The lifecycle of casks: the production, use, and repurposing of casks in the Netherlands (1300–1800)

Oosterbaan, J.

9. Conclusion

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9.1 Introduction

This dissertation explores the multifaceted role of casks from Dutch archaeological contexts dating from the Late Middle Ages to the Early Modern period (1300–1800). The archaeological data are enhanced through the application of complementary analytical techniques, including dendrochronology, 3D scanning, and photometric stereo analysis. Through a multidisciplinary approach that integrates this archaeological data with information from outside the discipline, such as written sources, iconographic materials, museum collections, and interviews with present-day coopers, the study provides a comprehensive understanding of the production, use, repurposing, and broader economic significance of these wooden containers. The analysis of cask marks and their associated data not only enriches our understanding of the material culture of trade and craftsmanship but also highlights the significance of combining primarily historical and archaeological data. At the core of this doctoral research lies the central question:

What do casks from Dutch archaeological contexts from 1300 to 1800, examined through an interdisciplinary analysis, reveal about their lifecycle (production, use, and repurposing)?

The research question incorporates the various phases in the lifecycle of the casks, forming the conceptual backbone of the dissertation (Figure 1.6). This lifecycle perspective aligns with the study's analytical approach based on *chaîne opératoire* theory. The theory emphasizes the sequence of actions, choices, and transformations involved in the production, use, and reuse of material objects, providing an effective framework for understanding the technological and social dimensions of cask manufacture and use throughout their lifecycle.

In addition to these three lifecycle phases, the production, use as transport containers and repurposing a fourth theme, cask marks, was also studied. While cask marks appear in several phases of a casks' lifecycle, they offer valuable insights into production control, trade networks, ownership, and trade regulation. For this reason, cask marks are addressed as a separate research theme, following the chronological treatment of the lifecycle phases in the earlier chapters. The research results of this theme are discussed in Section 9.2.

Section 9.3 presents the main research results derived from the various sub-studies, organized according to the key research themes of production, use as a transport container, repurposing, and cask marks. The results of each sub-study are discussed within these thematic categories, with attention both to their specific contribution to addressing the overarching research question and to their broader significance

for archaeology and related disciplines. The section concludes with an integrative reflection on the cumulative insights in relation to the central research question. Section 9.4 offers a theoretical and methodological reflection, including a critical evaluation of the methodology and data limitations. Finally, section 9.3 outlines opportunities for future research and provides recommendations for advancing the study of casks in both archaeological and multidisciplinary contexts.

9.2 Conclusions

Between 1300 and 1800, the Netherlands experienced a profound economic transformation, emerging as one of Europe's most urbanized and commercially advanced regions. This transformation was fueled largely by trade, which unfolded along a series of overlapping trade networks in which the Netherlands played a central role.

Casks were indispensable transport containers for bulk goods throughout this period, coming into increasingly widespread use from the Late Middle Ages onward. Their functionality extended far beyond their capacity to store commodities: casks offered durable, stackable, and reusable solutions that supported both storage, long-distance transport. In urban settings, casks were a visible presence within the cooper guilds and among their principal clients, such as breweries and fisheries. They were also a familiar sight in marketplaces and at trade fairs, as well as in taverns and inns. Within domestic contexts, repurposed casks found new uses as tables and chairs, and, in less visible ways, as structural components such as shafts of cesspits and water wells. In this sense, the cask was an omnipresent element of both the maritime and urban landscape.

Consequently, casks occur frequently in both urban and maritime archaeological contexts in the Netherlands. Nevertheless, as previously noted, they have received only sporadic academic attention, and comprehensive studies devoted to this artifact group remain rare. Therefore, essential aspects such as the successive phases that constitute the casks' lifecycle and the lifespan of the lifecycle have remained poorly known. These research topics are examined in detail in the first sub-study.

The lifecycle of casks comprises three main phases: production, use as transport containers, and repurposing. The production phase can be further divided into the production of coopers' timber, the drying and transport of the timber, and its subsequent processing into casks. The lifecycle therefore begins with the growth of the oldest tree rings in the timber that was eventually used by coopers to assemble the casks. Subsequent research examined the lifespan of the casks using several dating methods, with dendrochronological analysis and dates from finds in repurposed casks providing the principal chronological data (Chapter 2).

Analysis of the dataset indicates that the timber production phase, spanning the period from the formation of the oldest tree ring to the felling of the tree, had a median

duration of approximately 150 years. The data further show that the subsequent drying and transport phase lasted around three years, during which the timber was seasoned and transported to cooperages. The production process itself lasted seven weeks and included both the final drying of the timber and the manufacture of the casks. The use phase, during which casks served as transport containers, had a median duration of six years, while repurposed casks, often employed as linings for cesspits and water wells, remained in use for an additional 75 years.

The total reconstructed lifespan of a cask was approximately 234 years. This sub-study not only sheds light on the longevity of casks, which is crucial for interpreting the results of the other sub-studies of this dissertation, but also highlights how the dating of casks should be interpreted in other studies. For instance, dendrochronology is frequently used to date cask-lined features. However, this research demonstrates that there can easily be a time gap of over a hundred years between a dendrochronological date (when samples with sapwood are absent) and the repurposing phase of the cask.

A similar issue arises in maritime archaeology, where dendrochronological samples are frequently used to approximate the sinking date of a ship. Again, if the sample lacks sapwood, the timber used for a cask could fall within a time range of over 150 years, offering only limited precision regarding the actual date of sinking. For wood specialists working in archaeological contexts, the median value of 150 years for the timber used in casks is particularly valuable. It offers important insights into the variation in the age of the timber that can be present in a single cask.

Production of casks

The first stage of the cask production was analyzed in a sub-study that focused on the specifications of coopers' timber (Chapter 3). This research examined both the provenance of the timber and its diachronic development. The primary objective was to gain a better understanding of the extent to which coopers' timber was imported and to assess what proportion of the casks from Dutch archaeological contexts had been produced domestically in the Netherlands.

For this purpose, a comprehensive dataset was assembled, comprising 946 successfully dendrochronologically dated tree-ring series derived from cask staves or headboards. These series represent a total of 357 casks recovered from archaeological contexts across the Netherlands. A notable finding from this dataset was that only 16% of the casks included one or more tree-ring series containing sapwood. This low percentage indicates a marked preference for timber not containing sapwood for cask construction.
This preference is consistent with historical regulations documented in coopers' guild records from several cities in the Netherlands, such as Haarlem (1567),

Dordrecht (1606), Amsterdam (1609), and Leiden (1743), which explicitly prohibited the use of timber containing sapwood (Table 5.1). Such regulations were likely intended to ensure the quality and durability of the casks, as sapwood is generally more susceptible to decay and less suitable for a tight seal.

The casks recovered from Dutch archaeological contexts revealed seven distinct provenance areas for coopers' timber: the Rhineland, the Meuse Valley, the North German Plain, the Baltic region, Poland, France, and the Burgundy/Loire Valley (Figure 3.3). Compared to other crafts in the Netherlands that relied on imported timber, one particularly notable absence is southern Scandinavia. Although timber from southern Scandinavia was widely used in the Netherlands for a variety of purposes such as shipbuilding, the construction of buildings, and foundations (Section 3.3.1), there is no evidence that it was used for the production of casks. A clear explanation for this absence has not been found. However, it appears that timber from southern Scandinavia either did not meet the requirements or satisfy the preferences of coopers, or, simply, it may not have been available to them.

Conversely, French timber is rarely identified in dendrochronological research focused on applications outside of cask-making, yet it is distinctly present in the cask dataset. This pattern is also evident in written sources, although the references to the import of French timber to the Netherlands are few. Archival sources, such as the records of the Zaandam timber auctions between 1655 and 1811 do not mention France as a source of imported timber. In contrast, timber from regions such as the Rhineland, the port of Hamburg (representing the North German Plain), and various ports along the Baltic Sea is frequently mentioned in both written sources and in customs records such as the Sound Toll Registers (Section 3.3.1). These sources consistently identify these areas as key points of origin for imported timber, while French timber is notably absent.

The fact that French timber is almost entirely absent from both archival records and dendrochronological analysis of timber used in non-cooperage contexts, while it is distinctly present in the cask assemblage, strongly suggests that casks made from French wood were most likely manufactured in France. These casks probably served as containers for French products and were imported into the Netherlands as such, rather than as raw timber intended for local cask production.

The diachronic analysis of the provenance of timber in the casks from Dutch archaeological contexts revealed several significant patterns that reflect broad economic and logistical developments in northwestern Europe. Throughout the High Middle Ages, large-scale timber trade was primarily conducted along major river systems, with the Meuse Valley and the Rhineland emerging as the dominant source regions. Between 1100 and 1300, no less than 81.5% of the timber used for casks can be attributed to these two areas (Table 3.3).

From the late 13th century onward, the Dutch archaeological record reflects a shift in timber trade patterns with the rise of the Hanseatic League, which expanded supply routes via the Baltic Sea. Timber from Poland, the Baltic region, and the North German Plain became increasingly prominent, indicating a growing reliance on maritime transport alongside traditional riverine trade. This reliance on seaborne trade was not limited to the north and east; by the late 15th century, French timber also appears in the record, pointing to expanding maritime connections with the southern parts of Europe. This development marks a geographical broadening of timber supply routes and indicates a growing reliance on seaborne trade alongside traditional riverine systems.

These developments point to a clear shift in timber supply patterns over time. Until around 1500, the Rhineland and Meuse Valley dominated as sources of coopers' timber. In the Early Modern period (1500–1700), maritime trade led to a more balanced distribution: 42.2% of the timber came via river routes, 41.5% from Hanseatic regions (Baltic, Poland, North German Plain), and 16.3% from France, suggesting the import of finished French casks (Table 3.3).

Provenance analysis alone cannot determine how many casks were made in the Netherlands, as casks made abroad could have been imported as finished products containing goods from their region of origin, as previously demonstrated by the examples of casks made from French timber.

To identify casks likely produced in the Netherlands, the presence of multiple provenance areas within a single cask was used as a proxy for local assembly. Among the casks in the dataset for which provenance could be determined for several parts, around 18% showed timber from more than one provenance area (Section 3.3.3). To rule out incidental repairs as the cause, a stricter analysis was conducted focusing on casks with multiple parts from different provenance areas. This reduced the share to 9.7%, supporting the conclusion of genuine multi-sourced timber in the construction.

The occurrence of multiple provenance areas within a single cask can also be considered diachronically. The earliest examples of this in the Dutch archaeological record appear in the 14th century, coinciding with the founding of the first of what would become 38 coopers' guilds across the Netherlands. A second line of evidence comes from the provenance regions themselves: of the 15 casks with multiple timber sources, nine contain at least one stave of Baltic or Polish origin. As shown in the Sound Toll Registers (Table 3.2), the Dutch Republic was a major importer of timber from these areas, strengthening the argument that such casks were produced in the Netherlands.

The second sub-study on cask production (Chapter 4), examines the next phases in the production of casks in the Netherlands. It outlines the development of the coopers' trade in connection with urban, economic, and technological changes

from the Late Middle Ages to the Early Modern period. The chapter opens with an analysis of the role and functioning of craft guilds in the Netherlands, among which coopers' guilds were responsible for overseeing cask production.
Thirty-eight coopers' guilds are registered in the Database Dutch Craft Guilds, which catalogs historical guilds within present-day Netherlands.[498] A clear diachronic pattern can be observed in their establishment, which closely reflects regional economic development. The earliest coopers' guild appeared in Sluis in 1397, near the thriving trade hubs of Flanders and Brabant. In the 15th century, coopers' guilds spread across Zeeland, especially on Walcheren, and to key towns in Holland such as Dordrecht (1437) and Gouda (1453), where demand for casks was driven by, for instance, the beer breweries. The 16th century marked further expansion into major urban centres like Delft, Leiden, and Amsterdam, and also into inland towns connected to major waterways, including Breda and Deventer. By the 17th and 18th centuries, the spread had stabilized, with new guilds emerging both along the coast, such as in Schiedam and Hoorn, and further inland, in cities like Leeuwarden, Amersfoort, and Zwolle. This geographic diffusion of coopers' guilds reflects both the economic growth and logistical integration of the Dutch Republic over time (Section 4.3).

The products of the coopers' guilds are often closely linked to developments in the industries they served. High-volume goods like beer and herring, stored in casks, generated substantial demand, meaning the growth of coopers' guilds should be considered alongside the guilds related to brewing, beer trade, fishing, and its trade. The data show that in 62.1% of the cities with a coopers' guild, a brewers' guild was also present, and in 40% of these cities, a fishmongers' guild existed, indicating a strong interconnection of these trades (Table 4.2).

The organizational structure of Dutch coopers' guilds, well-documented from the 16th century onward, remained remarkably stable until their dissolution in 1811. The Amsterdam coopers' guild charter of 1542 outlines a clear hierarchical system led by a small board of four masters, or *overlieden*, responsible for administration, quality control, and representation. Inspectors (*keurmeesters*) oversaw the craftsmanship standards, ensuring casks met strict specifications. Guild membership required an apprenticeship, an admission fee, and passing a master examination tailored to making local products. Apprentices and journeymen formed the workforce, with numbers fluctuating according to economic demand and seasonal cycles (Table 4.3). The guild system allowed for a flexible workforce, adapting to changes in trades reliant on casks. Guild leadership was often held by a select few over multiple terms, reinforcing a stable and tight-knit governance.

The actual production of casks in cooperages between 1300 and 1800 is described in several publications, such as those by Waelput and Kilby (Section

498 Database Dutch Craft Guilds, 2012.

4.4). These publications include step-by-step accounts provided by 20th-century coopers, describing the artisanal production process without the use of lathes or machine-made cask components. The assembly of casks is also documented in 18th-century encyclopedias, where the process is not only described in detail but also illustrated (Section 4.4.1). To verify whether the production techniques described in these sources were applicable throughout the full research period, 3D scans were made of four archaeologically recovered casks, dated between the 15th and 20th centuries.

The analysis of the 3D-scanned casks focused on three aspects: stave width variation, wedge marks indicating wood splitting, and traces of hoop placement. The 20th-century cask had evenly sized staves and no distinguishable closing stave, suggesting machine production. Wedge marks, a sign the timber had been split with a wedge rather than sawn, were visible only on the 15th- and 16th-century casks. The absence of such marks in later examples aligns with a shift to sawn staves from the 18th century onward, though finishing could have obscured wedge traces on earlier casks. Tool marks on the exterior of the casks, often appearing as transverse lines across the staves, indicate the placement of hoops during production or later repairs.

To estimate the value of casks during the research period, a brief sub-study of cask prices was conducted. While prices varied depending on cask type, records show that in the mid-17th century, an unskilled laborer could buy a half-*anker* (specific type of cask) with about one day's wages, while a beer cask equaled nearly two days' wages. Additionally, an 18th-century document from the Vlissingen coopers' guild provides insight into cask pricing for salted fish. The pricing breakdown reveals that raw materials accounted for 55% of the total price, labour for 35% of the selling price, and the master coopers' profit made up the remaining 10% (Section 4.5).

Use as transport containers

Chapter 5 examines the use of casks as transport containers, with a particular focus on establishing the specifications of beer and herring casks, with the aim of enabling their identification in archaeological investigations. The focus on casks for these two products is informed by findings from Chapter 4, which highlight how coopers' guilds were closely tied to the beer and herring trades, two sectors that dominated export activity in regions such as Zeeland and Holland. To estimate the scale of cask circulation, herring-catch data were used to assess container demand, revealing that approximately 350,000 herring casks were needed annually. The demand for beer casks was even higher; between 1543 and 1545, an estimated 950,000 beer casks were used in just nine major beer-producing cities in Holland (Section 5.1).

This sub-study began with identifying the specifications of beer and herring casks, which were not always the same. These specifications included capacity, dimensions, number of staves and headboards, stave thickness, number of hoops, timber used, and the presence and type of holes. To determine the standard characteristics for each cask type, ordinances from various coopers' guilds were analyzed, as these documents prescribed the required measurements and construction details (Section 5.4.1). Additionally, several gauging instruments from the Amsterdam Museum, dating from 1658 to 1801, were examined. These tools, inscribed with designations such as *1658 1/2 HARING VADT* (1658 half-herring cask), were used to measure and gauge the length and maximum and minimum diameters of casks, allowing their capacity to be calculated (Section 5.4.2). Other features, such as the number of staves, headboards, hoop sets, and types of holes, were studied using historical paintings, which provided visual evidence of construction details not always documented in written sources (Section 5.4.3). These specifications were applied to archaeological casks to analyze potential correlations. Although clear material evidence for herring casks is rare, one example was found in the wreck of the *Biddinghuizer Colfschip*, where a cask containing herring remains was recovered. Comparable examples of beer casks have not yet been identified in Dutch archaeological contexts (Section 5.4.4).

The sub-study revealed clear and consistent differences between beer and herring casks in terms of size, construction, and design. Beer casks typically had a larger capacity (over 130 liters), thicker staves (at least 1.4 cm), and a greater number of staves (14–15), whereas herring casks were standardized at 120 liters, with thinner staves (minimum 0.9 cm) and slightly fewer staves (12–13). In terms of holes, beer casks often featured multiple types, such as bungholes, tapholes, and ventilation holes, while herring casks generally included only a single round bunghole in the bilge.

A notable distinction between beer and herring casks lies in the consistency of their characteristics. Herring casks from Holland were standardized at a volume of 120 liters and subject to stringent regulations, whereas beer casks exhibited considerable variation. This discrepancy can be attributed to the comprehensive regulatory oversight of the herring fishery and its related components, including casks in which the herring was packed. Such regulation was closely linked to the internationally recognized reputation of herring from Holland and Zeeland, enforced by interregional interest organizations like the College van de Grote Visserij. Beer casks, on the other hand, exhibited considerable variation in size, which can be interpreted as the absence of a shared reputation and consequently a lack of centralized oversight and standardization. Regulation of the beer trade was primarily a local urban matter, resulting in specifications that varied between cities or even breweries, which meant that standardization of the capacity of beer casks was largely absent (Section 5.5).

Repurposing

Casks, originally designed for storing and transporting goods, were frequently repurposed after they were no longer useful as a transport container. Their sturdy wooden construction made them ideal for secondary functions, including household furniture and storage containers. In maritime contexts, they served as buoys and flotation devices for fishing nets. Even when dismantled, their parts were repurposed in urban settings for building frameworks or as flooring. When no further repurposing was possible, the wood could then be used as firewood. Thanks to their versatility, casks became a common sight in both domestic and public environments throughout the Late Middle Ages and Early Modern period.

The most recognized archaeological repurposing of casks is as linings for cesspits and water wells. Typically, the heads were removed, and the casks were stacked and dug in to form a shaft. As soil was dug out from inside the cask, the cask could be sunk into place, serving both as structure and a temporary casing during placement.

The study presented in Chapter 6 focuses on the repurposing of casks as shaft linings, using a case study approach centered on three large-scale excavations in Vlissingen: Groote Markt, Spuistraat, and Dokkershaven. Drawing on a dataset of 226 casks repurposed as linings for cesspits and water wells, the case study explores how soil conditions, economic factors, and cask availability influenced the decision to use casks instead of brick in cesspit and well construction. These factors likely shaped the choice to repurpose casks as a practical and cost-effective construction solution.

The first factor considered in the case study as a possible influence on the choice between cask-lined and brick-lined cesspits and water wells is soil condition, with unstable soils often linked to more frequent use of cask linings, as seen in Dordrecht. Vlissingen, where soil variability is present, offers a case to test this hypothesis, as its historic centre contains three soil types: stable, sandy creek beds in the west, an infilled former channel with unstable soils in the centre of the city, and peat-rich sediment in the east.

Contrary to expectations, the more stable creek bed and peat areas showed a higher percentage of cask-lined cesspits (94% and 96%, respectively) than the unstable channel zone (77%). Water wells showed a similarly inconsistent pattern, with cask linings more common in stable soils and less so in peat-rich areas (Section 6.3.2). Differences in soil conditions did have a consistent effect on the depth of water wells, with the deepest wells found in the infilled channel area, likely due to a lower groundwater table. Overall, these results suggest that soil conditions in Vlissingen had limited impact on lining choices, implying that other factors such as material availability and economic considerations played more decisive roles.

Financial means was the second factor considered, with brick lining requiring a significantly higher financial investment but offering greater durability. This hypothesis was confirmed by data from the Groote Markt excavation in Vlissingen (1575–1625): parcels owned by individuals with below-average financial means predominantly had cask-lined cesspits and water wells, while those owned by wealthier individuals more often featured brick lining (Section 6.3.3).

The third possible factor influencing the choice between a cask- or brick-lined cesspit or water well was the availability of casks for repurposing. This factor is closely linked to the second one, economic considerations, since the abundant availability of repurposable casks likely reduced the financial investment required for the cask-lined option.

The availability of casks was initially examined through the presence of a coopers' guild in Vlissingen. The existence of such a guild was taken as an indication of coopers engaged in production and repair work, which in turn implied that casks suitable for repurposing would be available in the city. In Vlissingen, cesspit data reveal a sharp increase in the number of cask-lined structures following the founding of the coopers' guild. This suggested a correlation, but to verify this, data from other cities in the Netherlands were also analyzed.

However, the ratio between cask-lined and brick-lined features in the cities of Dordrecht, Haarlem, Leiden, Alkmaar, 's-Hertogenbosch, Deventer, and Amersfoort showed no straightforward or immediate correlation between the establishment of a coopers' guild and a concurrent rise in the proportion of cask-lined cesspits following the guilds' foundation (Table 6.10). The situation in Vlissingen was therefore reassessed, revealing that the number of brick-lined features also increased from 1500 onward (Table 6.9), leading to the conclusion that the overall increase in the number of cesspits and water wells was more closely related to the expansion of Vlissingen rather than specifically to the founding of the coopers' guild and an increased availability of repurposable casks it ensured (Section 6.3.4).

A striking aspect of the comparison between Vlissingen and other cities was the high proportion of cask-lined features found there. In Vlissingen, 86% of cesspits and 55% of water wells were constructed from casks. In contrast, the cities of Haarlem, Leiden, Alkmaar, 's-Hertogenbosch, Deventer, and Amersfoort combined have only 39 cask-lined cesspits out of a total of 640, representing just 6%. Only Dordrecht showed similar percentages of features with cask-lined features.

Both Dordrecht and Vlissingen stand out from other cities because they functioned as trans-shipment ports during the Late Middle Ages and the Early Modern period. In these ports, casks were routinely transferred from one ship to another. For certain products, such as beer and wine, the contents were often decanted into different casks before being traded further. This process undoubtedly led to many casks no longer being needed as transport containers, which likely resulted in an abundance

of repurposable casks in a wide range of sizes, as a great variety of products passed through the trans-shipment ports.

The sizes of the casks used for the lining of features in Vlissingen were analyzed to determine whether there was a wide variety of sizes used, as would be expected in a trans-shipment port, or a consistent size, as would be expected if the casks were repurposed from the locally dominant herring fishery in Vlissingen. The analysis revealed a great variety of repurposed cask sizes in Vlissingen (Table 6.11). Therefore, the availability of casks in these cities is likely less related to the presence of a coopers' guild and more to the abundance of casks that had outlived their use as transport containers in these trans-shipment ports.

Overall, the case study on the repurposing of casks reveals that the widespread use of cask-lined cesspits and water wells in Vlissingen was primarily driven by cask availability and economic considerations. As a trans-shipment port, Vlissingen had an excess of discarded casks, offering an affordable and readily available alternative to brick. This option was especially preferred by property owners with limited financial means. In contrast, local soil conditions had little influence on construction choices. Together, these findings highlight that material repurposing in urban infrastructure was shaped not only by practical constraints but also by broad economic and logistical factors unique to port cities like Vlissingen.

Unlike many other sub-studies in this dissertation, the research on cask repurposing was conducted as a case study, focusing on a limited aspect of the overall research area. The dataset consists solely of cesspits and water wells in Vlissingen, which were then compared to those from several other cities. Therefore, it is important to assess to what extent the results of this case study are representative of other cities in the Netherlands.

Vlissingen was chosen as the case study area due to the large number of exca*vat*ed cesspits and water wells, as well as the significant presence of cask-lined features. However, Vlissingen occupies a unique position compared to many other Dutch cities. First, it experienced rapid growth during the 16th century, and second, it functioned as a trans-shipment port, serving both maritime trade and commerce with cities like Antwerp. Furthermore, the soil conditions in Vlissingen differ significantly from those of inland cities such as Deventer and Nijmegen. Therefore, generalizing the results of this Vlissingen-focused study to all Dutch cities would be ill advised. However, the comparison is valid for cities with a similar diachronic development, position in trade networks, and soil conditions, such as Middelburg, Veere, and Dordrecht.

Cask marks

One of the key studies in this dissertation focuses on cask marks, which are frequently found on casks from archaeological contexts, yet often receive only superficial attention in archaeological reports. This is primarily the result of ambiguity about their purpose, preventing a proper understanding of their significance and related position in trade networks. However, when studied in detail, these marks offer valuable insights into production control, trade networks, ownership structures, and regulatory practices of cask production, transport, and contents.

The aim of this sub-study is to clarify the function of cask marks by examining their intended purpose, the phase in the casks' lifecycle during which they were applied, and the individuals or groups responsible for marking the casks. To this end, the Database WOODAN Cask Marks (www.woodancaskmarks.org) was developed to group cask marks by function (Chapter 7) according to a newly established typology. The database contains 1,021 cask marks from archaeological contexts, supplemented by 880 examples from written sources, bringing the total dataset to 1,901 marks.

Although cask marks have been studied in archaeological, historical, and architectural-historical disciplines, a comprehensive and integrated investigation into the full range of marks found on casks has so far been lacking. Archaeological studies of cask marks in the Netherlands usually focus on situations where large numbers are found at a single site. These studies are rare and tend to be site-specific, focusing only on the marks found in that particular context. Historical and architectural-historical research, on the other hand, has often concentrated on a single type of mark, for example, gauge marks or count marks. This narrow focus has resulted in a fragmented understanding of wider marking practices and has hindered efforts to distinguish clearly between different types of cask marks and their function.

The findings from research have been combined in this dissertation to create a new typology, supplemented by an analysis of primary written sources to extract additional information about cask marks, as well as interviews with contemporary coopers. After the typology was established, it was applied on cask marks found in archaeological contexts, revealing additional details about the various cask marks. The resulting typology identifies six main cask mark types, some of which are further divided into subtypes.

1. Production mark
   A. Construction mark
   B. Coopers' mark

2. Cask gauge mark
   A. Cask gauge approval mark
   B. Cask gauge rejection mark

3. Content gauge mark
   A. Content gauge approval mark
   B. Content gauge rejection mark

4. Identification mark
   A. Product identification mark
   B. Personal identification mark

5. Corporate identification mark
   A. Count mark
   B. Content quantification mark

Each type and subtype of cask mark served a distinct purpose, and to differentiate them, three features were analyzed (Section 7.5). First, the design of the cask marks varied between types. Additionally, the methods used to apply these marks differed and involved tools such as timber scribes, knives, branding irons, compasses, brushes, and strike irons. The application methods were further examined using photometric stereo techniques, which enabled detailed cross-sectional imaging of the marks. Finally, the location of the marks on the cask also varied by type, including the head (external), head (internal), bilge bottom, bilge centre, and bilge near the hole.

The first type of cask mark applied during a casks' lifecycle was a production mark, which could be one of two subtypes: a construction mark and a coopers' mark. Construction marks were made by coopers to assist in assembly, such as measuring, matching parts, and sequencing staves. These marks, typically incised with knives or compasses, mainly appear on cask heads and sometimes on bilges, though marks on the bilge were often removed during finishing. Their designs vary, including V-shaped marks for matching and concentric lines for orientation and measuring of the heads. Coopers' marks were added after production to track output, identify makers, and ensure quality control. Often required by guilds and export laws in the 15th century and following, these marks feature straight lines, crosses, monograms, or Christian symbols, applied with tools such as timber scribes or branding irons, which made durable marks. Production marks are commonly found on cask heads (internal and external) or the bung stave in the bilge, with some regulations specifying exact placement (Sections 7.7.1 and 7.8.1).

The second type of cask mark, the cask gauge mark, was applied at the end of production by inspectors (*keurmeesters*) to certify a casks' quality and capacity. Approval marks indicated compliance with strict regulations on dimensions, materials used, and watertightness, clearing casks to be filled for trade. Rejection marks identified casks that failed inspection and needed repair before they could be filled. These marks were crucial for maintaining standards, especially for export goods like beer, herring, and butter, and their use dates back to the 15th century.

Approval marks often featured a city's coat of arms or identifying letters and were typically branded onto the widest stave of the bilge. Rejection marks commonly had a circular design. Annual inspections of reused casks ensured ongoing quality. The distinctive role of these marks, applied by official inspectors, highlights their importance in a casks' lifecycle and justifies their classification as a separate mark type (Sections 7.7.2 and 7.8.2).

After casks entered the second phase of their lifecycle as a transport container for goods, a second gauging process was carried out. Unlike the initial inspection, which focused on the casks' quality and capacity, this subsequent gauging was aimed specifically at the contents of the cask. This resulted in the application of a third type of cask mark, known as the content gauge mark. The contents were assessed, and if they met the requirements, the cask was marked with a content gauge approval mark. Contents that did not met the required standard, were marked accordingly. Particularly important in the export-oriented herring trade in Holland in the Late Middle Ages and Early Modern period, these marks guaranteed product quality, indicated the catch period and the export destination. They were clearly visible and applied to be durable typically with a timber scribe, most often on the bilge or heads of the cask (Sections 7.7.3 and 7.8.3).

The fourth and most frequently occurring cask mark type, an identification mark, was used to identify a casks' contents and associated persons or companies. During their use as transport containers, casks were marked with identification marks to enable easy recognition. Product identification marks indicated the contents. Such clear labelling helped avoid confusion, for example, keeping track of the many different products in VOC ships' cargo (Verenigde Oost-Indische Compagnie, Dutch East India Company). Personal marks acted as signatures of merchants or owners, facilitating trade and transport. Corporate marks signified ownership or origin, often used by breweries or the VOC. Unlike official inspection marks, these marks were applied by traders themselves without strict regulations regarding design or placement. They ranged from letters to logos and were applied using branding irons, ink, or paint, allowing quick identification of the casks' contents and ownership (Sections 7.7.4 and 7.8.4).

Count marks, the fifth type of mark in the typology, were used to indicate the quantity of casks during their use as transport containers. Applied informally by merchants, consumers, and traders, these marks helped quantify goods. As part of everyday trade, such as the counting and marking of ship cargoes at toll stations, these cask marks were applied outside any formal institutional framework, which explains the limited written evidence concerning their regulation. Typically, count marks comprised tally systems or numeric symbols like Arabic or Roman numerals, reflecting regional and temporal variations. Archaeological evidence shows these marks were usually incised with a timber scribe or knife and placed on random parts of a cask, such as the bilge or heads. Their widespread, practical use justifies

their classification as a distinct type of cask mark (Sections 7.7.5 and 7.8.5).

The sixth and final type of cask mark is the content quantification mark, applied by officials after the casks arrived at their destination. These marks recorded the measured volume of the contents so that excise duties could be calculated, which was a vital source of cities' revenue. The mark that has received the most attention, the wine gaugers' mark, features distinctive design elements, lines indicating quantity and transverse crosses to indicate counting had been completed, thus preventing fraud. These marks were incised with a timber scribe and placed on a casks' bilge near the bung hole. The marks' detailed design and institutional role underscore their importance in regulating trade and taxation in medieval cities (Sections 7.7.6 and 7.8.6).

The eleven subtypes of cask marks, some of which, such as personal ownership marks, could be applied multiple times to a single cask, suggest that most casks were marked. Nevertheless, archaeological reports often mention unmarked examples. This absence can be partly explained by the fact that certain marks were typically applied only to casks with export products, like wine or herring, each of which had its own set of marks. Casks used for products intended for local trade generally bear fewer cask marks, as there was no need for elaborate quality control since the producer of the cask or its contents was in direct contact with the final consumer.

Additionally, many marks may have gone unrecognized during archaeological research. In maritime contexts, casks often disintegrate, making marks harder to detect, especially after exposure to post-depositional factors like shipworm damage. On terrestrial sites, insufficient cleaning or limited focus may have hindered mark identification. This may be the result of limited attention to cask marks, which this sub-study seeks to address by highlighting their value and promoting more systematic documentation.

Building on the results of the individual sub-studies, the four central research themes, namely production, use as transport containers, reuse, and cask marks, have been examined in detail. They have been addressed together in this dissertation within the framework of the casks' lifecycle, guided by the *chaîne opératoire* theory (Section 1.3.1), which served as the primary theoretical backbone. This approach has produced multifaceted insights into casks from Dutch archaeological contexts dating from the Late Middle Ages to the Early Modern period (1300–1800). At the same time, it establishes a methodological foundation that enables a further interpretative step, in which the cask can be employed not only as an object of study but also as an analytical tool for situating the archaeological site of discovery, for instance a shipwreck, within a broader maritime cultural landscape (Section 1.3.2).

The way in which casks can be employed to situate an archaeological site within the maritime cultural landscape is particularly illustrated in the final sub-study, which focused on identifying the shipwreck BZN 4 as the frigate *'t Hart* (Chapter 8). The research was initiated with the identification of a specific mark, MSP, found on four casks from the shipwreck, which could be directly linked to an individual recorded in historical sources, Matheus Sigismundus Pallak (1709–1767). This ultimately allowed the identification of the BZN 4 shipwreck and the contextualization of both the casks and the entire shipwreck within the maritime landscape, providing a clear example of the value of casks as tangible archaeological evidence for situating not only the artifacts themselves but also their site of discovery within a maritime cultural context.

As stated, the research was initiated by identifying the cask mark MSP and establishing its direct link to Matheus Sigismundus Pallak in historical sources. This connection allowed for targeted archival research, which clarified Pallak's trade network. The investigation also revealed the frigate *'t Hart*, known to have sunk near Texel in 1751, which matched BZN 4 in both location and date. These findings supported the hypothesis that the BZN 4 shipwreck could be identified as the frigate *'t Hart*.

To test this hypothesis, a systematic comparison was made between archaeological data from BZN4 and historical records about *'t Hart*. These included the construction date, ship dimensions, use as a merchant vessel, cargo and equipment, the location of the shipwreck, and the date of sinking. Dendrochronological analysis dated BZN4's timber to 1736–1746, aligning closely with *'t Hart*'s known construction year of 1739. Measurements from the wreck suggest a ship of 30.6 m in length and 9 m in beam, very close to *'t Hart*'s documented dimensions of 30.8 m x 8.4 m (Section 8.4).
The cargo provides perhaps the strongest evidence: BZN4 carried casks filled with coffee beans, and written sources confirm that *'t Hart* was transporting coffee, cocoa, and sugar. Five cask marks found on BZN4 matched those listed in *'t Hart*'s cargo documentation, even though only a small portion of the estimated 780 casks was recorded during excavation. Further archival investigation revealed that Arent Hartjens, likely the ship's namesake, conducted business with Pallak and handled shipments of coffee bearing the MSP mark, in Amsterdam, further linking the wreck to *'t Hart*.

This convergence of archaeological evidence and historical documentation makes a compelling case for identifying BZN4 as *'t Hart*. The case study highlights the significant potential of cask marks to connect material remains with written records. By combining archaeological and archival research, this case reconstructs not only the identity of a shipwreck but also offers insights into 18th-century maritime trade, shipping practices, and commercial networks in the Dutch Republic (Section 8.5).

Reflecting on the central research question, the sub-studies reveal significant insights into the phases of a casks' lifecycle between 1300 and 1800. Cask production was an important and extensive craft, especially in the port cities of

the western Netherlands, which served as key markets for the trade of beer and herring. These cities imported the necessary timber primarily from the Rhine and Meuse valleys, as well as from regions around the North Sea and Baltic Sea.

During its use, the cask primarily served as a storage and transport container for liquids such as beer, wine, as well as for dry goods, highlighting its versatility. Herring and beer casks each had their own specific characteristics, and other products likely required casks with distinct features, including their own sets of cask marks. Archaeological evidence shows that damaged or discarded casks were rarely wasted; instead, they were often repurposed as household furniture, storage containers, or shaft for cesspits and water wells, demonstrating sustainable practices. The lifecycle of a cask reflects not only the skilled craftsmanship and economic networks of the period but also the resourcefulness and sustainability embedded in its use and repurposing. This comprehensive understanding underscores the casks' crucial role within the maritime cultural landscape of the Netherlands between 1300 and 1800 and offers substantial opportunities for future research into this underexplored and underappreciated wooden container from Dutch archaeological contexts.

9.3 Data limitations and methodological considerations

This study employs a multidisciplinary research design, integrating archaeological, dendrochronological, historical, iconographic, and material data from museum collections. Throughout, the archaeological data remains central, providing the primary framework for analysis and situating the research firmly within the archaeological domain, while the complementary data sources enriches contextual and supplementary understanding and supported cross-disciplinary interpretations. Each of the data sources have its own limitations and is collected and employed in different ways. In the first instance, however, it is important to reflect on the archaeological data, as it forms the foundation for the study's interpretations and conclusions.

The main focus of source criticism lies in the limited representativeness of archaeological data. Although a considerable number of casks have been included across the various datasets, they still account for only a fraction of the total casks that circulated during the research period. Consequently, analyses based on these datasets should be used primarily to identify overarching patterns and long-term trends in the lifecycle of casks, rather than to draw conclusions about specific developments linked to short time spans or isolated events.

The representativeness of the dataset is further limited because only casks from archaeological contexts with sufficient contextual information were included. The compilation of the datasets relied primarily on published archaeological data, with only limited use of unpublished material. As a result, casks from excav*at*ions conducted prior to approximately 1990, many of which are documented only

in unpublished excavation records, are largely absent from the datasets. This introduces an additional layer of selection bias into the archaeological evidence used in this dissertation.

Further limitations in the composition of the dataset become clearer when examining the two distinct find contexts: urban and maritime. Urban contexts are particularly limiting because the casks recovered there were primarily repurposed, especially as linings in cesspits and water wells. The data show that only casks with a diameter greater than 45 centimeters were suitable for such repurpose. As a result, smaller casks, which also circulated between 1300 and 1800, are underrepresented in the dataset.

Additionally, the dataset shows a relative overrepresentation of casks originating from the coastal zone of the Netherlands. While this may partly reflect the actual higher prevalence of cask use in this region, it is also influenced by varying soil conditions. The waterlogged environments typical of the Dutch coastal zone provide favourable preservation conditions for wooden artefacts. In contrast, such conditions are largely absent in the eastern and southern parts of the country where the soil is sandy. Here wooden casks are less likely to have survived, except in cases where they remained below the groundwater table. This preservation bias may therefore have contributed to the apparent concentration of archaeological cask finds in the coastal region of the Netherlands.

The portion of the dataset derived from maritime archaeological contexts comes primarily from shipwrecks. It is evident that many of the casks disintegrated after the sinking of the ship, unless they had already been washed away during the sinking. The fragmentation into individual cask components also means that, at many shipwreck sites, the cask elements are recorded as separate finds rather than reconstructed as complete casks. This complicates analysis of these finds at cask level.

Furthermore, casks that have been dendrochronologically analyzed play an important role in several sub-studies. In assembling the datasets presented in Chapters 2 and 3, successful dendrochronological dating was even a requirement for a cask to be included. This introduces a bias, as not all casks from Dutch archaeological contexts have been dated dendrochronologically, resulting in a dataset that is inherently selective. In many cases, only the components with the highest potential for tree-ring analysis are sampled during fieldwork, typically those from relatively large casks, which are more likely to contain sufficient tree rings for successful dendrochronological analysis.

As previously indicated, the casks from archaeological contexts, whether dendrochronologically analyzed or not, are further contextualized through the use of additional data sources. This applies particularly to written sources, which are employed in each sub-study but represent only a fragment of the available

material, leaving considerable potential for further data extraction. For example, approximately 880 cask marks from historical records are included, collected from only a few archival documents, which was already regarded as a significant yield. Similarly, in the study of iconographic sources, the RKD Netherlands Institute of Art History database was consulted. While this database contains many relevant historical paintings and etchings, it does not capture all potential material. Beyond this source, only limited use was made of iconographic materials, as the time required to conduct a more exhaustive search within the scope of this research would not have produced proportionate results.

The methodological considerations for the research presented in this dissertation primarily concern reflection on the theoretical framework, with the lifecycle of the cask serving as the central *chaîne opératoire*. The study has been successful in providing a general overview of the various individual phases that together constitute this lifecycle, making it a broadly applicable study of a category of finds from Dutch archaeological contexts.

Building on the methodological reflection outlined above, this dissertation demonstrates that casks constitute a particularly suitable artefact category for application of the *chaîne opératoire* framework. The approach has proven effective in structuring and integrating the successive stages of the cask lifecycle, from production through use, reuse, and final deposition, thereby confirming its value for analyzing complex artefact biographies. However, the results also suggest that casks are especially informative for the socio-cultural dimension of the framework, as they embed the object within broader networks of production, trade, and consumption.

Rather than focusing solely on manufacture, the study highlights how casks connect producers, packers, transporters, merchants, and consumers, and how successive reuse and repurposing extend their interpretative potential. In addition, merchant marks enable direct linkage with increasingly detailed archival sources for the period 1300–1800.

In this sense, the case study suggests that the *chaîne opératoire* framework can be meaningfully extended through the study of casks, as these differ in important respects from the lithic artefacts for which the approach was originally developed. In contrast to lithics, casks are directly embedded in their use phase as containers for identifiable commodities, linking them explicitly to the products they once held. Moreover, they acquire different meanings for different actors: as packaging for producers, as trade goods for merchants, and as containers of merchandise or foodstuffs for consumers. This multi-layered functionality is materially inscribed on the object itself, not only through use-wear but also through deliberately applied caskmarks that create a bridge to archival sources. Finally, their later repurposing as furniture or as shafts in water wells and cesspits represents an additional and

distinct use phase in the cask lifecycle, thereby adding an extra layer of interpretative potential for this artefact category within the *chaîne opératoire* framework.

Based on the results of the sub-studies structured through the *chaîne opératoire* framework, the next step is to position casks within their contexts by adopting the maritime cultural landscape approach as the subsequent theoretical backbone. So far, this has only been done to a limited extent, as the absence of an overall understanding of the casks' lifecycle previously made such an approach challenging. However, the sub-study presented in Chapter 8 serves as a clear example of how casks can be used to place a shipwreck within the broader maritime landscape, illustrating that these frequently encountered archaeological finds hold a key role in reconstructing and interpreting such maritime landscapes.

Another methodological aspect concerns the multidisciplinary framework through which the research in this dissertation was conducted. This approach integrated archaeological, dendrochronological, historical, iconographic, and material data from museum collections. In addition, supplementary data were gathered through 3D scanning, photometric stereo techniques, and interviews with contemporary coopers who continue to practice traditional methods. The multidisciplinary setup proved methodologically productive, as it enabled the analysis of casks not merely as material remains but as historically embedded artefacts with social, economic, and technological significance. In particular, the integration of material and textual sources deepened the interpretative scope and provided multiple layers of evidence for reconstructing the casks' lifecycle.

This general overview, however, can vary significantly when examining specific types of casks. For example, a herring cask followed a different lifecycle than a beer cask. Herring casks had particular characteristics, which affected the way they were constructed. Their lifespan also differed from casks intended for other products such as beer or wine, as they were typically used only once and not reused. The cask marks applied to herring casks also differed, reflecting a separate quality control system and trade network. In other words, the herring cask fulfilled its role within a distinct maritime landscape compared to, for example, a beer cask. Specific studies on cask for individual content could potentially be conducted in future research, using the results of this dissertation as a foundational framework.

9.4 Recommendations for future research

The research is structured around a layered theoretical framework, with the *chaîne opératoire* as the primary focus, examined through the lifecycle of casks, and the maritime landscapes in which they operated forming a secondary analytical layer. In line with this layered approach, recommendations for future research are first presented with regard to the casks' lifecycle, followed by potential additional studies focused on the maritime landscape.

Firstly, it can be noted that the datasets compiled for this dissertation capture a substantial proportion of the casks documented in Dutch archaeological contexts, a level of coverage that was not achieved with other types of data sources. Information from these complementary sources, particularly written records, can be considerably expanded to provide more detail on specific aspects, such as their use as transport containers, patterns of repurposing, and cask marks. In future research, it would also be possible to approach the topic primarily from the perspective of written sources, using archaeological data as contextual and supplementary evidence to enrich interpretations and validate patterns identified in the documentary record.

Secondly, it is recommended that the research framework established in this dissertation be applied to casks from other countries. The current study's geographical scope was necessarily limited by the present-day borders of the Netherlands, but as expected, the topic is best approached from an international perspective. Research in neighboring countries, such as the United Kingdom, Belgium, France, and Germany, would provide a valuable extension and contribute to a better understanding of casks in a broader international context, , as cask circulation was not constrained by modern national borders.

Thirdly, some of the focused sub-studies presented in this dissertation could be further expanded by conducting similar research on additional topics. For example, research could examine the specifications of casks used for products other than beer and herring, as explored in Chapter 5, such as dairy products or wine. Similarly, the sub-study of the repurposing phase, which was addressed here through a case study focused on Vlissingen (Chapter 6), could be extended to other cities or regions.

As indicated, the research results from the various phases of the cask lifecycle can also be used to situate the casks within the maritime landscapes in which they operated. This could be initiated with studies of the lifecycle of casks used for specific products that were widely produced in the Netherlands, such as herring, beer, or dairy products. Such research could also be conducted with a focus on specific regions or time periods, provided that sufficient archaeological data is available to ensure reliable analysis. Such targeted research would provide a stronger foundation for reconstructing the associated maritime landscapes, allowing for a more precise understanding of their organization, economic networks, and special scope.

Further research into cask marks on as-yet unidentified shipwrecks could be highly fruitful, as demonstrated by the successful identification of the BZN 4 wreck (Chapter 8). In such cases, cask marks can provide a vital link between the archaeological evidence of a shipwreck and the historical documentation recorded in written sources. To maximize the likelihood of identification, research should initially focus

on shipwrecks that have yielded a substantial number of marked casks, preferably bearing letter or character combinations, as these facilitate searches in digitized and transcribed archival materials. Comprehensive documentation of the ship's details and cargo is also essential for achieving a reliable identification. Consequently, the most promising candidates are often relatively recent shipwrecks, such as those dating from the seventeenth or eighteenth century.

As a final recommendation, both urban field archaeologists and maritime archaeologists are encouraged to pay greater attention to the systematic documentation of casks. The compilation of the dataset for this study benefited from the numerous archaeological reports in which casks were recorded. However, it also became clear that the level of detail in which these finds were documented varied considerably between reports, resulting in incomplete datasets for many individual casks. To fully realize the analytical potential of this artefact category, a more consistent recording strategy is required. Casks should be documented through a set of standardized measurements and construction attributes, including overall dimensions (height and minimum and maximum diameter) from which capacity can be derived, as well as the number of staves and headboards, stave thickness, hoop configuration, timber type, and type of holes.