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ON THE UTILITY OF THE DATABASE FOR THE STUDY OF WINDOWS AND LANDSCAPES IN TWO VILLAS FROM ROMAN CAMPANIA (VILLA OF DIOMEDES, VILLA OF POPPAEA)

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Abstract: The study of the housing in the Roman world focused primarily on the organization of the housing. However, since the beginning of the 21st century, building archaeology offered new approaches and methods to better understand the Roman house. Construction archaeology, and the studies associated with it, are often faced with the difficulty of treatment of a great data quantity. Moreover, as the construction archaeology is still developing, methodological approaches are also a dynamic research field. In this study, the goal is to investigate some possibilities of use of a database to process such quantity of data in construction archaeology and especially in the studies of windows in the Roman house. In this case, two Roman villas, the villa of Diomedes in Pompeii (NA) and the villa of Poppaea in Oplontis (Torre Annunziata, NA) were selected for their preservation state as well as for their various constructive moments. The scope is to treat and compare the different variables thanks to the use of a database. This crossed analysis allows to compare the size of the windows. It is also a powerful tool to conduct statistical analysis such as correspondence analysis to make links between different window sizes and construction techniques, an interesting chronological and cultural indicator in the construction of a villa. It is therefore possible to see that the use of the database is a very powerful tool to find such type of correspondence between variables and one can only wonder the other use of the database in that field.

Keywords: Construction archaeology, statistics, cultural heritage, database.

1. Historical context

The arrival of the Romans in the Campanian region after the battle of Zama in 202 BCE, but especially following the deduction of the Sullan colony after the Social War at the beginning of the Ist century BCE led to a massive outburst of population and a quick urbanization (Lafon, 2001, pp. 47 and 65). The presence in the region of famous *gens* such as the *Cornelii* and their war veterans launched an unprecedented movement of new constructions in the Bay of Naples. Building their home, the Roman elite took advantage of the landscape and the ground surrounding them[1]. These new constructions showed wealth and social status to the rest of their peers. As said by Pierre Gros (2001, p. 267), domestic architecture is considered:

> *«a place where a sensibility can be expressed and where it is possible to stage architectural and ornamental themes […] underlining their culture as well as their wealth, in a context in which it is possible to express it free from the city constraints and the political requirements, but also leisure, in its more diverse and higher form (otium).»*

In 62-63 CE an earthquake preceding the eruption shook the region and led the owners to conduct major reconstructions and transformations on their properties (Gros, 2001, p. 102 and following) as owners tended to reuse and restructure their old dwellings. The eruption of Mount Vesuvius in 79 CE sealed this construction situation in place. During the three centuries between the settlement of the Romans and the eruption, construction techniques evolved quickly. It is, therefore, an interesting variable element to exploit in order to investigate functional analysis as much as chronology in Roman buildings.

This study aims to compare data from the windows of the villa of Diomedes in Pompeii and the villa of Poppaea in Oplontis, both located in the Bay of Naples. On the one hand, the villa of Diomedes was built around the beginning of the IInd century BCE and then remodelled and extended until 79 CE (Dessales, 2020, pp. 287-446). On the other hand, the villa of Poppaea was built from scratch at the beginning of the Ist century BCE and extended until the eruption in 79 CE (Gazda et al., 2016, pp. 66-68). Comparing and exploiting the two datasets allows gathering information about construction logics and logistics within the two Roman villas. The goal is to see how the use of statistical methods on construction elements such as windows enables us to distinguish building patterns or dissimilarities.

2. Data-mining and research methodology

To conduct this comparison, data was gathered in the two villas during two data collection campaigns in 2022 and 2023[2]. In total, a sample of 125 windows has been studied. This smaller dataset is extracted from a larger database focusing on windows within the Roman world, currently under study[3]. The data collected

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[1] It is visible in Pliny the Younger's correspondence, where he describes abundantly the views from his villa (*Epistulae,* II, 17 and V, 6.).

[2] All the information regarding the villa of Diomedes, as part of the *Villa Diomedes Project*, is also available online at: http://villadiomede.huma-num.fr/3dproject/

[3] Thesis by Romane Desarbre at the University of Padua, under the supervision of Jacopo Bonetto.

in both villas was then compared to understand the similarities and the differences within windows. Various statistical analyses have been conducted on the data to cross variables and show the possibilities offered *via* a database analysis within these two Campanian villas[4].

3. Application and results

In order to see if there is any variation in the shape of windows, the first step of this data analysis is to sort the dataset by height and width to see any grouping is possible in the windows within the two villas. This would allow us to compare the dimensions of the windows. The plotting of the height against the width of the entire dataset (fig. 1) already shows some concentrations. Some concentrations are already noticeable on this first chart (fig. 2). To identify the concentration in a precise and reliable way, we conducted a cluster analysis on the dataset to classify data into subgroups (Everitt, 2011). The distance between the points of the cluster chart represents how close the data is. The tree represents the way the data was sorted (fig. 3 and 4). Thanks to the cluster analysis, it is possible to identify five groups. It is interesting to note that the clusters are not particularly linked to the villa the windows were part of: for example, in the cluster 3, windows called n° 210, 211 and 212, from the villa of Poppaea (Oplontis) are very close to n°31, 35 and 56 that are from the villa of Diomedes (Pompeii).

The 125 windows studied are spread unevenly amongst the groups formed by the cluster analysis. Groups 1, 3 and 4 represent almost 90% of the total population. Within these three, groups 1 and 3 are a similar size (24 and 31 windows), whereas group 4 dominates with 57 windows (45% of the total population). On the other hand, groups 2 and 7 represent 10% of the total population. It is possible to observe a trend for the windows gathered in each group:

- Group 1 (in black on the cluster analysis), is a densely gathered cluster. The height and the width of these windows are similar, and the windows of this group tend to be more square-shaped (as opposed to rectangular-shaped). They are also the smallest windows of the sample.
- Group 2 (in red on the cluster analysis) contains mainly very tall, narrow windows, where the height can be superior to one meter. This group is also the less populated (six windows) and appears very spread out.
- Group 3 (in green on the cluster analysis) is once again a fairly gathered group. The height and the width, generally under a meter, do not seem to have a particular ratio.
- Group 4 (in darker blue on the cluster analysis) also presents no particular ratio between the height and the width. The measurements are usually over a meter. It is also the most populated group.

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[4] The idea of a computational study of windows is already used by Lucia Michielin in her PhD (Michielin, 2021). Some other studies have been conducted on doors, especially in relation to space syntax analysis (Lauritsen, 2011).

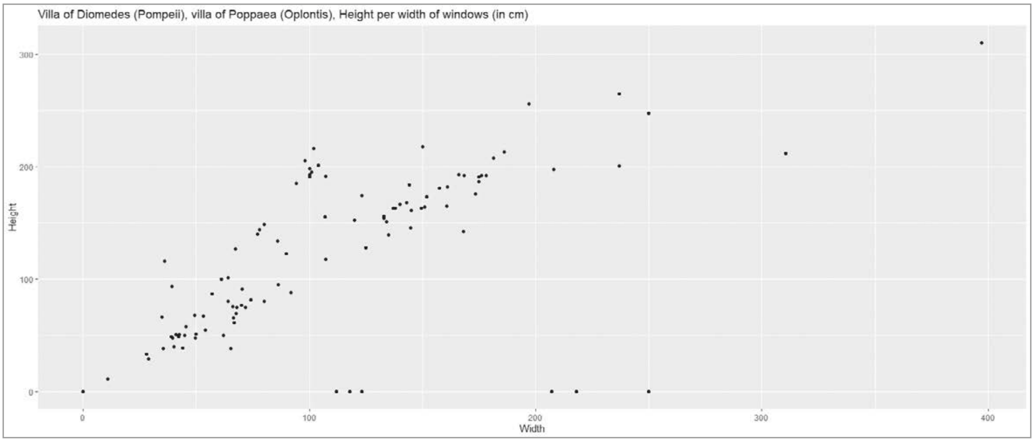

fig. 1. Height per width chart of the windows (in cm), Villa of Diomedes (Pompeii), villa of Poppaea (Oplontis).

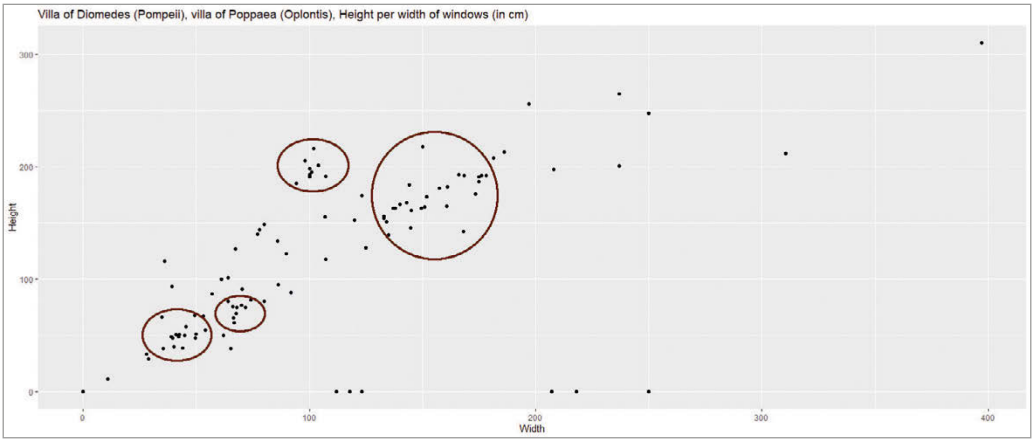

fig. 2. Some possible concentrations on the height per width chart, villa of Diomedes (Pompeii), villa of Poppaea (Oplontis).

- Group 5 (in light blue on the cluster analysis) is the most spread-out group. It is the group containing the biggest windows, with measurement around two meters or above.

This first classification size-wise is then crossed with the different construction techniques present in the villas to determine whether the change in sizes is linked to a change in building techniques. The open access database, ACoR[5], has been chosen to formalize the construction techniques. To each window was attributed, when

[5] ACoR: *Atlas des techniques de la Construction Romaine*, developed under the supervision of Hélène Dessales (ENS – AOrOc). The database is available online at https://acor.huma-num.fr/. The details about every construction technique mentioned in this article are available in the database.

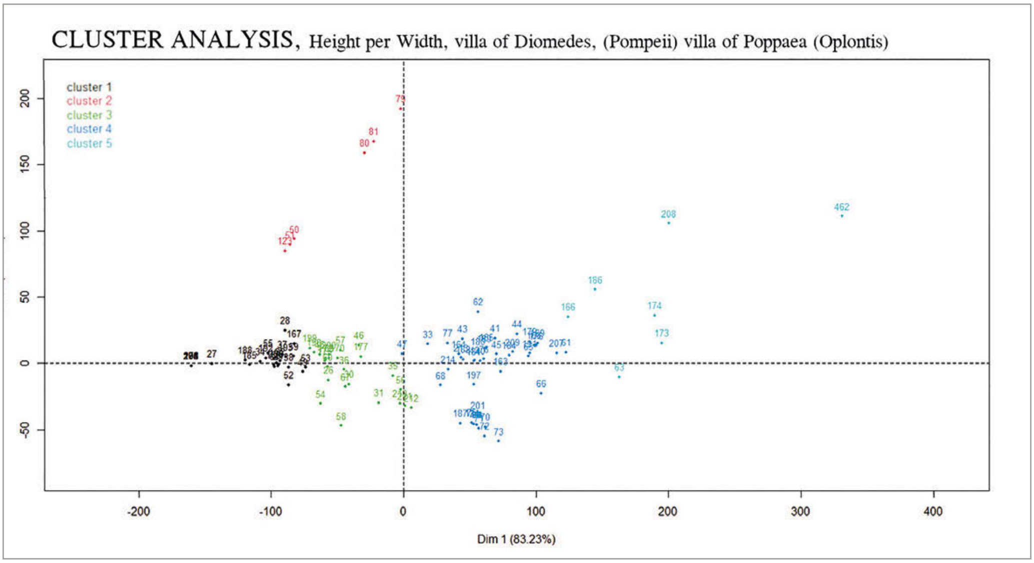

fig. 3. Cluster analysis, height and width of the windows in the villa of Diomedes (Pompeii) and villa of Poppaea (Oplontis).

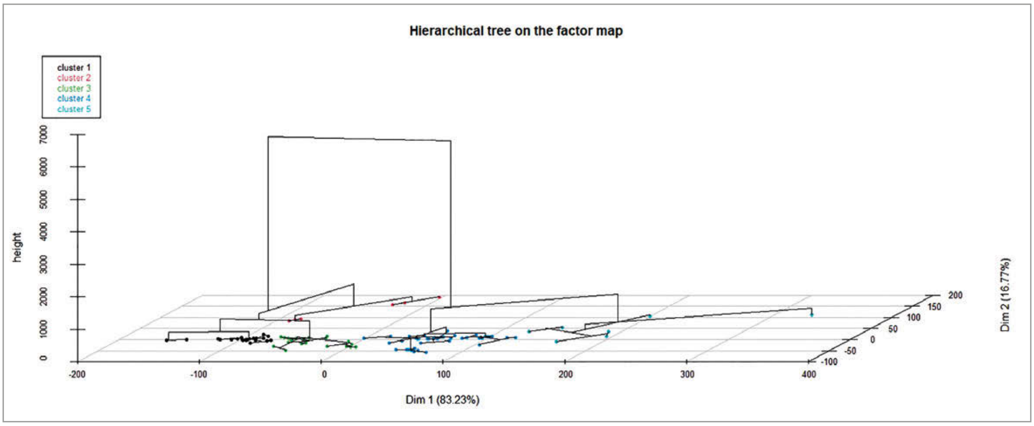

fig. 4. Hierarchical tree on a factor map, cluster analysis.

possible[6], its construction type within the building. Each FE-XXXX represents a construction technique compared to their surrounding wall. For example, windows made with the FE-0065 techniques are windows from the villa of Poppaea, with jambs in a technique that is not the one used for the walls surrounding them and a square embrasure.

To study the relationship between the construction techniques and the windows' dimensions, a correspondence analysis model has been used. Such analysis is used to compute the closeness or the distance between elements to understand

[6] Due to numerous restorations or because the plaster is still in place on some walls, it is sometimes impossible to identify the construction type.

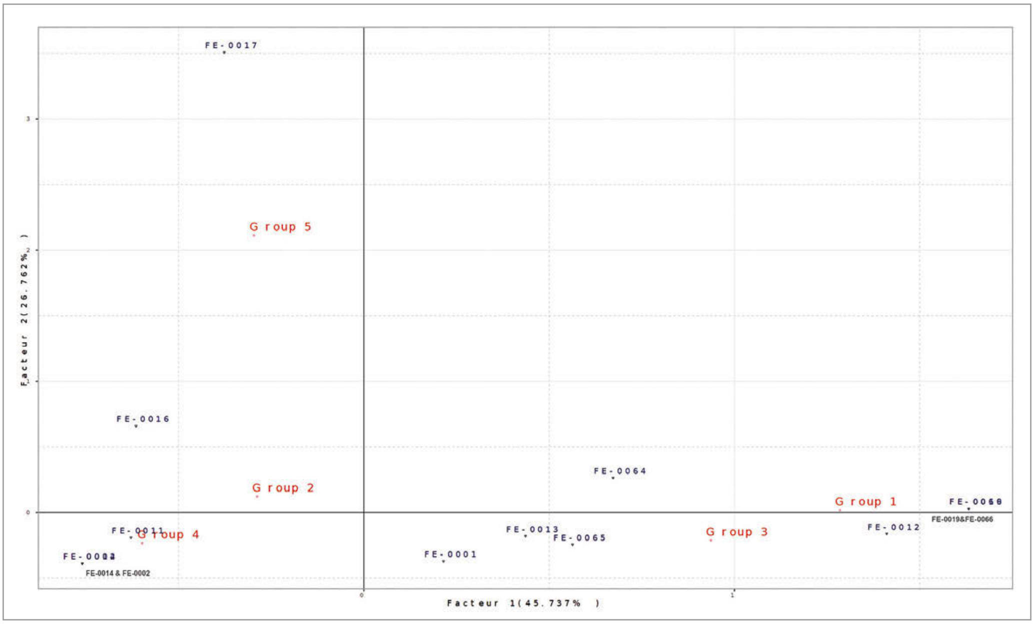

fig. 5. Correspondence analysis model, representation with factor 1 and 2.

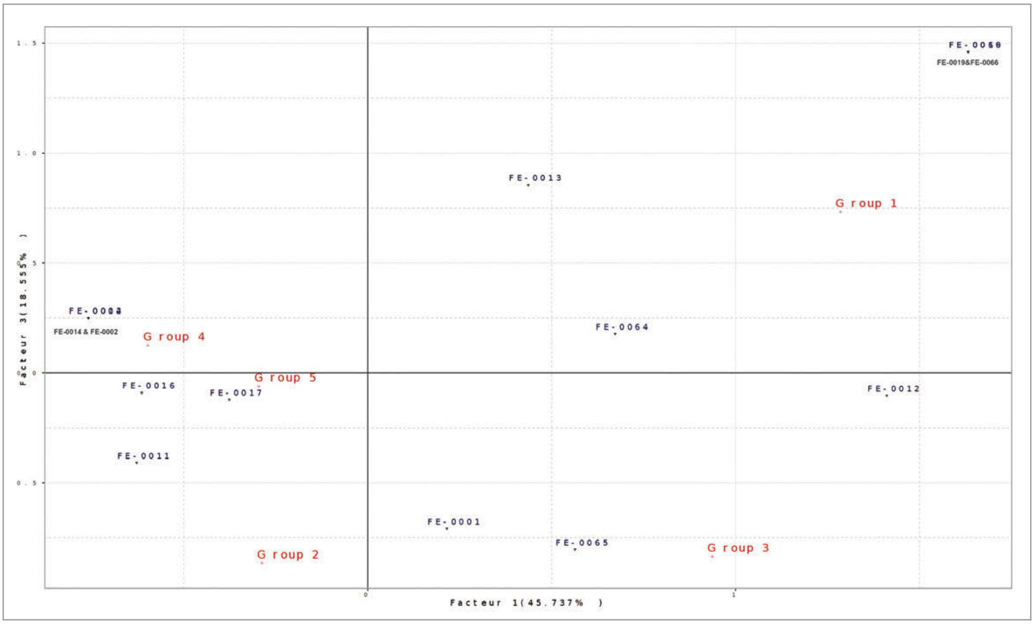

fig. 6. Correspondence analysis model, representation with factor 1 and 3.

the general organization of the data (Baxter, 2015). It reduces elements computed on a multidimensional level in bidimensional representations. The reading of this correspondence analysis model is done through the angle between the different elements, the more acute the angle from the origin of the axes is, the closer the elements are. Techniques were analysed according to the groups previously created.

The techniques appearing to be close enough to each other will then be compared to see if there is any common point between them[7]. The two graphs between factors 1 and 2 (fig. 5) and 1 and 3 (fig. 6) represent over 90% of the information gathered by the correspondence model. Due to the smaller size of the data sample, we chose not to exclude individual values.

Both representations of the correspondence analysis model seem to show some strong association between construction techniques and the groups identified after the cluster analysis. FE-0066, and FE-0019 are clearly associated with the first group in both representations of the correspondence analysis model, but the second model suggests that FE-0012 is also associated with this group. FE-0065, and FE-0001 seem to be closer to group 3 whereas FE-0011, FE-0014 and FE-0002 are associated with group 4. FE-0017, FE-0016 and in a slight way FE-0011 seem to be closer to group 5. No construction techniques seem to be closely linked to group 2. FE-0013 and FE-0064 show no strong association with any group.

For the first group, the comparison of the ACoR type of each window shows that the construction technique used for the jambs of the windows is the same as the one used for the wall and they do present a separate still piece. FE-0012 and FE-0019 also present a slayed embrasure. This means that, for the smaller windows of the sample, there seems to be no extra need to make the jamb with another technique or add a separate sill piece for structural purposes. FE-0012 and FE-0019 present a slayed embrasure which suggests that these windows were mainly used for light or airflow circulation within the house[8].

The windows constructed with FE-0001 and FE-0065 and associated to the third group present little to no specific technique for the construction of the windows. FE-0001 has the jamb in the same technique as the wall surrounding the window, and FE-0065 uses small stones in the same material as the surrounding wall to structure the jambs, suggesting no need for extra jamb support. The embrasure is not slayed anymore and their association with group 3 suggests that the windows do not have particularly big dimensions.

FE-0011, FE-0002 and FE-0014, associated with group 4 are construction techniques showing some structured elements to the jamb. They are made from several elements, either blocks or terracotta elements. FE-0002 and FE-0014 also have the particularity to have jack arch lintels to better support the windows. This technique allows the constructor to report part of the weight onto the jambs instead of it weighing directly onto a more fragile monolithic simple lintel (Adam, 1984, p. 179 and following).

The last group, composed of the biggest elements, is made of three construction techniques very closely associated with it, FE-0011, FE-0016, and FE-0017. These techniques are also the opposite of group 1 and the smaller windows in general,

[7] For this correspondence analysis, we chose to exclude the FE-0015 technique, as being too different and interfering with the results.

[8] Vitruvius specifies that light can be especially important in stairs or corridors, in order to prevent users from falling (Vitruvius, *De Architectura*, VI, 6.6-7).

suggesting that these techniques are used for the biggest windows. The three construction techniques are very diverse between themselves. It seems like the bigger the window was getting, the more creative the constructors had to be to guarantee the structural integrity. They also combine more diverse construction materials in the jambs with yellow Napolitan tuff or architectural terracottas. These materials are used in construction in Roman Campania during the middle of the Ist century BCE and especially during the Ist century CE (Dessales, 2022, p. 97 and following). Their use indicates that the construction of said bigger windows was a phenomenon going on after the middle of the Ist century when the construction industry was growing in Campania (Gros, 2001, p. 102; Lafon, 2001, p. 101). These materials are also linked to reconstructions following the 6263 CE earthquake, when architectural terracottas fallen from buildings during the earthquake were used in the rebuilding process, giving a possible chronological horizon for the construction of the window (Adam, 2020). The technique FE0016 also has a jack arch that enables the weight to be evenly distributed on the jambs, especially on big openings (Adam, 1984, p. 183).

4. Discussion and Conclusion

This comparative analysis between window sizes and construction techniques on the two villas enabled us to make some links between window sizes and the way they were constructed. The strategies and the materials developed and used by Roman builders give chronological indications on the constructive horizon of the windows. However, as it is composed of only 125 elements, the dataset under study was limited and stayed restricted to only two villas. However, this case shows that a study about windows on a much larger dataset scale could bring information on construction strategies or chronology.

But more questions arise from this example. For instance, the bigger windows of the fifth group opened on some kind of landscape. Yet what type of landscape was seen through them? Was there a preference for one element or the other? Is it the same in urban and extra-urban contexts? Such use of databases and statistical tools would be a possible method to answer these kinds of questions.

Author Contributions Statement

Concepts and methodology: Romane Desarbre; Data collection and management: Romane Desarbre; Data analysis: Romane Desarbre; Writing and reviewing the original draft: Romane Desarbre, Jacopo Bonetto; Figures: Romane Desarbre; Supervision: Jacopo Bonetto; Project administration: University of Padua, Cultural Heritage department; Fundings acquisition: University of Padua

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