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Building Survey

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Introduction

One of the most common activities in building construction since ancient times has been measurement. Traditionally, manual methods have evolved in response to new challenges related to the collection of geometric information, whether for the design, refurbishment, or rehabilitation of buildings. The use of measuring tapes and hand-drawn sketches has been common for centuries, and although these tools have gradually improved over time, the fundamental principle has remained the same: the use of sketches drawn by hand. However, with the advancement of digital technologies, more efficient and accurate methods have been developed, such as three-dimensional laser scanning.

The aim of this report is to present these differences through the development of a survey of the corridors of a building in which both methods were used. This includes the use of traditional measuring tapes and the recording of information through hand-drawn sketches on paper, in contrast with a survey carried out using a 3D laser scanner. From the comparative analysis of both methods, professionally valuable results are obtained in relation to planning and efficiency in building surveys.

1. Planning the Survey

1.1. Purpose of the survey

To understand the advantages offered by digital 3D surveys for obtaining geometric information in spaces where interior dimensions are required with greater accuracy and through a more efficient process, a survey was carried out using a laser scanning device (Terrestrial Laser Scanner – TLS) based on LiDAR technology, applying the station-based scanning method. The selected enclosed space was one of the corridors located on the upper floors of the Dylan Thomas Building, which presents a certain level of geometric complexity in terms of the detail of the information to be collected. This includes structural elements such as columns and stair accesses, as well as architectural elements, mainly doors. These elements are particularly relevant for the production of drawings in building design or modification processes.

A second survey was also conducted using traditional measuring tapes and a laser distance meter, together with pencil and paper for hand-drawn sketches and the recording of the required measurements for each corridor and its structural elements. The purpose of carrying out both surveys is to enable a comparative analysis at each stage of the surveying process, from planning through to the production of the required drawings.

This comparison highlights how the review of information from the database is facilitated and to what degree human errors are reduced when compared with traditional measurement methods.

1.2. Survey Area Definition

In accordance with the guidelines established for this survey, the area was defined in advance with the objective of achieving an appropriate level of detail within the time available to complete the task during a four-hour class session.

The main areas of the upper-floor corridor of the building were included, prioritising those sections where the general geometry of each polygon generated at each scanning station could be effectively captured.

Restricted access zones and certain areas that, according to the initial instructions, were considered not relevant to the objectives of the study were excluded. This approach allowed resources to be optimised for data processing. As a result, the areas of interest were defined by focusing on general dimensions, visible architectural elements, and structural components such as columns, without going into detailed construction elements due to time constraints.

1.3. Site Assessment

Before the execution of the survey, a preliminary site evaluation was carried out with the purpose of identifying favourable conditions for the survey, without restricting the free movement of people circulating through the access areas of the site. Within this evaluation, consideration was given to the availability of space where the placement of the equipment and the movement required at each scanning station could be carried out without any obstruction or the presence of physical obstacles that could affect its execution.

When analysing some of the potential challenges related to the use of Terrestrial Laser Scanning, particularly those associated with atmospheric conditions, it was determined that, as this was an indoor environment, there were no issues that could affect the performance of the survey. (Callidus Building Surveys Ltd, 2024)

Natural and artificial lighting conditions present on site were also considered, as these could influence the operability of the scanner. Additionally, the type of adjacent surface textures did not represent any problem or limitation for the organisation of the work.

The survey was carried out in working groups, which were divided to perform both the digital 3D survey and the traditional survey method. The equipment used for both methods is described in Appendix D of this report.

The digital survey was conducted using a terrestrial laser scanner (TLS), based on LiDAR technology and operating in a static, station-based acquisition mode. The instrument is compact and specifically suited for indoor environments such as corridors, providing dense point cloud data with near full-field coverage (Bosche, Forster and Valero, 2015).

1.3.1. 3D Laser Scanning Methodology

The methodology followed for the 3D survey consisted of placing the scanner in strategic positions and at appropriate distances in order to obtain complete coverage of the previously defined areas. Each group performed scanning operations from each station and captured information from a fixed point, moving in an anticlockwise direction while recording all the data. Using the scanner configuration tablet, the connection between one station and the next was established until the polygon was closed. Once the data were processed, the resulting point cloud was used as a basis for the extraction of measurements and for its integration with computer-aided design software.

1.3.2. Traditional survey methodology

The equipment used for the traditional method consisted of measuring tapes, pencil and paper to produce hand-drawn sketches and to record the corresponding measurements. With regard to manual measurements, sketches were prepared by hand, and the recorded information was transcribed and

transferred into AutoCAD in order to compare the information obtained using both methods.

1.4. Risk Assessment Summary

During the planning of the survey, one of the upper corridors of the Dylan Thomas Building was selected, as it presented low pedestrian circulation during the measurement activities. In addition, the organisation of a large group was divided into smaller working groups, which were assigned to carry out both the digital 3D survey and the traditional survey method.

Operational and environmental risks and mitigation

- **Operational risks**

- **Pedestrian traffic**

- Offices and cubicles in use
- Opening and closing of doors

- Mitigation

- Conceptual planning by sections
- Avoiding obstruction of circulation routes

- **Intermediate and fire doors**

- Potential blockages
- Geometric variations between corridor wings

- Mitigation

- Use of door wedges to keep doors open
- Consideration of stations and transitions during execution

- **Environmental risk**

- **Incomplete or poorly installed false ceiling**

- A section of the false ceiling presented missing or incorrectly placed panels
- No evidence of collapse, but irregular geometry was observed

- Mitigation
 - Caution during circulation
 - Consideration of these conditions within the point cloud
- **Minor controlled risks**
 - **Windows and other elements**
 - Windows and emergency exit with potential lighting variations
 - Lifts with reflective metallic surfaces
- Mitigation
 - Visual review of the collected data
 - Greater focus on geometry rather than colour

Table 1. Summary of Risk Assessment

Source: Own elaboration

Risk	Type	Impact	Mitigation
Pedestrian traffic	Operational	Low	Section-based planning
Intermediate doors	Operational	Medium	Stations at key nodes
Incomplete false ceiling	Environmental	Low–medium	Caution and on-site checking
Metal lifts	Environmental	Low	Visual control of noise
Enclosed corridors	Operational	Low	Appropriate overlap

Despite all the risks identified for this study, the site presented favourable conditions for the execution of the survey, with clear routes and well-signposted access points. The identified risks were considered manageable and did not represent any obstacle or setback for the planning and execution of the survey.

2. Practical Survey Execution

2.1. Evidence of on-site work

The execution of the survey was carried out in accordance with the planned activities. The meeting point was the auditorium of the Dylan Thomas Building,

where instructions were given, working groups were organised, and the measuring instruments and equipment were assigned (see Figure 1(a), Appendix A).

One of the teams was assigned to carry out the measurements using measuring tapes and a laser distance meter, taking notes and producing hand-drawn sketches to perform the conventional survey. The other group proceeded with the execution of the digital survey using the 3D scanner.

The survey site and the different measurement activities were documented through photographs (see Appendix A).

2.2. Survey Execution Summary

Afterwards, the teams moved to the survey site and, once the tripod and the scanner were positioned, the configuration and scanning process was carried out using the tablet of the 3D laser scanner until the information from that point was processed. In this way, the initial station point was established, which allowed the capture of the first corner of the northern section of the upper corridor of the building. From this point, the work continued by moving to the following stations in an anticlockwise direction towards the west, covering the southern corridor section and finishing with the eastern section of the corridor (see Appendix D).

2.3. Problems encountered and solutions

During the execution of the survey, the problems encountered were minor. These included people moving through the corridors and some doors that needed to be opened and held in position using door wedges to avoid partially limiting the scanner's line of sight.

Additionally, as the working groups consisted of approximately ten people operating within corridors between 1.0 and 1.5 metres wide, it was necessary to move outside the scanner's field of view during data acquisition to mitigate potential issues. These actions helped to reduce the generation of shadows in the point cloud and allowed adequate coverage of the areas of interest. It was also observed that real-time decisions were taken, showing flexibility with the original planning during the execution of this type of survey

3. Measurement and Analysis

3.1. Measurements obtained from laser scanning

For this process, the measurements analysed in this study were obtained from terrestrial laser scanning (TLS) and transferred to the processing software, where the results were delivered in printed format. Although the survey was carried out in 3D, the information provided corresponded mainly to a two-dimensional floor plan generated from a horizontal section of the point cloud obtained from the scan. These sections are formed by connecting lines where a higher concentration of grouped points is present, which together define each line.

From this plan, which can be generated using computer-aided design software such as AutoCAD, it is possible to extract the general dimensions of the studied area. This includes the total length and width of the corridors, as well as the different geometric measurements along their layout, until the actual geometry of the space is defined. Likewise, measurements of the door openings represented in the plan were obtained, determining both the width of the openings and their location within the corridors.

3.2. Comparison with traditional measurement methods

Using the 3D laser scanner, each station allowed the recording of all relevant information through the laser, making it possible to capture:

- Wall alignment
- Corridor width
- Exact location of doors
- Vertical elements such as stairs and lifts

In contrast, when using traditional methods with measuring tapes or manual laser distance meters, the time required varies depending on the level of detail needed. For this study, the instructor emphasised the collection of information sufficient to obtain a floor plan, in order to reduce the measurement time when using the traditional method.

The recording of information through 3D scanning allows the generation of a point cloud that is stored and can be used at any time according to the purpose of the survey, making it possible to generate drawings from this information (FARO, n.d.).

Using the traditional method, one of the main difficulties encountered was the transcription of hand-drawn sketches and the need to analyse them with team members when measurements were unclear or when ambiguous dimensions needed clarification from drawings made without scale. In some cases, it was necessary to return more than once to confirm specific information. This makes the task of consolidating the information to be drawn in plans considerably time-consuming.

From the perspective of accuracy, laser scanning offers a considerably greater advantage, reducing the accumulation of human errors associated with manual measurement in traditional methods, especially over long distances that must be measured in segments to obtain the total dimension.

Overall, the use of laser scanning represents a more efficient, accurate, and complete methodology for obtaining geometric information in built environments.

3.3. Conclusion:

The terrestrial laser scanning allows the complete geometry of the environment to be captured quickly and accurately, generating a comprehensive digital record that can be used for different analyses and projects without the need to repeat fieldwork. This is particularly relevant in spaces with complex geometry and high levels of detail.

Although it is true that the acquisition cost of laser scanning equipment is high for an individual professional, this type of technology represents an essential tool for specialised companies, consulting firms, and public agencies, as it improves the quality, efficiency, and completeness of their surveys. In this sense, both methodologies complement each other depending on the needs and available resources of each project.

4. References

Bosche, F.N., Forster, A.M. and Valero, E. (2015) *3D Surveying Technologies and Applications: Point Clouds and Beyond*. Heriot-Watt University.

Callidus Building Surveys Ltd (2024) *Common Challenges in Laser Surveying and How to Overcome Them*. Available at:

<https://callidussurveys.co.uk/common-challenges-in-laser-surveying-and-how-to-overcome-them/> (Accessed: 3 January 2026).

FARO (n.d.) *Point Clouds generated from Lidar for Beginners*. Available at: <https://www.faro.com/en/Resource-Library/Article/Point-Clouds-for-Beginners> (Accessed: 3 January 2026).

APPENDICES

Appendix A



Figure A1: Survey preparation Area (a), Representative internal environments surveyed on the second floor of the Dylan Thomas building. Sub-figures (a–i) illustrate typical corridor conditions, access points, fire-rated doors, ceiling and light conditions, lift areas, and the terrestrial laser scanning setup.

Source: A. Montecinos photographs.

Appendix B

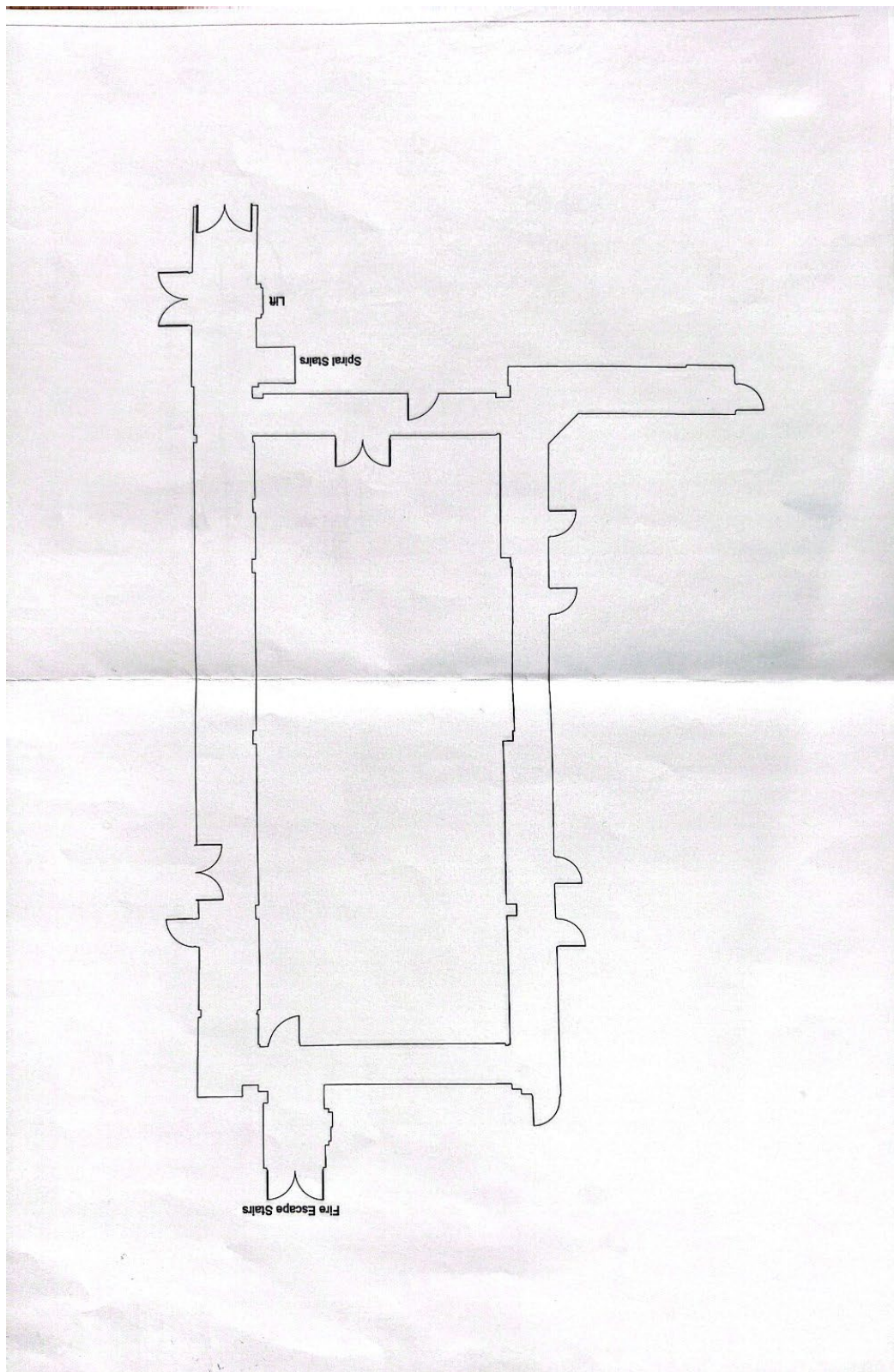


Figure B1: Figure B1. Floor plan derived from terrestrial laser scanning data provided by the course instructor.

Appendix C

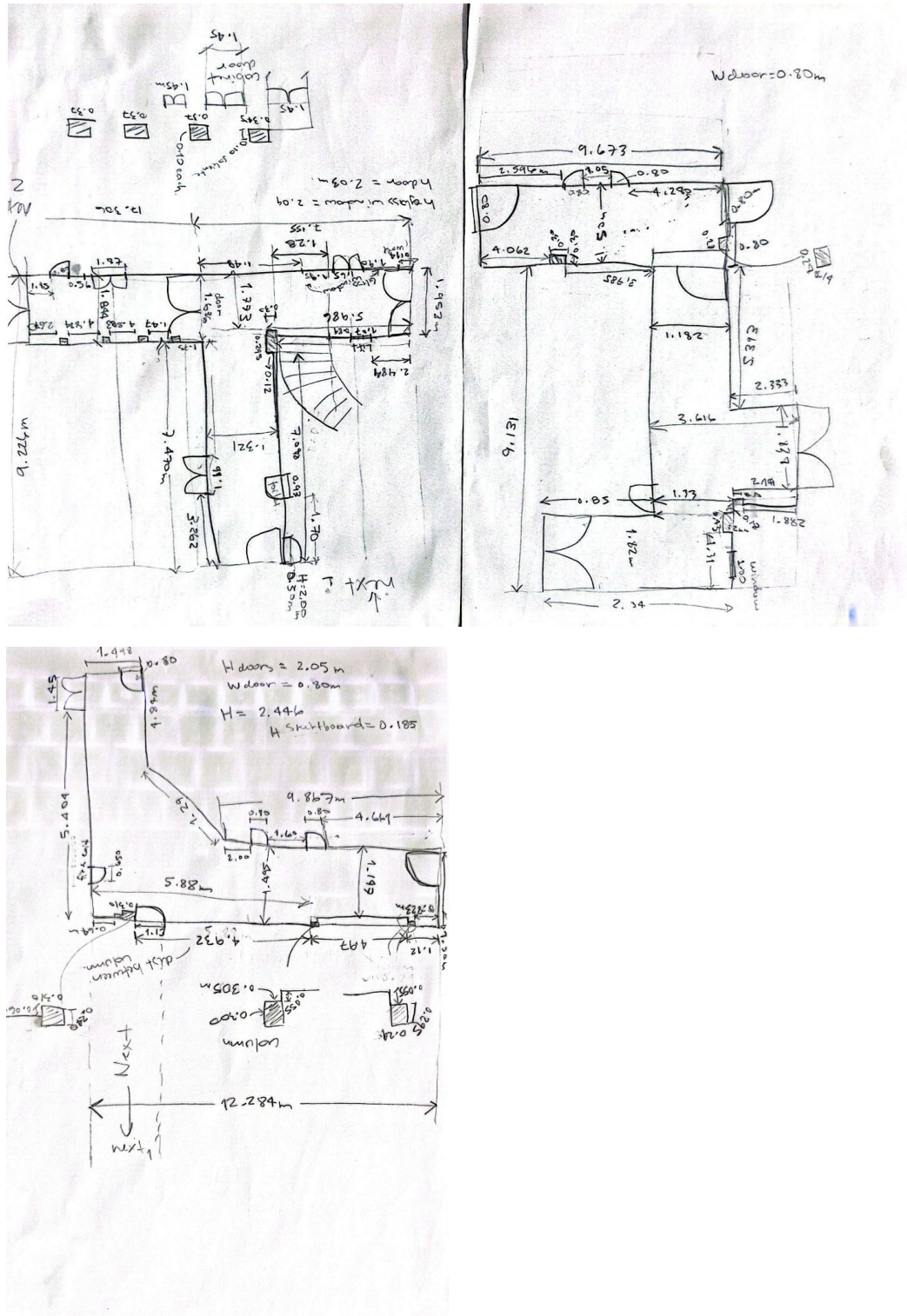


Figure C1: Hand sketches produced during on-site measurement and planning, drawn using paper and pencil to record corridor geometry, access points, and spatial relationships prior to digital data processing.

Source: Author's own sketches.

Appendix D

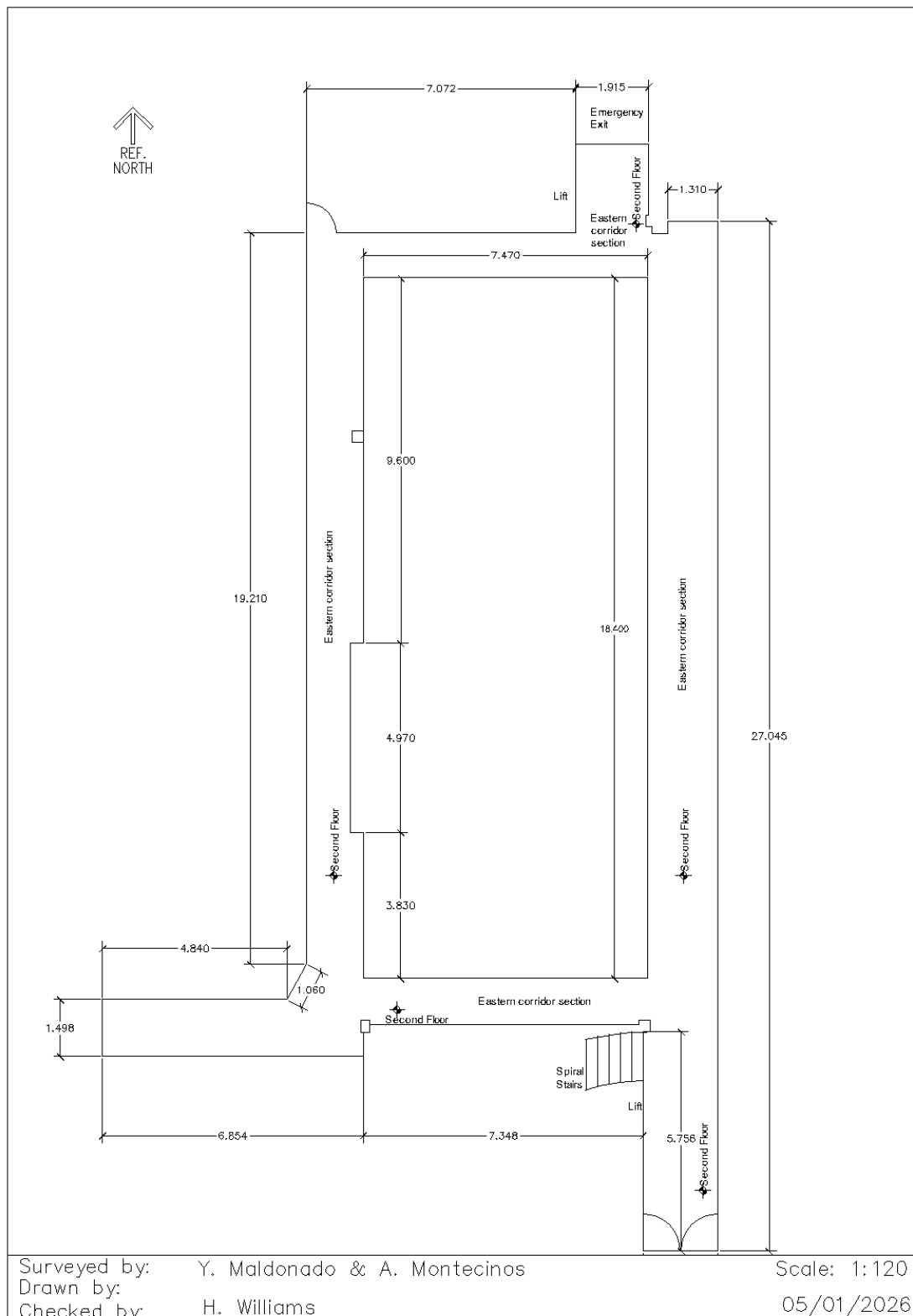
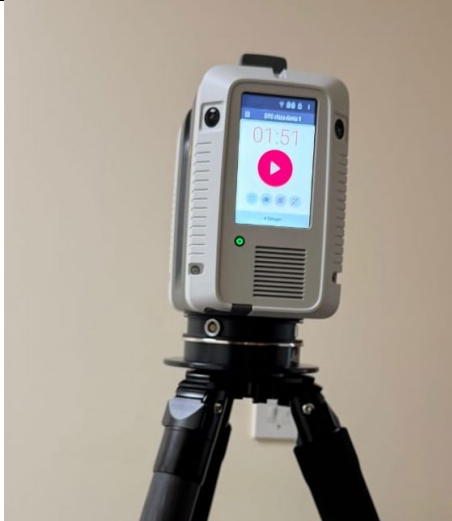


Figure D1: AutoCAD floor plan generated from hand sketches and survey measurements, representing the layout of the second-floor corridors and associated access points.
Source: Author's own drawing.

Appendix E

Table E1: Survey equipment and supporting tools used during the site measurement and planning activities.

Source: Author's own drawing.

Equipment	Description	Purpose	Illustration
Terrestrial laser scanner	Static LiDAR-based scanner mounted on a tripod	Acquisition of 3D point cloud data	
Scanner tablet / controller	Tablet device connected to the scanner	Scan control, configuration, and data monitoring	
Door wedges	Triangular door stops	Temporary fixation of doors to maintain open access	
Measuring tape	Manual measuring tape	Reference measurements and distance checks	
Laser distance meter	Handheld electronic distance measuring device	Quick linear distance verification	
Paper and pencil	Manual recording materials	Field notes, sketches, and annotations	