rather tan sampling logic. In line with this, the proposed methodology will define the foundations for the subsequent steps, allowing it to be applied to different case studies selected according to their suitability for the intended research objetives exposed.

The focus of this stage of the research work is to validate the capacity of the proposed methodology to accurately identify, gather, and visually present the information pertaining to the objectives multiscalar analysis described above. A further validation through qualitative methods has been considered but ultimately considered potentially valuable a future research stage in which we validate the interaction flow with users of the methodology, e.g., game world designers.

First of all, we will select from the case study the main location to be analyzed. Acording to the multiscalar prodecure, three different work strategies are defined based on three scales:

1. The world scale. It focuses on the main areas that make up the virtual world. It is crucial to identify and focus on the key locations of the game, as these will become the main case studies, serving as the central anchor for all design. Within the context of the video game, five case studies stand out corresponding to five main maps that exert a decisive influence on the narrative and graphic structure of the game.

    a. White Orchard: It starts the game with an area of 0.8 km², marking the starting map of the game with the smallest extension.
    b. Velen & Novigrad: This is the second map to explore, being more extensive with 15.2 km² compared to the previous one.
    c. Skellige Isles: As the third and final map related to the main plot of the game, it covers an extension of 28.9 km² and stands out as the largest map.
    d. Kaer Morhan: This is the fourth map, designated as one of the two optional expansions of the game, offering additional territory to explore in its 1.4 km².
    e. Toussaint: Corresponding to another optional expansion, this fifth map covers 8 km², being the largest among the two expansions.

2. The city scale. Once the world scale case studies are determined, the urban cores that determine them are addressed within each map. In this specific case, the map 2: Velen & Novigrad is chosen as the sample to be analyzed, as it corresponds to the middle stage of the game that transitions between the initial and final levels and also includes all types of scales in its urban cores:
    a. Small-scale city – Small urban core of Velen
    b. Medium-scale city– Medium urban core of Velen
    c. Large-scale city – Free City of Novigrad

3. The housing scale. Once the city-scale case studies are selected, we will analyze one of them at the building scale, focusing the analysis on one of the buildings where part of the main plot unfolds, essential to complete the game. The following sub-case study within case study 2.1 is chosen: Small urban core of Velen:
    a. Housing: Velen Palace.

Therefore, the different categories and final case studies selected are established (Fig. 1):

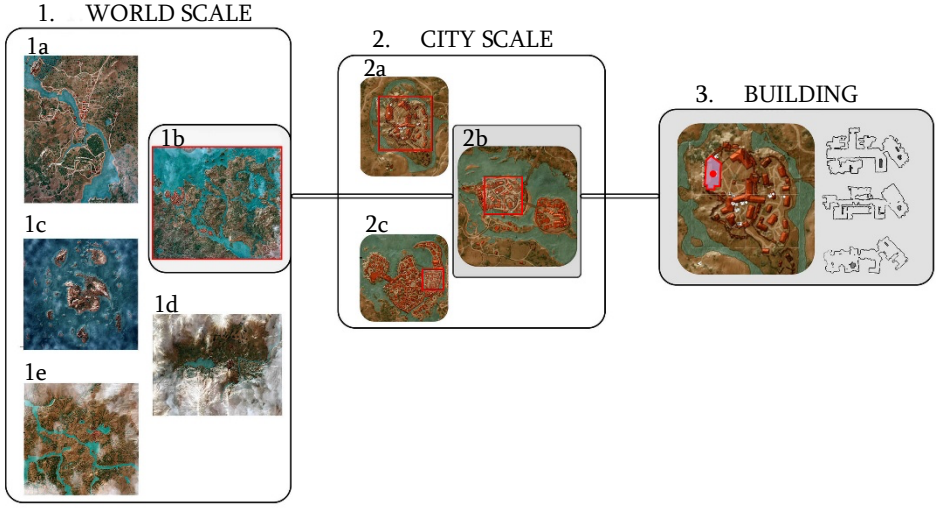

Fig 1. Case studies methodology scheme

Once the case studies have been selected, data will be extracted through direct gameplay experience for the small and medium scale cases. The extracted data will be recorded by hand directly into the map corresponding to the appropiate scale of analysis. For large scale analysis, data will be obtained from published sources containing game content maps, as illustrated by the interactive maps provided on the web [44] since it is unfeasible to explore such an extensive territory through personal exploration alone. Once all the data has been colleted, the plans will be restructured using professional 3D design software, specifically *AutoCAD* and *Revit* (Autodesk Inc., San Rafael, CA, USA), to ensure precise and standardized visual representation.

4. Data visualization

Several studies have already graphed other virtual worlds using their own methodologies [45-48]. According with the rules stablished by the methodology presented in this study, after gathering the information, different graphic elements (Table 1) are developed to understand the extent of each of the virtual worlds that make up the game with the graphical complexity it entails. The temporalization of these connections has also been graphed, addressing another chapter with this methodology. Using this same method, the graphic temporality os this case study has already been analyzed, expanding its parameterization to include the measurement of time and distance [49]. Likewise, we thus extract the same information based on the following table of contents:

Table 1. Chart typologies at each scale according to case methodology.

	World Scale
Data collection	**1. General mapping Content – location** **a. With reference map.** Mapping content and reference points. **b. Without reference map.** Node-content relation map. Mapping of content linked with its nearest location. **Extracted parameters:** o Landmarks / Contents by location **2. General mapping Distance– time** a. **Related to general content mapping without a reference map.** Graphic representation of timing by scales taking measures of the distance between contents ant its node. b. **Related to timing representation by graphic scale.** Visualization by points identifying color gradients. **Extracted parameters:** o Distances / Timing **3. Tables of results:** o Timing linked with the different typologies of location-content stuctures. / Contents by location / Timing / Content by timing
Charts from cross-referencing data by case study	**a. List of number and typology of content by location** o Stacked bar charts / Pie charts/Round charts **b. List of estimated timing by location** o Stacked bar charts / Line chart
Charts from data crossing. General level	**a. List of most repeated contents** o Bar graphic / Stacked bar charts / Pie charts by location **b. List of estimated timing by content** Stacked bar charts …
	City Scale
Data collection	**1. General mappings for the location of physical parameters** **a. With reference map.** Data collection on plans by hand in real time. **b. Without reference map.** 2D computer graphics. **Extracted parameters:** Population density / Loots / Architectural elements / Lighting / Decision taking points. **2. Tables of results related to each parameter at each city scale.**
Charts from cross-referencing data by case study	**a. Count of general units by scale** o Stacked bar charts / Bar graphic / Line graph **b. Count of poulation density by scale** o Stacked bar charts / Pie charts/Round charts / Line graph

	Building Scale
Data collection	**1. General floor plans or tables of results by content or by location** **a. With reference map.** Data collection on plans by hand in real time. **b. Without reference map** 2D computer graphics.. **Extracted parameters:** o Population density o Loots o Architectural elements o Lighting o Decision taking points **2. Table of results: parameters at each city scale.**

To obtain results from each scale of operation, a process of decomposition and larger screening is required as the scale to be addressed increases. Therefore, at the world scale, it will be necessary to perform a double data crossover: first to obtain conclusions at an individual level, and then to obtain them at a general level. At the city scale, however, a direct data crossover can be performed, allowing data to be obtained individually relative to each parameter based on each scale in the same graph. Finally, for the building scale, we can draw conclusions directly from the plan, and this data crossover is not essential, with extracting count tables being sufficient.

The analysis will be carried out using Tableau [50] , which enables the automatic generation of data visualizations from the extracted result tables. For the information crossover, these data tables will be processed using this artificial intelligence software, which leverages the VizQL engine to apply common statistical algorithms such as K-Means for clustring and ETS for forecasting, thus automatically generating the proposed graphic material (Table 1).

5. World Scale

Let's examine the application of the world scale to the mentioned video game. A visual identification code of color and an identifying letter is assigned to each of its contents (Fig. 2) to proceed with the detailed analysis in each of the maps. A code is also associated with each location (Annex I).

Fig 2. Generic content legend

5.1 White Orchad

The first map to analyze corresponds to the one that starts the game. It is a small village located in Temeria, in a seemingly idyllic setting. The sky is blue and the cherry trees are in bloom. The river runs through the village and continues to the north. It has a humble aesthetic with simple houses. The juxtaposition between a warm and sunny spring and the devastated landscape adds color and realism to the game's atmosphere [51].

From the analysis of the map, we first extract the key locations or landmarks on the terrain and associate geographically proximate contents with these locations, thus linking them to their nearest reference point. We thus identify their territorial affiliation link. As it is an open world, and one can travel from one main location to another, the starting point to reach each of these locations will always be defined and conditioning the experience of the journey (Figure 3, A). We then extract and analyze the graphic information marked on the map. We will have then the scheme of connections and links of each content with its main location (Figure 3, B).

Furthermore, the proposed graphics are extracted (Fig. 3, C and D). From the data cross, we can conclude that a minimum of 2 and a maximum of 7 contents are established per reference location. The locations with the most contents to complete would be location 1a.6 and 1a.10 with a total of 7 contents.

The most frequent encounter occurs in "Bandit Camp (D)," which consists of a territory invaded by bandits, resulting in a forced interaction. In this situation, the player is attacked and forced to react to the enemies. This encourages the player to remain alert, as the interaction is inevitable regardless of their preference, forcing them to stay active. It can be inferred that the repetition of this interaction seeks to maintain the player's constant attention.

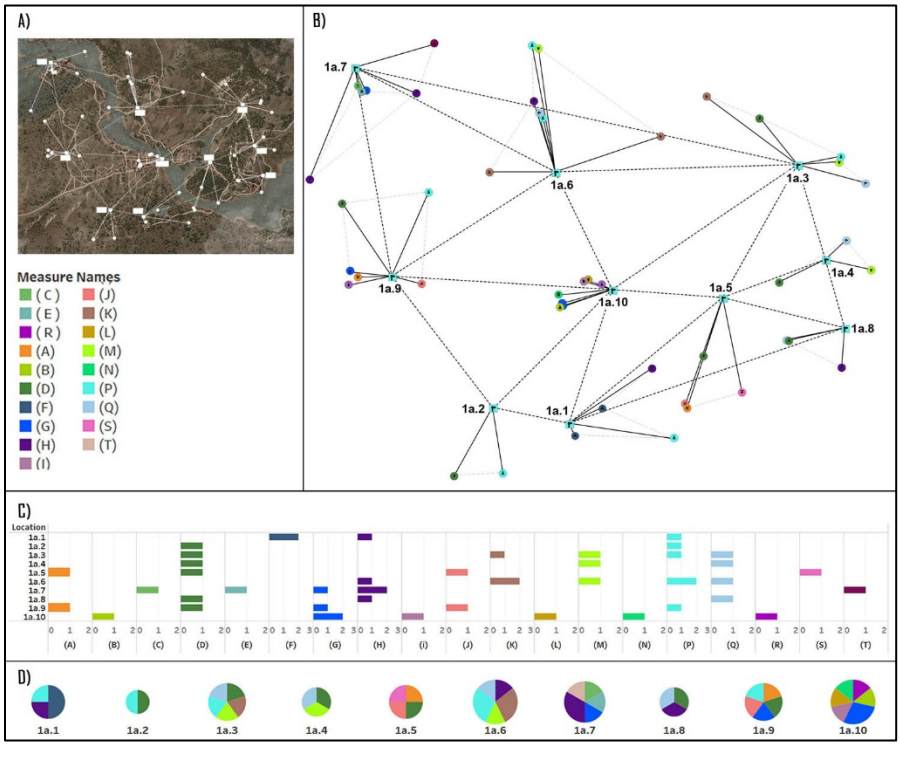

Fig. 3. Data collection in White Orchad. A) General analysis and legend. B) Count of content maps by location. C) Bar graph: content by location. D) Pie charts: content by location.

Additionally, we observe how this content is evenly distributed throughout the territory, providing a generalized experience at all times that cannot be avoided. Once this forced interaction is completed, the attackers become "rewards" or "loot," offering another form of interaction by providing items that the player can acquire. This reinforces voluntary interaction after an involuntary interaction, such as a forced attack, leveraging the adrenaline and motivation of the moment.

5.2 Velen and Novigrad

The second map consists of two main cities: Velen and Novigrad. The analysis of the Velen & Novigrad map follows the same methodology described previously (Fig. 4).

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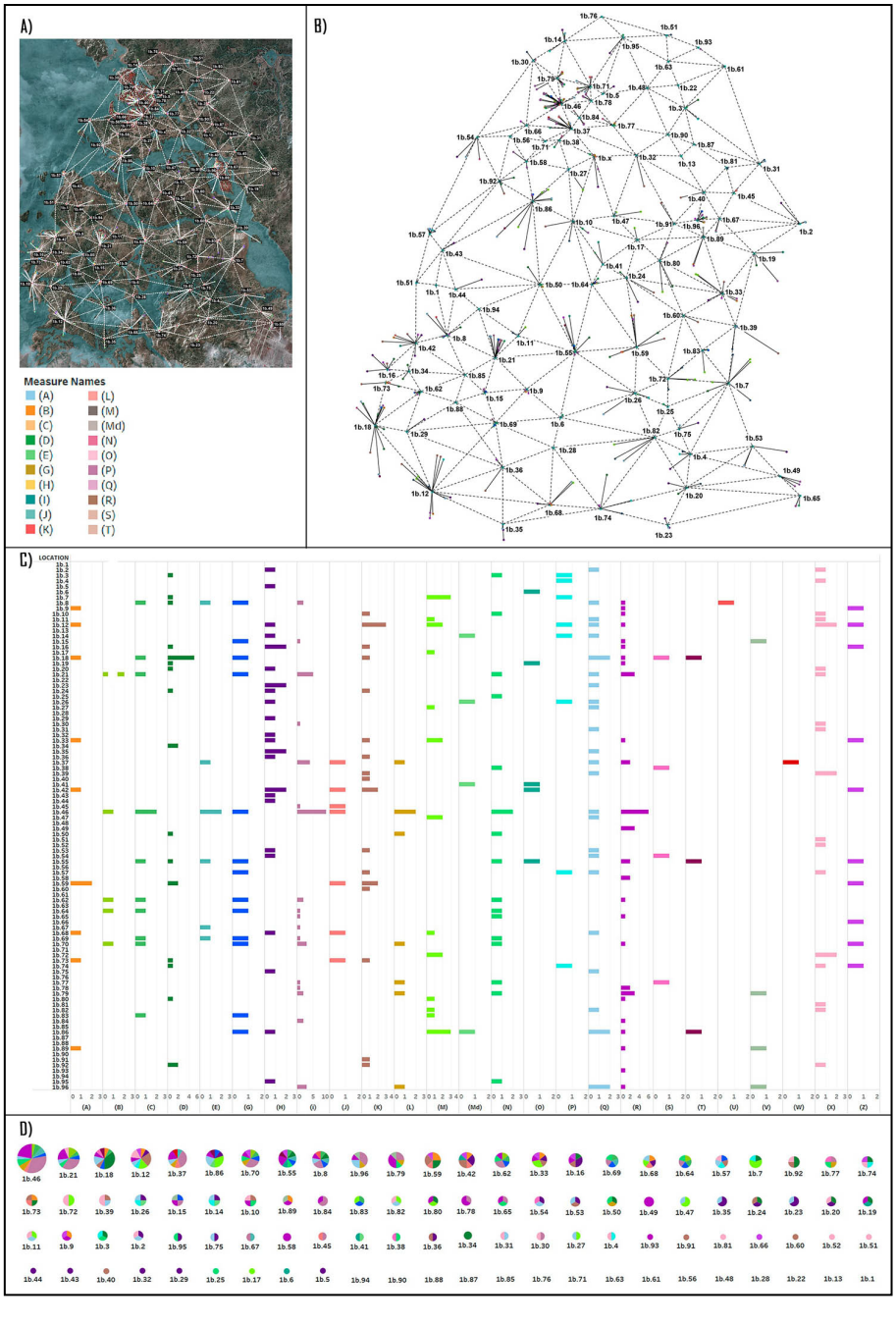

Fig. 4. Data collection in Velen & Novigrad. A) General analysis and legend. B) Mapping of contents by location. C) Bar charts: Contents by location. D) Pie charts: Contents by location

Velen is a wild and anarchic land that constitutes a province northeast of Temeria.

> *"When designing Velen, we used a range of dark colors. We modeled the constructions—villages and fortifications—based on medieval buildings as described in written sources, illustrations, engravings, and archaeological excavations. Our designers and artists consulted historical treatises on architecture from Central and Eastern Europe. High roofs covered with straw crown the wooden cottages and the pens. To protect them from moisture, some houses in swampy areas have been built on stilts."* [23]

Novigrad, the turbulent northern metropolis, rises alongside the mouth of the Pontar: "We made numerous sketches and drawings before tackling the design of the city's harbor district. We wanted it to have a realistic appearance and to feel the atmosphere of a prosperous and lively medieval port as you walk through it. With this idea in mind, we drafted plans showing stone docks, transport canals, warehouses, and cranes. Elements such as stone interiors, columns, arched vaults, or hot and cold water pools are inspired by the classical baths of Ancient Rome. Our designers tried to give them a unique appearance in line with the world we had created." [23]

5.3 Skellige Isles

Skellige Isles, the rocky and inhospitable archipelago, is formed by six larger islands and several dozen smaller islets, all battered by the cold gales and waves of the Great Sea. The inspiration draws from medieval architecture (Fig.5) and the rocky In both this level and the previous one, coasts of Northern Europe [23]. Once again, we follow the same procedure (Fig. 6)

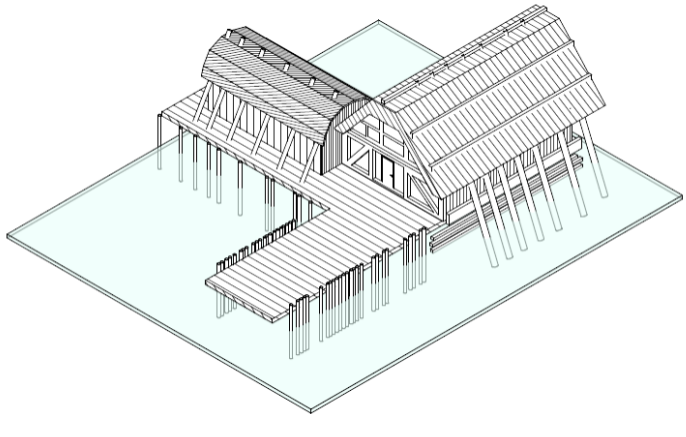

Fig. 5. Building module based on medieval architecture in Skellige Isles.

In both this level and the previous one, we observe a maximum count of 17 contents per location. In this case, the most repeated content is "Smugglers cache (S)", which consists of smuggling hideouts that offer rewards to the player voluntarily.

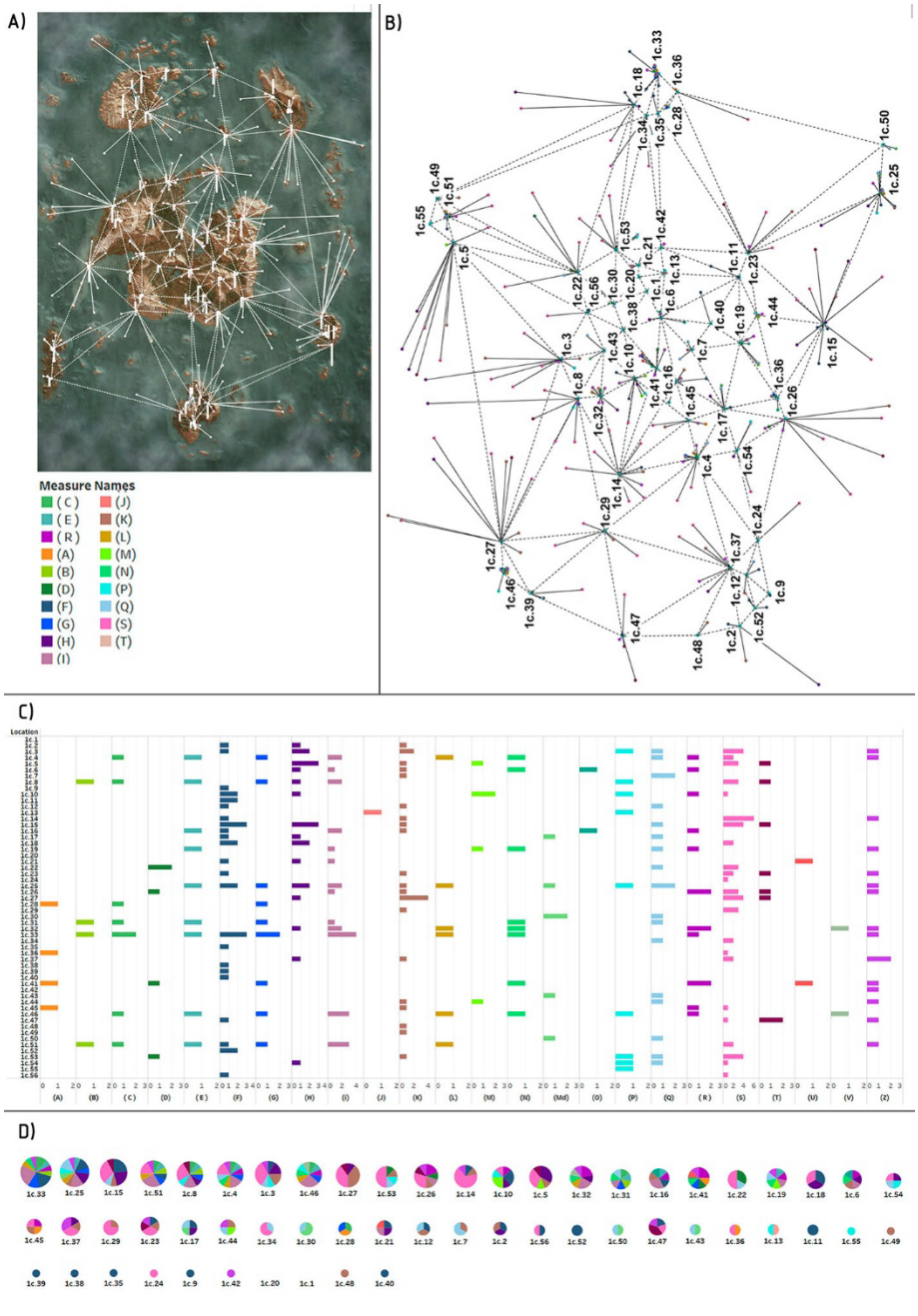

Fig. 6. Data collection in Skellige Isles. A) General analysis and legend. B) Mapping of contents by location. C) Bar charts: Contents by location. D) Pie charts: Contents by

5.4 Kaer Morhen

Kaer Morhen is an inaccessible mountain fortress. The castle's days of grandeur have passed, the battlements and moat have deteriorated, and a cold wind blows through the spacious halls. [23]

This territory offers us a very extensive map with few contents, only 7 are found. The most repeated content would be the number of entrances, architectures of great presence that lead to a marked territory. They usually have guards associated with them, so interaction can be forced if desired. This emphasizes the voluntary nature of this territory, as interaction occurs only if the player wishes, and can be enjoyed optionally.

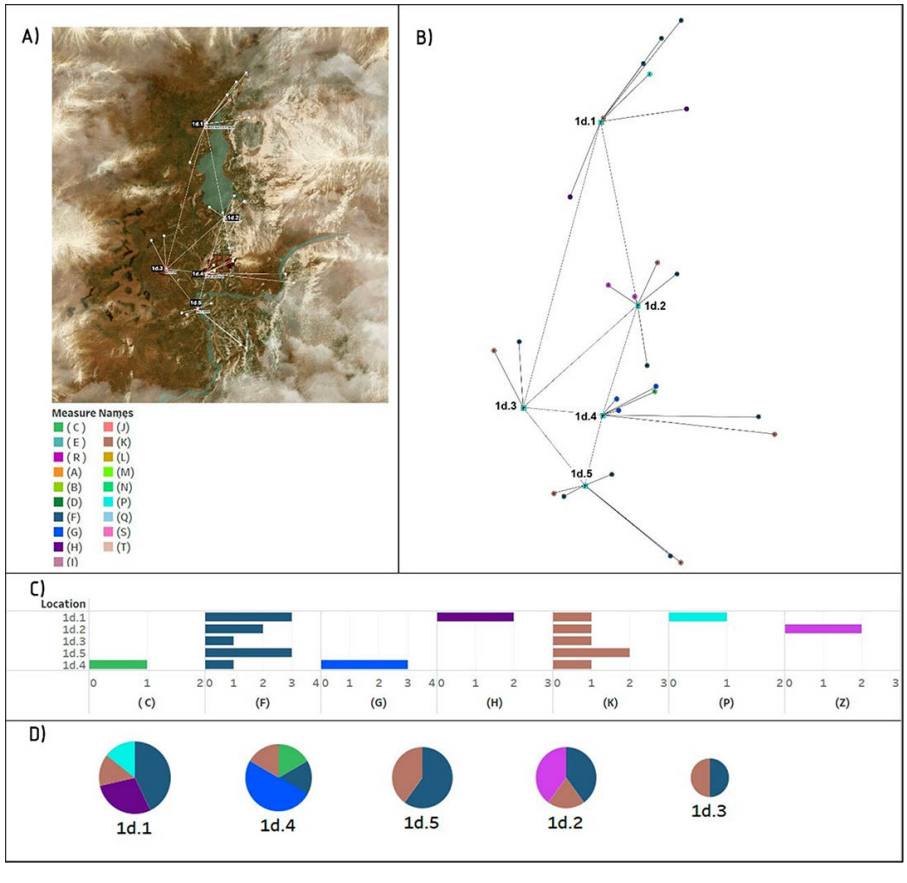

Fig. 7. Data collection in Kaer Morhen. A) General analysis and legend B) Mapping of contents by location. C) Bar charts: Contents by location D) Pie charts: Contents by location

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5.5 Toussaint

Toussaint is a vassal duchy of Nilfgaard, legendary for its beauty, with exquisite views. Beneath the vineyards lies a gigantic underground system of ancient mines and interconnected dungeons, as well as natural caves and passages that supposedly connect to the center of the earth [23].

As it is an optional territory, it continues with the dynamics of the previous map, with voluntary interaction contents. However, the offer is more comprehensive, with many more "side quests (!)" or secondary missions, which serve as an extra motivation for those seeking reinforcement to the main plot. In the last two territories, there are no longer elements of obligatory active interaction.

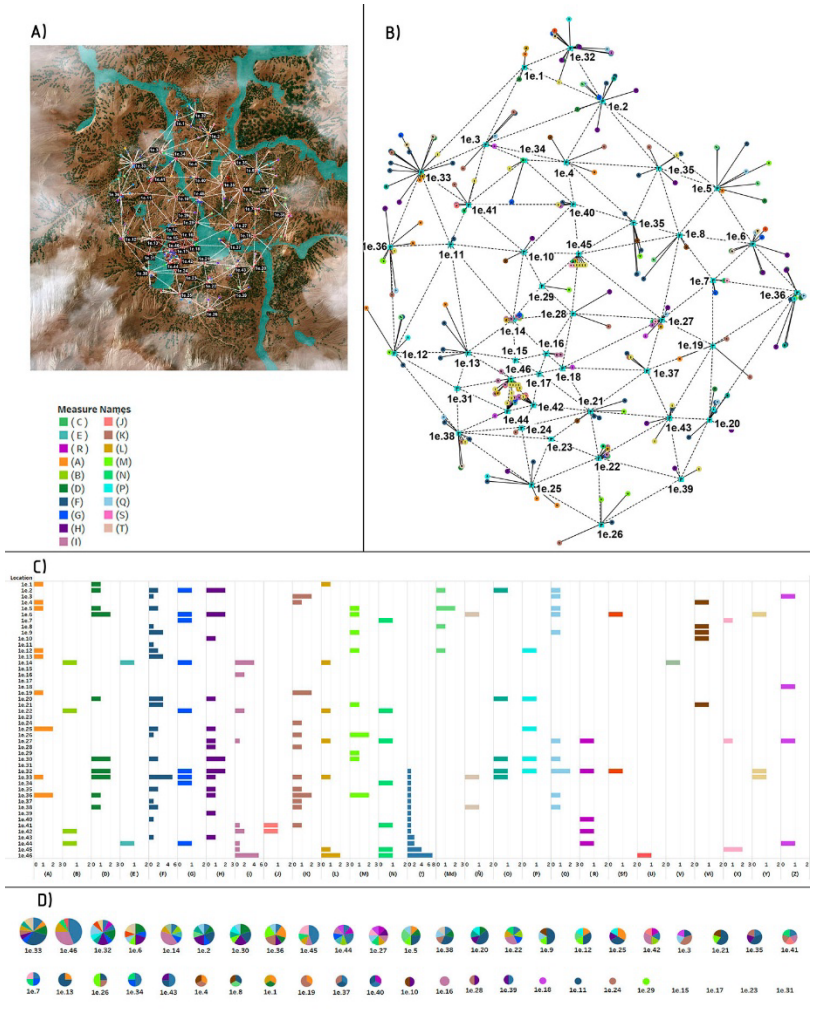

Fig. 8. Data collection in Toussaint A) General analysis and legend. B) Mapping of contents by location C) Bar charts: Contents by location D) Pie charts: Contents by location

6 City Scale

Within the Velen & Novigrad world-scale map, we find cities of different sizes. We can observe cities of small size (2a), medium (2b), and large (2c). Therefore, these three cases of analysis will allow us to establish a comparison regarding how each of them has been designed. To extract objective conclusions, a quantification of data equivalent to a portion of land of 250 m2 will be extracted within each city, allowing for comparable data to be extracted.

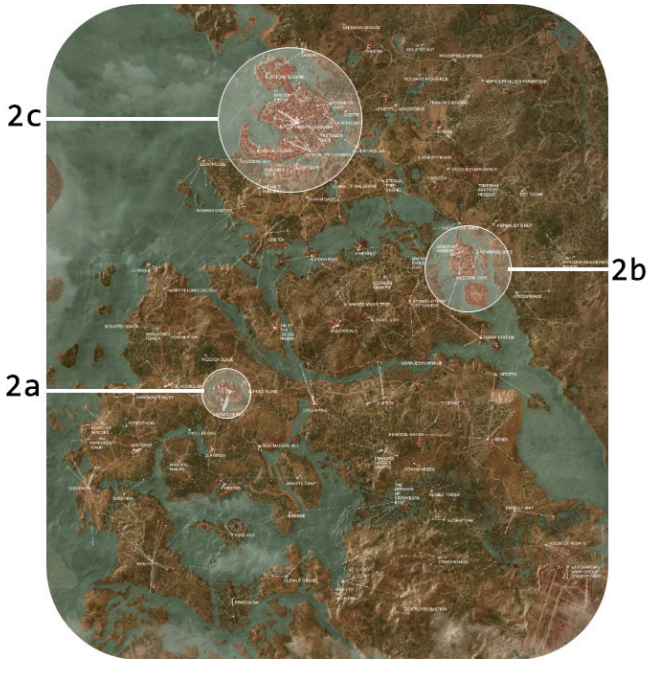

Fig. 9. General map - Location of small city scale (2a), medium city scale (2b) and large city scale (2c) in Velen & Novigrad.

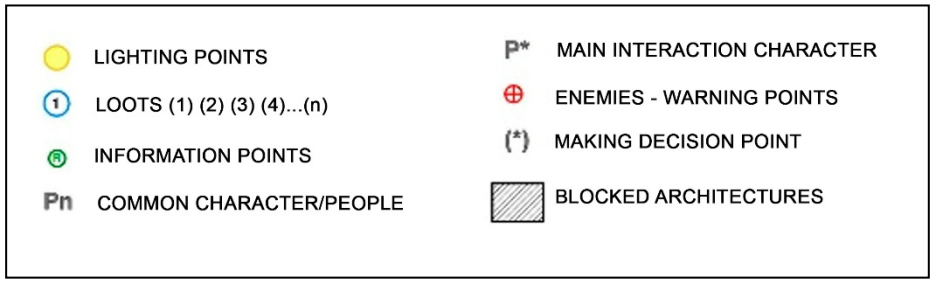

Fig. 10. Legend of paramenters extracted in each floor plan.

Fig. 11. Large urban city: Free city of Novigrad. Extracted parameters – map layout.

Fig.12. Medium urban center in Velen. Extracted parameters – map layout.

Fig. 13. Small urban center in Velen: Extracted parameters – map layout.

7. Building Scale: Vizima´s Palace

Within one of the three types of cities considered in the city scale, we find a singular building where part of the main narrative of the video game unfolds.

Therefore, this building, the Vizima Palace, will be the subject of study at a more particular level in terms of scale, thus analyzing the different floor plans of one of the main locations in the game. It is possible, therefore, to obtain a data count as well as a general view of the spatial distribution of each of the elements arranged.

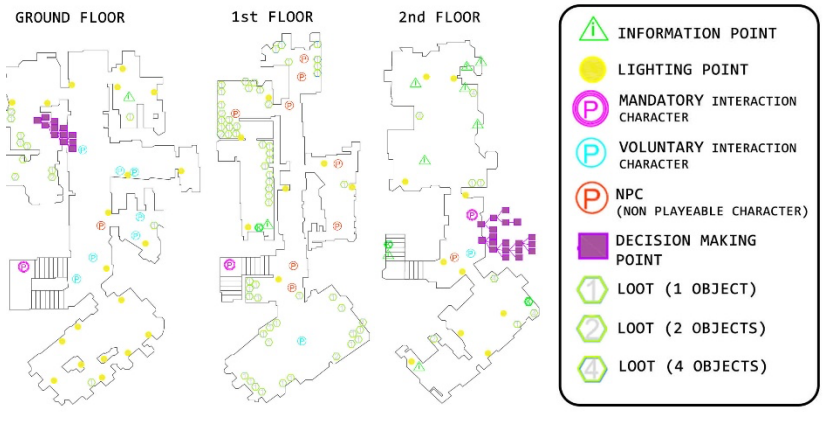

Fig.14 Vizima´s Palace: Extracted parameters floor plans.

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8. Discussion: A Comprehensive Consideration on Analysis

Fig. 15. World scale. List of conclusions from the most repeated contents. A) Bar chart. B) Pie chart. C) Stacked bar charts.

Upon analyzing and data crossing the five maps (fig.15), it is observed how the contents increase as the level rises, as expected. However, the interest lies in the type of content that is encouraged based on the level. In the initial and middle levels, which are supposed to hook the player into the plot, the most repeated contents seek to force the player's active interaction, not allowing passivity and engaging them in the game dynamics. When we reach the final level, the repeated contents are voluntary in nature, though not without mystery and curiosity. This fact is further reiterated in the expansions, which follow the same pattern. The player no longer needs those motivation incentives, also inherent in the player's own skill evolution.

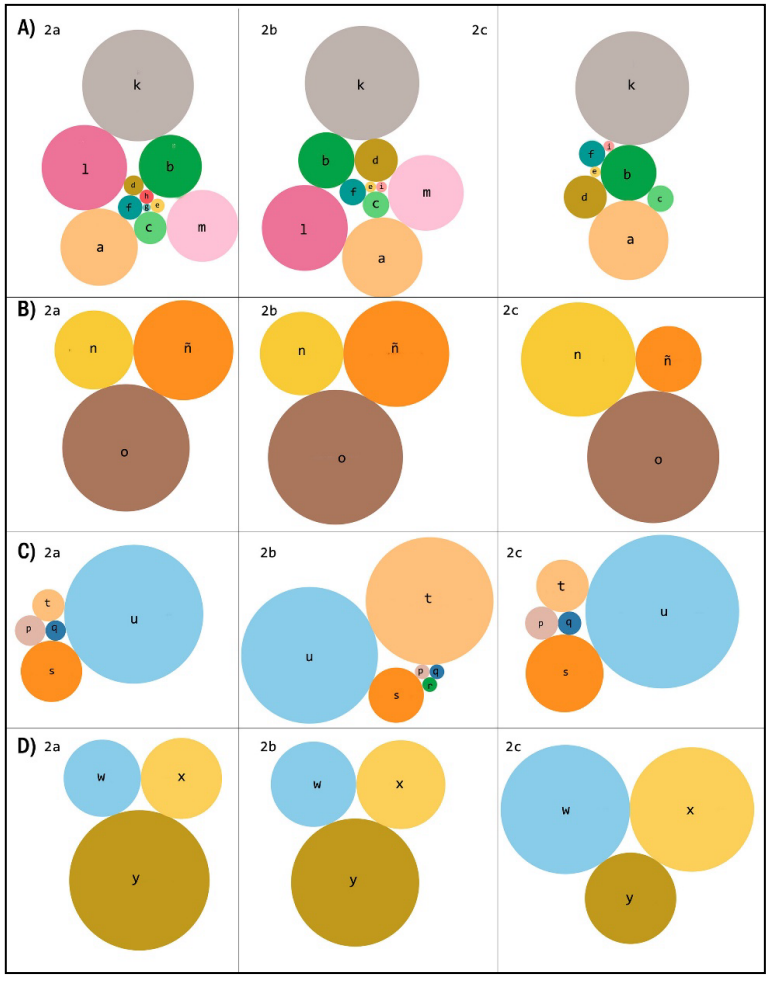

Fig.16. City scale: Most repeated contents. A) Pie charts related to the amount of loots by scale B) Pie charts related the lighting points by scale C) Pie charts related the population density by scale D) Pie charts related architectures by scale

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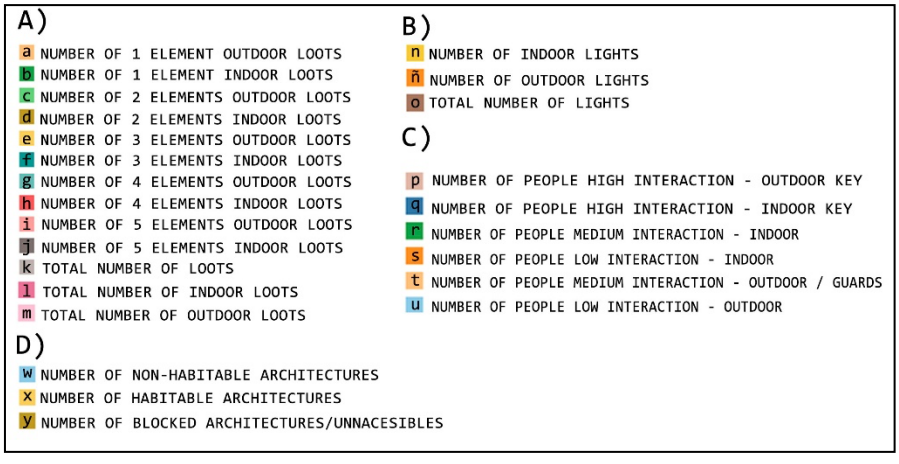

Fig.17 Legend related to fig. 16 and the city scale conclusions.

From the city scale, a series of data has been extracted based on predefined parameters. A uniform distribution of loot is observed both indoors and outdoors according to the density of each city. The number of interactions grows steadily as the scale of the city in which they are inserted increases (Fig. 18a).

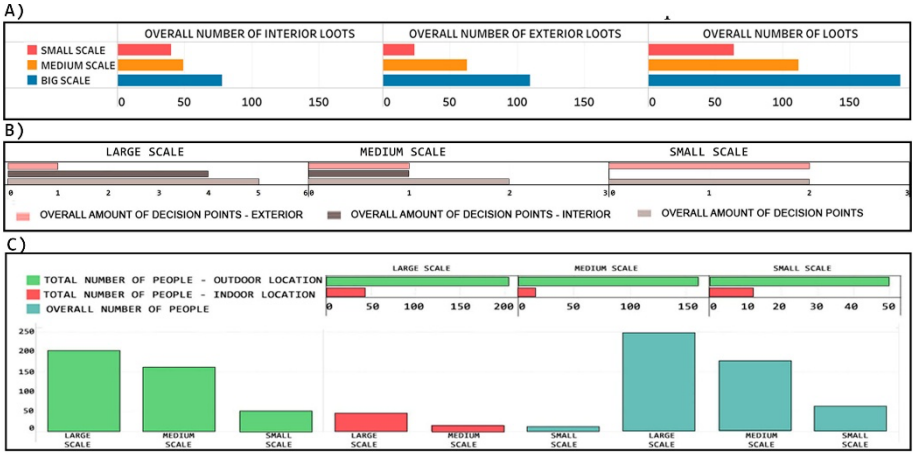

Fig.18 A) Results related to loots in each scale. B) Results related to decision taking points in each scale C) Results related to population density en each scale.

Decision-making points predominate in the large-scale city compared to smaller-scale cities, presumably due to the significant increase in population and therefore the number of people one can interact with (Fig. 18b).

This design strategy also subtly leads the character to the physical locations they are interested in reaching by setting a route. Population density is proportional to size and population number (Fig. 18c).

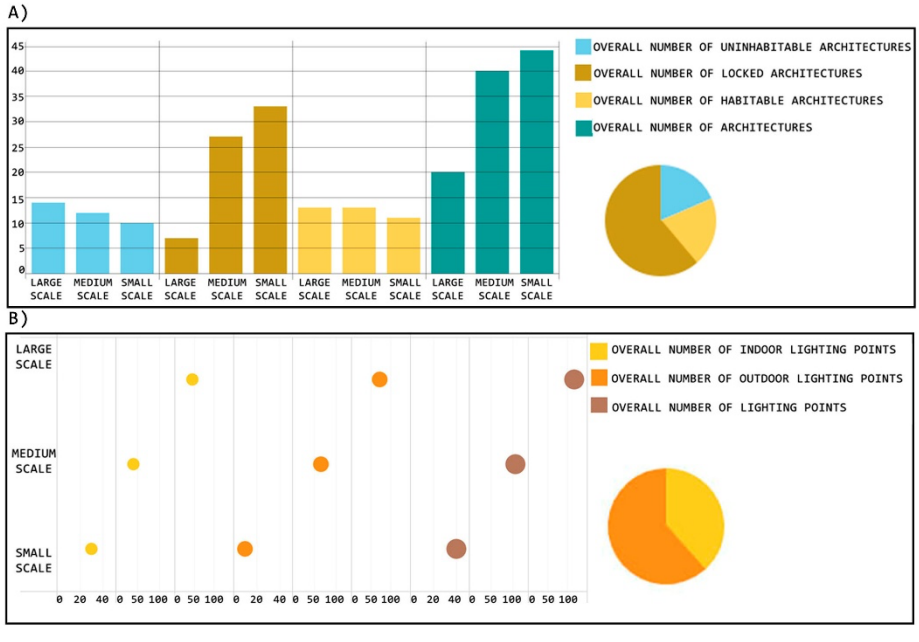

Fig.19 A)Results related to architecture B) Results related to lighting points

More than half of the architectures encountered are closed, blocked, or inaccessible, and this number increases as we scale up the city being analyzed. These are empty spaces, serving as barriers to passage (Fig. 19a). Besides, there are more light points outside than inside, with dwellings where lighting is either non-existent or very poor. This makes it difficult to navigate or move due to the lack of light, forcing the search for switches to provide visibility. However, exteriors are well-lit, with less forced interaction with urban lights compared to interior lights (Fig. 19b).

Regarding the building analyzed, the Vizima Palace, which inevitably forms part of the main plot, it is noteworthy how the conception of space and its graphic representation is completely different from an academic architectural representation. While in a video game, the representation must be intuitive and experiential, in real life, a plan must be exact to be constructed. In this case, the spatial conception is based on the useful space; spaces that are not traversable, such as those occupied by a bed or a table, are not represented. The intention of this is to intuitively, quickly, and visually focus and guide the player to where they want to

go. If it were not for a simple representation, it would require more time to be understood, causing the player to lose interest.

9. Conclusions

After applying the methodology of the case study, design patterns can be observed that substantialy vary depending on the scale analyzed, thus extracting from each variable a series of enlightening guidelines that determine how to generate a more comprehensive spatial experience at the design level.

From the analysis at the world scale, it is concluded that a total of 17 or more contents are not considered in any level. Furthermore, a total of 29 types of interaction contents are appreciated, alternating in each main location. There is a tendency towards active content in the scenarios, forcing player involvement. This tendency decreases as the level increases, appreciating more passive, optional, or voluntary content, where the player decides their focus of interest.

From the analysis at the city scale, it is concluded that the number of loots or rewards (backpack items) is uniformly distributed throughout the territory both indoors and outdoors, proportional to the density of the designed city. These rewards are generally multiple, close, and of a single item, encouraging the immediacy of positive reinforcement. The absence of light points or their dim presence can be used as a resource to force user involvement and interaction with the environment. Light points are generally observed every 2-4m2 in most cases. The presence of blocked or inaccessible architectures serves as a strategic planning element. They go unnoticed at medium and large scales, giving a false sense of a big city. It is necessary to evenly distribute the number of accessible and inaccessible architectures, allowing resource optimization without losing the feeling of content. Decision-making points increase as the population density scale increases since interactions between characters are more frequent and are designed based on that urban core scale. Population density also increases in relation to the size of the urban core, observing how we can regulate the degree of interaction within the city by controlling the type of inhabitants or characters we use.

From the analysis at the housing scale, it is extracted that the graphic representation of the plans is simplified, based on the useful space where the player can move. The use of KEY or guiding elements, which represent a mission in the very short term, responds to an immediate and continuous satisfaction system. They also act as guides through space. There is thus a very powerful connection of the player with the "physical" virtual space and how this determines their experiential experience and their routes. The location of interaction points along the route is strategic, forcing them into a pre-designed trajectory. The main character acts as a guiding element throughout the building. Blocked spaces are also observed that

cannot be accessed until others are completed. In total, three brief mini-missions are appreciated that function in chained action-reaction mode, sequenced based on a design strategy that reinforces the concept of immediacy, positive reinforcement, and continuous stimuli.

This methodology enables a global mapping, from the general to the specific, of content and parameters across different levels. This makes it a comprehensive and innovative method, particularly in its incorporation of tools from the field of architecture into the analysis of digital architectures. It demonstrates the possibility of replicating the method across all spatial distributions of open-world environments, allowing the inherent complexity and scale of these worlds to be addressed in a methodical and precise manner, and understandable to the eye of a game world designer. This approach allows for an objetive accounting and the collection of data that facilitates the identification of well-designed and poorly designed areas. In turn, it enables the recognition of which design strategies contribute to realistic player inmersion and which do not. These contributions are potentially relevant to the design and development process of video game worlds, as they enable te use of architectural tools and analyses by users who are not experts in the field. This allows world designers, map creators, narrative developers and other relevant graphic component designers in virtual environments to access this precise information.

In terms of achieving the research objetives, the primary goal of developing a methodology and demonstrating its application to the present case study has been accomplished. To this end, a review of the current methodological landscape was carried out, incorporating tools that had not previously been considered. Additionally, a series of specific and objetive validations related to the spatial design of the selected case study have been extracted. These findings are intended to be compared with future research in order to reach more generalizable conclusions.

All these findings lay the groundwork, which will be consolidated or refuted by future research, where the case method is again applied to other case studies, allowing comparisons at the different scales of all the data extracted in each of them. Therefore, a door is left open to continue unraveling the keys of virtual design and defining the foundations on which a thoughtful, studied digital architecture is based, and that makes us vibrate as much as the experientiality of a real space.

As lessons learned, we can conclude that much of the data extracted using this methodology had to be collected manually. Therefore, the use of software tools to accelerate the data collection process would be a very interesting area of research, which remains open for potential future development. Such tools could unify the diversity of interfaces and workflows across different virtual environments in order to analyze them effectively.

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Appendix I

Locations

1.World Scale

World map	Locations
1a. White Orchad	**1a.1** Abandoned Village / **1a.2** Broken bridge / **1a.3** Cacker bridge / **1a.4** Crossroads / **1a.5** Ford / **1a.6** Mill / **1a.7** Nilfgaardiasn garrison / **1a.8** Ransacked village / **1a.9** Sawmill / **1a.10** Weosong bridge
1b Velen & Novigrad	**1b.1** Abandoned tower / **1b.2** Aerama´s abandoned manor/ **1b.3** Alness / **1b.4** Ancient oak /**1b.5** Arette /**1b.6** Bandits camp / **1b.7** Benek / **1b.8** Blackbough / **1b.9** Boatmaker´s hut / **1b.10** Border post / **1b.11** Burned ruins / **1b.12** Byways / **1b.13** Carsten / **1b.14** Cavern / **1b.15** Claywich / **1b.16** Coast of wrecks / **1b.17** Codger´squarry / **1b.18** Condyle / **1b.19** Crossroads / **1b.20** Crossroads 2 / **1b.21** Crows perch / **1b.22** Dancing windmill / **1b.23** Destroyed bastion / **1b.24** delvi´s pit / **1b.25** downwarren / **1b.26** Dragon layer´s grotto / **1b.27** Drahim castle / **1b.28** Drudge / **1b.29** Duen Hen / **1b.30** Elector´s square / **1b.31** Est tayiar / **1b.32** Eternal fire chapel / **1b. 33** Ferry station / **1b.34** Forest Hug / **1b.35** Frichlow / **1b.36** Fyke isle /**1b.37** Gate of the hierarch / **1b.38** Glory gate / **1b.39** Grotto / **1b.40** Gustfields farm / **1b.41** Hanged man´s tree / **1b.42** Hangmans alley / **1b.43** Happy feeding ground / **1b.44** Heatherton / **1b.45** Herbalist´s hub / **1b.46** Hierarch square / **1b.47** Hindhold / **1b.48** Honeyfill meadworks / **1b.49** House of respite / **1b.50** Inn at the cross roads / **1b.51** Isolated hut / **1b.52** Isolated shack / **1b.53** Kimbolt way / **1b.54** Lighthouse / **1b.55** Lindenvale / **1b.56** Loggers hut / **1b.57** Lornruk / **1b.58** Lucians windmill / **1b.59** Lurtch / **1b.60** Marauder´s bridge / **1b.61** Martin Feulle´s farmstead / **1b.62** Midcopse / **1b.63** Moldavie residence / **1b.64** Muldrydale / **1b.65** Nilfgaardian army group center camp / **1b.66** Novigrad docks / **1b.67** Novigrad gate / **1b.68** Olena´s grove / **1b.69** Oreton / **1b.70** Oxefurt harbor / **1b.71** Portside gate / **1b.72** Reardon manor / **1b.73** Refugees camp / **1b.74** Road to bald mountain / **1b.75** Ruined tower / **1b.76** Sarrasin Grange / **1b.77** Seven cats inn / **1b.78** Southern gate / **1b.79** St gregory´s bridge / **1b.80** Stone cutter´s settlement / **1b.81** Temerian partisan hideout / **1b.82** The orphans of crookbak bog /**1b.83** Toderas / **1b.84** Tretogor gate / **1b.85** Troll bridge / **1b.86** Ursten / **1b.87** Vegelbud residence / **1b.88** Wastrel manor / **1b.89** Western gate / **1b.90** Wheat fields / **1b.91** White eagle fort / **1b.92** Widow´s grotto / **1b.93** Winespring grange / **1b.94** Wolven glade / **1b.95** Yantra/ **1b.96** Oxenfurt gate

1c.Skellige Isles	**1c.1** Abandoned Sawmill / **1c.2** Abandoned village / **1c.3** Ancient Crypt / **1c.4** Arinbjorn / **1c.5** Bay of winds / **1c.6** Blandare / **1c.7** Boxholm / **1c.8** Bridge to Kaer trolde / **1c.9** Clan tordarroch froge / **1c.10** Crossroads / **1c.11** Distillery / **1c.12** Dorve ruins / **1c.13** Druids camp / **1c.14** Eldberg lighthouse / **1c.15** Elverum thoseouse / **1c.16** Faylund / **1c.17** Fornhala / **1c.18** Freya´s garden / **1c. 19** Fyresdal / **1c.20** Gedyneith / **1c.21** Gedyneith 2 / **1c.22** Giant´s toes / **1c.23** Grotto / **1c.24** Gull point / **1c.25** Harviken / **1c.26** Holmtein´s port / **1c.27** Hov / **1c.28** Isolated hut / **1c.29** Kaer Alhult / **1c.30** Kaer Gelen / **1c.31** Kaer Muire / **1c.32** Kaer Trolde harbor / **1c.33** Larvik / **1c.34** Lofoten / **1c.35** Lofoten cementery /**1c.36** Lurthen / **1c.37** Marlin coast / **1c.38** Miners camp /**1c.39** Old watchtower / **1c.40** Palisade / **1c.41** Rannvaig / **1c.42** Redgill / **1c.43** Rogne / **1c.44** Ruined inn / **1c.45** Sund / **1c.46** Svorlag / **1c.47** The pali gap coast / **1c.48** Tor gvalch´ca / **1c.49** Trail to yngvar´s fang / **1c.50** Trottheim / **1c.51** Urialla harbor / **1c.52** Urskar / **1c.53** Whale graveyard / **1c.54** Wild shore / **1c.55** Yngvar´s fang / **1c.56** Yustianna´s grotto
1d. Kaer Morhen	**1d.1** Ruined Watchtower / **1d.2** Lakeside hut / **1d.3** Bastion / **1d.4** Kaer Morhen / **1d.5** Iron Mine
1e. Toussaint	**1e.1** The silver salamander inn / **1e.2** Trading post / **1e.3** Prophet lebioda statue / **1e.4** Coronata vineyard / **1e.5** Basane farm / **1e.6** Mont crane castle / **1e.7** Ardaiso quarry / **1e.8** Dun tynne hillside / **1e.9** Dun tynne castle / **1e.10** Sansretour valley / **1e.11** Chuchote cave / **1e.12** Rioux-cannes outpost / **1e.13** Bueclair palace / **1e.14** Tourney grounds / **1e.15** Coopers gate / **1e.16** San Sebastián / **1e.17** Habor Gate / **1e.18** Beuclair port / **1e.19** Casteldaccia abandoned state / **1e.20** Termes palace ruinins / **1e.21** erelachaiselongue cementer / **1e.22** Francollarts / **1e.23** Balgraad vineyard / **1e.24** Lebioda´s gate / **1e.25** Hortense vineyard / **1e.26** Tesham mutina ruins / **1e.27** Flovive / **1e.28** Count de la croix´s mill / **1e.29** Corvo bianco vineyard /**1e.30** Fort ussar ruins / **1e.31** Palace gardens/ **1e.32** Arthach palace ruins / **1e.33** Fox hollow / **1e.34** Plegmund´s bridge / **1e.35** Dun tynne crossroads / **1e.36** Ford ussar ruins / **1e.37** Toussaint prison / **1e.38** Seidhe llyghad amphitheater / **1e.39** Trastamara hunting cottage / **1e.40** Dulcinea windmill / **1e.41** Castel Ravello vineyard / **1e.42** Metinna gate / **1e.43** Gelesen farm / **1e.44** Nifgaardian embassy / **1e.45** The cockatrice inn / **1e.46** Gran place