Transforming our World through Universal Design for Human Development
I. Garofolo et al. (Eds.)

doi:10.3233/SHTI220877

Usability of Visiting Routes in Heritage: The Case Study of Mercati di Traiano

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Abstract. Large museums as services to the community, can be considered strategic facilities needing exploitation after the health emergency. Through optimising usability, some methodologies and tools taken from other building uses (hospitals, airports) for analysing users and flows seem effective in testing new spaces' uses. The case study of Mercati Traianei–Museo dei Fori Imperiali was investigated in two different periods and methods for comparing the impacting factors on usability and orientation of visiting routes. A direct analysis in 2015 detected crucial issues for walking through museum routes and connections, while a more recent indirect analysis went deeper through configurational methodologies included in the Spatial Decision Support System (SDSS). This methodology empowers analysis of the space syntax, and the factors affecting the visitors' satisfaction. The two methods were found to be effective for a deeper knowledge of the museum and its priorities. Tools of direct on-site observation are essential to promptly identify obstacles for upgrading usability. Instead, the configurational analysis allows a much faster application and supports a more global and dynamic vision of more inclusive visiting routes, avoiding visitors' stigmatisation.

Keywords. Large museum, Wayfinding, Spatial Decision Support System (SDSS), Configurational Analysis

1. The relaunch of heritage and the tools to support the revitalization project

Culture and tourism were among the sectors severely hit during the pandemic restrictions. In Italy, as well as in the rest of the world, over 90% of museum complexes and heritage sites faced a lockdown, that stopped the growing trend of visitors recorded in the pre-pandemic [1]. This figure, compared to 2019, dropped down to 72%, with a dramatic impact on the cultural sector, which rates over 5% of European GDP and it is a key of national identity and a business driver. Acknowledging heritage as a key strategy value for providing services to the community [2], the relaunch challenge of NGEU (PNRR Mission 1-Culture and Tourism) pis a recovery driver, also by highlighting innovative use methods as already tested to face the crisis (virtual access and interaction with culture in a digital environment, etc.). Along with strengthening 'intangible' formats of enjoyability to increase the audience engagement, the cultural institutions' strategy is also striving for an inclusion policy implementing physical access to heritage by removing architectural, physical, cognitive and sensorial obstacles to cultural experiences. This includes the largest extent of visitors, also by optimising routes and increasing the overall quality of the visiting experience, and it focuses on tools and

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methods for monitoring, analysing and evaluating design solutions as drivers to decision-making process.

According to the ICF model by WHO [3], physical space is a key factor for empowering, facilitating, or hindering the performances of human tasks and activities, which in this case also include the enjoyability of heritage. Thus, ICF must be adaptive to different functioning models that suit multi-faceted human needs.

Access to culture, also through the qualitative use of different heritage pieces, is then identified as an instrument for ensuring human rights and equal opportunities [4].

To focus on environmental communication as a driver for inclusion, the survey is carried on with other indirect analyses able to objectify characteristics of configuration and mutual visibility in different building spaces. This can produce project inputs of remodelling solutions for the optimization of usability, use methods and times of visitor's flows. These indirect surveys are defined as configurational analysis [5] and refer to Space Syntax-based methodologies [6]. They can empower, through specific SDSS, observation of factors impacting on spaces' usability and flows, which affect visitors' satisfaction [7].

This paper shows the potential of indirect detection tools such as the configurational analysis belonging to the SDSS, already tested in large museums such as the British Museum in London [8] and integrated to direct analysis in a previous study on the large archaeological museum of Mercati di Traiano-Museo dei Fori Imperiali in Rome [9]. This emphasised, together with the overall accessibility items directly observed, proximity spaces relations, circulation hierarchy, routes differentiation, legibility of accesses, ways of using spaces.

2. The case study of Mercati di Traiano-Museo dei Fori Imperiali

To check the integrability of direct type analysis with the study of Space Syntax, we selected the large archaeological museum of Mercati di Traiano-Museo dei Fori Imperiali as a case study. It is in a strategic core location of the Roman Forum, next to the Colosseum and the Capitoline Museums. It is a typical case of layout complexity, due to different altimetric features. This museum was relaunched in 2007 and belongs to the Civic Museums of Roma Capitale (Musei in Comune). It consists of three different levels for visiting the outdoor archaeological area of the Great Hemicycle (Figure 1, "levels 0, 1, 2") and the Great Hall with the main entrance accessible from Via IV Novembre (Figure 1, "level 3"). The upper level (Figure 1, "level 4") of the Great Hall houses permanent and temporary exhibitions. The last level (Figure 1, "level 5") houses administrative offices.

2.1. Direct analysis: detecting critical issues for accessibility

The direct analysis was carried out starting from a cooperation program on the evaluation of accessibility and usability in the built environment ("Avaliação de Acessibilidade e Usabilidade no Ambiente Construído") between the Federal University of Rio de Janeiro (UFRJ PROARQ / Núcleo Pró-acesso) and CNR (2013-2015). This project examined and compared the regulatory and application context of accessibility in Brazil and Italy for the development of an evaluation tool that could merge requirements, guidelines and recommendations of the two countries in order to obtain a homogeneous evaluation method for two different contexts.

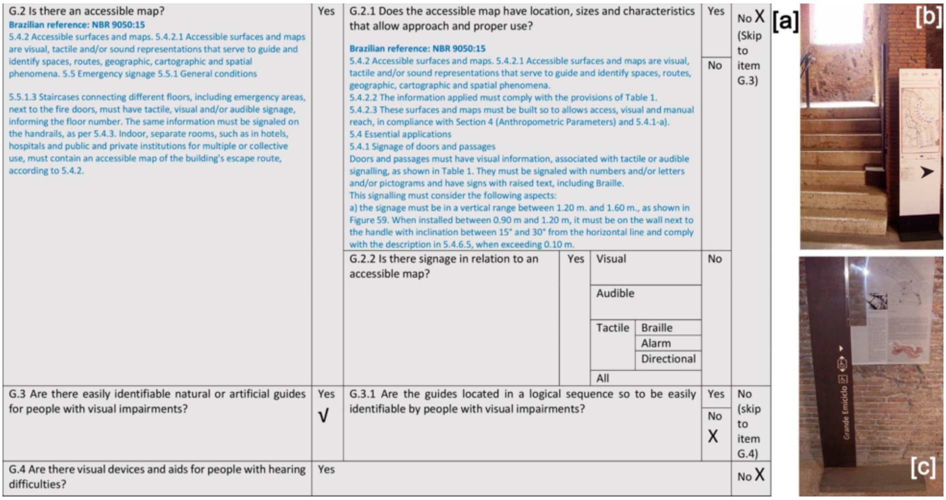
Figure 1. Layout of functional areas and visiting routes of Mercati di Traiano-Museo dei Fori Imperiali

The evaluation format included 8 macro-areas of the built environment, applicable to most public buildings: **A**-Outdoor access area to the building; **B**-Entrance/Access; **C**-Reception (information desk, ticket office, cloakroom); **D**-Circulation (corridors, footbridges, walkways); **E**-Vertical circulation (ramps, staircases, elevators, lifting systems); **F**-Specific areas/rooms (depending on building type); **G**-Information, signage and orientation.

By merging requirements from the accessibility codes of the two countries (highlighting the most favourable or innovative measures in case of requirement conflict), a questionnaire of about 180 questions was developed for reporting the state of accessibility/usability of the items within groups A to G, according to a tree structure with "yes/no" questions going deeper to further questions.

This tool applied to two case studies of large museums: the Imperial Museum of Petropolis (Brazil) and the Mercati di Traiano-Museo dei Fori Imperiali in Rome.

For the Italian case study we mapped blue circles of crucial points and passages in the four floor plans (levels from 2 to 5), associated with photos and a commentary - classified from A to G according to the macro-area, also in reference to orientation and wayfinding [10]. We report question G.2 (section G *"Information, signage and orientation area"* of the questionnaire) on accessible maps and G.2.1 on proper use (Figure 2a). Two G.2.1 points are reported in a commentary with suggested solutions for signage and reference photos (Figures 2b and 2c). We finally illustrate (Figure 3) the inspection routes, the observation points, and the photos of the critical issues discussed in the following sections.



G.2 Is there an accessible map? **Brazilian reference: NBR 9050:15** 5.4.2 Accessible surfaces and maps. 5.4.2.1 Accessible surfaces and maps are visual, tactile and/or sound representations that serve to guide and identify spaces, routes, geographic, cartographic and spatial phenomena. 5.5 Emergency signage 5.5.1 General conditions 5.5.1.3 Staircases connecting different floors, including emergency areas, next to the fire doors, must have tactile, visual and/or audible signage, informing the floor number. The same information must be signaled on the handrails, as per 5.4.3. Indoor, separate rooms, such as in hotels, hospitals and public and private institutions for multiple or collective use, must contain an accessible map of the building's escape route, according to 5.4.2.	Yes	G.2.1 Does the accessible map have location, sizes and characteristics that allow approach and proper use? **Brazilian reference: NBR 9050:15** 5.4.2 Accessible surfaces and maps. 5.4.2.1 Accessible surfaces and maps are visual, tactile and/or sound representations that serve to guide and identify spaces, routes, geographic, cartographic and spatial phenomena. 5.4.2.2 The information applied must comply with the provisions of Table 1. 5.4.2.3 These surfaces and maps must be built so to allows access, visual and manual reach, in compliance with Section 4 (Anthropometric Parameters) and 5.4.1-a). 5.4 Essential applications 5.4.1 Signage of doors and passages Doors and passages must have visual information, associated with tactile or audible signalling, as shown in Table 1. They must be signaled with numbers and/or letters and/or pictograms and have signs with raised text, including Braille. This signalling must consider the following aspects: a) the signage must be in a vertical range between 1.20 m. and 1.60 m., as shown in Figure 59. When installed between 0.90 m and 1.20 m, it must be on the wall next to the handle with inclination between 15° and 30° from the horizontal line and comply with the description in 5.4.6.5, when exceeding 0.10 m.			Yes No	No X (Skip to item G.3)
		G.2.2 Is there signage in relation to an accessible map?	Yes	Visual Audible Tactile: Braille / Alarm / Directional All	No	
G.3 Are there easily identifiable natural or artificial guides for people with visual impairments?	Yes √	G.3.1 Are the guides located in a logical sequence so to be easily identifiable by people with visual impairments?			Yes No X	No (skip to item G.4)
G.4 Are there visual devices and aids for people with hearing difficulties?	Yes					No X

Figure 2. a) Question G.3 from the questionnaire in section G (Information, signage and orientation); b) Point PC120024: clearer horizontal sign with bigger legend needed ; c) Point PC090009: more legible text with bigger fonts and legend needed.

Figure 3. Graphic representation of the synthesis of the direct investigation

This survey highlights solutions to improve the accessibility situation as from 2015, after a previous remodelling with three accessible visiting routes. To better understand the effectiveness of solutions after the on-site survey and to identify further issues in the specific area of environmental communication, the application of configurational analysis was tested on the same spaces.

2.2. Indirect analysis: the survey on spatial configuration

Based on previous findings, we carried out a set of configurational analysis to objectify the relevant space syntactic properties for the purpose of usability and wayfinding (permeability, proximity, connections, visibility). In this phase, we adopted the open-source software called depthmap 0.8.0. This application helps perform two analyses: 1) physical accessibility, by measuring connectivity and integration among different spaces; 2) visual access to different spaces, which, as shown in several studies [11] [12], considerably affects visitors' navigation and thus their visiting experience.

To carry out the first session of analysis, the first step adopts an abstract spatial building model through a graph development of spaces as nodes and lines as connections, i.e. the points of physical access among spaces. Applying the specific case-study (sequential or not), environmental links emerged to bind visitors to a specific route. Further analysis was then conducted to measure the connectivity of each space (given a 'root' space linking to a maximum number of spaces). By replicating this calculation for each space, we measured the integration (HH) level of each space in relation to the all museum (Figures 4a and 4b).

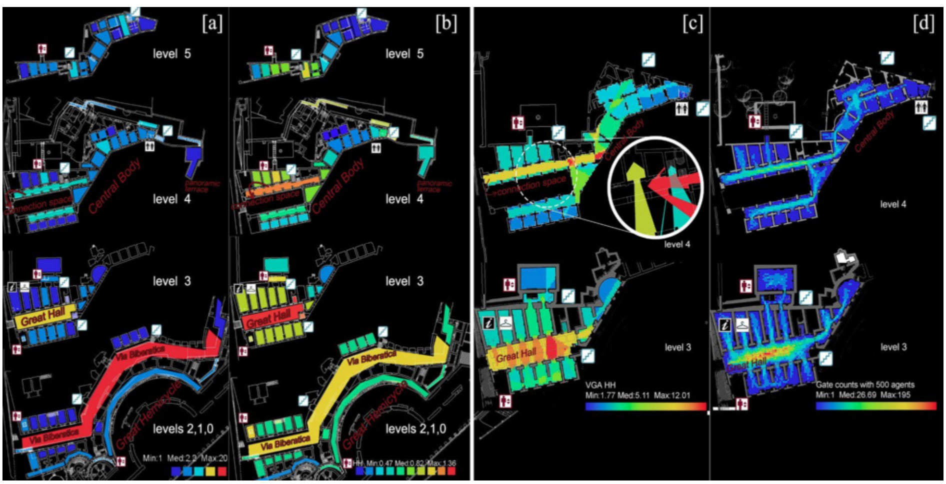


Figure 4. a) analysis of connectivity; b) analysis of the spatial integration (HH); c) analysis of visibility level; d) analysis of flows through agents.

The software rendered a qualitative visualisation of the results, marking the most connected spaces in red (and the best integrated ones by the same chromatic scale) and the most isolated spaces in blue. Based on connections number, as shown in Figure 4b, the outdoor of Via Biberatica appears the main access way to most rooms. However, it is not accessible to wheelchairs due to the irregular ancient basalt paving, as detected in the direct observation (Figure 3). Although hardly walkable with reduced mobility, Via Biberatica is still enjoyable from the upper view on level 4, thus giving an indirect visual access to the layout.

Observing Figure 4b, the best integrated space in relation to the all museum is the Great Hall, which is a key function as a reception hall, but also as "pivotal space" of access to different rooms through the least number of passages. The rooms of the Central Body at level 4 are not really connected and integrated. However, they help access the outdoor of Giardino delle Milizie, the panoramic terrace and the outdoor route that connects to Great Hemicycle at level 1. This step is therefore essential for "closing" a loop route that would positively impact on all the visiting areas, without coming back to the start point.

For the second session of analysis on visual access, the space was discretized into a grid of points from which we calculated the visual integration, i.e. the largest number of mutually visible points (Figure 4c). Finally, a flow analysis was carried out based on 'agents' (entities that, basing on the visibility of the grid points, make decisions statistically like human behaviour) able to simulate flows inside spaces (Figure 4d).

In this case we noted that the environments with better visibility and more likely to be visited are once again the Great Hall and the connection space on the upper level. The linear sequence of some passages through the rooms of that level makes a number of visual "corridors", which suggest route guidance to visitors. These "intuitive" routes, as observed during direct survey, especially when next to the points of direction change, would need an implemented communication through a wayfinding system (signs, devices, environmental clues, etc.) able to disclose a coherent sequence of the exhibition rooms and a clear relationship between the different rooms. Moreover, this system should include an implemented reachability of the Central Body's rooms. These resulted less connected and less visible for the purpose of a circular visit route, which, while crossing the outdoors, would go back to the Great Hall entrance (Figure 4a).

3. Analysis results and routes suggestions

The two analyses were carried out in different periods and objectified some crucial issues for the full use of the museum, suggesting potential values to address solutions. To overcome the "criticality" of spatial configuration, which detected a poor connection and visibility of the rooms in the Central Body, we need to implement the overall information system through multisensory solutions and specific direction signage once you reach the second level of the Great Hall (which appears to be the second most integrated space). This is advisable due to high heritage constraints that do not allow design remodelling. Thus, to increase environmental communication, information totems should be used. Configurational analysis to identify highly visible points can facilitate strategic points for installations. To date, as observed in the direct analysis (Figure 4b), information are located in the staircase wall; however, as observed in the analysis of the "2D isovists" (i.e. the polygons formed by all the points visible from a given observation point), these would be more visible if located next to the parapet in front of the staircase, so to be visually accessible among all visitors going up/downstairs and using the lift. The final segment of the current visiting route ends with the last rooms of the Central Body, through which the visitor can walk downstairs back to the Great Hemicycle. This connection, however, could not be inclusive of visitors with reduced mobility. Therefore, installing a new lifting system in harmony with heritage constraints is advisable for inclusive use. This installation would also normalise a visit experience with no hassle for visitors with reduced mobility, who currently have to cover the route back to one of the two lifts. Generally, to implement an inclusive wayfinding system, we need to increase the environmental communication level. To allow all visitors a faster and intuitive understanding of personalised visiting routes, the strategy is information reverberation through a communicative approach able to convey information through multiple sensory channels, also through innovative sensory materials [13], reversible devices and technical solutions with minimal impact on the museum. Based on three most common scenarios of heritage constraints for potential installations, we assume three strategies, sorted by increasing impact, as a reference for proper space transformability.

a) Spaces with valuable features.

Adopting minimal strategies, i.e. with a low-cost budget, by upgrading an existing wayfinding system or traditional signage with reversible solutions, or replacing old signage with "light" artefacts. These are cognitively more intuitive and can communicate information through multisensorial channels.

b) Spaces with more flexible options.

Strategies with no prejudice to pre-existence. This implies an overall reconfiguration of the wayfinding system by interactive devices and technologies, also including innovative materials (sensorial, nanotechnology materials, etc.).

c) Spaces with more options of design solutions.

Redesigning of the wayfinding system with a consistent layout remodelling. This comes along with the interior design, the environmental (lighting, ventilation, etc.) systems, the finishings and the multimedia (sound, optical effects, etc.).

4. Conclusions

The two applied analysis and evaluation methodologies of crucial issues for usability helped for a deeper knowledge of the museum in order to evaluate common impact factors and to identify better layout of flows and routes. This appears to be a positive approach for visitors and museum managers in implementing cultural content, reducing stress factors, promoting inclusion, hospitality and safety in the museum through an overall visitors satisfaction, as well as scheduling personalised visiting routes and optimising resources. Indirect analyses on spatial syntax study are complementary to common direct analysis tools of designers and evaluators of large museums (check-lists). To complete the evaluation of all relevant usability factors, the next development of this research would provide further effective information directly from end users through common methodologies (Post Occupancy Evaluation, user experience, etc.) that record how visitors perceive the space and its communicative features. The result of integrated observation/detection systems (direct-analog and indirect-digital) determines a valuable observational/scientific knowledge that stimulates collaborative work and dialogue among institutions, experts and stakeholders from the heritage management. This allows defining shared policies and action. The data obtained (interactive, updatable and proactive) should support decision-making and governance processes to identify alternative solutions, strategies, actions and planning of large museums.

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